UNIVERSITY OF Miami

Tarek M. Khalil
Dean

M E M O R A N D U M

May 11, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Response to Memoranda of 4/28/95

The interdepartmental M.S. Program with concentration in Medical Informatics is organized as an interdepartmental program under the auspices of the Graduate School's interdisciplinary and interdepartmental programs. The title modification of the M.S. concentration in Occupational Ergonomics and Safety is proposed for an existing interdepartmental concentration. As approved by the Senate and Board of Trustees in 1975, the Graduate Council is empowered to act on interdepartmental and interdisciplinary programs.

The change of the title for the Ph.D. program in Ergonomics to "Ergonomics and Human Factors" was sent to the College of Engineering for approval. Once this approval is received, we will forward it to the Senate for consideration of the change.

TMK/msb

cc: Dr. Luis Glaser
Dr. Bernard Fogel
Dr. Robert Rubin
Dr. Lewis Temares
Graduate Council

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

UNIVERSITY OF Miami

FACULTY SENATE
2 1995

CDFHI

MEMORANDUM

April 17, 1995

TO: *Dr. Sara Czaja*
Department of Industrial Engineering

FROM: *Tarek M. Khalil, Dean*
The Graduate School

SUBJECT: *M.S. in Occupational Ergonomics and Safety*

Graduate Council approved unanimously the change of name of the Interdepartmental Program in Occupational Ergonomics and Safety to the more general title "Masters of Science in Ergonomics and Human Factors" while retaining the concentration in Occupational Ergonomics and Safety. The title of the Ph.D. program (in Ergonomics), was also approved to be expanded to Ph.D. in Ergonomics and Human Factors.

Congratulations and best wishes.

TMK:nb

Copy to: *Dr. Shihab Asfour, Industrial Engineering*
Dr. Elsayed Abdel-Moty, Industrial Engineering
Dr. Earl Wiener, Management Science
Dr. Rodney Wellens, Psychology

Graduate School
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Coral Gables, Florida 33124-2220
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UNIVERSITY OF MIAMI
DEPARTMENT OF INDUSTRIAL ENGINEERING

MASTER OF SCIENCE IN
ERGONOMICS AND HUMAN FACTORS

Objective

*The objectives of this multidisciplinary program are to prepare students from various disciplines for careers in human factors and ergonomics, and to meet the demands and challenges of modern industry, government, military, healthcare and service organizations. The degree is given through the Department of Industrial Engineering, but is multidisciplinary and involves faculty from the Departments of Psychology, Management Science, Management, Biomedical Engineering and Epidemiology. Thus students from disciplines other than Engineering (but not excluding) are encouraged to apply. Furthermore, students will be encouraged to take course work in various departments, including psychology, management science, management, and epidemiology. The program is designed to be flexible so as to allow students, as advised by their mentors, to pursue a course of study tailored to their needs, interests, and occupational aspirations. The program offers two tracks: a thesis and a non thesis option.

Admission and Program Requirements

*The thesis option will include 30 semester credit hours of course work in the areas of ergonomics and human factors, 6 hours of which are thesis credits. An oral examination in defense of the thesis will be required.
* The non thesis option will include 36 semester credit hours of course work in the areas of ergonomics and human factors, 3 hours of which are a Master's project.
*Applicants are required to hold a Bachelor of Science degree in a field of science, engineering or technology related to human factors.
*Applicants must meet the regular admissions criteria of the Graduate School, which includes a 3.0 GPA and a minimum score of 1000 on the verbal and quantitative portion of the GRE.
*The student must maintain a grade of "B" or better in all core courses.
*The program will be administered by a program committee.
*Upon admission the student will be assigned a faculty mentor who will be responsible for the student's advisement and in most cases will serve as the thesis advisor. The program committee will select the faculty mentor in accordance with the interest of the student.

Minimum Prerequisites for Applicants

*Calculus
*Probability and Statistics
*Physics or Statics

Financial Assistance

*Assistantships are available through the Department of Industrial Engineering, Department of Psychology, and the Department of Management Science.

Program Description

Core Course Requirements

IEN 551 Accident Prevention Systems
IEN 557 Ergonomics and Human Factors Engineering
IEN 612 Design of Experiments or Equivalent (MAS 603 or PSY 630 and PSY 631)
IEN 656 Human Information Processing and Design
IEN 657 Ergonomics and Occupational Biomechanics
IEN 710 Master's Thesis (6 hrs.) or IEN 694 Master's Project (3 hrs.)

Suggested Electives (9 credits required for thesis option or 12 credits for non thesis option)

IEN 651 Advanced System Safety
IEN 658 Ergonomics and Special Populations
IEN 558 Industrial Hygiene I
IEN 559 Industrial Hygiene II
IEN 659 Work Physiology
EPH 521 Fundamentals of Epidemiology
MAS 602 Applied Multivariate Statistics
MAS 606 Non-Parametric Statistics
MAS 641 Operations Research Models in Management
MGT 651 Behavior and Organizational Systems
PSY 605 Psychophysiology
PSY 606 Psychobiology
PSY 610 Behavioral Medicine
PSY 625 Social Psychology
PSY 632 Multiple Regression and Multivariate Statistics

Program Committee

Dr. Shihab Asfour
Professor of Industrial Engineering

Dr. Abdel-Moty
Research Associate Professor of Industrial Engineering

Dr. Sara J. Czaja
Professor of Industrial Engineering

Dr. Earl Wiener
Professor of Management Science

Dr. Tarek Khalil
Professor of Industrial Engineering

Dr. Rodney Wellens
Chair and Professor of Psychology

UNIVERSITY OF Miami

FACULTY SENATE

CDEHI

MEMORANDUM

TO: Dr. Tarek M. Khalil
Dean, Graduate School

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 28, 1995

SUBJECT: Ph.D. Program in Ergonomics

Thank you for your memorandum of April 17, 1995 asking me to bring to the Senate's attention that the Graduate Council approved to expand the title of the Ph.D. Program in Ergonomics to the Ph.D. Program in Ergonomics and Human Factors.

In reviewing the material attached to the above memorandum, I did not find any reference to the approval of this change by the College of Engineering faculty. I believe this is necessary before any such action is taken by the Senate or, for that matter, the Graduate Council. Please advise.

P.S. I also received from your office copies of a similar approval for the M.S. Program in Occupational Ergonomics and Safety. (Memorandum to Professor Czaja dated 4/17/95). Again, I could not find action by the College of Engineering faculty. Please advise.

KY/b

cc: Dean M. Lewis Temares, College of Engineeering

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

CDFH

UNIVERSITY OF Miami

MEMORANDUM

April 17, 1995

TO: Dr. Kamal Yacoub, Chairman
Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Ph.D. Program in Ergonomics

Upon the request of the Faculty Committee of the Ph.D. Program in Ergonomics, the Graduate Council at its April 12th meeting unanimously approved to expand the title of the Ph.D. program in Ergonomics to Ph.D. in Ergonomics and Human Factors. I would appreciate it if you could notify the Senate as you feel appropriate.

TMK:nb
Copy to:
Dr. Sara Czaja
Dr. Shihab Asfour
Dr. Elsayed Abdel-Moty
Dr. Earl Wiener
Dr. Rodney Wellens

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
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Fax 305-284-5441

UNIVERSITY OF Miami

December 12, 1994

Dr. Tarek Khalil
Dean of the Graduate School
210 Ferre Building
Coral Gables Campus

Dear Dr. Khalil:

We recently formed a committee to evaluate the existing interdepartmental Master of Science Degree Program in Occupational Ergonomics and Safety. The committee members consisted of myself, Drs. Khalil, Wiener, Wellens, Asfour, and Abdel-Moty. The committee determined that it would be beneficial to the Graduate Program if we modified the existing Master's program such that the name of the program be changed to Master's of Science in Ergonomics and Human Factors. In addition, the core course requirements would be modified such that the number of core required courses be reduced and the courses reflect a broader focus in human factors and ergonomics. The propsoed program also places an increased emphasis on the advisor-student relationship. Instead of a highly specified curriculum we purpose more "negotiation" between the student and his/her advisor in the selection of courses. The intent of the changes are to appeal to a broader range of students and make the program more flexible. The current emphasis is on occupational ergonomics and this program would not be appealing to students interested in other aspects of human factors such as information processing or human computer interaction. In addition, the program will involve more faculty as the modified program will involve the Departments of Psychology, Management Science, Management, and Epidemiology. The program will be administered through the Department of Industrial Engineering.

We propose that the Master's of Science in Ergonomics and Human Factors serve as the "standard" "umbrella" program and that within this program an additional track is available in "Occupational Ergonomics and Safety" for students who have a specialized interest in this area. This track is already developed within the Industrial Engineering Department.

We also propose that the title of the existing interdepartmental Ph.D. program in Ergonomics be changed to Ergonomics and Human Factors. In addition, we wish to modify the core course requirements of this program so that they are consistent with the proposed MS degree. The rationale for the changes are the same as stated above.

I have enclosed descriptions of both the proposed MS and Ph.D. programs. If you have any questions please feel free to contact me (284-2371).

Sincerely,

Sara J. Czaja

Sara J. Czaja
Professor

Department of Industrial Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0623
Fax: 305-284-4040 • Phone: 305-284-2344 • Telex: UM 519308

UNIVERSITY OF MIAMI
DEPARTMENT OF INDUSTRIAL ENGINEERING

Ph.D. IN ERGONOMICS AND HUMAN FACTORS

Objective

The objectives of this multidisciplinary program are to prepare students with in-depth knowledge in the methodologies and concepts of ergonomics and human factors to meet the demands and challenges of modern industry, government, military, healthcare and service organizations. The degree is given through the Department of Industrial Engineering, but is multidisciplinary and involves faculty from the Departments of Psychology, Management Science, Management, Biomedical Engineering, and Epidemiology. Thus students from disciplines other than Engineering (but not excluding) are encouraged to apply. Furthermore, students will be encouraged to take course work in various departments, including psychology, management science, management, and epidemiology. The program is designed to be flexible so as to allow students, as advised by their mentors, to pursue a course of study tailored to their needs, interests, and occupational aspirations.

Admission and Program Requirements

* It is expected that the student will have a Master's degree prior to enrollment in the Ph.D. program.
* Regulations concerning admissions, residence requirements, qualifying and final examinations, and dissertations as defined by the Department of Industrial Engineering and the Graduate School will be followed.
* The program will be administered by a program committee.
* Upon admission the student will be assigned a faculty mentor who will be responsible for the student's advisement and in most cases will serve as the Chair of the dissertation committee. The program committee will select the faculty mentor in accordance with the interest of the student.

Financial Assistance

Assistantships are available through the Department of Industrial Engineering, Department of Psychology, and the Department of Management Science.

Program Description

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

IEN 551 Accident Prevention Systems
IEN 557 Ergonomics and Human Factors Engineering
IEN 612 Design of Experiments or Equivalent (MAS 603 or PSY 630 and PSY 631)
IEN 656 Human Information Processing and Design
IEN 657 Ergonomics and Occupational Biomechanics

In addition it is expected that the students will have met the prerequisite requirements in

*Calculus
*Probability and Statistics
*Physics or Statics

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

IEN 651 Advanced System Safety
IEN 658 Ergonomics and Special Populations
IEN 558 Industrial Hygiene I
IEN 559 Industrial Hygiene II
IEN 659 Work Physiology
EPH 521 Fundamentals of Epidemiology
MAS 602 Applied Multivariate Statistics
MAS 606 Non-Parametric Statistics
MAS 641 Operations Research Models in Management
MGT 651 Behavior and Organizational Systems
PSY 605 Psychophysiology
PSY 606 Psychobiology
PSY 610 Behavioral Medicine
PSY 625 Social Psychology
PSY 632 Multiple Regression and Multivariate Statistics

The student's mentor and/or dissertation committee may recommend additional courses to suit the student's background and program objectives.

In addition students will be required to complete 12 hours of dissertation credit.

UNIVERSITY OF Miami

FACULTY SENATE

To: Professor Mansur Kabuka, Program Director for Medical Informatics

From: Kamal Yacoub, Chair, Faculty Senate

Date: May 17, 1996

Subject: Program Committee for the M. S. Degree Program in Medical Informatics

In accordance with the Faculty Senate legislation approving the M. S. degree program in Medical Informatics, and in consultation with the appropriate deans, the program committee for the above M. S. program will consist of the following:

Professor Mansur Kabuka	Program Director and Committee Chair, Department of Electrical and Computer Engineering and Department of Radiology
Professor Brian C. Bowen	Department of Radiology
Professor Pradip M. Pattany	Department of Radiology
Professor Mark O'Connell	Department of Medicine
Professor John Collins	Department of Electrical and Computer Engineering
Professor Christos Douligeris	Department of Electrical and Computer Engineering
Professor Ozcan Ozdamar	Department of Biomedical Engineering
Professor Dilip Sarkar	Department of Mathematics and Computer Science
Professor Michael French	Department of Epidemiology and School of Business
Dean of Engineering or Designee	
Dean of Medicine or Designee	

As we informed you at the Senate meeting, the role of the program committee is analogous to that of the departmental faculty vis-a-vis departmental programs. You are expected to call meetings of the program committee at least once every semester. Good luck and best wishes with your new program.

KY/ca

cc: Provost Luis Glaser
Medical Informatics Committee Members
Dr. Robert Quencer, Chair, Department of Radiology
Dr. Tzay Young, chair, Department of Electrical Engineering

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325 Ashe-Admin. Bldg.
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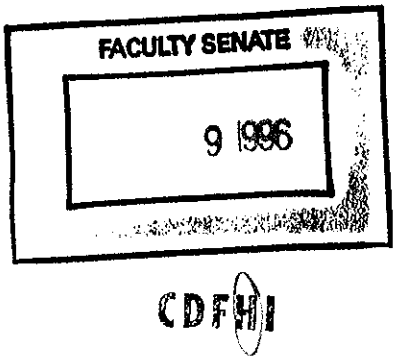
UNIVERSITY OF
Miami



May 3, 1996

Dr. Kamal Yacoub
Chair, Faculty Senate
325 Ashe-Admin. Bldg.
Coral Gables, FL 33124-4634

Re: M.S. Degree Program in Medical Informatics

Dear Dr. Yacoub:

Thank you for your memo dated April 17, 1996 regarding the M.S. Degree Program in Medical Informatics and your request for a nominee from clinical faculty other than Radiology for a Medical School representative on the Oversight Committee. I would like to suggest that you choose one of the following three individuals:

Dr. C. Gillon Ward from the Department of Surgery.
Dr. Jeffrey Augenstein from the Department of Surgery.
Dr. Mark O'Connell from the Department of Medicine.

I have not discussed this with any of them. They have a longstanding interest in medical informatics.

Best regards.

Sincerely yours,

John G. Clarkson, M.D.
Senior Vice President for
Medical Affairs and Dean

JGC:bd

Senior Vice President for Medical Affairs and Dean
P.O. Box 016099
Miami, Florida 33101
305-243-6545 Fax 305-243-4888

CDF

UNIVERSITY OF Miami

COLLEGE OF ARTS AND SCIENCES

Office of the Dean

MEMORANDUM

TO: Kamal Yacoub, Chair
Faculty Senate

FROM: Ross C Murfin
Dean

DATE: May 8, 1996

SUBJECT: M.S. Degree Program in Medical Informatics

Per your request for a representative from the Department of Mathematics and Computer Science to serve on the Medical Informatics oversight committee, I, and the department chair, recommend Dilip Sarkar, associate professor of computer science. Prof. Sarkar can be reached at 284-2575.

pc: Alan Zame, Chairperson
Dilip Sarkar, Associate Professor
Department of Mathematics and Computer Science

P.O. Box 248004 • Coral Gables, Florida 33124-4620 • 305-284-4117 • Fax: 305-284-5637

CDFHI

UNIVERSITY OF Miami

MEMORANDUM

DATE: April 25, 1996

TO: Dr. Kamal Yacoub, Chair, Faculty Senate

FROM: Dr. M. Lewis Temares

RE: M.S. Degree Program in Medical Informatics

Dr. Ozcan Ozdamar has agreed to serve on the oversight committee for the M.S. Program in Medical Informatics as the representive from the Department of Biomedical Engineering. He can be reached at 284-2136.

MLT:fc

cc: Barbara L. Hoadley

College of Engineering
Office of the Dean
P.O. Box 248294
Coral Gables, Florida 33124-0620
Phone: 305-284-6035
Fax: 305-284-3815
mtemares@umiamivm.ir.miami.edu

UNIVERSITY OF
Miami

FACULTY SENATE

MEMORANDUM

TO: Dr. John Clarkson, Senior Vice President for Medical Affairs and Dean
Dr. Ross Murfin, Dean, College of Arts and Sciences
Dr. Paul Sugrue, Dean, School of Business Administration
Dr. M. Lewis Temares, Dean, College of Engineering

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 17, 1996

SUBJECT: M.S. Degree Program in Medical Informatics

The Faculty Senate, at its meeting of April 1, 1996, approved an interdepartmental M.S. Program in Medical Informatics sponsored by the Department of Radiology of the Medical School and the Department of Electrical and Computer Engineering of the College of Engineering. The Program will be administered through the Department of Radiology and will have a program oversight committee consisting of the following representatives: Professor Mansur Kabuka, Department of Electrical and Computer Engineering and the Department of Radiology (Program Director); Brian C. Bowen, Department of Radiology; Pradip M. Pattany, Department of Radiology; Professor John Collins, Department of Electrical and Computer Engineering; Professor Christos Douligeris, Department of Electrical and Computer Engineering; Dean or Representative, School of Medicine; Dean or Representative, College of Engineering.

In addition, the Senate approved enlarging this oversight committee to include the following four department/school representatives appointed by their respective deans.

1. Department of Biomedical Engineering
2. Computer Science Program, Department of Mathematics and Computer Science
3. School of Business
4. Medical School (clinical faculty other than Radiology)

Please inform the Senate of your selection to fill the above (highlighted) position. The Senate will in turn inform the Program Director of your choice.

cc: Dean Tarek Khalil, Graduate School
Dr. Mansur Kabuka, Program Director
Dr. Robert M. Quencer, Department of Radiology
Dr. Tzay Young, Department of Electrical & Computer Engineering

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UNIVERSITY OF
Miami
FACULTY SENATE

MEMORANDUM

TO: President Edward T. Foote II

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 12, 1996

SUBJECT: Faculty Senate Legislation #95008(B) -
Establishment of the M.S. Degree in Medical Informatics

The Faculty Senate, at its meeting of April 1, 1996, voted to approve the M.S. Degree in Medical Informatics (FS #95008(B). The text of the legislation is attached for your review.

This legislation is forwarded to you for your action.

KY\b

Attachment

cc: Provost Luis Glaser
Dean Tarek Khalil, Graduate School
Dean John Clarkson, School of Medicine
Dean Lewis Temares, College of Engineering
Professor Mansur Kabuka, Engineering and Radiology

4/11/96

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
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Fax 305-284-5515

Approval of the Minutes

The minutes were corrected by substituting "...transcripts show that the degree was formerly awarded by the College of Arts and Sciences" in the fourth line of page 3. The minutes were approved as corrected. Excused absences were approved for Professors Brown, Criss, Fishman, Lopez-Gottardi, Peterson, Savage, Swain, Varona and Whelan.

M.S. Program in Medical Informatics (Second Reading)

The Chair reviewed the background of the proposal for the M.S. in Medical Informatics and the two additional requirements set by the Senate. Information on the enlarged oversight committee and the two new core courses was included with the agenda. It was *moved* and seconded to approve the program. The *motion carried.*

Following the vote, there was discussion regarding the evaluation of new graduate programs. It was *moved* and seconded to have the Provost report back to the Senate in three years on the status of new programs, after consultation with the Graduate School. The *motion carried* by a vote of 23 in favor and 7 opposed. It was suggested that the Chair request the Dean of the Graduate School to inform the Senate of the results of every review which takes place.

Uniformity in Employee Benefits

Mr. David Lieberman, Senior Vice President, spoke about an apparent contradiction between the *Faculty Manual* and actual practice concerning the fringe benefits enjoyed by the Medical School clinical faculty. Clinical faculty dependent tuition and clinical faculty enrolled in the UM Care plan, particularly the out-of-network benefit, are the main issues of concern. Mr. Lieberman presented the following questions for examination over the summer: "1) Is this an employee benefit, or is it simply a component of salary increase? 2) Are the revenues which fund this in fact sufficiently unique from other University revenues that it can be concluded that this use is appropriate? 3) Can and should this arrangement be restructured to take it outside the University; and if so, what are the ramifications of so doing--is it a precedent we want to set, or should we simply not care what a group of faculty do with their salaries? 4) Can or should the arrangement be changed but with the understanding that if a department wants to provide additional salary for an agreed-upon purpose, it's acceptable? The present system is probably more formal. It certainly results in cross-subsidization, but a different system might be more decentralized, more discretionary. 5) Should a similar opportunity be extended to other faculty, administrators, and staff? The utilization and costs would be more difficult to predict, but if the utilization rate were the same as that of clinical faculty, it could cost 3-4% of salaries, that we'd have

UNIVERSITY OF Miami
SCHOOL OF MEDICINE

Department of Radiology (M-812)
Center for Medical Imaging
and Medical Informatics
Professional Arts Center, Suite #301
1150 N.W. 14th Street
Miami, Florida 33136-2116
Tel: 305-243-7630
Fax: 305-243-7633

MEMORANDUM

Date : 3/14/96

To: Ad Hoc Committee on Medical Informatics
Professor Mark O'Connell, Department of Medicine
Professor Ozcan Ozdamar, Department of Biomedical Engineering
Professor Dilip Sarkar, Department of Mathematics and Computer Science

From: Mansur R. Kabuka

Subject: Master of Science Program in Medical Informatics

I want to thank you for your contributions to the above program proposal and your thoughtful report. The Faculty Senate at its meeting on February 26,1996 discussed the above proposal and your committee's report as part of its first reading. At the end of this discussion, a motion was made to bring this proposal back for a second (and hopefully final) reading with two modifications :

1- An enlarged program committee
2- Outline of new core courses

Attached is the proposed enlarged program committee and outlines of the new core courses RAD604 and RAD608. I hope you find these modifications to the proposal satisfactory.

Again , thank you for your help and cooperation.

Attachment

cc: Dr Kamal Yacoub, Chair, Faculty Senate

ADDENDUM
TO THE
PROPOSAL FOR A
MASTER OF SCIENCE DEGREE IN
MEDICAL INFORMATICS

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiology.
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineering.
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineering.
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

Faculty members from the following departments or schools as appointed by their respective deans:

- Biomedical Engineering
- Computer Science (Department of Mathematics and Computer Science)
- Business
- Medicine (Clinical Departments outside Department of Radiology)

The program Committee will be responsible for academic aspects of the program such as curriculum, admission standards, approval for graduation and, student petitions. The committee will be chaired by the Program Director who will be responsible for administration of the program.

RAD 604

Medical Informatics

Course Description

Computer applications in health care, hospital information, information management, radiology, patient monitoring, decision support, pharmacy, and laboratory information. Hardware and software issues, security, and standards. Ethical and social issues in medical informatics.

Textbook

Edward Shortliffe and Leslie Perreault, Medical Informatics, Addison-Wesley, 1990.

Topics

1. Medical Informatics
2. Medical Data: Its acquisition, storage, and use
3. Clinical decision-support
4. Essential concepts for medical computing
5. Patient monitoring
6. Hardware and software
7. Medical Information Systems:
    - Hospital information systems
    - Laboratory information systems
    - Pharmacy systems
    - Radiology systems
    - Clinical decision support systems
    - Medical record systems
    - Health assessment systems
8. Standards
    - Health Level Seven (HL7)
    - Digital Imaging and Communication in Medicine (DICOM)
    - International Classification of Diseases (ICD-9-CM)
    - Common Object Request Broker Architecture (CORBA)
9. Security and privacy
10. Ethical and social issues in medical informatics

RAD 608

Computer-Based Medical Records

Course Description

Survey of existing Computerized Patient Record (CPR) systems. Requirements and procedures for CPR development and implementation. Technological building blocks for CPR systems. Legal aspects of computer-based patient records and record systems.

References

1. Richard Dick and Elaine Steen, The Computer-Based Patient Record, National Academy Press, 1992.
2. Computer-Based Medical Systems, Proceedings of the IEEE Symposium, 1993-1996.

Topics

1. The patient record
2. Strengths and weaknesses of paper patient records
3. The computer-based patient record technology
4. Clinical assessment
5. Software issues and software quality
6. CPR development and implementation
7. Integration of clinical data
8. Legal aspects of CPR

A New Graduate Program in Medical Informatics

Professor Mansur Kabuka presented the proposal for M. S. degree in Medical Informatics. Dr. Ozcan Ozdamar discussed the recommendation of the ad hoc Committee appointed by the Senate Chair to review the proposal. At the end of the discussion, it was *moved* and seconded to accept the first reading of the proposal with the provision that for the second reading, the proposal should show 1) an enlarged program committee, 2) course outline for the new core courses. The *motion carried.*

Undergraduate Major in Elementary Education

Professor Scott Baldwin, Chair of the Department of Teaching and Learning, introduced the request of the Department to reestablish the Bachelor of Science in Education. He informed the Senate that his department was responsible for undergraduate and graduate programs in the area of teacher education. The School began in 1929, and for the last 57 years it has been training teachers for Florida and other parts of the country in an uninterrupted fashion. About 10 years ago the administration decided to deactivate the program. All the students became part of the College of Arts and Sciences and were required to complete a major and fulfill all the general education requirements in the College. In addition, they had to complete the necessary courses for teacher certification. This past summer the Dean of the School of Education informed the Department of Teaching and Learning that the Bachelor of Science in Education was being reactivated. The faculty of the Department of Teaching and Learning appointed a committee to define the general education requirements for the Bachelor Degree in the School of Education. The faculty of the Department first, and the faculty of the School later, approved the general education requirements. The faculty of the Department recommends to reduce the curriculum in the area of arts and humanities and in the social sciences. The faculty wanted to offer a double major degree program comparable to the degree in the School of Communication. Discussion followed about the need of the School of Education to submit a report to the Senate describing what they wish to do. It was agreed to agenda the item for the next Faculty Senate meeting on April 1, 1996.

Learning Center Facilities

Professors de Sylva and Millas spoke on behalf of the faculty who teach in the Learning Center Facilities. They reported on the meeting to discuss the conversion of the LC facilities held by the faculty on December 14, 1995. Vice Provost John Masterson stated that he had agreed to identify the specific problems the conversion was causing and solve them.

Report to the Faculty Senate on a Proposal for a M.S. Program in Medical Informatics

From: Ad hoc committee on Medical Informatics
Ozcan Ozdamar, Ph.D., Dept. Biomedical Engineering, Chairperso
Mark O'Connell, M.D., Dept. Medicine
Dilip Sarkar, Ph.D., Dept. Mathematics and Computer Science

Date: February 14, 1996

We strongly endorse the development of a post-graduate degree program in medical informatics at the University of Miami and we unanimously recommend the faculty senate approve the proposed program with the following changes. We feel these changes would strengthen the program and help ensure its success in coming years.

1. The program described on page 14 of the proposal is composed of professors from the departments of electrical and computer engineering, radiology and administrative representatives (dean or designee, ex-officio). As rightfully stated in the proposal, medical informatics is a broad field with an interdisciplinary character and the program committee should reflect this nature. We recommend that representatives from the departments of biomedical engineering, computer science, biostatistics, and clinical departments at the medical school also be included in the program committee.

2. The expanded program committee must meet at least once every semester to review the status of the program and the students in the program.

3. The educational plan for those required core courses not yet in existence must be defined. This effort would greatly benefit from the expanded multidepartmental representation suggested for the program committee.

   We also recognize that the proposed curriculum can be further strengthened by inclusion of relevant courses offered in other departments such as biomedical engineering, computer science, and

biostatistics. We recommend that the expanded program committee closely examine the curriculum and make necessary revisions to include additional relevant courses. Such changes will not only make the program stronger but will increase the efficiency of the university by eliminating redundant courses and increasing enrollment in existing ones.

4. The program should develop a mechanism for quality assessment and improvement. A thorough review of the program's strengths and weaknesses should be completed at the end of each of the first 2 years and provided to the faculty senate.

5. Enrolled students should be provided with comprehensive and aggressive career counseling and develop placement services to ensure their successful progress after graduation. This will obviously enhance the attractiveness of the program for future enrollees.

ADDENDUM
TO THE
PROPOSAL FOR A
MASTER OF SCIENCE DEGREE IN
MEDICAL INFORMATICS

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiolog
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineeri
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineeri
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

Faculty members from the following departments or schools as appointed by their respective deans:

- Biomedical Engineering
- Computer Science (Department of Mathematics and Computer Science)
- Business
- Medicine (Clinical Departments outside Department of Radiology)

The program Committee will be responsible for academic aspects of the program such as curriculum, admis standards, approval for graduation and, student petitions. The committee will be chaired by the Program Di who will be responsible for administration of the program.

UNIVERSITY OF
Miami

MEMORANDUM

DATE: October 4, 1995

TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Bernard J. Fogel, M.D., Dean, School of Medicine
and
Dr. M. Lewis Temares, Dean, College of Engineering

RE: Proposal for a Master of Science Degree in Medical Informatics

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Attached is a proposal for an interdisciplinary Master of Science Degree in Medical Informatics between the Department of Radiology, and the Department of Electrical and Computer Engineering, College of Engineering. This proposal was approved unanimously by the faculty of the Department of Radiology on August 29, 1995, and by the faculty of the College of Engineering and the Council of the School of Medicine on September 27, 1995.

We endorse this proposal, including the proposed annual budget of approximately $105,000. Please initiate the process of getting this proposal approved. We would like to promote this program as soon as possible and have it included in the AY96 University Bulletin.

The program will be administered by the Department of Radiology at the School of Medicine, chaired by Robert M. Quencer, M.D., and by Dr. Mansur Kabuka, Director and Administrator of the program, with an advisory committee of the two deans and two faculty from each school/college. Please contact either Dean Fogel or Dean Temares with any questions on this proposed degree program.

Thank you in advance for your efforts on our behalf.

Attachment
cc: Dr. Luis Glaser
Dr. Samuel S. Lee
Dr. Thomas D. Waite
Dr. Tzay Y. Young
Dr. Mansur Kabuka
Robert M. Quencer, M.D.

Senior Vice President for Medical Affairs and Dean
P.O. Box 016099
Miami, Florida 33101
305-243-6545 Fax 305-243-1888

MEDICAL INFORMATICS M.S. PROPOSAL REPORT

Subcommittee members:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, Meteorology and Physical Oceanography
Dr. E. Saltzman, Marine and Atmospheric Chemistry
Dr. D. Sarkar, Mathematics

The Graduate School's Physical Sciences Committee met with Vice Provost Robert Rubin and Dr. Mansur Kabuka from the Department of Radiology on April 3, 1995 to discuss the proposed Interdepartmental Program leading to an M.S. degree in Medical Informatics. The exchange centered around the proposal for the program put together by the department. Overall, the committee found that the plans for the program were well laid out and that the medical school has a strong commitment to the financial support of this program. The curriculum makes wide use of existing courses and blends the talents of the Engineering School and the Radiology Department in a creative manner.

Comparison of the program's offering with similar programs at other universities were provided in the report. The balance between computer oriented training, data base courses, and introduction to medical sciences mirrors these other programs. Concern was expressed over the requirement of 36 thesis track hours and 39 non-thesis hours in the program. The committee was especially concerned over the extra six to nine hours being a disincentive for students coming up through biomedical engineering or the proposed joint B.S. in Computer Engineering and M.S. in Medical Informatics Program. A suggestion was made to require a "minimum" of 30 hours plus additional course work in the various core areas. This would allow students with prior backgrounds in the core course areas to complete the curriculum while making use of their prior training. A short discussion was also held on future growth in the program. The need for care in tuning courses in this rapidly growing field was acknowledged. It was pointed out that the program may wish to expand to Ph.D. offerings within a three to five year time frame. Dr. Rubin brought up the issue that this program might produce more of a professional degree serving the medical community with M.S. practitioners rather than necessarily growing into a specialty academic field at the Ph.D. level. The committee encouraged the department to return to Council with a short report on the development of the program within two years and looks forward to hearing plans for the longer term goals of this effort.

In summary, the committee enthusiastically supports the new program and wishes it luck in fulfilling its goals over the next few years.

April 12, 1995

Proposal for a Master of Science Degree in Medical Informatics

Department of Radiology
School of Medicine

Department of Electrical
and Computer Engineering
College of Engineering

Hosted by

Department of Radiology

School of Medicine

1. RATIONALE

The rapidly growing knowledge base in the medical field is vast and encompasses both scientific knowledge and the day–to–day business of providing healthcare. To understand the medical user's complex needs, information scientists need formal training in the healthcare environment to implement complicated information science techniques. It is crucial to identify the processes in healthcare which could benefit most from information technology because a broad brush approach could be costly and inhibit progress. Recently, **the Association of American Medical Colleges formed the Steering Committee** to evaluate the status of medical informatics in the United States. The Steering Committee on the Evaluation of Medical Information Science in Medical Education concluded that medical informatics is basic to the understanding and practice of modern medicine. One recommendation of this committee indicates that medical informatics should become an integral part of the medical curriculum.

The World Health Organization report on "Informatics and Telematics in Health" stresses that managerial decision–making in healthcare requires accurate, reliable, relevant, and timely information. It further notes that the health worker of the year 2000 is likely to be a person with immediate access to a large amount of data along with analytical decision support routines to assist in decision making. These needs will require advanced research and development in the areas of database, statistical data analysis, data storage, validation, retrieval, presentation, distribution, decision support systems, knowledge–bases, artificial intelligence and neural networks. Multidisciplinary expertise is required to achieve the essential level of knowledge in these areas.

This proposal develops the offering of a M.S. degree in Medical Informatics. It is in the best interests of the University, the community of the southeast region, and the students that a M.S. degree in medical informatics be established.

The program is designed to prepare individuals to develop, use, and evaluate applications of information technology in the health care environment. The program also stresses the methods used to study the effectiveness of information technology applications.

What is Medical Informatics?

Medical Informatics is the scientific field that deals with medical information, data, and knowledge. It deals with the concepts and principles of acquiring, processing, and presenting information to support medical practice, problem solving and decision making in the healthcare industry. Medical Informatics touches on all basic and applied fields in medical science and is closely related to modern information technologies including computing and communication. Medical informatics has emerged as a new discipline due to a number of factors, including advances in computing and communications technology, an increasing awareness that the medical knowledge base is unmanageable by traditional methods, and a growing conviction that knowledge retrieval and expert decision making are important to modern medicine. Modern technologies enable the capture and organization of medical user requirements. Challenges in developing and using these technologies in healthcare include developing enterprise integration tools to translate information, helping users determine what information they need, and facilitating information flow across the healthcare enterprise. Also, using technology requires developing business modeling techniques to define and analyze the relationships among the different processes in providing healthcare.

Knowledge of computers is a major element of the medical informatics. However, effective research and development in this area also requires practical knowledge and fundamental research in cognitive science, clinical medicine, basic medical sciences, biostatistics, epidemiology, hospital organization, hospital financing and reimbursement, management and decision sciences, and medical ethics. In such an interdisciplinary field, students must be exposed to these diverse topics.

Medical informatics spans a wide range of activities that includes, but is not limited to:

(1) basic research and exploratory experiments
(2) applied research and evaluation of approaches
(3) technological development for specific user needs
(4) deployment of practical applications
(5) planning and policy development for using information technology in health care and medical education

Medical Informatics Education

A recent study by Gassert et al (1991)* indicated the increased demand for graduate level education in medical informatics. The results of a survey of accredited hospitals of 300 beds or more in 19 states demonstrated that all institutions use computer technology in healthcare practice and/or administration. Almost three–fourths of the hospitals already allocate one or more budgeted positions for managers of information systems. An additional 50% of the respondents foresaw a need for such positions in their institutions within two years. Virtually all respondents saw some need for a graduate program.

Currently, the number of graduate medical informatics programs (M.S. and Ph.D.) nation wide is limited. Although academic units of medical informatics are established at only a few institutions in the United States, an increasing number of schools is considering this activity.

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* Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC.

The following is a partial list of the medical informatics programs available in the United States:

1. Columbia University: Post–Doctoral training program in Medical Informatics

2. Duke University/University of North Carolina: MS, PhD, and Post Doctoral programs in Medical Informatics

3. Harvard University/Massachusetts Institute of Technology/New England Medical Center: MS, PhD, and Post–Doctoral program in Medical Informatics

4. Stanford University: MS, PhD, and Post–Doctoral program in Medical Information Science

5. University of Missouri: MS in Library and Information Science, PhD in Medical Informatics, Post–Doctoral program in Medical Informatics, and short term (3–6 months) training for medical and veterinary students

The proposed program within the University of Miami would provide individuals with the skills and expertise needed for applying the concepts and knowledge of medical informatics in healthcare and academic medical research, development, and education. The proposed program will offer degrees to individuals with career commitments to applying computer engineering and related disciplines to the field of medicine. The University of Miami is well poised to offer new programs in Medical Informatics at the graduate level. This program will have a strong core curriculum in computer engineering, as well as concentrations in biological and physical sciences. The strengths of the Medical School in these areas will differentiate the University of Miami from other regional universities such as Florida International University and Florida Atlantic University. This will provide a significant leverage in attracting quality students to the program. In addition, the program will have the unique opportunity to draw upon the resources of the Medical School to offer significant exposure to research and applications in medicine. **In addition, currently no graduate programs in medical informatics exist in Florida, while only a few exist in the nation. The university will have a tremendous edge for attracting students by being the first to offer such a program in the state, as well as the advantage of being closely associated with a renowned medical school.**

Rationale for Success

The ability to introduce a new program in medical informatics successfully arises from the following factors:

(1) As mentioned earlier, no universities in Florida, and only a few in the nation, offer graduate programs in medical informatics.

(2) Industry partners involved with current research and development work are interested in establishing co–op programs in the new program areas.

(3) State–of–the–art laboratories exist at the University, both at the School of Medicine and on the Coral Gables campus, and are great incentives for attracting students.

(4) Existing courses, as well as courses under development, can be used as part of the curriculum. This presents a tremendous recruiting tool for attracting students interested in medical careers.

(5) The new program will promote interdisciplinary research by providing a natural environment for interaction between faculty from various departments.

1.a Exact Title of Degree

Master of Science Degree in Medical Informatics

1.b Purpose and Goals of Degree

The purpose of the degree is to prepare qualified candidates to serve the needs of the healthcare industry, academic, research and government institutions. The program is designed to provide students with the skills and knowledge required to deal with basic and applied research and development, and the deployment of innovative technologies in the medical fields. In addition, the program will allow students to pursue their medical education and is designed to accommodate the premedical curricula and medical school admission requirements.

1.c Assessment of Demand and Job Market

The expanding applications of computing techniques into medical environments requires well–trained individuals to design, develop, select, and manage the medical–computing system. Modern developments in healthcare and computer industries dictate the need for skilled personnel to design research programs and carry out the experimental and developmental activities in both industries.

Many computer companies (for example Hewlett–Packard, the world's largest medical equipment maker) have established healthcare groups. According to National Institute of Standards and Technology (NIST), Arnst et al (1994)* estimated that the market of healthcare information systems would reach $13 billion by the year 1998.

The Department of Health and Human Services estimates that a nationwide electronic healthcare information network could provide a savings expected to exceed $100 billion over the next eight years. According to the NIST (1994), healthcare is the fastest growing market in the computer field. It is estimated that hospitals will spend $6.7 billion a year on information systems in 1996, a 36.7% increase over 1993.**

The success of developing these services requires interdisciplinary research and development projects in both healthcare settings and computer industry and demands leaders who can effectively bridge the two fields. The demand for such professionals, with proper training in Medical Informatics, has escalated in recent years in both healthcare and advanced technology industries.

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* Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104–106.

** National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

As mentioned earlier, the survey conducted by Gassert et al (1991) indicated the increased demand for graduate level education in medical informatics. According to Greenes and Shortliffe (1990)* , researchers with formal training in medical informatics are a rare breed. The need for programs that combine medical informatics training with curricula that encompass multidisciplinary areas of expertise, is recognized by many institutions. The increased awareness of the importance of this field of study has been motivated by the efforts of the National Library of Medicine to support these programs. Greenes and Shortliffe indicate that the demand for medical informatics specialists surpasses the supply of skilled professionals.

The proposed program will provide graduates the opportunity to join research facilities in the area of medical information systems. Also, it will enable students to pursue medical education degrees after graduation.

1.d Relationship to Other Cognate Fields

This new program will complement existing biomedical engineering and biomedical activities at the university by expanding its application from biomedical devices to medical information sciences. In addition, graduates will have the opportunity to work as engineers and scientists in medically related fields, or in medical informatics careers. The program also will service the needs of the medical school for candidates who are proficient in computer engineering and science, as these skills become increasingly important for using sophisticated medical equipment and medical computer systems.

* Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority", JAMA, February 1990, Vol 263, No 8.

2. PHYSICAL RESOURCES

2.a Library Holdings

The Otto G. Richter Library and the Medical School Library have a very large collection of materials that are very useful for the programs in medical informatics. Since the medical informatics area are interdisciplinary in nature, the subjects covered are common with several other departments which expand the library holdings and budget allocation by subject area.

A partial listing of journals and periodicals available in medical informatics and related disciplines are given below. No additional journals are needed at this time.

Academic and Library Computing
Acronyms Administration
Advanced Technology Libraries
Advances in Bioengineering
Advances in Biomedical Engineering
AIweek
American Documentation
American Journal of Medical Electronics
AMIA News : Newsletter of the American Medical Informatics Association
Annual Review of Biophysics
Annual Review of Information Science
Applied Artificial Intelligence
ASAIO Journal
ASAIO Transactions
Audiovisual Instruction with/Instructional Resources
Biodegradation
Biomedical Communications
Biomaterials, Artificial Cells
BIOSIS
Biomaterials, Medical Devices
Biomedical Engineering
Biomedical Instrumentation
Biotechnology
Biotechnology and Bioengineering
Biotechnology Letters
Bulletin of Prosthetics Research
Byte
Campus–wide Information Systems
Chemical Journals Online Bulletin
Clinical Physics
Computers and Biomedical Research
Computers and Medicine
Computers in Biology and Medicine
Computers in Libraries
Computers in Eyecare Ophthalmology
Electronic Library

Eyecare Technology Ophthalmology
Human Factors
IEEE Engineering in Medicine and Biology
IEEE Transactions on Biomedical Electronics
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Systems, Man, and Cybernetics
IEEE Transactions on Medical Imaging
Information, News, Sources
Information Retrieval & Library
Interactive Healthcare Newsletter
International Journal of Bio–medical Engineering
IRE Transactions on Medical Electronics
ISI Online News
ISA Journal
Issues in Science and Technology
Journal of the American Medical Association
Journal of Biocommunication
Journal of Biomechanics
Journal of Biomedical Materials
Journal of Cardiovascular Diagnosis
Journal of Cardiovascular Techniques
Journal of Documentation
Journal of Clinical Engineering
Journal of Fermentation Technology
Journal of Medical Engineering
Journal of Rehabilitation Research
Journal of Rehabilitation Research and Development (clinical supplement)
Library Network/MEDLARS
M.D. Computing
MacUser
Medical & Biological Engineering
Medical Instrumentation
Medical Research Engineering
MEDLARS/Network Technical Bulletin
MedLink Archives
Methods of Information in Medicine
Modern Trends in Biomechanics
NLM Technical Bulletin
Online Libraries and Microcomputer
Physicians Video Guide
Physiological Measurement
PsycInfo News
Weekly Government Abstracts. Bi Reference
Trends in Biotechnology

2.b Laboratory Facilities

Image Processing and Multimedia Laboratory

The Image Processing and Multimedia Laboratory provide the ultimate environment for both research and development in the fields of image processing, scientific visualization, and multimedia applications. The hardware offered by the lab consists of numerous Sun SPARC 10 end user graphical workstations, PC's, a Sun 690 file server, a Sun SPARC 1000 file server and various peripherals, such as color printers, postscript printers, slide maker, optical disk jukeboxes for massive storage, etc., all connected to a high speed FDDI network. Most of the end user workstations are equipped with microphones and video cameras for use with multimedia applications. Software tools used in the laboratory include: Khoros, AVS, Ptech, Ontos, MathLab, and various software libraries to support the research and development of algorithms in image processing, visualization, video editing, multimedia, and advanced networking like ATM and ISDN, necessary to support distributed multimedia applications.

Medical Informatics Laboratory

The Medical Informatics Laboratory (MIL) provides the client/server computing foundation required to support the medical information and imaging functions for the Center for Medical Imaging and Medical Informatics (CMIAMI). MIL is composed of several Sun SPARC 1000 servers with multiprocessor capabilities, four to eight processors, and 150 GB of fiber channel attached hard disk drives. The servers are intended to provide heavy computing services for both teaching and research applications. In addition, these servers allow the access of medical images for analysis and diagnosis purposes as well as supporting database servers for the development of medical information system applications. The MIL contains several Sun SPARC 5 and SPARC 20 workstations with multi–monitor support (1,2,4, or 8 monitors). These workstations play the client role in the computing environment of the MIL. They function as the gateway for accessing the 2D & 3D imaging capabilities and the medical information system for both research and development purposes.

Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy Laboratory

The Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) Laboratory located at the MRI building houses three whole body MRI systems, 1.0T HPQ and 1.5T HPQ clinical scanners, a 1.5T Edge Research Scanner to be used for basic MR research and advanced clinical research.

Computed Tomography, X–Rays, and Ultrasound Laboratory

The Computed Tomography, X–Rays, and Ultrasound Laboratory has 5 CT scanners, 6 fluoro–machines, 3 vascular laboratories, 1 neuro–suite and 8 c–arms, in addition to a large number of mammographic general–purpose and mobile x–ray machines.

Nuclear Medicine Laboratory

The Nuclear Medicine Laboratory of the University of Miami School of Medicine/Jackson Memorial Medical Center is equipped with one triple head SPECT camera, 2 dual head SPECT cameras, 2 single head SPECT camera, 7 stationary camera and 2 mobile systems. All cameras are networked. Also available are counting devices and a radio–pharmacological preparation laboratory.

Other Laboratories

Software Engineering Laboratory
Digital Signal Processing Laboratory
Computer Aided Engineering Laboratory
Microprocessor Laboratory
Electronics and Measurement Laboratory
Telecommunication and Networking Laboratory
Other Laboratories on Coral Gables Campus

3. CURRICULUM

The proposed program curriculum is designed to reflect the broad, interdisciplinary field of medical informatics. This program is offered by the School of Medicine in conjunction with the College of Engineering. It stresses both the basic sciences of medical informatics and the practical knowledge necessary to design and implement computer applications and modern information technology in the medical field.

The program offers both a 30 credit hour thesis option (including 6 credits thesis work), as well as a 36 credit hour non–thesis option. The program consists of a core of four courses (listed below) and two groups of courses A and B (also listed below). Each student must take the four core courses as well as two courses from Group A and two courses from Group B. All pre–requisites for all courses must be satisfied (see Graduate Bulletin). In addition, students selecting the thesis option must complete 6 credits of thesis work. Students selecting the non–thesis option must complete an additional four courses selected from Group A and/or Group B and/or the group of courses listed under elective courses.

Students lacking the appropriate computer background need to makeup for this deficiency by taking the appropriate courses from the courses listed under deficiency courses. Students who had any of the courses as part of their undergraduate program should make appropriate substitution to meet the credit requirements.

Required courses: (all students, thesis/non–thesis)

RAD 604 Medical Informatics
RAD 608 Computer–Based Medical Records
EEN 592 Medical Imaging / RAD 510 Medical Imaging
EPH 502 Biostatistics II or EPH 6xx Clinical Research

Group A (6 credits minimum)

EEN 512 Object–Oriented Software Engineering
EEN 523 Principles of Database Systems (Project: Database Management of Medical Applications)
EEN 537 Principles of Artificial Intelligence (Project: Artificial Intelligence in Medicine)
EEN 547 Expert Systems
EEN 621 Object–Oriented Database Systems
EEN 534 Computer Communications Networks

Group B (6 credits minimum)

BME 501 Unified Medical Science I
BME 502 Unified Medical Science II
PHS 512 Systemic Physiology
CBA 505 Neuroanatomy
RAD 505 Anatomy and Physiology: Diagnostic Imaging Prospective
BMB 506 Fundamentals of Biochemistry and Molecular Biology
BMB 508 Biochemistry and Molecular Biology Lab
BMB 509 Molecular Biology of the Gene I
MIC 501 Medical Microbiology
MIC 524 Microbial and Molecular Genetics
MIC 612 Pathobiology I

Deficiency Requirements

EEN 118 Introduction to C and Software Engineering
EEN 317 Engineering Data Structures in C++

Elective Courses (including but not limited to):

RAD 500 Diagnostic Physics
RAD 501 Nuclear Medicine Imaging
RAD 601 MR Imaging / MR Spectroscopy
RAD 602 CT Imaging / X–Rays / Ultrasound
RAD 651 Special Problems in Medical Informatics
EEN 538 Introduction to Digital Image Processing
EEN 548 Machine Learning
EEN 591 High–Speed Networking
EEN 597 Neural Networks
EEN 653 Pattern Recognition
EEN 656 Information Theory
BME 511 Clinical Engineering
BME 580 Biomedical Instrumentation
BME 622 Biomedical Signal Processing
MTH 529 Computer Graphics

Admission

Admission of a student to the University of Miami for any semester does not imply that such student will be re–enrolled in any succeeding academic semesters. All those wishing to take courses for graduate credit, whether or not they wish to become candidates for the degree, must submit an application for admission directly to the program director at:

University of Miami,
Department of Radiology
1150 N.W. 14th Street, Suite 301
Miami, Fl., 33136

This graduate program is open to persons with a background in computer science, chemistry, physical science, biology, mathematics, or engineering

The applicant's file includes:

(1) Completed application form
(2) Official transcript of all college work previously taken
(3) Official score report of the Graduate Record Examination (GRE) taken within five years
(4) Three letters of recommendation sent directly to the department
(5) Official score report of the Test of English as a Foreign Language (TOEFL) for any international applicant whose native language is not English
(6) Application fee of $35.00

Fellowships, tuition scholarship, and assistantships in research or instruction are available for qualified students.

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiology.
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineering.
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineering.
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

The program Committee will be responsible for academic aspects of the program such as curriculum, admission standards, approval for graduation and, student petitions. The committee will be chaired by the Program Director who will be responsible for administration of the program.

5. BIBLIOGRAPHY

Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104–106.

Association of American Medical Colleges,. "Medical Education in the Information Age," Proceedings of a Symposium on Medical Informatics, Washington D.C., 1986.

Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC

Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority," JAMA, February 1990, Vol 263, No 8.

National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

World Health Organization, "Informatics and Telematics in Health: Present and Potential Uses," Geneva, 1988.

FIVE-YEAR PROFORMA: GRADUATE PROGRAM IN MEDICAL INFORMATICS
UNIVERSITY OF MIAMI SCHOOL OF MEDICINE

25-Sep-95

First year expenses/Department of Radiology:

Program Faculty	Base salary	Effort	Program Cost	Program Incremental Cost
Kabuka, Mansur; Director		25%		0
Bowen, Brian		10%		0
Fishman, Joel		10%		0
Georgiou, Michalakis		10%		0
Goodman, Kenneth		20%		7,267
Hussain, Basit		15%		0
John, Nigel		15%		0
Pattany, Fred		15%		0
TBA-teaching		15%		7,500
TBA-teaching		15%		7,500
Younis, Akmal		15%		0
Non-clinical faculty CFB @		26.80%		5,968
Sub-total			138,477	28,235
Administrator	28,000	100%	28,000	28,000
Staff CFB @		27.25%	7,630	7,630
Fellowships: 2	9,000		18,000	18,000
Brochure			6,000	6,000
Clerical, misc. supplies			2,000	5,000
Instruction materials			3,135	3,135
Recruitment			6,000	6,000
Contingency			3,000	3,000
Radiology Sub-total			212,242	105,000

First year expenses/Department of Electrical and Computer Engineering:

Kabuka, Mansur		25%		0
Collins, John		25%		0
Douligeris, Christos		25%		0
TBA		25%		0
		1.0 FTE	64,000	0
Non-clinical faculty CFB @		26.80%	17,152	0
Electrical and Computer Engineering Sub-total			81,152	0

FIVE YEARS EXPENSE (without annual increase) 525,000

REVENUE (also without annual increase)

Yr 1:	10 students; 2 on fellowship =	8	16,000	112,000
Yr 2:	10 incremental students =	18	16,000	288,000
Yr 3:	15 incremental students (1) =	23	16,000	368,000
Yr 4:	20 incremental students (2)=	33	16,000	528,000
Yr 5:	Status quo =	33	16,000	528,000
				1,824,000

(1) 10 students graduated; total students enrolled = 25 students; 2 of which are on fellowship
(2) 35 total students enrolled; 2 of which on fellowship

PLEASE NOTE

The original proposal included resumes for the following U. M. faculty members

Dr. Mansur R. Kabuka; Professor of Computer Engineering and Radiology

Dr. Brian Charles Bowen; Assistant Professor of Radiology

Dr. Pradip M. Pattany; Research Assistant Professor of Radiology

Dr. George N. Sfakinakis; Professor of Radiology

Dr. Christos Douligeris; Associate Professor of Electrical and Computer Engineering

Dr. John Collins; Assistant Professor of Computer Engineering

The full proposal included these resumes and other correspondence forwarded to the members of the ad hoc Committee appointed by the Faculty Senate Chair to review the proposal and send recommendations to the Senate (see first two pages)

The full proposal will be at hand during the Senate meeting

RAD 604

Medical Informatics

Course Description

Computer applications in health care, hospital information, information management, radiology, patient monitoring, decision support, pharmacy, and laboratory information. Hardware and software issues, security, and standards. Ethical and social issues in medical informatics.

Textbook

Edward Shortliffe and Leslie Perreault, Medical Informatics, Addison-Wesley, 1990.

Topics

1. Medical Informatics
2. Medical Data: Its acquisition, storage, and use
3. Clinical decision-support
4. Essential concepts for medical computing
5. Patient monitoring
6. Hardware and software
7. Medical Information Systems:
   - Hospital information systems
   - Laboratory information systems
   - Pharmacy systems
   - Radiology systems
   - Clinical decision support systems
   - Medical record systems
   - Health assessment systems
8. Standards
   - Health Level Seven (HL7)
   - Digital Imaging and Communication in Medicine (DICOM)
   - International Classification of Diseases (ICD-9-CM)
   - Common Object Request Broker Architecture (CORBA)
9. Security and privacy
10. Ethical and social issues in medical informatics

RAD 608

Computer-Based Medical Records

Course Description

Survey of existing Computerized Patient Record (CPR) systems. Requirements and procedures for CPR development and implementation. Technological building blocks for CPR systems. Legal aspects of computer-based patient records and record systems.

References

1. Richard Dick and Elaine Steen, The Computer-Based Patient Record, National Academy Press, 1992.
2. Computer-Based Medical Systems, Proceedings of the IEEE Symposium, 1993-1996.

Topics

1. The patient record
2. Strengths and weaknesses of paper patient records
3. The computer-based patient record technology
4. Clinical assessment
5. Software issues and software quality
6. CPR development and implementation
7. Integration of clinical data
8. Legal aspects of CPR

UNIVERSITY OF
Miami

FACULTY SENATE

To: Professor Mansur Kabuka, Program Director for Medical Informatics

From: Kamal Yacoub, Chair, Faculty Senate

Date: May 17, 1996

Subject: Program Committee for the M. S. Degree Program in Medical Informatics

In accordance with the Faculty Senate legislation approving the M. S. degree program in Medical Informatics, and in consultation with the appropriate deans, the program committee for the above M. S. program will consist of the following:

Professor Mansur Kabuka	Program Director and Committee Chair, Department of Electrical and Computer Engineering and Department of Radiology
Professor Brian C. Bowen	Department of Radiology
Professor Pradip M. Pattany	Department of Radiology
Professor Mark O'Connell	Department of Medicine
Professor John Collins	Department of Electrical and Computer Engineering
Professor Christos Douligeris	Department of Electrical and Computer Engineering
Professor Ozcan Ozdamar	Department of Biomedical Engineering
Professor Dilip Sarkar	Department of Mathematics and Computer Science
Professor Michael French	Department of Epidemiology and School of Business
Dean of Engineering or Designee	
Dean of Medicine or Designee	

As we informed you at the Senate meeting, the role of the program committee is analogous to that of the departmental faculty vis-a-vis departmental programs. You are expected to call meetings of the program committee at least once every semester. Good luck and best wishes with your new program.

KY/ca

cc: Provost Luis Glaser
Medical Informatics Committee Members
Dr. Robert Quencer, Chair, Department of Radiology
Dr. Tzay Young, chair, Department of Electrical Engineering

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305-284-3721
Fax 305-284-5515

CDF

UNIVERSITY OF Miami

COLLEGE OF ARTS AND SCIENCES

Office of the Dean

MEMORANDUM

TO: Kamal Yacoub, Chair
Faculty Senate

FROM: Ross C Murfin
Dean

DATE: May 8, 1996

SUBJECT: M.S. Degree Program in Medical Informatics

Per your request for a representative from the Department of Mathematics and Computer Science to serve on the Medical Informatics oversight committee, I, and the department chair, recommend Dilip Sarkar, associate professor of computer science. Prof. Sarkar can be reached at 284-2575.

pc: Alan Zame, Chairperson
Dilip Sarkar, Associate Professor
Department of Mathematics and Computer Science

P.O. Box 248004 • Coral Gables, Florida 33124-4620 • 305-284-4117 • Fax: 305-284-5637

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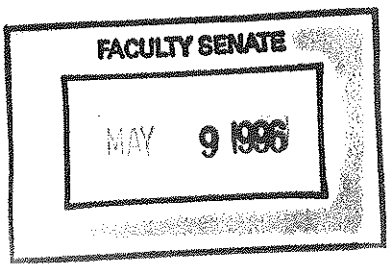

CDFHI

May 3, 1996

Dr. Kamal Yacoub
Chair, Faculty Senate
325 Ashe-Admin. Bldg.
Coral Gables, FL 33124-4634

Re: M.S. Degree Program in Medical Informatics

Dear Dr. Yacoub:

Thank you for your memo dated April 17, 1996 regarding the M.S. Degree Program in Medical Informatics and your request for a nominee from clinical faculty other than Radiology for a Medical School representative on the Oversight Committee. I would like to suggest that you choose one of the following three individuals:

Dr. C. Gillon Ward from the Department of Surgery.
Dr. Jeffrey Augenstein from the Department of Surgery.
Dr. Mark O'Connell from the Department of Medicine.

I have not discussed this with any of them. They have a longstanding interest in medical informatics.

Best regards.

Sincerely yours,

John G. Clarkson, M.D.
Senior Vice President for
Medical Affairs and Dean

JGC:bd

Senior Vice President for Medical Affairs and Dean
P.O. Box 016099
Miami, Florida 33101
305-243-6545 Fax 305-243-4888

UNIVERSITY OF Miami

CDFMI

Paul K. Sugrue
Dean

May 2, 1996

TO: Kamal Yacoub
Chair, Faculty Senate

FROM: Dean Paul K. Sugrue

SUBJECT: **M.S. Degree Program in Medical Informatics**

I would like to nominate Dr. Michael French to serve on the program oversight committee of the M.S. Degree Program in Medical Informatics. Dr. French holds a full-time faculty position in the Department of Epidemiology and Public Health with a secondary appointment in the School of Business. He assumed his duties as Research Associate Professor and Director, Academic Programs in Health Administration, effective October 1, 1995.

Dr. French has proven to be a valuable addition to the University family and I believe would provide valuable input to the program oversight committee.

He can be contacted directly at 243-6005.

Office of the Dean
School of Business Administration
P.O. Box 248027
Coral Gables, Florida 33124-6520
305-284-4643
Fax: 305-284-6526

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: President Edward T. Foote II

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 12, 1996

SUBJECT: Faculty Senate Legislation #95008(B) -
Establishment of the M.S. Degree in Medical Informatics

The Faculty Senate, at its meeting of April 1, 1996, voted to approve the M.S. Degree in Medical Informatics (FS #95008(B). The text of the legislation is attached for your review.

This legislation is forwarded to you for your action.

4/30/96

Kamal,
I approve.
Thanks.

KY\b

Attachment

cc: Provost Luis Glaser
Dean Tarek Khalil, Graduate School
Dean John Clarkson, School of Medicine
Dean Lewis Temares, College of Engineering
Professor Mansur Kabuka, Engineering and Radiology

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UNIVERSITY OF
Miami
SCHOOL OF MEDICINE

Department of Radiology (M-812)
Center for Medical Imaging
and Medical Informatics
Professional Arts Center, Suite #301
1150 N.W. 14th Street
Miami, Florida 33136-2116
Tel: 305-243-7630
Fax: 305-243-7633

MEMORANDUM

Date : 3/14/96

To: Ad Hoc Committee on Medical Informatics
Professor Mark O'Connell, Department of Medicine
Professor Ozcan Ozdamar, Department of Biomedical Engineering
Professor Dilip Sarkar, Department of Mathematics and Computer Science

From: Mansur R. Kabuka

Subject: Master of Science Program in Medical Informatics

I want to thank you for your contributions to the above program proposal and your thoughtful report. The Faculty Senate at its meeting on February 26,1996 discussed the above proposal and your committee's report as part of its first reading. At the end of this discussion, a motion was made to bring this proposal back for a second (and hopefully final) reading with two modifications :

1- An enlarged program committee
2- Outline of new core courses

Attached is the proposed enlarged program committee and outlines of the new core courses RAD604 and RAD608. I hope you find these modifications to the proposal satisfactory.

Again , thank you for your help and cooperation.

Attachment

cc: Dr Kamal Yacoub, Chair, Faculty Senate

ADDENDUM
TO THE
PROPOSAL FOR A
MASTER OF SCIENCE DEGREE IN
MEDICAL INFORMATICS

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiology.
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineering.
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineering.
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

Faculty members from the following departments or schools as appointed by their respective deans:

- Biomedical Engineering
- Computer Science (Department of Mathematics and Computer Science)
- Business
- Medicine (Clinical Departments outside Department of Radiology)

The program Committee will be responsible for academic aspects of the program such as curriculum, admission standards, approval for graduation and, student petitions. The committee will be chaired by the Program Director who will be responsible for administration of the program.

RAD 604

Medical Informatics

Course Description

Computer applications in health care, hospital information, information management, radiology, patient monitoring, decision support, pharmacy, and laboratory information. Hardware and software issues, security, and standards. Ethical and social issues in medical informatics.

Textbook

Edward Shortliffe and Leslie Perreault, Medical Informatics, Addison-Wesley, 1990.

Topics

1. Medical Informatics
2. Medical Data: Its acquisition, storage, and use
3. Clinical decision-support
4. Essential concepts for medical computing
5. Patient monitoring
6. Hardware and software
7. Medical Information Systems:

    - Hospital information systems
    - Laboratory information systems
    - Pharmacy systems
    - Radiology systems
    - Clinical decision support systems
    - Medical record systems
    - Health assessment systems

8. Standards

    - Health Level Seven (HL7)
    - Digital Imaging and Communication in Medicine (DICOM)
    - International Classification of Diseases (ICD-9-CM)
    - Common Object Request Broker Architecture (CORBA)

9. Security and privacy

10. Ethical and social issues in medical informatics

RAD 608

Computer-Based Medical Records

Course Description

Survey of existing Computerized Patient Record (CPR) systems. Requirements and procedures for CPR development and implementation. Technological building blocks for CPR systems. Legal aspects of computer-based patient records and record systems.

References

1. Richard Dick and Elaine Steen, The Computer-Based Patient Record, National Academy Press, 1992.
2. Computer-Based Medical Systems, Proceedings of the IEEE Symposium, 1993-1996.

Topics

1. The patient record
2. Strengths and weaknesses of paper patient records
3. The computer-based patient record technology
4. Clinical assessment
5. Software issues and software quality
6. CPR development and implementation
7. Integration of clinical data
8. Legal aspects of CPR

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

To: Dr. Robert M. Quencer, Chair, Radiology
Dr. Tzay Young, Chair, Electrical and Computer Engineering

From: Kamal Yacoub
Chair, Faculty Senate

Date: February 22, 1996

Subject: Graduate Program in Medical Informatics

This is to inform you that the agenda for the upcoming Faculty Senate meeting on Monday, February 26, 1996 [see attached] includes under Item No. B4 your department request for a graduate program in Medical Informatics. Also attached is a report of the ad hoc Committee appointed by the Senate to review this program.

Dr. Mansur Kabuka, director of the proposed program and Dr. Ozcan Ozdamar, chair of the ad hoc Committee have been invited to attend and present their views. You or your representatives are welcome to attend and participate in the discussion.

KY/ca

Attachment

cc Dean John G. Clarkson, School of Medicine
Dean M. Lewis Temares, College of Engineering
Dr. Mansur Kabuka, program director
Dr. Ozcan Ozdamar, chair, Senate Review Committee

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UNIVERSITY OF Miami

FACULTY SENATE

Faculty Senate Meeting Agenda
Monday, February 26, 1996
* * * **Faculty Club, 1550 Brescia** * * *

		Approximate Time
A	Introductory Matters	
A1	Chairman's Remarks	3:00 p.m.
A2	President's Remarks	3:05 p.m.
A3 *	Approval of the Minutes of January 22, 1996	3:15 p.m.
A4	Excused Absences	3:20 p.m.
A5	Other Announcements,	
	1 - Learning Communities, John Masterson	3:25 p.m.
	2 - Wellness Center, Norman Parson, Director	3:30 p.m.
B	General Matters	
B1	Report from the Distinguished Faculty Scholar Award Committee - Professor Howard Gordon	3:35 p.m.
B2 *	Request from the College of Arts & Sciences to Rename the Bachelor of General Studies Degree to the Bachelor of Liberal Arts Degree - Dean Murfin	3:45 p.m.
B3 *	Request from the School of Continuing Studies to Rename the Bachelor of Continuing Studies Degree to the Bachelor of General Studies Degree - Dean Holden	3:55 p.m.
B4 *	A New Graduate Program in Medical Informatics Mansur Kabuka, program Director Ozcan Ozdamar, Chair of Senate Review Committee	4:00 p.m.
B5 *	1996 Report from the Academic Standards Committee Stephen Cantrell, Chair	4:20 p.m.
B6	Undergraduate Major in Elementary Education [Information]	4:50 p.m.
B7	Uniformity in Employee Benefits [Information]	5:00 p.m.
B8	Learning Center Facilities - D. de Sylva and A. Millas	5:10 p.m.
B9	DF-15 Form - Peter Bellis	5:20 p.m.
B10	Matters from the Floor	5:30 p.m.

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biostatistics. We recommend that the expanded program committee closely examine the curriculum and make necessary revisions to include additional relevant courses. Such changes will not only make the program stronger but will increase the efficiency of the university by eliminating redundant courses and increasing enrollment in existing ones.

4. The program should develop a mechanism for quality assessment and improvement. A thorough review of the program's strengths and weaknesses should be completed at the end of each of the first 2 years and provided to the faculty senate.

5. Enrolled students should be provided with comprehensive and aggressive career counseling and develop placement services to ensure their successful progress after graduation. This will obviously enhance the attractiveness of the program for future enrollees.

Report to the Faculty Senate on a Proposal for a M.S. Program in Medical Informatics

From: Ad hoc committee on Medical Informatics
Ozcan Ozdamar, Ph.D., Dept. Biomedical Engineering, Chairperson
Mark O'Connell, M.D., Dept. Medicine
Dilip Sarkar, Ph.D., Dept. Mathematics and Computer Science

Date: February 14, 1996

We strongly endorse the development of a post-graduate degree program in medical informatics at the University of Miami and we unanimously recommend the faculty senate approve the proposed program with the following changes. We feel these changes would strengthen the program and help ensure its success in coming years.

1. The program described on page 14 of the proposal is composed of professors from the departments of electrical and computer engineering, radiology and administrative representatives (dean or designee, ex-officio). As rightfully stated in the proposal, medical informatics is a broad field with an interdisciplinary character and the program committee should reflect this nature. We recommend that representatives from the departments of biomedical engineering, computer science, biostatistics, and clinical departments at the medical school also be included in the program committee.

2. The expanded program committee must meet at least once every semester to review the status of the program and the students in the program.

3. The educational plan for those required core courses not yet in existence must be defined. This effort would greatly benefit from the expanded multidepartmental representation suggested for the program committee.

   We also recognize that the proposed curriculum can be further strengthened by inclusion of relevant courses offered in other departments such as biomedical engineering, computer science, and

Report to the Faculty Senate on a Proposal for a M.S. Program in Medical Informatics

From: Ad hoc committee on Medical Informatics
Ozcan Ozdamar, Ph.D., Dept. Biomedical Engineering, Chairperson
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biostatistics. We recommend that the expanded program committee closely examine the curriculum and make necessary revisions to include additional relevant courses. Such changes will not only make the program stronger but will increase the efficiency of the university by eliminating redundant courses and increasing enrollment in existing ones.

4. The program should develop a mechanism for quality assessment and improvement. A thorough review of the program's strengths and weaknesses should be completed at the end of each of the first 2 years and provided to the faculty senate.

5. Enrolled students should be provided with comprehensive and aggressive career counseling and develop placement services to ensure their successful progress after graduation. This will obviously enhance the attractiveness of the program for future enrollees.

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: Professor M. O'Connell, Department of Medicine
Professor O. Ozdamar, Department of Biomedical Engineering
Professor D. Sarker, Department of Mathematics & Computer Science

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: December 7, 1995

SUBJECT: Master of Science Program in Medical Informatics

This is to ask you to serve on an ad hoc committee to review the attached Masters program in Medical Informatics and make your recommendation to the Faculty Senate. This proposed program is sponsored by the Department of Radiology in the School of Medicine and the Department of Electrical and Computer Engineering in the College of Engineering. So far, this program has been approved by the two sponsoring departments, the Medical School Council, the College of Engineering faculty as well as the Graduate Council.

I request that Professor Sarkar chair this committee. I suggest that Professor Kabuka, Director of this program, be contacted for any additional information needed by this committee.

The Faculty Senate is scheduled to meet on January 22, February 26, April 1 and April 29. This proposal will require two readings at two Senate meetings. Agenda for these meetings, and attachments, will be mailed a week in advance of these meetings. It will be very helpful of we can get your written recommendations in time to attach them to the January meeting agenda.

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I hope you will all agree to serve on this committee. Thank you very much for your cooperation.

KY/b

Attachment

cc: Provost Luis Glaser
Dean John Clarkson, School of Medicine
Dean Tarek Khalil, Graduate School
Dean M. Lewis Temares, College of Engineering
Dr. Robert Quencer, Chair, Department of Radiology
Dr. Tsay Young, Chair, Department of Electrical & Computer Engineering
Dr. Mansur Kabuka, Department of Electrical and Computer Engineering

UNIVERSITY OF Miami

MEMORANDUM

November 15, 1995

TO: Dr. Kamal Yacoub, Chairman
Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics Program

At its November 8th meeting, Graduate Council discussed the attached proposal for the interdepartmental program on Medical Informatics. A motion was made and passed to approve the proposal with the following proviso:

> That the program produces a detailed budget expenditure and analysis two years after its initiation and that a report of student enrollment and satisfaction with the program be presented to Council in two years.

I am enclosing a copy of the proposal for your action. I am also enclosing a copy of the report prepared by the Council Subcommittee on Programs and Degrees.

Thank you for your consideration.

TMK:nb
Enclosures

Copy to:
Dr. Luis Glaser, Provost
Dean Bernard Fogel, School of Medicine
Dean Lewis Temares, College of Engineering
Dr. Samuel Lee, Associate Dean, College of Engineering
Dr. Robert Quencer, Chair, Department of Radiology
Dr. Tzay Young, Chair, Department of Electrical Engineering
Dr. Mansur Kabuka, Electrical and Computer Engineering

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
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Fax 305-284-5441

BIOGRAPHICAL SKETCH

Dr. Mansur R. Kabuka, Professor of Computer Engineering, Electrical Engineering, and Radiology.

Dr. Kabuka received Ph.D. degree from the University of Virginia at Charlottesville in 1983. His current research interest are in image processing, medical imaging, medical informatics, neural networks, and information technology. He has published research papers addressing several aspects of the above areas. Some of the project recently completed include face image analysis for the study of human emotions, multimedia radiology diagnosis workstation, advance image management system, cooperative medicine workstation, campus wide integrated patient registration facility, hypermedia campus information system, image analysis of 3-D micromotion of porous-coated femoral prostheses, and an integrated image processing and visualization system. Dr. Kabuka is the founder and Director of the Medical Imaging and Medical Informatics Center. He initiated and played a principal role in establishing M.S. Medical Informatics, the off-campus graduate programs, the M.S. in industrial electronics and computers at McDonnel Douglas (Titusville, FL), and M.S. in computer science with Department of Math and Computer Science at IBM (Boca Raton, FL) and has contributed significantly to undergraduate and graduate curriculum development. He has been consultant to several companies. Dr. Kabuka served on many Department, College, and University Committees. He is a member of the College of Engineering Council, the College of Engineering Research Council, and the University Computer Advisory Committee. He served on the University of Miami Faculty Development Comittee. **Dr. Kabuka is an active member of the Florida High Technology and Industry Council: The Computer Integrated Engineering. He reviewed numerous large scale inter-disciplinary projects and centers.**

CURRENT FUNDING

Distributed Multimedia Medical Imaging Environment, PI, PACS Services, $1,699,077 (Five Years, Start date: June 1, 1995).

Distributed Multimedia Integrated Medical Information Infrastructure, PI, U.S. Department of Commerce $2,126,419 and Industry $1,364,128. (Pending).

SELECTED PAPERS (1993-1995)

1. Kabuka, M.R. (with S. Bhide and N. John), "A Boolean Neural Network Approach for the TSP," IEEE Trans. on Computer, Vol. 42, number 10, pp 1271-1278, 1993.
2. Kabuka, M.R. (with Basit Hussain), "A Novel Feature Recognition Neural Network," IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 16, number 1, pp. 98-106, 1994.
3. Kabuka, M.R. (with Andres Rios), "Image Compression with a Dynamic Autoassociative Neural Network," Journal of Mathematical and Computer Modelling (Invited), 1994.
4. Kabuka, M.R. (with S. Bhattacharjee and Bruce Guthbert), "Facial Surface Imaging and Biobehavioral Assessment," IEEE Engineering in Medicine and Biology, to appear.
5. Kabuka, M.R. (with S. Gazula), "Real-Time Supervised Classifiers using Boolean Neural Networks," IEEE Trans. on Pattern Analysis and Machine Intelligence, to appear.
6. Kabuka, M.R. (with A. Rios), "A High Performance Neural Network-based Compression System for MR Images," the Society of Magnetic Ressonance in Medicine 12th Annual Meeting, 1993.
7. Kabuka, M.R. (with A. Younis), "Adaptive Classification and Compression of MR Images using Neural Network Architecture," the Soc. of Magnetic Resonance in Medicine 12th Meeting, 1993.
8. Kabuka, M.R. (with Gregory M. Shebert), "An Improvement to the Neural Network Compression of Medical Image Data," IEEE Data Compression Conference, March 1993.
9. Kabuka, M.R. (with Markus Gudmundsson), "An Integrated Patient Oriented Workstation for Radiological Diagnosis," IEEE Engineering in Medicine and Biology Conference, 1993.

10. Kabuka, M.R. (with D. Xu), "Image Analysis of 3-D Micromotion of Porous-Coated Femoral Prostheses," IEEE Computer-based Medical Systems Symposium, 1993.
11. Kabuka, M.R. (with S. Bhattacharjee), "Face Image Analysis for the Study of Human Emotions," IEEE Engineering in Medicine and Biology Conference, 1993.
12. Kabuka, M.R. (with S. Bhide, S. Gazula and G. Shebert), "An ASIC Implementation of a User Configurable Boolean Neural Network Chip," World Congress on Neural Networks, 1993.
13. Kabuka, M.R. (with S. Bhide and N. John), "A Real-time Solution for the TSP using Boolean Neural Network," IEEE Int. Conf. on Neural Networks, 1993.
14. Kabuka (with E. Figueredo), "A Visual Medical Image Processing and Visualization System," SPIE Conference, Medical Imaging, 1994.
15. Kabuka, M.R. (with T. Wan), "Edge-Preserving Image Compression for Magnetic-Resonance Images Using DANN-based Neural Network," SPIE Conference, Medical Imaging, 1994.
16. Kabuka, M.R. (with A. Rios), "Neural Network Compression for Medical Images: Dynamic Autoassociative Neural Network (DANN) Codec," SPIE Conference Medical Imaging, 1994.
17. Kabuka, M.R. (with N. John, X. Li, A. Younis), "Towards Automatic Segmentation of MR Brain Images," SPIE Conference, Medical Imaging, 1994.
18. Kabuka, M.R. (with W. Sull), "Paradigm for Having a Logical Data Integration Between PACS and HIS," SPIE Conference, Medical Imaging, 1994.
19. Kabuka, M.R. (with S. Banerjee), "ATM-based Fiber Optic Network for Scalable and Modular PACS Design," SPIE Conference, Medical Imaging, 1994.
20. Kabuka, M.R. (with Maria J. Bianchi), "An Algorithm for Detection of Masses, Microcalcification and Skin Contours in Mammograms," Symposium for Computer Assisted Radiology, 1994.
21. Kabuka, M.R. (with X. Li and S. Bhide), "Labelling of MR Brain Images using a Boolean Neural Network," Symposium for Computer Assisted Radiology, 1994.
22. Kabuka, M.R. (with X. Li and N. John), "A Statistical Approach to the Segmentation of MR Brain Images," The Society of Magnetic Resonance Meeting, San Francisco, 1994.
23. Kabuka, M.R. (with S.M. Bhide), "Image Segmentation with Boolean Neural Networks for Medical Imaging," The Society of Magnetic Resonance Meeting, San Francisco, 1994.
24. Kabuka, M.R. (with F. Sauer), "Multimedia Technology in Radiology Department," ACM Multimedia 94, San Francisco, 1994.
25. Kabuka, M.R. (with S. Bhide, N. Borko, N. John, F. Sauer, W. Sull, S. Waly, and A. Younis), "Integration of Medical Information Systems using Object-Oriented Technology," OOPSLA'94 Workshop on Object-Oriented Technology for Health Care and Medical Information Systems, Portland, 1994.
26. Kabuka, M.R. (with S. Bhide, N. Borko, N. John, F. Sauer, W. Sull, S. Waly, and A. Younis, "Applying Object Oriented Technology in the Integration of Legacy Databases," Eleventh International Symposium on the Creation of Electronic Health Record Systems and Global Conference on Patient Cards, Orlando, Florida, 1995.
27. Kabuka, M.R. (with F. Sauer, S. Waly, "Automatic Data Entry Using Scanning and Color Segmentation of Driving Licenses", Eleventh International Symposium on the Creation of Electronic Health Record Systems and Global Conference on Patient Cards, Orlando, Florida, 1995.
28. Kabuka, M.R. (with X. Li), "Labeling of MR Brain Images Using a Boolean Neural Network," IEEE Trans. on Medical Imaging, In press.

BIOGRAPHICAL SKETCH

Brian Charles Bowen, Ph.D., M.D. Assistant Professor

EDUCATION

Stanford University: BS 1968 (Chemical Engineering)
University of Washington: MS 1970 (Chemical Engineering)
University of California, San Diego: Ph.D. 1977 (Chemistry)
University of Miami School of Medicine: (Ph.D. to M.D. Program): M.D. 1983 (Medicine)

RESEARCH AND PROFESSIONAL EXPERIENCE

(1969-1970) Teaching Assistant, Chemical Engineering, University of Washington, Seattle, WA
(1971-1974) Teaching Assistant, Physical Chemistry, University of California, San Diego, LaJolla, CA
(1975) Lecturer, Chemistry, University of California, Santa Cruz, Santa Cruz, CA
(1977-1980) Post-Doctoral Fellowship, Department of Biochemical Sciences, Princeton University, Princeton, NJ
(1980-1981) Post-Doctoral Fellowship, Department of Molecular Biology and Biochemistry, University of Wisconsin, Madison, WI
(1983-1984) Internship in Internal Medicine, University of Southern California, Los Angeles County Medical Center, Los Angeles, CA
(1984-1987) Residency in Diagnostic Radiology, Mount Sinai Medical Medical Center, Miami Beach, Florida
(1986-1987) Assistant Instructor of Radiology (during Residency), University of Miami School of Medicine, Miami, Florida
(1988-1989) Instructor of Neuroradiology, University of Miami School of Medicine, Miami, Florida
(1989-) Assistant Professor of Radiology, Neuroradiology Section, University of Miami School of Medicine, Miami, Florida

HONORS AND AWARDS

(1968) Undergraduate Research Grant, National Science Foundation
(1968-1969) Graduate Traineeship, National Science Foundation
(1971-1976) Predoctoral Traineeship, National Institute of Health
(1976) Earle C. Anthony Fee Scholarship
(1977-1978) Post-doctoral Fellowship, National Institute of Health
(1978-1979) Post-doctoral Fellowship, National Science Foundation, "National Needs"
(1979-1981) Post-doctoral Fellowship, Damon Runyon/Walter Winchell Cancer Fund
(1986-1987) Chief Resident, Department of Radiology, Mount Sinai Medical Center
(1987-1988) Dauer Fellowship in Magnetic Resonance Imaging, Department of Radiology, Mount Sinai Medical Center

PROFESSIONAL SOCIETIES

Radiological Society of North America , member
American College of Radiology, member
South Florida Radiological Society, member
Florida Radiological Society, member
American Society of Neuroradiology, senior member
American Medical Association, member

SELECTED PUBLICATIONS

Bowen BC, Parker WW, Lowenstein DA, Sheldon J, Duara R, (1990) MR signal abnormalities in memory disorder and dementia. AJNR 11:283-290; AJR 154:1284-1292

Bowen BC, Pascal S, Sheldon J, et al. (1990) Pathological verification of MRI -detected white matter disease in patients with Alzheimer's disease. Neurology 40 (suppl. 1):176

Bowen BC, Post MJD. (1990) Diagnostic imaging of CNS infection and inflammation In:Infections of the Nervous System. (ed) David Schlossberg, Springer-Verlag, New York pp.315-380

Bowen BC, Sattin W, Quencer RM, Kochan JP. (1990) MR angiography of orbital and intracranial malformations and arteriovenous fistulae. Radiology 177(p):90

Bowen BC, Post MJD. (1991) Intracranial infection In:Magnetic Resonance Imaging of the Brain and Spine.(ed)Scott Atlas, Raven Press, New York pp. 510-538

Feun LG, Savaraj N, Lee Y-Y, Landy H, Martinez-Prieto J, Charnsangavej C, Post MJD, Lee KF, Wallace S, **Bowen BC**, Kochan JP, Yung W-K. (1991) Phase I pharmacokinetic study of intracarotid cisplatin and bleomycin. Selective Cancer Therapeutics 7:29-36

Post MJD, **Bowen BC**, Sze G. (1990) MR of spinal infection. Rheumatic Diseases Clinics of North America. W.B. Saunders Co., Philadelphia 773-794

Madsen PW III, Green BA, **Bowen BC.** (1992) Syringomyelia, In: The Spine 3rd edition (ed) Rothman RH and Simeone FA. W.B. Saunders Co., Philadelphia 1575-1604

Rovira JM, Post MJD, **Bowen BC.** (1992) Central nervous system infections in HIV positive patients. Neuro Imaging clinics of North America. W.B. Saunders Co., Philadelphia 179-200

Falcone S, Quencer RM, **Bowen BC**, Bruce JH, Naidich TP. (1992) Creutzfeldt-Jakob disease:two cases with focal symmetrical cortical involvement by MR imaging. AJNR 13:403-406

Sklar EML, Quencer RM, **Bowen BC**, Altman NB, Villaneuva P. (1992) MR applications in cerebral injury. Radiology Clinics of North America. W.B. Saunders Co., Philadelphia 353-366

Margosian P, **Bowen BC.** (1992) Practical clinical aspects of MR angiography. Picker Users Manual, Picker International Inc., Cleveland 1-10

Lam BL, Shatz NJ, Glaser JS, **Bowen BC.** (1992) Pseudotumor cerebri from cranial venous obstruction. Ophthalmology 99:706-712

Singer C, Berger JR, **Bowen BC**, Bruce JH, Weiner WJ. (1993) Akinetic-Rigid syndrome in a 13 year old female with HIV-related progressive multifocal leukoencephalopathy. Movement Disorders 8:113-116

Lawton Smith J, **Bowen BC.** (1993) Ocular Pulsation in Neurofibromatosis. A Clinical/Neuroradiologic Correlation. J. of Clinical Neuro-ophthalmology 13:163-170

Whiteman ML, Post MJD, **Bowen BC.** (1993) White matter diseases in AIDS. Neuroimaging Clinics of North America. In Press

Wester DJ, Whiteman ML, **Bowen BC**, Leh F, Teleshi F, Belles BL. (1993) MR and CT imaging of the post-operative neck. Radiology 189(p):392

Goldstein WS, **Bowen BC**, Balkany T. (1994). Hemangioendothelioma of the temporal bone masquerading as glomus tympanicum. Annals of Otology, Rhinology, Laryngology 103:156-159, 1994

Bowen BC, Quencer RM, Margosian P, Pattany PM. (1994) MR angiography of occlusive disease of arteries in the head and neck: current concepts. AJR 162:9-18

Madsen PW III, **Bowen BC.** (1994) Spinal cord disease. In: Functional Neuroimaging (ed) Roger Kelley, Futura Publishing Company, Inc., Mount Kisco, New York. In Press

Singer C, Green BA, **Bowen BC**, Bruce J, Weiner WJ. (1994) Late presentation of congenital muscular torticollis: use of CT and MR imaging. Movement Disorders 9:100-103

Ray G, Levin BE, **Bowen BC.**(1994) A longitudinal examination of crossed aphasia. Arch Neurol 51:95-100

Bowen BC, Block RE, Sanchez-Ramos J, Pattany PM, Lampman DA, Murdoch JB, Quencer RM. (1994) Proton MR spectroscopy of the brain in 14 patients with Parkinson's Disease. AJNR. In Press

BIOGRAPHICAL SKETCH

Pradip M. Pattany, Ph.D.
Research Assistant Professor

EDUCATION

University of Bradford, UK:	B. Tech. 1982 (Applied Physics)
University of Manchester, UK:	M. Sc. 1983 (Analytical Science)
University of Lyon, France:	Ph.D. 1992 (Magnetic Resonance Imaging)

PROFESSIONAL EXPERIENCE

1983-1985	Scientist/Systems Engineer in Physics group, Picker Int'l. Ltd., UK
1985-1988	Staff Scientist in Clinical Research group, Picker International Ltd., UK
1988-1993	Director of R&D, MRI of Colorado, Colorado Springs, CO
1988-present	Clinical Assistant Professor, Dept. of Radiology, Univerisity of Colorado, Health Sciences Center, Colorado, CO
1993-present	Research Assistant Professor, Dept. of Radiology, University of Miami, Miami, Florida

PATENTS

1985	MR Imaging of High Velocity
1986	Low Rf dosage MR Imaging of High Velocity Flow
1986	Motion Artifact Suppression Technique for MR Imaging
1991	Flow Angiology with Static Signal Suppression

HONORS AND AWARDS

1987 Picker Management Award of Excellence for Outstanding Contributions to NMR Imaging and Dedication to Clinical Research

1987 I R 100 Award as selected by Research and Development magazine for "Motion Artifact Suppression Technique (MAST)" as one of the 100 most significant new technical products of the year

1988 Award given in recognition of contribution to the US Olympic committee, Sports Medicine and Science Division for MR cardiology work with weight trainees

SELECTED PUBLICATIONS

Bowen BC, Block RE, Sanchez-Ramos J, **Pattany PM,** Lampman DA, Murdoch JB, Quencer RM. Proton MR Spectroscopy of the Brain in 14 Patients with Parkinson's Disease. AJNR, 1995 16: pp 61-68.

Elgarresta LF, Fishman JE, Bowen BC, **Pattany PM.** MR Imaging of the Proximal Subclavian Arteries. Proc. RSNA; Radiology 386:193, 1994.

Bowen BC, Quencer RM, Margosian P, **Pattany PM**: MR Angiography of Occlusive Disease of the Arteries in the Head and Neck: Current Concepts. AJR 1994 Vol. 162, No. 1, pp.9-18.

Pattany PM., Hendrick RE: "Spoiled Gradient Echo (SGE) Imaging versus SE Imaging: Pelvic Cyst Case," The Raven MRI Teaching File. MRI: Principles and Artifact, Raven Press 1993, pp. 105.

Pattany PM, Hendrick RE: "Steady State Gradient Echo (SSGE) Imaging versus SE Imaging: Pelvic Cyst Case," The Raven MRI Teaching File. MRI: Principles and Artifact, Raven Press 1993, pp. 109.

Fleck SJ, **Pattany PM,** Stone MH, Kraemer WJ, Thrush J, Wong K: Magnetic Resonance Imaging of Left Ventricular Mass: Junior Olympic Weight Lifters. American College of Sports Medicine, 1993.

Pattany PM, Block RE, Bowen BC, Khosla A: Improvement of Signal-to-Noise Ratio of Proton: MR Spectra of the Brain with Cardiac Gating. RSNA 1993, pp. 413.

Hajnal JV, Bryant DJ, Kasuboski L, **Pattany PM**, De Coene B, Lewis PD, Pennock JM, Oatridge A, Young IR, Bydder GM: MRI of the brain and spinal cord using T_2 weighted inversion recovery pulse sequences: A new approach to the diagnosis of subtle disease. JCAT 1992:16(6):841-844.

Margosian P, **Pattany PM:** Magnetization Transfer used as a Tool to Increase the Contrast of Magnetic Resonance Angiography Images. Proc. SMRM 1992.

Pattany PM, Peters BH, Bjork RJ, Jarvis DH, et al: Clinical Evaluation of Restrictive Diffusion in White Matter Tracts. Proc. SMRM, 1992.

Sherman JL, Sceats DJ,, **Pattany PM,** Jarvis DH, Palmer, N: Clinical Evaluation of a Three-dimensional Surgical Planning Technique for Brain Tumors. Proc. SMRI 1992, pp. 101.

Sherman JL, **Pattany PM,** Jarvis DH: Clinical Evaluation of the GEMS Technique in the Spine. Proc. SMRI 1992, pp. 95.

Pattany PM, Sherman JL, Wong K, Jarvis DH: Analysis and Reduction of Motion Artifacts on the Second Echo of a Multiecho Sequence. Proc. SMRI 1992, pp. 112.

Sherman JL, **Pattany PM:** Savvy Flip-angle Changes Generate Desired Contrast. MR Quarterly 43-49, 1991.

Sherman JL, **Pattany PM:** Review and update: Blood Flow and MR Angiography. Appl. Radiol. 20:43-53, 1991.

Pattany PM, Fleck SJ, Lucia A, Zimmerman SD, et al: Reliability of Cardiac Morphology Using MRI Techniques. American College of Sports Medicine Annual Meeting 1991.

Vollrath RS, **Pattany PM:** Comparison of Second Echo with and without Motion Suppression in the Phase Encode Direction in 2DFT Multisection MR Imaging. Proc. SMRI, 1991, pp. 250.

Fleck SJ, **Pattany PM,** Kearney JT, Kraemer WJ, et al: Relationship of Left Ventricular Mass to Maximum Oxygen Consumption in Weight Lifters. Proc. SMRI 1991, pp. 230.

Pattany PM, Wong K: Flow Angiography with Static Signal Suppression. Proc. SMRI 1991, pp. 177.

Pattany PM, Wong K: MR Angiography of the Foot with 2DFT STIR Sequences. Proc. SMRI 1991, pp. 177.

BIOGRAPHICAL SKETCH

George N. Sfakianakis, M.D. Ph.D.	Prof.of Radiology	July 17, 1938 SS# 289-56-4438

Aristoteleion Univ.of Thessaloniki, Greece	M.D. 1962	Medicine
Aristoteleion Univ.of Thessaloniki	Ph.D. 1970	Endocrinol.
Ohio State University, Columbus, Ohio	B.S. 1973	Nucl.Medicine

Professional Positions Held:

Internship (Rotating), Greece.	1962-1964
Military Duty - General Medicine	1964-1966
Residency in Internal Medicine, Greece.	1966-1968
Ph.D. Postgraduate Training, Greece	1968-1970
Fellow, Nuclear Medicine and Ultrasound and Endocrinology, Ohio State University, Columbus, Ohio	1970-1973
Chief, Nucl Med Laboratory, Children's Hospital, Columbus, Ohio	1974-1979
Assistant Professor of Radiology, Ohio State University	1973-1979
Associate Professor of Radiology/Nuclear Medicine and Pediatrics, University of Miami School of Medicine	1979-1984
Professor of Radiology, Division of Nuclear Medicine	1984-Present
Director, Division of Nuclear Medicine, University of Miami, Hospitals and Clinics, Jackson Memorial Medical Center	1989-Present

Honors:

Honorable Mention Award, "Tc-99m-Pertechnetate Scrotal Imaging of Pediatrics" (teaching exhibit), Miami, 1979.

Bronze Medal Award, "Gastrointestinal Radiotracer Studies in Pediatrics" (teaching exhibit). 27th Annual Meeting, Society of Nuclear Medicine, Detroit, June 1980.

Silver Medal Award, on "Captopril Scintigraphy" (Teaching Exhibit), 35th Annual Meeting Society of Nuclear Medicine, San Francisco, California, June 1988.

Bibliography

No. of Articles: 37; No. of Abstracts: 53; No. of Book Chapters: 2.

1. Sfakianakis GN, Anderson GF, King DR and Boles Jr. ET: The Effect of Gastrointestinal Hormones on the Pertechnetate Imaging of Extopic Gastric Mucosa in Experimental Meckel's Diverticulum. J Nucl Med 22:678-683, 1981.
2. Sfakianakis GN, Al-Sheikh W, Heal A, Rodman G, Zeppa R, Serafini AN: A Prospective Comparative Clinical Study of the Sensitivity and Specificity of In-111-Leukocyte and Gallium-67 Scintigraphy in the Diagnosis of Occult Sepsis". J Nucl Med, 23(7):618-626, 1982.
3. Sfakianakis GN, DeLand F: Radioimmunodiagnosis and Radioimmunotheray 1982. J Nucl Med, 23:840-850, 1982.

4. Sfakianakis GN, Smuclovisky C, Strauss J, Hourani M, Lockhart G, Zillereulo M, et al: Improving the Technique of Nuclear Cystography: The Manometric Approach. The Journal of Urology, 131:1061-1064, 1984.
5. Sfakianakis GN, Sfakianaki E, Bourgoignie J: Renal Scintigraphy Following Angiotensin-Converting Enzyme Inhibition in the Diagnosis of Renovascular Hyertension (Captopril Scintigraphy). Nuclear Medicine Annual 1988, Raven Press, N.Y. L.M.Freeman and H.S.Weissman, editors. p125-170, 1988.
6. Karatzas ND, Sfakianakis GN, Pappas D, Duncan R, Heal A, Serafini, Kung HF: Experimental Increase in Brain HIPDM Uptake by Hepercapnia. J Nucl Med, 29:1675-1682, 1988.
7. Sfakianakis GN, Garty I, Serafini AN: Radioantibodies for the diagnosis and treatment of cancer. Radioimmunoimaging (RAI) and Radioimmunotherapy (RAT). Cancer Investigation 8(3/4):381-405, 1990.
8. Serafini AN, Mallin W, Ezuddin S, Watson C, Ganz W, Soto R, Green N, Sfakianakis GN: From murine to human monoclonal antibodies: An overview of the role of immunoscintigraphy in cancer. J Clin Immunoassay 16(4):290-293, 1993.
9. Ruiz A, Ganz WI, Post JD, Camp A, Landy H, Mallin W, Sfakianakis GN: Use of Thallium-201 brain SPECT to differentiate cerebral lymphoma from toxoplasma encephalitis in AIDS patients. Am J Neuroradiol 15:1885-1894, 1994.
10. Irvin GL,III, Prudhomme DL, Deriso GT, Sfakianakis GN, Chandarlapaty SKC: A new approach to parathyroidectomy. Annals Surg 219(5):574-581, 1994.

BIOGRAPHICAL SKETCH

Joel Elliot Fishman, MD, Ph.D.
Assistant Professor

EDUCATION

Massachusetts Institute of Technology: BS 1981, (Physics)
University of Pennsylvania: MD 1987
University of Pennsylvania: Ph.D. 1987

PROFESSIONAL EXPERIENCE

1987-1988	Internship in Internal Medicine, St. Mary Medical Center, Long Beach, California
1988-1992	Residency in Diagnostic Radiology, University of California, Los Angeles, California
1990	Chief Resident, Dept. of Radiological Sciences, University of California, LA, California
1992-1993	Fellow in Body Imaging, Jackson Memorial Hospital, Miami, Florida

HONORS AND AWARDS

1978	Summer Student Research Fellowship, National Institutes of Health
1981-1987	NIH Medical Scientist Training Program Fellowship for MD Ph.D. University of Pennsylvania
1985	Society of Magnetic Resonance in Medicine Stipend to present research at the Fourth Annual Meeting, London, England
1987	Undergraduate Research Prize, American Heart Association, Pennsylvania Affiliate

PROFESSIONAL SOCIETIES

Sigma Xi
Radiological Society of North America

SELECTIVE PUBLICATIONS

Fishman JE, Brown K, Aberle D, Batra P, Kadell B, Weiner M, Rooholamini S: The CT appearance of nonmalignant disease of the esophagus. American Roetgen. Ray Society Annual Meeting, 1990.

Fishman JE, Aberle D, Moldauer N, Figlin RA: CT versus chest radiography in monitoring thoracic metastatic disease in patients on interleukin-2/alpha-interferon therapy. American Roentgen. Ray Society Annual Meeting, 1991.

Merinbaum D, Montalvo BM, Guerra JJ, **Fishman JE,** Yrizarry J, Dickson P, Casillas J, Kunberger L: The role of sonography in transjugular intrahepatic protosystemic shunt placement. American Roentge. Ray Society Annual Meeting, 1993.

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Olazabal R, Huson II, **Fishman JE,** Nuñez D, Amendola M: Is it clot or is it not? CT evaluation of IVC thrombosis. RSNA Annual Meeting, 1993.

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Fishman JE, Aberle DR, Moldawer NP, Belldegrun A, Figlin RA: Atypical contrast reactions associated with systemic interleukin-2 therapy. AJR 156:833-834.

Fishman JE, Joseph RC. Renal vein thrombosis in utero: duplex sonography in diagnosis and follow-up. Pediatric radiology. In Press.

BIOGRAPHICAL SKETCH

Abdulmehdy M. Jabir, M. Phil.
Research Assistant Professor

EDUCATION

University of London, England:	M. Phil., 1979 (Radiation Physics)
University of Basra, Iraq:	BS, 1968 (Physics)

RESEARCH AND PROFESSIONAL EXPERIENCE

1985-present:	Physicist, Jackson Memorial Medical Center, Miami, Florida
1986-present:	Instructor, School of Radiologic Technology, Jackson Memorial Hospital
1987-1991:	Nuclear Medicine Physicist, VA Medical Center, Miami, Florida
1989-1991:	Research Instructor, Department of Radiology, University of Miami School of Medicine
1989-present:	Coordinator, Basic Sciences/Residency Program, UM/Jackson Memorial Medical Center, Miami, Florida
1991-1993:	Instructor, Department of Radiology, University of Miami School of Medicine
1991-present:	Instructor, School of Ultrasound Technology, Jackson Memorial Hospital
1992-present:	Director, Nuclear Physics and Instrumentation, Jackson Memorial Center Miami, Florida
1993-present:	Research Assistant Professor, Department of Radiology, University of Miami School of Medicine

SELECTIVE PUBLICATIONS

Efange SMN, Kung HF, Mash DC, **Jabir AM,** Billings J, Pablo J, Dutta A, Freahler A: Pargyline-sensitive Selective Accumulation of a Radiolabeled MPTP Analog in the Primate Cerebral Cortex and Basal Ganglia. **Synapse** 5:207-212, 1990.

Jabir AM, Serafini AN, Chandarlapaty SK, Sfakianakis GN, Riviera R: Evaluation of a Direct Method for Radiopharmaceutical Dosimetry Based on SPECT Acquired Data. In: Proceedings of the 5th International Radiopharmacy Dosimetry Symposium, Oak Ridge, Tennessee: US Department of Energy Publication No. Conf. 910529; 1992, pp. 352-365.

Serafini AN, Gallup D, Vargas-Cuba R, Sevin BU, Averette H, Hardin V, **Jabir AM,** Dewanjee MK, Dwyer K, Sfakianakis GN: Intravenously Administered CYT-103 in the Imaging of Ovarian Carcinoma: Correlative Findings with Standard Imaging, Surgery and Pathology. **Diagn Oncol,** 2:261-266, 1992.

Nedd K, Sfakianakis GN, Ganz W, Uricchio B, Vernberg D, Villaneuva P, **Jabir AM,** Bartlett J, Keena J, ^{99m}Tc-HMPAO SPECT of the Brain in Mild to Moderate Traumatic Brain Injury Patients: Compared with CT - a Prospective Study. **Brain Injury** 7(6):469-479, 1993.

Jabir AM: The Applications of Thermally Stimulated Conductivity in Radiation Dosimetry. **Medical Physics** 17(3), p. 541, 1990.

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Jabir AM, et al: Detectability of cold lesions with multiwindow imaging of In: 111: A phantom study. **Medical physics** 17(3), 1990.

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Jabir, AM, Jabir R, Serafini AN: Effect of timing of SPECT imaging on the SPECT determined volume. **Radiology Supplement,** 189:415, 1993.

Chaneles MC, **Jabir AM,** Echenique AM, Fiedler J, Piña M: Three dimensional representation of the heel effect. **Radiology Supplement,** 189:409, 1993.

BIOGRAPHICAL SKETCH

Michalakis F. Georgiou Biomedical Engineer/ Research Associate

May 3, 1962
SS# 593-42-5644

University of Miami, C.Gables, FL Electrical Engin.	B.S.	1986
University of Miami, C.Gables, FL Biomedical Engin.	M.S.	1988

Profesional Experience:

Teaching Assistant, Department of Biomedical Engineering, University of Miami.	1986-1988
Research Associate, Division of Nuclear Medicine, University of Miami, School of Medicine.	1989-Present

Research Experience

Master's Thesis: "Determination of Bioelectric Sources in a Volume Conductor from External Measurements of the Electric Potential", Department of Biomedical Engineering, University of Miami. December 1988.

Honors, Awards, Appointments and Memberships:

National Honor Societies: Tau Beta Pi, Eta Kappa Nu, Phi Kappa Phi, Golden Key, Outstanding College Students of America (OSCA), National Dean's List.

University of Miami Honors: President's Honor Roll (4 times), Dean's list (8 times), Electrical Engineering Award, Scholastic Achievement Engineering Award, Graduate Biomedical Engineering Scholarship.

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EDUCATION

Columbia University, M.S. 1985, M.Phil. 1987, Ph.D. 1989
National Technical University of Athens, Greece
Department of Electrical Engineering, Diploma in E. E., July 1984

EXPERIENCE

1989-present	**Department of Electrical and Computer Engineering University of Miami, Associate Professor**
1994-present	**Ocean Pollution Research Ctr, Assoc. Director for Engin.**
May-June 1990	**INRS Telecommunications, University of Quebec, Visiting Scientist.**
1984-1989	**Columbia University, Research Assistant**

SELECTED PUBLICATIONS

- M. F. Georgiou, G. N. Sfakianakis, G. Johnson, C. Douligeris, S. Scandar, E. Eisler, and B. Binkley, "Multivendor Nuclear Medicine PACS Provides Fully Digital Operation at the University of Miami/Jackson Memorial Hospital", *SPIE: PACS: Design and Evaluation,* Newport Beach, CA, February 1994.
- M. Kabakcioglou, C. Douligeris, G. Thuroczy and M. Bodo, "Application of Machine Learning and Expert System Methods for Automated Cerebrovascular Screening", Hungarian Medical Conference, September 1994.
- C. Douligeris and L. Kumar, "Fairness Issues in the Networking Environment: A Survey", *Computer Communications* , Vol. 18, Number 4, April 1995, pp. 288-299.
- C. Douligeris and I. Pereira, " A Telecommunications Quality Study Using the Analytic Hierarchy Process, *IEEE Journal on Selected Areas on Communications,* Special Issue on Quality of Telecommunications Services, Networks and Products, Vol. 12, No 2, February 1994, pp. 241-250.
- C. Douligeris and R. Mazumdar, "Multilevel Flow Control in Telecommunication Networks", *Journal of the Franklin Institute,* Vol. 331B, No. 4, 1995.
- C. Douligeris, "Multiobjective Flow Control in Delay Constrained Telecommunication Networks", *Journal of the Franklin Institute,* Vol. 331B, No. 1, pp. 77-100. January 1994.
- R. Mazumdar, L.G. Mason and C. Douligeris, "Fairness in Network Optimal Flow Control: Optimality of Product Forms", *IEEE Transactions on Communications,* pp. 775-782, May 1991.
- Z. Zhang and C. Douligeris, "Convergence of Synchronous and Asynchronous Greedy Algorithms in a Multiclass Telecommunications Environment", *IEEE Transactions on Communications,* Vol. 40, No. 8, August 1992, pp. 1277-1281.

- C. Douligeris and R. Mazumdar, "Efficient Flow Control in a Multiclass Telecommunications Environment", *IEE Proceedings, Part I,* Vol. 138, No. 6, December 1991.
- S. Liebesman, C. Douligeris and H. Pham, "Quality Assurance Management", *IEEE Communications Magazine,* Special Issue on Quality Assurance Management, Editorial, October 1994, p. 25.
- C. Douligeris, E. Iakovou and A. Korde, "A Synthesis of Decision Models for Analysis, Assessment, and Contingency Planning for Oil Spill Incidents", *Omega, The International Journal of Management Science*, Vol. 22, No. 5, 1994.
- K.G. Zografos, C. Douligeris and L. Chaoxi, "Model for Optimum Deployment of Emergency Repair Trucks: Application in Electric Utility Industry", *Transportation Research Record,* No. 1358, pp. 88-94, 1992.
- C. Douligeris, " An Integrated Approach to Intelligent Home Systems" *IEEE Communications Magazine,* Special Issue on Intelligent Buildings: From Materials to Multi-media, Vol. 31, No. 10, pp. 52- 61, October 1993.

FUNDED RESEARCH PERFORMED

- Routing Models for Transportation of Elderly and Disabled Persons", Miami Center for Human Factors and Aging, Miami, FL, 1994 ($9,800) Principal Investigator.
- Oil Spill Information Management System", United States Coast Guard, 1994-1995, Proj. Co-Leader (with C. N. Mooers), (Project Budget $255,489)
- "Marine Oil Transportation Model", United States Coast Guard, 1994-1995, Proj. Leader, (Project Budget $192,917).
- Design of Prototype South Florida Oil Spill Management System", USCG, 1993-1994 ($50,000, with Drs K. Zografos, L. Iakovou, J. Englehardt, F. Wu and J. Collins) Principal Investigator.
- "Integrating Business and Engineering Curricula", National Consortium for Technology in Business, 1992 ($6,000) Principal Investigator.
- "Enhancements and Modifications of the Service Restoration Model: Integration with Geographic Information Systems Technology" Florida Power & Light, 1992-1993 ($84,344, with Dr. K. G. Zografos) Co-Principal Investigator in 1992, Principal Investigator in 1993.
- "Assessing the Effectiveness of FP&L Training Programs through the Variability of Work Performance: The Service Restoration Operations Paradigm", FP&L through the U. of Miami Institute for the Study of Quality, 1990-1991. ($19,815, with Dr. K. G. Zografos) Co-Principal Investigator.
- "A Model for Reducing Service Restoration Time Through the Optimum Deployment of Service Restoration Units", Florida Power and Light, Academic Years 1990-1991, 1991-1992 ($109,313 with Dr. K. G. Zografos) Co-Principal Investigator.
- "Multiobjective Flow Control in Computer Networks", Florida High Technology and Industry Council, 1990-1991. ($20,000 planning phase, $ 40,000, operational phase) Principal Investigator.

EDITORIAL RESPONSIBILITIES

IEEE Communications Magazine: Technical Editor, March 1994-present.
Associate Technical Editor, 1992-1994.

IEEE Communications Magazine: Guest Co-editor of special issue on "Quality Assurance Management", October 1994.

IEEE Communications Magazine: Guest Co-editor of special issue on "Communications for the Medical Environment", October 1996.

The Institute of Emergency Management Conference (TIEMEC 1995), Steering and Technical Program Committee Member.
IEEE Southeastcon 1993: Executive Committee, Publications Committee Co-chair
IEEE Communications Theory Workshop 1993: Local Organizing Committee
IEEE INFOCOM 1992, 1993, 1994, 1995: Technical Program Committee Member
IEEE ICC 1994: Computer Communications Committee Representative in Technical Program Committee
IEEE ICC 1992, Chicago, IL: Session organizer and chairman
IEEE INFOCOM 1991, Bal Harbor, FL: Member of Local Organizing Committee
ORSA First Workshop on Telecommunications, Boca Raton, March 1990: Session Chairman
ORSA Second Workshop on Telecommunications, Boca Raton, March 1992: Session Chairman
Reviewer: IEEE Transactions on Communications, IEE Proceedings, IEEE Transactions on Engineering Management, IEE Electronics Letters, Annals of Operations Research, Computer Networks and ISDN Systems, IEEE Journal of Selected Areas in Communications, IEEE/ACM Transactions on Networking, International Journal of Microcomputer Applications, International Journal on Communication Systems
IEEE INFOCOM, IEEE ICC, IEEE GLOBECOM
IEEE International Phoenix Conference on Computers and Communications 1995
International Conference on Computer Communications and Networks (IC3N'95).

Organizer of Computer Communications Workshop, March 1991, University of Miami.

Fourth Data Communications Conference, Raleigh NC, October 1993, Technical Program Committee Member.

PROFESSIONAL AND HONORARY ORGANIZATIONS

IEEE Communications Society (Member since 1989)
IEEE Communications Society, Computer Communications Technical Committee (Member since 1989)
ORSA, Special Interest Group on Telecommunications (Associate Member since 1989)
ACM, Special Interest Group on Computer Communications, (Associate Member since 1994)
Technical Chamber of Greece (Member since 1984)

VITA

John William Collins

Assistant Professor
Department of Electrical and Computer Engineering
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Citizenship: United States

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Academic Degrees

Ph.D., Computer Science, University of Illinois, January, 1994. GPA: 5.0/5.0
M.S., Computer Science, University of Illinois, May 1988. GPA: 5.0/5.0
B.S., Mechanical Engineering, Rose-Hulman Institute of Technology, May 1979. GPA: 3.6/4.0

Professional Experience

1992–present Instructor/Assistant Professor, Department of Electrical and Computer Engineering, University of Miami. Courses taught: Systems Programming, Object-Oriented Software Engineering, Principles of Artificial Intelligence, Expert Systems.

1986–1992 Research Assistant, Qualitative Reasoning Group, Department of Computer Science, University of Illinois. (Director, Dr. Kenneth D. Forbus). Major funder: NASA (Johnson, Langley).

1981–1985 Senior Research Engineer, Applied Research Group, Motorola Portable Products Division – Communications Sector, Plantation Florida.

1979–1981 Product Development Engineer, Motorola Portable Products Division – Communications Sector, Plantation Florida.

Summer 1978 Project Engineer's Assistant (for $40 million expansion project), Dow-Corning Corporation, Carrollton, Kentucky.

Research Interests

Artificial Intelligence	Connectionist Architectures	Probabilistic Inference
Model-Based Reasoning	Object-Oriented Methodologies	Cognitive Simulation
Automated Diagnosis	Truth Maintenance Systems	Multimedia

Publications

Conferences with Rigorous Review

Collins, J. and DeCoste, D. "CATMS: An ATMS which avoids Label Explosions." In *Proceedings of the Ninth National Conference on Artificial Intelligence*, Los Angelos, CA, July 1991.

Collins, J. "A Neural Network Based on Co-Occurrence Probabilities." In *Proceedings of the First IEEE International Conference on Neural Networks*, San Diego, CA, June, 1987.

Collins, J. and Forbus, K. "Reasoning about Fluids Via Molecular Collections." In *Proceedings of the Sixth National Conference on Artificial Intelligence*, Seattle, WA, July, 1987. Also appears in D. Weld and J. deKleer, editors, *Readings in Qualitative Reasoning about Physical Systems*, Morgan Kauffman, San Mateo, CA, 1990.

Workshops and other Conferences

DeCoste, D. and Collins, J. "IQE: An Incremental Qualitative Envisioner." In *Proceedings of the Fifth International Workshop on Qualitative Reasoning about Physical Systems*, Austin, TX, May 1991.

Collins, J. "Building Qualitative Models of Thermodynamic Processes." In *Proceedings of the Third International Workshop on Qualitative Reasoning about Physical Systems*, Stanford, CA, August 1989.

Collins, J. "Reasoning about Fluids Via Molecular Collections." In *Abstracts of the First International Workshop on Qualitative Reasoning about Physical Systems*, Urbana, IL, May, 1987.

Collins, J. "Finite Element Modeling: Pre- & Post-processing on a Desktop Computer." In *Proceedings of the Third International ASME Computers in Engineering Conference*, Chicago, IL, August, 1983.

Technical Reports

Collins, J. "Process-Based Diagnosis: An Approach to Understanding Novel Failures." PhD thesis, University of Illinois at Urbana-Champaign, January 1994. (Technical Report UIUCDCS-R-94-1846.)

Collins, J. "Process-Based Diagnosis: An Approach to Understanding Novel Failures." Technical Report # 48, Institute for the Learning Sciences, December 1993.

Collins, J. "Diagnosis as Failure Understanding." Technical Report UIUCDCS-R-91-1699, University of Illinois at Urbana-Champaign, May 1991.

DeCoste, D. and Collins, J. "CATMS: An ATMS which avoids Label Explosions." Technical Report # 13, Institute for the Learning Sciences, Northwestern University, Evanston, IL, May 1991.

Recent Submissions

Collins, J. and Forbus, K. "Molecular Collections: An Ontology for Reasoning about Fluids." Submitted to: *Machine Intelligence*.

Professional Affiliations

Member, American Association for Artificial Intelligence.
Member, Institute for Electrical and Electronics Engineers
Member, Association for Computing Machinery.
Member, American Society of Mechanical Engineers.
Registered Professional Engineer, State of Florida.

Awards

Member, Phi Kappa Phi national honor society.
Member, Eta Kappa Nu electrical engineering honor society.
Recipient, Cognitive Science/Artificial Intelligence Fellowship, 1988-1989.
Research Assistant, University of Illinois Dept. of Computer Science, 1986-1992.
Graduated with honors from Rose-Hulman Institute of Technology, Spring 1979.
Recipient, National Merit Commended Student Award, Spring 1975.

Personal

Born:	1/16/57 in Fort Wayne, IN.
Married:	Two sons, ages one and four years.
Health:	Excellent. Height 6'; weight 165 lbs.
Hobbies:	Automotive repair, carpentry, backpacking, canoeing, music.

Funded Research

"An Adaptive Decision Support System for Oil Spill Countermeasures", United States Coast Guard, 1994-1995, ($39,079 with Drs C. Douligeris and E. Iakovou) Task Principal Investigator.

"Object-Oriented Database Design for Oil Spill Management System", United States Coast Guard, 1994-1995 ($42,736, with Dr. A. Thakore) Task Co-Principal Investigator.

"Geographic Information Systems and Advanced Visualization Techniques", United States Coast Guard, 1994-1995 ($125,237, with Drs C. Douligeris, A. Thakore and B. Baca).

"Design of Prototype South Florida Oil Spill Management System", United States Coast Guard, 1993-1994 ($50,000, with Drs K. Zografos, L. Iakovou, J. Englehardt, F. Wu and C. Douligeris).

UNIVERSITY OF Miami
SCHOOL OF MEDICINE

Department of Radiology
Robert M. Quencer, M.D.
Professor and Chairman
Tel: 305-243-4701
Fax: 305-243-7635

August 29, 1995

Dr. Tzay Y. Young
Professor and Chairman
Department of Electrical and Computer Engineering
405 McArthur B (0640)

Dear Dr. Young:

This letter will serve to inform you that the Department of Radiology intends to sponsor an interdisciplinary Master of Science program in Medical Informatics to be offered jointly by the Department of Radiology and the Department of Electrical and Computer Engineering.

We ask you to review this program and indicate your intent to offer the courses indicated.

As we have discussed, the first class of this program is planned to begin in the Fall of 1996.

Sincerely yours,

Robert M. Quencer, M.D.
Professor and Chairman

RMQ/ogp
cc: Dr. Mansur R. Kabuka

UNIVERSITY OF Miami
SCHOOL OF MEDICINE

Department of Radiology
Robert M. Quencer, M.D.
Professor and Chairman
Tel: 305-243-4701
Fax: 305-243-7635

September 14, 1995

TO: Dr. Tsay Y. Young
Professor and Chairman
Department of Electrical and Computer Engineering

FROM: Robert M. Quencer, M.D.
Professor and Chairman

SUBJECT: Department of Radiology Faculty vote on Graduate Program in Medical Informatics

On September 12, 1995 at our Department's monthly faculty meeting the proposed co-sponsored graduate program in Medical Informatics was unanimously approved by our faculty.

On September 27, 1995 the Medical School Council meets to consider approval of this program (4:00 pm in the Sylvester Conference Room - Sylvester Cancer Center). Prior to that meeting I will need in writing the results of your faculty's vote and the Council of College of Engineering's vote relative to this program.

We look forward to working with you.

cc: Dr. Kabuka

UNIVERSITY OF Miami

MEMORANDUM

September 14, 1995

To: Dr. Robert M. Quencer
Professor and Chairman
Department of Radiology

From: Dr. Tzay Y. Young
Professor and Chairman
Department of Electrical & Computer Engineering

Subject: Interdepartmental Program in Medical Informatics

We are very pleased to learn that the faculty of the Department of Radiology has approved unanimously the proposed M.S. program in medical informatics.

The faculty of the Department of Electrical and Computer Engineering held a meeting on September 1st, 1995, and approved unanimously this proposed program. In addition, the College of Engineering Council met on September 13, and voted unanimously to recommend to the faculty of the College of Engineering for approval of the proposed interdepartmental program. Since the President and the Provost are scheduled to meet the engineering faculty at the next CoE faculty meeting, the proposal of this M.S. program will likely be considered for approval at the October 27, 1995 meeting of the college faculty.

We look forward to having this program started in the Fall of 1996.

TYY/mp

cc: Dr. Kabuka

Department of Electrical and Computer Engineering
P.O. Box 248294
Coral Gables, Florida 33124-0640
Phone: 305-284-3291
Fax: 305-284-4044
E-mail: ece@eng.miami.edu

biochemistry and molecular biology (BMB 610).

A written comprehensive examination is given at the end of the first year. After another 6 months the student is required to take a qualifying examination in the form of a research proposition. The proposition examination committee continues as the dissertation committee, and meets with the student twice a year.

Inquiries should be directed to Dr. Walter Scott; Chairman, Graduate Studies Committee; Department of Biochemistry and Molecular Biology; University of Miami School of Medicine; P. O. Box 016129; Miami, FL 33101.

COMBINED M.D.-PH.D. DEGREE.

The Department participates in a combined M.D.-Ph.D. Program in which students may obtain both degrees. The curriculum will be tailored to the needs of the individual student. Students interested in this program should contact Dr. Walter Scott, Chairman, Graduate Studies Committee, Department of Biochemistry and Molecular Biology.

PROGRAM IN NEUROSCIENCES.

An interdisciplinary program in Neurosciences with research specialization in Biochemistry and Molecular Biology leading to the Ph.D. degree is described under a separate listing for the Program.

G501. Seminars
1 cr.
Companion course to BMB 506, consisting of student and/or faculty presentations on recent research topics. *Prerequisite or corequisite: BMB 506.*

G502. Physical Biochemistry
3 cr.
Thermodynamics of biochemical reactions including chemical potential and equilibrium constants. Principles of diffusion and viscosity with applications to the ultracentrifuge, electrophoresis and chromatography. Topics in spectroscopy including visible, UV and IR absorption and fluorescence. Biochemical applications of ORD, CD, NMR and ESR. X-ray crystallography. *Prerequisite: CHM 365.*

G503. Proteins and Enzymes
3 cr.
This course deals with the structures and mode of action of proteins and enzymes in greater depth than BMB 506. Topics to be discussed include the determination of the covalent and 3D structures of proteins, the relationship of amino acid sequences to the evolutionary history and folding properties of proteins, the mechanisms of enzyme action from the viewpoints of organic chemistry, protein chemistry and kinetics, enzyme inhibition, allostery and cooperativity and the application of molecular genetics techniques, particularly site-directed mutagenesis, to the investigation of structure-function relationships in enzymes and other proteins. *Prerequisite: BMB 506 or permission of instructor.*

G505. Metabolic Processes
2 cr.
Intermediary metabolic processes. Catabolism of carbohydrates, lipids, and nitrogen compounds. Biosynthetic processes leading to amino acids, lipids, isoprenoids, sugars, etc. Regulation of metabolism and cellular economy by various means, including hormones. Lecture, 2 hours. *Prerequisite: BMB 506 or permission of instructor.*

G506. Fundamentals of Biochemistry and Molecular Biology
3 cr.
Basic areas of biochemistry and molecular biology. Central concepts are emphasized. Lecture, 3 hours. *Prerequisite: CHM 202 and two semesters of biology.*

G508. Biochemistry and Molecular Biology Laboratory
1 cr.
Experience in a spectrum of biochemical experiments ranging from enzyme chemistry to recombinant DNA. Laboratory, 3 hours. *Prerequisite or corequisite: BMB 506.*

G509. Molecular Biology of the Gene I
3 cr.
Biochemical processes involved in the propagation and expression of genetic information in both prokaryotes and eukaryotes. Basic cellular processes of DNA replication, repair, genetic recombination, RNA transcription and processing, protein synthesis, control of gene expression, and cell differentiation. Recombinant DNA technology. Reading includes both textbook assignments and original research papers. *Prerequisite or corequisite: BMB 506 or permission of instructor.*

G511. Topics in Biochemistry and Molecular Biology
1-3 cr.
Selected topics from the fields of applied and pure biochemistry and molecular biology taught as a tutorial. *Prerequisite or corequisite: BMB 506.*

G545. Research Problems in Biochemistry and Molecular Biology
2-3 cr.
Laboratory research problems in various fields of biochemistry, including literature search, experiment design, data gathering and evaluation of results. *Prerequisite: BMB 508 and permission of instructor.*

601. Seminar
1 cr.

609. Molecular Biology of the Gene II
2 cr.
This course is a continuation course for BMB 509. It covers essentially the same topics as BMB 509 but at a more advanced level. It brings the student to the forefront of research in Molecular Biology. The course material is discussed exclusively in the form of original research papers. Based on this experience, students are required to propose experimental approaches to biological problems and defend them. *Prerequisite: BMB 509.*

610. Advanced Topics in Biochemistry
1-5 cr.
Senior seminars designed to cover in depth recent developments in the field of biochemistry with the purpose of keeping advanced graduate students abreast with new theoretical and experimental findings. General subjects such as mechanisms of enzyme action, oxidative phosphorylation, active transport, metabolic controls and disorders, steroid biochemistry, biochemical genetics, etc. The detailed program will be announced annually. Majors in Biochemistry and Molecular Biology will be expected to take this course each semester in their second and third years. *Prerequisite: BMB 506 and departmental permission.*

BMB 506 → 508 509

Group B

Biochemistry and Molecular Biology

6 cr.
The entire human body is dissected with emphasis on morphology and its functional and clinical application. Teaching aids in the form of osteology loan sets, models, prosected material and films on regional anatomy are utilized. Students are introduced to radiologic anatomy in correlation with regional dissections. *Prerequisite: Permission of course supervisor.*

G501. Human Embryology
1 cr.
Introduction to development of major human organ systems in embryos. Lecture, self-study, and laboratory. *Prerequisite: Permission of course instructor.*

G504. Histology
4 cr.
Light and electron microscopic structures of organs. Structure correlated with function at physiological and biochemical levels. Primary emphasis on the morphological basis for function at the microscopic and ultrastructural levels. *Prerequisite: Permission of course supervisor.*

G505. Neuroanatomy
3 cr.
This course is an introduction to the major structures and pathways of the human central nervous system. The student dissects a whole brain and examines transverse sections of the brain stem and spinal cord. This course is correlated with the concurrent Neuro-physiology course. *Prerequisite: Permission of course supervisor.*

601. Seminar
1 cr.
For graduate students in Cell Biology and Anatomy. Direction by departmental members of Graduate Faculty.

606. Computer Applications in Research
2 cr.
Microcomputer programs beneficial to a wide variety of biomedical research applications. *Prerequisite: Permission of instructor.*

610. Readings in Cell Biology
1-6 cr.
Current and classical research papers in cell, developmental and molecular biology. Critical evaluation of papers and the methodologies used. *Prerequisite: Permission of course supervisor.*

611. Accelerated Basic Science Medical Curriculum
18 cr.
Beginning in the latter part of June each year, extending to the middle of February of the ensuing year, the following accelerated and intensive complete basic science medical curriculum is offered: Embryology, Gross Anatomy, Histology, Biochemistry, Neuroanatomy, Biophysics and Neurophysiology, Systemic Physiology, Pathology, Medical Microbiology, and Pharmacology. A single grade will be entered on the graduate transcript for this course. *Prerequisite: Admission to the Combined M.D./Ph.D. degree Program.*

612. Pathobiology I
3 cr.
Required for Physician Scientist Program students; open to graduate students. Two, three-hour sessions (first hour at multi-headed scope followed by two hours of laboratory) per week for eight weeks in the fall semester (September and October; days and times to be arranged). The purpose of the pathobiology course is to provide graduate students with knowledge of basic principles for understanding normal histomorphology and pathologic lesions associated with experimentally induced and naturally occurring diseases. The keystone of this innovative, short course is the small group's socratic study of a series of autopsy cases—each represented by a set of microscopic slides. The cases are preselected to allow the students to focus on specific, basic concepts early and organ-system lesions later. Students spend the first hour of the biweekly sessions at a multi-headed scope creating a profile of the patient—including age, sex, race, and chief disease. At the end of the first hour deliberations, students receive feedback regarding their conclusions by being provided with a summary of the patient's history and autopsy findings. Students review relevant gross specimens and kodachromes during the biweekly two-hour laboratory sessions. *Prerequisite: Admission to the Physician Scientist Program or the graduate program in one of the five basic science departments located at the School of Medicine.*

613. Topics in Cell Biology
1-6 cr.
Formal seminar course in which each student presents a lecture relating to a specific theme. Topical areas in cell, developmental and molecular biology with the subject changing each term. *Prerequisite: Permission of course supervisor.*

614. Biological Structure I: Macromolecular
3 cr.
This course deals with the structures and properties of biological macromolecules, with particular emphasis on proteins. A brief introduction to the physical chemistry of macromolecules in aqueous systems will be followed by a detailed discussion of all levels of macromolecular structure including protein folding and evolution. The second half of the course will focus on mechanisms of catalysis at the molecular level including discussion of various mechanisms of enzyme regulation. This course will also provide an introduction to selected techniques used in the study of macromolecules, including aspects of protein chemistry, spectroscopic methods, NMR, ESR and protein crystallography. *Prerequisite: BMB 506 or equivalent, or permission of instructor.*

615. Biological Structure: Supramolecular
3 cr.
This course covers the interactions, both covalent and non-covalent, of different classes of biological molecules and the organization of biological molecules into larger complexes and higher order structures. Topics will include covalent modifications of proteins and lipids; non-covalent interactions of proteins with nucleic acids, carbohydrates and lipids; and organization of biological molecules into bacteriophage, organelles, membranes and tissues. A consideration of methods of investigation of supramolecular structure is included. *Prerequisite: BMB 506 or equivalent, or permission of instructor.*

Cell Biology and Anatomy

GROUP B

G501. Medical Microbiology
5 cr.
Nature of microbial agents of infectious disease. Relationship of virulence to host resistance. Fundamental immunologic concepts. Microbial physiology and genetics, and the structure, design and mechanism of action on antimicrobials. *Prerequisite: Permission of Department Chairman.*

G521. Immunobiology
3 cr.
Current concepts of lymphoid subsets, chemical modulators and genetics. Development and maintenance of the immune system. *Prerequisite: MIC 524. Corequisite: BMB 401 or 506.*

G523. Mechanisms of Bacterial Virulence
3 cr.
Factors implicated in bacterial pathogenesis. Diseases which exemplify different pathogenic "strategies." Design of antibiotics and vaccines. *Prerequisite: MIC 524, BMB 401 or 506.*

G524. Microbial and Molecular Genetics
3 cr.
Molecular mechanisms relating to DNA function, mutation, repair and recombination. *Prerequisite: MIC 501.*

G525. Virus-Host Interactions
3 cr.
The obligate intracellular parasitic nature of viruses and the host defenses against viral infections. *Prerequisite: MIC 524. Corequisite: MIC 521.*

611. Accelerated Basic Science Medical Curriculum
18 cr.
Beginning in the latter part of June each year, extending to the middle of February of the ensuing year, the following accelerated and intensive complete basic science medical curriculum is offered: Embryology, Gross Anatomy, Histology, Biochemistry, Neuroanatomy, Biophysics and Neurophysiology, Systemic Physiology, Pathology, Medical Microbiology, and Pharmacology. A single grade will be entered on the graduate transcript for this course. *Prerequisite: Admission to the Combined M.D./Ph.D. degree Program.*

612. Pathobiology I
3 cr.
Required for Physician Scientist Program students; open to graduate students. Two, three-hour sessions (first hour at multi-headed scope followed by two hours of laboratory) per week for eight weeks in the fall semester (September and October; days and times to be arranged). The purpose of the pathobiology course is to provide graduate students with knowledge of basic principles for understanding normal histomorphology and pathologic lesions associated with experimentally induced and naturally occurring diseases. The keystone of this innovative, short course is the small group's socratic study of a series of autopsy cases—each represented by a set of microscopic slides. The cases are preselected to allow the students to focus on specific, basic concepts early and organ-system lesions later. Students spend the first hour of the biweekly sessions at a multi-headed scope creating a profile of the patient—including age, sex, race, and chief disease. At the end of the first hour deliberations, students receive feedback regarding their conclusions by being provided with a summary of the patient's history and autopsy findings. Students review relevant gross specimens and kodachromes during the biweekly two-hour laboratory sessions. *Prerequisite: Admission to the Physician Scientist Program or the graduate program in one of the five basic science departments located at the School of Medicine.*

616. Advanced Molecular Biology
3 cr.
The molecular basis of cellular function and regulation in both procaryotic and eucaryotic systems. The molecular genetics and biochemistry of the genetic material and its utilization during replication, transcription, translation and cellular growth, division and differentiation. Recombinant DNA technology and molecular genetics are discussed. This course is designed for graduate students in biological sciences. A good background in biology or biochemistry is recommended.

626. Laboratory Experimentation
4 cr.
One or two laboratory training session of 6-12 weeks each. Each student will rotate through faculty research laboratories in the areas of immunology, molecular biology and microbiology, (bacteriology, virology, parasitology) where they will receive "hands on" experience by participating in ongoing research projects. *Prerequisite: MIC 501 and permission of Chairman of Graduate Studies Committee.*

627. Laboratory Experimentation
6 cr.
Two or three laboratory training sessions of 6-12 weeks each. Each student will rotate through faculty research laboratories in the areas of immunology, molecular biology and microbiology, (bacteriology, virology, parasitology) where they will receive "hands on" experience by participating in ongoing research projects. *Prerequisite: MIC 501 and permission of Chairman of Graduate Studies Committee.*

MIC 501 MIC 612
MIC 524

GROUP B
Microbiology and Immunology
MIC

are expected to participate in some teaching.

Requirements for the M.S. Degree Include:

1. 24 credits on the graduate level (exclusive of six thesis credits) including credit for course 600 each semester in residence;
2. writing an acceptable thesis;
3. satisfactory performance on the M.S. examination, which emphasizes topics related to the thesis. Up to six graduate credits earned elsewhere may be acceptable toward M.S. requirements.

Requirements for Admission to Candidacy for the Ph.D. Degree Include:

1. 36 graduate credits (exclusive of dissertation research);
2. satisfactory performance on a qualifying examination that comprises a written comprehensive examination and the submission and oral defense of a research proposal. Both aspects involve demonstrating mastery of relevant physiological principles and methods. The examination must be passed not later than 24 months after enrollment in the Department. Up to 12 transfer credits earned elsewhere may be acceptable toward Ph.D. requirements.

The Ph.D. dissertation research must be original work of a quality acceptable for publication in a first-rate scientific journal.

For further details on requirements, the general information sections of this *Bulletin* should be consulted.

Prospective applicants are urged to write early to the Department for further information on the Department's activities, training resources, requirements, and financial aids. Address inquiries to: Dr. D. Landowne; Chairman, Graduate Studies Committee; Department of Physiology and Biophysics; P. O. Box 016430; Miami, FL 33101.

Program in Neurobiology

The Department of Physiology and Biophysics offers graduate and postdoctoral training programs in Neurobiology. The graduate program leads to the Ph.D. degree. These programs are funded by an NIH training grant. Training is available in developmental neurobiology, sensory receptor mechanisms, axonal electrophysiology, ionic mechanism of the nerve impulse, electrophysiological and molecular aspects of synaptic and neuromuscular transmission, ion channels in nerve and muscle cell membranes, nerve cell culture, metabolic aspects of nervous function, molecular neurobiology, neuroimmunology, protein synthesis and transport in neurons, nerve regeneration, and regulation of muscle contraction. Prospective graduate students who are interested in this Program should so indicate when applying for admission to the Department. Admission to the Program may occur either at the time of or after admission to the Department.

Program in Neurosciences

An interdisciplinary program in Neurosciences with a research specialization in Physiology and Biophysics, and leading to the Ph.D. degree, is described under a separate listing for the program.

M.D./Ph.D. Programs

Students interested in pursuing careers in academic medicine or, more generally, in medically-related research may wish to enter a dual (M.D./Ph.D.) degree program. Details about this program and application procedures are obtainable from the Graduate Studies Committee Chairman at the address given above.

G510. Cell Physiology Biophysics
2 cr.
This course is designed as preparation for the study of mammalian physiology. It is usually scheduled as an intensive course, adapted to the schedule of the medical curriculum and occupying the equivalent of two to three days per week for two-three weeks. The student is introduced to general principles of cell physiology, chemical and physical structure of membranes, membrane transport and electrical membrane phenomena. Topics studied include excitation, contraction, energy transduction, nerve impulse conduction, and synaptic transmission. Lecture and laboratory. *Prerequisite: Permission of the Departmental Graduate Studies Committee.*

G511. Neurophysiology
3 cr.
Physiology of the mammalian nervous system. It is usually scheduled as an intensive course, adapted to the schedule of the medical curriculum and comprising roughly five hours of lecture and four hours of conference weekly for five to six weeks. A lecture course coordinated with neuroanatomy. *Prerequisite: PHS 510 or 641, or an equivalent; permission of the Departmental Graduate Studies Committee. Prerequisite or corequisite: CBA 505.*

X **G512. Systemic Physiology**
5 cr.
Physiology of the mammalian cardiovascular, respiratory, renal, digestive, endocrine and reproductive systems. It is usually scheduled as an intensive course, adapted to the schedule of the medical curriculum and occupying the equivalent of about two days a week for most of semester. Lecture and laboratory. *Prerequisite: Permission of the Departmental Graduate Studies Committee, including endocrinology.*

GROUP B

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: Professor D. Sarker, Department of Mathematics & Computer Science
Professor O. Ozdamar, Department of Biomedical Engineering
Professor M. O'Connell, Department of Medicine

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: December 18, 1995

SUBJECT: Master of Science Program in Medical Informatics

This is an update on my letter of December 7, 1995 in which I asked each of you to serve on an ad hoc committee to review, on behalf of the Senate, the proposed Masters Program in Medical Informatics.

I am glad to receive confirmation of your willingness to serve on this committee and I take note of Dr. Sarkar's preference not to chair the committee if it is expected to report early in the spring semester. Therefore, and at my request, Dr. Ozdamar has agreed to chair this committee.

I look forward to receiving your written recommendations by mid-February so we can attach them to the call for the February meeting of the Faculty Senate.

Again, thank you very much for your willingness to serve.

KY/b

cc: Provost Luis Glaser
Dean John Clarkson, School of Medicine
Dean Tarek Khalil, Graduate School
Dean M. Lewis Temares, College of Engineering
Dr. Robert Quencer, Chair, Department of Radiology
Dr. Tsay Young, Chair, Department of Electrical and Computer Engineering
Dr. Mansur Kabuka, Department of Electrical and Computer Engineering

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

UNIVERSITY OF
Miami

MEMORANDUM

DATE: October 4, 1995

TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Bernard J. Fogel, M.D., Dean, School of Medicine
and
Dr. M. Lewis Temares, Dean, College of Engineering

RE: Proposal for a Master of Science Degree in Medical Informatics

---

Attached is a proposal for an interdisciplinary Master of Science Degree in Medical Informatics between the Department of Radiology, and the Department of Electrical and Computer Engineering, College of Engineering. This proposal was approved unanimously by the faculty of the Department of Radiology on August 29, 1995, and by the faculty of the College of Engineering and the Council of the School of Medicine on September 27, 1995.

We endorse this proposal, including the proposed annual budget of approximately $105,000. Please initiate the process of getting this proposal approved. We would like to promote this program as soon as possible and have it included in the AY96 University Bulletin.

The program will be administered by the Department of Radiology at the School of Medicine, chaired by Robert M. Quencer, M.D., and by Dr. Mansur Kabuka, Director and Administrator of the program, with an advisory committee of the two deans and two faculty from each school/college. Please contact either Dean Fogel or Dean Temares with any questions on this proposed degree program.

Thank you in advance for your efforts on our behalf.

Attachment
cc: Dr. Luis Glaser
Dr. Samuel S. Lee
Dr. Thomas D. Waite
Dr. Tzay Y. Young
Dr. Mansur Kabuka
Robert M. Quencer, M.D.

Senior Vice President for Medical Affairs and Dean
P.O. Box 016099
Miami, Florida 33101
305-243-6545 Fax 305-243-4888

UNIVERSITY OF Miami

Executive Vice President and Provost

MEMORANDUM

May 17, 1995

TO: Dean Bernard J. Fogel
School of Medicine

Dean M. Lewis Temares
College of Engineering

Dr. Robert W. Rubin
Vice Provost for Research and Deputy Dean,
Research and Graduate Studies

Dean Tarek M. Khalil
Graduate School

Professor Mansur R. Kabuka
College of Engineering

FROM: Luis Glaser
Executive Vice President
and Provost

SUBJECT: Medical Informatics

I have just concluded a meeting with Kamal Yacoub and Bill Awad on this subject. We all agree that the program on medical informatics is interesting, important, and one that we need to complete as quickly as possible. On the other hand, it is also important that the appropriate departments and schools approve this program as need be. We have a Medical School Council meeting scheduled for May 31, where this program can be approved, but the following needs to happen.

P.O. Box 248033
Coral Gables, Florida 33124-4628
(305) 284-3356
Fax: (305) 284-6758

1. From the material that I have seen, we need to define the characteristics of the students that are being trained in the program, i.e. the admission requirements. Is this a program to train engineering graduates, or is this a program to train people with other backgrounds, and if so do they go on the same track?

2. We need a budget and approval for the budget from the appropriate sources of funds.

3. We need each of the two departments, Radiology and Electrical Engineering, to commit to participate in the training for these programs, even if it only involves existing courses.

4. We need to get the departments to communicate on this matter.

5. Respective school approvals need to be obtained.

I believe that all of this can be done before May 31 so that we can proceed with these programs.

I am well aware of the fact that interdisciplinary programs can potentially be approved by the Graduate Council, but before they get this approval they must be fully approved by the participating departments and schools. In addition, once the programs are approved by the Graduate Council, I believe that it is our practice, even if it may not have been so codified, that such degree granting programs need Senate approval.

Thank you all for your help.

LG:vls

cc: Dr. Kamal Yacoub

To: JK & WW

From: K.Y

Advisory Council Meeting Tuesday $3^{00} - 4^{00}$

To discuss a serious academic matters including

Graduate Council & Graduate Dean approved on 4/12/95

a New M.S. program in Medical Informatics

without the approval of Medical School Council (& College of Engineering)

or Faculty Senate. Please see attached

4/28 memo from Yacoub to Khalil

5/11 response from Khalil to Yacoub

- Front page of proposal
- Program Committee

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: Dr. Tarek M. Khalil
Dean, Graduate School

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 28, 1995

SUBJECT: M.S. in Medical Informatics

This is in reference to the new M.S. program in Medical Informatics submitted by the Department of Radiology in the School of Medicine. You informed me that the Graduate Council approved this program and yet I do not find any mention of the program being approved by the Medical School Council which is empowered to act on such matters on behalf of the faculty of the School of Medicine. Such approval is necessary before submission to the Graduate Council and eventually to the Faculty Senate.

KY/b

cc: Dean Bernard Fogel
School of Medicine

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

UNIVERSITY OF Miami

Tarek M. Khalil
Dean

M E M O R A N D U M

May 11, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Response to Memoranda of 4/28/95

The interdepartmental M.S. Program with concentration in Medical Informatics is organized as an interdepartmental program under the auspices of the Graduate School's interdisciplinary and interdepartmental programs. The title modification of the M.S. concentration in Occupational Ergonomics and Safety is proposed for an existing interdepartmental concentration. As approved by the Senate and Board of Trustees in 1975, the Graduate Council is empowered to act on interdepartmental and interdisciplinary programs.

The change of the title for the Ph.D. program in Ergonomics to "Ergonomics and Human Factors" was sent to the College of Engineering for approval. Once this approval is received, we will forward it to the Senate for consideration of the change.

TMK/msb

cc: Dr. Luis Glaser
Dr. Bernard Fogel
Dr. Robert Rubin
Dr. Lewis Temares
Graduate Council

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

Proposal for the Establishment of a M.S. Program in Medical Informatics

Department of Radiology
School of Medicine

4. FACULTY

Program Director

Dr. Mansur R. Kabuka	Department of Electrical & Computer Engineering/Department of Radiology

Program Committee

Committee Chairperson

Dr. Robert W. Rubin	Vice Provost and Deputy Dean, Research and Graduate Studies

Dr. Jeffery Augenstein	Department of Surgery/Ryder Trauma Center
Dr. Judy Bean	Department of Epidemiology and Public Health
Dr. Ronald G. Clark	Department of Cell Biology and Anatomy
Dr. Laurence B. Gardner	Department of Medicine
Dr. Ozcan Ozdamar	Department of Biomedical Engineering
Dr. Pradip M. Pattany	Department of Radiology
Dr. Robert M. Quencer	Department of Radiology
Dr. Stuart A Stein	Departments of Neurology, Medicines and Pediatrics

Program Faculty

Judy Bean, Ph.D.	Department of Epidemiology and Public Health
Ronal E. Block, Ph.D.	Department of Radiology
Brian Charles Bowen, Ph.D., M.D.	Department of Radiology
Ronald G. Clark, Ph.D.	Department of Cell Biology and Anatomy
John Collins, Ph.D.	Department of Electrical & Computer Engineering
Francis Donahue, D.O.	Department of Radiology
Christos Douligeris, Ph.D.	Department of Electrical & Computer Engineering
Joel Elliot Fishman, M.D., Ph.D.	Department of Radiology
Keneth Goodman, Ph.D.	Director, Forum for Bioethics and Philosophy
Abdulmehdy M. Jabir, M.Phil.	Department of Radiology
Mansur R. Kabuka, Ph.D.	Department of Electrical & Computer Engineering/Department of Radiology
George Kutty, Ph.D.	Center for Medical Imaging and Medical Informatics
Ronald Charles Joseph, M.D.	Department of Radiology
Ozcan Ozdamar, Ph.D.	Department of Biomedical Engineering
Pradip M. Pattany, Ph.D.	Department of Radiology
Reeza Rossie,M.S.E.E.	Medical Networks, School of Medicine
George N. Sfakinakis, M.D.	Department of Radiology
Frank Sauer, M.S.Comp.Sc.	Center for Medical Imaging and Medical Informatics
Frank Stitt,M.D.	Department of Epidemiology and Public Health
David Schwartz, M.D.	Department of Radiology
Stuart A Stein, M.D.	Departments of Neurology, Medicines and Pediatrics
Wonhee Sull, Ph.D.	Center for Medical Imaging and Medical Informatics
Arun Thakore, Ph.D.	Department of Electrical & Computer Engineering
Martin Trafler, Ph.D.	Department of Radiology
Sherif M. Waly, Ph.D.	Center for Medical Imaging and Medical Informatics
Thomas Williams	Assoc Director of Systems Integration & Access, Louis Calder Memorial Librar
Tzay Young, Ph.D.	Department of Electrical & Computer Engineering

Proposal for a

Master Program in Interdepartmental Studies

with a Concentration in

Medical Informatics

Sponsored by

The Department of Radiology	and	The Department of Electrical and Computer Engineering
in the School of Medicine		in the College of Engineering

Required Approvals

Faculty of the Department of Radiology at its meeting on _____

_____
Chair's Signature

Faculty of the Department of Electrical and Computer Engineering at its meeting on _____

_____
Chair's Signature

Medical School Council at its meeting on _____

_____
Dean's Signature

Faculty of the College of Engineering at its meeting on _____

_____
Dean's Signature

Budget Approval by the Provost on _____

_____
Provost's Signature

Graduate Council at its meeting on _____

_____
Graduate Dean's Signature

UNIVERSITY OF Miami

Tarek M. Khalil
Dean

CDFHI

M E M O R A N D U M

May 11, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Response to Memoranda of 4/28/95

The interdepartmental M.S. Program with concentration in Medical Informatics is organized as an interdepartmental program under the auspices of the Graduate School's interdisciplinary and interdepartmental programs. The title modification of the M.S. concentration in Occupational Ergonomics and Safety is proposed for an existing interdepartmental concentration. As approved by the Senate and Board of Trustees in 1975, the Graduate Council is empowered to act on interdepartmental and interdisciplinary programs.

The change of the title for the Ph.D. program in Ergonomics to "Ergonomics and Human Factors" was sent to the College of Engineering for approval. Once this approval is received, we will forward it to the Senate for consideration of the change.

TMK/msb

cc: Dr. Luis Glaser
Dr. Bernard Fogel
Dr. Robert Rubin
Dr. Lewis Temares
Graduate Council

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

UNIVERSITY OF Miami

FACULTY SENATE

CDFIII

MEMORANDUM

TO: Dr. Tarek M. Khalil
Dean, Graduate School

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 28, 1995

SUBJECT: M.S. in Medical Informatics

This is in reference to the new M.S. program in Medical Informatics submitted by the Department of Radiology in the School of Medicine. You informed me that the Graduate Council approved this program and yet I do not find any mention of the program being approved by the Medical School Council which is empowered to act on such matters on behalf of the faculty of the School of Medicine. Such approval is necessary before submission to the Graduate Council and eventually to the Faculty Senate.

KY/b

cc: Dean Bernard Fogel
School of Medicine

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

UNIVERSITY OF Miami

Tarek M. Khalil
Dean

M E M O R A N D U M

April 17, 1995

TO: Dr. Kamal Yacoub, Chairman
Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics Program

As per your request, I am enclosing herewith a copy of the proposal for the interdepartmental program on Medical Informatics. If you may need any additional information, please let me know.

TMK/msb

Enclosure

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

UNIVERSITY OF Miami

Vice Provost for Research and Deputy Dean for Research and Graduate Studies
P.O. Box 016960 (R64), 1600 N.W. 10 Avenue, Miami, Florida 33101

M E M O R A N D U M

TO: Dr. Tarek Khalil, Dean of The Graduate School

FROM: Robert W. Rubin, Vice Provost and Deputy Dean

SUBJ: Medical Informatics Program

DATE: 3-2-95

This is to confirm that the School of Medicine is committed to the hard dollar costs for the new Medical Informatics program budget (enclosed). These are the responsibility of the Department of Radiology. The hard dollar amount is $105,000/yr. The other expenses listed ($191,165/yr.) represent cost shared salaries which have been agreed to by the respective administrators. The revenue figures quoted are of course estimates but appear reasonable. There will be a complicated split of revenues between the Department of Radiology and the College of Engineering which will be negotiated after we have some experience with the student mix. From an institutional standpoint I am prepared to live with the figures presented in the enclosed proposed 5 yr. budget. Thank you.

Administrative Offices
Suite 1148
(305) 547-5706
Fax: (305) 547-3549

Graduate Studies
Suite 1070
(305) 547-6406
Fax: (305) 547-3593

Research Administration
Suite 1149
(305) 547-6232
Fax: (305) 548-4611

FIVE YEAR PROFORMA: GRADUATE PROGRAM IN MEDICAL INFORMATICS
Department of Radiology
University of Miami School of Medicine

DRAFT

First year expenses:

Program Faculty	FTE Base salary	Rate	Program Cost	Funded Cost
Kabuka, Mansur	75,690	25%	18,923	0
Clark, Ronald	59,911	25%	14,978	14,978
Goodman, Mark	75,000	15%	11,250	11,250
Mathews, George	41,000	15%	6,150	0
Pattany, Fred	89,280	15%	13,392	0
Sauer, Frank	38,000	15%	5,700	0
Stitt, Frank	130,000	15%	19,500	19,500
Waly, Sherif	35,000	15%	5,250	0
Younis, Akmal	50,000	15%	7,500	0
Non-clin faculty CFB @		26.80%	27,508	12,255
Administrator	22,000	50%	11,000	0
Staff CFB @		27.25%	2,998	0
Fellowships: 3	9,000		27,000	27,000
Brochure			6,000	6,000
Clerical; misc. supplies			2,017	2,017
Incremental space			0	0
Instruction materials			3,000	3,000
Recruitment			6,000	6,000
Contingency			3,000	3,000
			191,165	105,000
FIVE YEARS EXPENSE (without annual increase)			955,824	524,999

REVENUE (also without annual increase)

Yr 1:	10 students; 3 on fellowship =	7	14,000	98,000
Yr 2:	10 incremental students =	17	14,000	238,000
Yr 3:	15 incremental students (1) =	22	14,000	308,000
Yr 4:	20 incremental students (2)=	32	14,000	448,000
Yr 5:	Status quo =	32	14,000	448,000
				1,540,000

(1) 10 students graduated; total students enrolled = 25 students; 3 of which are on fellowship
(2) 35 total students enrolled; 3 of which on fellowship

UNIVERSITY OF Miami

MEMORANDUM

DATE: March 7, 1995

TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Dr. M. Lewis Temares

RE: Proposal for the Establishment of a M.S. Program in Medical Informatics

The College of Engineering and its Dean fully endorse and support the joint program with the School of Medicine to establish a M.S. Program in Medical Informatics.

MLT:fc

College of Engineering
Office of the Dean
P.O. Box 248294
Coral Gables, Florida 33124-0620
305-284-2404
Fax: 305-284-3815

MEDICAL INFORMATICS M.S. PROPOSAL REPORT

Subcommittee members:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, Meteorology and Physical Oceanography
Dr. E. Saltzman, Marine and Atmospheric Chemistry
Dr. D. Sarkar, Mathematics

The Graduate School's Physical Sciences Committee met with Vice Provost Robert Rubin and Dr. Mansur Kabuka from the Department of Radiology on April 3, 1995 to discuss the proposed Interdepartmental Program leading to an M.S. degree in Medical Informatics. The exchange centered around the proposal for the program put together by the department. Overall, the committee found that the plans for the program were well laid out and that the medical school has a strong commitment to the financial support of this program. The curriculum makes wide use of existing courses and blends the talents of the Engineering School and the Radiology Department in a creative manner.

Comparison of the program's offering with similar programs at other universities were provided in the report. The balance between computer oriented training, data base courses, and introduction to medical sciences mirrors these other programs. Concern was expressed over the requirement of 36 thesis track hours and 39 non-thesis hours in the program. The committee was especially concerned over the extra six to nine hours being a disincentive for students coming up through biomedical engineering or the proposed joint B.S. in Computer Engineering and M.S. in Medical Informatics Program. A suggestion was made to require a "minimum" of 30 hours plus additional course work in the various core areas. This would allow students with prior backgrounds in the core course areas to complete the curriculum while making use of their prior training. A short discussion was also held on future growth in the program. The need for care in tuning courses in this rapidly growing field was acknowledged. It was pointed out that the program may wish to expand to Ph.D. offerings within a three to five year time frame. Dr. Rubin brought up the issue that this program might produce more of a professional degree serving the medical community with M.S. practitioners rather than necessarily growing into a specialty academic field at the Ph.D. level. The committee encouraged the department to return to Council with a short report on the development of the program within two years and looks forward to hearing plans for the longer term goals of this effort.

In summary, the committee enthusiastically supports the new program and wishes it luck in fulfilling its goals over the next few years.

April 12, 1995

UNIVERSITY OF Miami

M E M O R A N D U M

March 22, 1995

TO: *Subcommittee on Programs and Degrees*
Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: *Tarek M. Khalil Dean*
The Graduate School

SUBJECT: *Medical Informatics M.S. Program*

A meeting has been scheduled for Monday, April 3 at 9:00 a.m. in the Ferre Building Conference Room 3rd. floor to discuss the establishment of an Interdepartmental M.S. Program in Medical Informatics.

Thank you for your participation.

TMK:nb

Copy to: Dr. John W. Brown

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax 305-284-5441

UNIVERSITY OF Miami

M E M O R A N D U M

March 2, 1995

TO: Subcommittee on Programs & Degrees Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: Dr. Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics M.S. Program

I am enclosing, for your information, a copy of a proposal for the establishment of an Interdepartmental M.S. Program in Medical Informatics.

A meeting will be scheduled soon to discuss this proposal.

TMK:nb

Enclosure

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax 305-284-5441

5-YEAR PROFORMA: MEDICAL INFORMATICS M.S. PROGRAM

FIRST YEAR EXPENSES

Program Faculty	% Effort
Mansur Kabuka (Director)	25%
Frank Stitt	15%
Kenneth Goodman	15%
Ron Clarke (Assoc. Director)	25%
Pradip Pattany	15%
George Mathews	15%
Akmal Younis	15%
Frank Sauer	15%
Sherif Waly	15%
Administrator	100%
3 fellowships	
Subtotal	**$180K**
Brochure	6K
Recruitment costs	6K
Instruction materials	8K
Supplies/miscellaneous	5K
Contingency	3K
Subtotal	**$28K**
Contingency	3K
FIRST YEAR TOTAL	**$208k**
TOTAL 5 YEAR COSTS	**$1,040,000**

YEAR 1

10 student 3 of which are on fellowship
Revenue **$98K**

YEAR 2

10 incremental students
Revenue **$238K**

YEAR 3

15 incremental students
Revenue **$308K**

10 students graduated from the program
Total students enrolled = 25 students; 3 of which are on fellowship

YEAR 4

20 incremental students
Revenue **$448K**

Total students enrolled = 35 students; 3 of which on fellowship

YEAR 5

Status Quo **$448K**

*The difference in the balance is expected to be offset from other activities, e.g., certificate programs and off campus programs.

Proposal for the Establishment of a M.S. Program in Medical Informatics

Department of Radiology
School of Medicine

1. RATIONALE

The rapidly growing knowledge base in the medical field is vast and encompasses both scientific knowledge and the day-to-day business of providing healthcare. To understand the medical user's complex needs, information scientists need formal training in the healthcare environment to implement complicated information science techniques. It is crucial to identify the processes in healthcare which could benefit most from information technology because a broad brush approach could be costly and inhibit progress. Recently, **the Association of American Medical Colleges formed the Steering Committee** to evaluate the status of medical informatics in the United States. The Steering Committee on the Evaluation of Medical Information Science in Medical Education concluded that medical informatics is basic to the understanding and practice of modern medicine. One recommendation of this committee indicates that medical informatics should become an integral part of the medical curriculum.

This proposal is developed to offer a M.S. degree in Medical Informatics. It is in the best interests of the University, the community of the southeast region, and the students that a M.S. degree in medical informatics be established.

The World Health Organization report on "Informatics and Telematics in Health" stresses that managerial decision-making in health care requires accurate, reliable, relevant, and timely information. It further notes that the health worker of the year 2000 is likely to be a person with immediate access to a large amount of data along with analytical decision support routines to assist in decision making. These needs will require advanced research and development in the areas of database, statistical data analysis, data storage, validation, retrieval, presentation, and distribution, decision support systems, knowledge-bases, artificial intelligence and neural networks. Multidisciplinary expertise is required to achieve the essential level of knowledge in these areas.

The program curriculum is developed to reflect the interdisciplinary structure of the medical informatics field. The program is designed to prepare individuals to develop, use, and evaluate applications of information technology in the health care environment. The program also stresses the methods used to study the effectiveness of information technology applications. The proposed M.S. degree is an interdepartmental program between the School of Medicine and the College of Engineering which will be hosted by the Department of Radiology.

What is Medical Informatics?

Medical Informatics is the scientific field that deals with medical information, data, and knowledge. It deals with the concepts and principles of acquiring, processing, and presenting information to support medical practice, problem solving and decision making in the health care industry. Medical Informatics touches on all basic and applied fields in medical science and is closely related to modern information technologies including computing and

communication. Medical informatics has emerged as a new discipline due to a number of factors, including advances in computing and communications technology, an increasing awareness that the medical knowledge base is unmanageable by traditional methods, and a growing conviction that knowledge retrieval and expert decision making are important to modern medicine. Modern technologies enable the capture and organization of medical user requirements. Challenges in developing and using these technologies in healthcare include developing enterprise integration tools to translate information, helping users determine what information they need, and facilitating information flow across the healthcare enterprise. Also, using technology requires developing business modeling techniques to define and analyze the relationships among the different processes in providing healthcare.

Knowledge of computer engineering is a major element of the medical informatics. However, effective research and development in this area also requires practical knowledge and fundamental research in cognitive science, clinical medicine, basic medical sciences, biostatistics, epidemiology, hospital organization, hospital financing and reimbursement, management and decision sciences, and medical ethics. In such an interdisciplinary field, students must be exposed to these diverse topics.

Medical informatics spans a wide range of activities that includes, but is not limited to:

(1) basic research and exploratory experiments
(2) applied research and evaluation of approaches
(3) technological development for specific user needs
(4) deployment of practical applications
(5) planning and policy development for using information technology in health care and medical education

Medical Informatics Education

A recent study by Gassert et al (1991)* indicated the increased demand for graduate level education in medical informatics. The results of a survey of accredited hospitals of 300 beds or more in 19 states demonstrated that all institutions use computer technology in health care practice and/or administration. Almost three-fourths of the hospitals already allocate one or more budgeted positions for managers of information systems. An additional 50% of the respondents foresaw a need for such positions in their institutions within two years. Virtually all respondents saw some need for a graduate program.

Currently, the number of graduate medical informatics programs (M.S. and Ph.D.) nation wide is limited. Although academic units of medical informatics are established at only a few institutions in the United States, increasing numbers of schools are considering this activity.

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* Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC.

The following is a partial list of the medical informatics programs available in the United States:

1. Columbia University: Post-Doctoral training program in Medical Informatics

2. Duke University/University of North Carolina: MS, PhD, and Post Doctoral programs in Medical Informatics

3. Harvard University/Massachusetts Institute of Technology/New England Medical Center: MS, PhD, and Post-Doctoral in Medical Informatics

4. Stanford University: MS, PhD, and Post-Doctoral program in Medical Information Science

5. University of Missouri: MS in Library and Information Science, PhD in Medical Informatics, Post-Doctoral program in Medical Informatics, and short term (3-6 months) training for medical and veterinary students

The proposed program within the University of Miami would provide individuals with the skills and expertise needed for applying the concepts and knowledge of medical informatics in health care and academic medical research, development, and education. The proposed program will offer degrees to individuals with career commitments to applying computer engineering and related disciplines to the field of medicine. The University of Miami is well poised to offer new programs in Medical Informatics at the graduate level. This program will have a strong core curriculum in computer engineering, as well as concentrations in biological and physical sciences. The strengths of the Medical School in these areas will differentiate the University of Miami from other regional universities such as Florida International University and Florida Atlantic University. This will provide a significant leverage in attracting quality students to the program. In addition, the program will have the unique opportunity to draw upon the resources of the Medical School to offer significant exposure to research and applications in medicine. **In addition, currently no graduate programs in medical informatics exist in Florida, while only a few exist in the nation. The university will have a tremendous edge for attracting students by being the first to offer such a program in the state, as well as the advantage of being closely associated with a renowned medical school.**

Rationale for Success

The ability to introduce a new program in medical informatics successfully arises from the following factors:

(1) Because we have the faculty from both the School of Medicine and the College of Engineering needed to carry the program, there will be almost no extra costs for starting the new program.

(2) The new program would promote interdisciplinary research and development by providing a natural environment for interaction between faculty from the School of Medicine and the College of Engineering.

(3) Existing courses, as well as courses under development, can be used as part of the curriculum. This presents a tremendous recruiting tool for attracting students interested in medical careers.

(4) State-of-the-art laboratories for medical imaging, medical informatics, multimedia, and software engineering exist at the university and are great incentives for attracting students.

(5) Multimedia interactive educational tools and curricula will be developed using sophisticated new teaching methods to enhance the learning environment.

(6) The development projects in progress at the medical school in networking, electronic imaging, and medical information systems can be used to teach students and interact with the medical faculty via electronic communications and video-conferencing capabilities.

(7) The interdisciplinary focus of the current research and development work conducted by the Center for Medical Imaging and Medical Informatics is an important tool for attracting students interested in research opportunities.

(8) Industry partners involved with current research and development work are interested in establishing co-op programs in the new program areas.

(9) As mentioned earlier, no universities in Florida, and only a few in the nation, offer graduate programs in medical informatics.

1.a Exact Title of Degree

Master of Science in Medical Informatics

1.b Purpose and Goals of Degree

The purpose of the degree is to prepare qualified candidates to serve the needs of the health care industry, academic, research and government institutions. The program is designed to provide students with the skills and knowledge required to deal with basic and applied research, development, and the deployment of innovative technologies in the medical fields.

1.c Assessment of Demand and Job Market

The expanding applications of computing techniques into medical environments requires well-trained individuals to design, develop, select, and manage the medical-computing system. Modern developments in health care and computer industries dictate the need for skilled personnel to design research programs and carry out the experimental and developmental activities in both industries.

Many computer companies (for example Hewlett-Packard, the world's largest medical equipment maker) have established healthcare groups. According to National Institute of Standards and Technology (NIST), Arnst et al (1994)* estimated that the market of healthcare information system would reach $13 billion by the year 1998.

The Department of Health and Human Services estimates that a nationwide electronic healthcare information network could provide a savings that are expected to exceed $100 billion over the next eight years. According to the NIST (1994), healthcare is the fastest growing market in the computer field. It is estimated that hospitals will spend $6.7 billion a year on information systems in 1996, a 36.7% increase over 1993.**

The success of developing these services requires interdisciplinary research and development projects in both health care settings and computer industry and demands leaders who can effectively bridge the two fields. The demand for such professionals, with proper training in Medical Informatics, has been escalated in the recent years in both health care and advanced technology industries.

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* Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104-106.

** National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

As mentioned earlier, the survey conducted by Gassert et al (1991) indicated the increased demand for graduate level education in medical informatics. According to Greenes and Shortliffe (1990)* , researchers with formal training in medical informatics are a rare breed. The need for programs that combine medical informatics training with curricula that encompass the multidisciplinary areas of expertise, is recognized by many institutions. The increased awareness of the importance of this field of study has been motivated by the efforts of National Library of Medicine to support these programs. Greenes and Shortliffe indicate that the demand for medical informatics specialists surpasses the supply of skilled professionals.

The proposed program will provide graduates the opportunity to join research facilities in the area of medical information systems. Also, it will enable students to pursue medical education degrees after graduation.

1.d Relationship to Other Cognate Fields

This new program will complement existing biomedical engineering and biomedical activities at the university by expanding its application from biomedical devices to medical information sciences. In addition, graduates will have the opportunity to work as engineers and scientists in medically related fields, or in medical informatics careers. The program also will service the needs of the medical school for candidates who are proficient in computer engineering and science, as these skills become increasingly important for using sophisticated medical equipment and medical computer systems.

1.e Relationship to Undergraduate Programs

Students who wish to pursue degrees within the current undergraduate Computer Engineering and Biomedical Engineering programs will continue to do so. However, in addition to the graduate program in Medical Informatics, **dual degree** programs are being designed to allow qualified students to pursue a combined B.S. in Computer Engineering / M.S. in Medical Informatics or a combined B.S. in Biomedical Engineering / M.S. in Medical Informatics.

The dual B.S. Computer Engineering / M.S. Medical Informatics program has been approved by the department of Electrical and Computer Engineering and forwarded to the College of Engineering for approval. The dual degree program in B.S. Biomedical Engineering / M.S. Medical Informatics is currently under consideration.

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* Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority", JAMA, February 1990, Vol 263, No 8.

2. PHYSICAL RESOURCES

2.a Library Holdings

The Otto G. Richter Library and the Medical School Library have a very large collection of materials that are very useful for the programs in medical informatics. Since the medical informatics area are interdisciplinary in nature, the subjects covered are common with several other departments which expand the library holdings and budget allocation by subject area.

A partial listing of journals and periodicals available in medical informatics and related disciplines are given below. No additional journals is needed at this time.

Academic and Library Computing
Acronyms Administration
Advanced Technology Libraries
Advances in Bioengineering
Advances in Biomedical Engineering
AIweek
American Documentation
American Journal of Medical Electronics
AMIA News : Newsletter of the American Medical Informatics Association
Annual Review of Biophysics
Annual Review of Information Science
Applied Artificial Intelligence
ASAIO Journal
ASAIO Transactions
Audiovisual Instruction with/Instructional Resources
Biodegradation
Biomedical Communications
Biomaterials, Artificial Cells
BIOSIS
Biomaterials, Medical Devices
Biomedical Engineering
Biomedical Instrumentation
Biotechnology
Biotechnology and Bioengineering
Biotechnology Letters
Bulletin of Prosthetics Research
Byte
Campus-wide Information Systems
Chemical Journals Online Bulletin
Clinical Physics
Computers and Biomedical Research
Computers and Medicine

Computers in Biology and Medicine
Computers in Libraries
Computers in Eyecare Ophthalmology
Electronic Library
Eyecare Technology Ophthalmology
Human Factors
IEEE Engineering in Medicine and Biology
IEEE Transactions on Biomedical Electronics
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Systems, Man, and Cybernetics
IEEE Transactions on Medical Imaging
Information, News, Sources
Information Retrieval & Library
Interactive Healthcare Newsletter
International Journal of Bio-medical Engineering
IRE Transactions on Medical Electronics
ISI Online News
ISA Journal
Issues in Science and Technology
Journal of the American Medical Association
Journal of Biocommunication
Journal of Biomechanics
Journal of Biomedical Materials
Journal of Cardiovascular Diagnosis
Journal of Cardiovascular Techniques
Journal of Documentation
Journal of Clinical Engineering
Journal of Fermentation Technology
Journal of Medical Engineering
Journal of Rehabilitation Research
Journal of Rehabilitation Research and Development (clinical supplement)
Library Network/MEDLARS
M.D. Computing
MacUser
Medical & Biological Engineering
Medical Instrumentation
Medical Research Engineering
MEDLARS/Network Technical Bulletin
MedLink Archives
Methods of Information in Medicine
Modern Trends in Biomechanics
NLM Technical Bulletin
Online Libraries and Microcomputer
Physicians Video Guide
Physiological Measurement

PsycInfo News
Weekly Government Abstracts. Bi Reference
Trends in Biotechnology

2.b Laboratory Facilities

Image Processing and Multimedia Laboratory

The Image Processing and Multimedia Laboratory provide the ultimate environment for both research and development in the fields of image processing, scientific visualization, and multimedia applications. The hardware offered by the lab consists of numerous Sun SPARC 10 end user graphical workstations, PC's, a Sun 690 file server, a Sun SPARC 1000 file server and various peripherals, such as color printers, postscript printers, slide maker, optical disk jukeboxes for massive storage,..etc, all connected to a high speed FDDI network. Most of the end user workstations are equipped with microphones and video cameras for use with multimedia applications. Software tools used in the laboratory include: Khoros, AVS, Ptech, Ontos, MatLab, and various software libraries to support the research and development of algorithms in image processing, visualization, video editing, multimedia, and advanced networking like ATM and ISDN, necessary to support distributed multimedia applications.

Medical Informatics Laboratory

The Medical Informatics Laboratory (MIL) provides the client/server computing foundation required to support the medical information and imaging functions for the Center for Medical Imaging and Medical Informatics (CMIAMI). MIL is composed of several Sun SPARC 1000 servers with multiprocessor capabilities, four to eight processors, and 150 GB of fiber channel attached hard disk drives. The servers are intended to provide heavy computing services for both teaching and research applications. In addition, these servers allow the access of medical images for analysis and diagnosis purposes as well as supporting database servers for the development of medical information system applications. The MIL contains several Sun SPARC 5 and SPARC 20 workstations with multi-monitor support (1,2,4, or 8 monitors). These workstations play the client role in computing environment of the MIL. They function as the gateway for accessing the 2D & 3D imaging capabilities and the medical information system for both research and development purposes.

Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy Laboratory

The Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) Laboratory located at the MRI building houses three whole body MRI systems, 1.0T HPQ and 1.5T HPQ clinical scanners, a 1.5T Edge Research Scanner to be used for basic MR research and advanced clinical research.

Computed Tomography, X-Rays, and Ultrasound Laboratory

The Computed Tomography, X-Rays, and Ultrasound Laboratory has 5 CT scanners, 6 fluoro-machines, 3 vascular laboratories, 1 neuro-suite and 8 c-arms, in addition to a large number of mammographic general-purpose and mobile x-ray machines.

Nuclear Medicine Laboratory

The Nuclear Medicine Laboratory of the University of Miami School of Medicine/Jackson Memorial Medical Center is equipped with one triple head SPECT camera, 2 dual head SPECT cameras, 2 single head SPECT camera, 7 stationary camera and 2 mobile systems. All cameras are networked. Also available are counting devices and a radio-pharmacological preparation laboratory.

Other Laboratories

Software Engineering Laboratory
Digital Signal Processing Laboratory
Computer Aided Engineering Laboratory
Microprocessor Laboratory
Electronics and Measurement Laboratory
Communication Laboratory

3. CURRICULUM

3.a Master of Science in Medical Informatics

The proposed program curricula is designed to reflect the broad, interdisciplinary field of medical informatics. The program stresses both the basic sciences of medical informatics and the practical knowledge necessary to design and implement computer applications and modern information technology in the medical field. The program is designed to fit variety of backgrounds from science, chemistry, biology and engineering undergraduate majors. The following is a list of the required and elective courses:

Core Courses

RAD 604 Medical Informatics
RAD 508 Computer-Based Medical Records
EEN 592 Medical Imaging
EEN 537 Principles of Artificial Intelligence (Project: Artificial Intelligence in Medicine)
EEN 523 Principles of Database Systems (Project: Database Management for Medical Applications)
BME 501 Unified Medical Science I / PHS 512 Systematic Physiology
EPH 502 Biostatistics II / EPH 6xx Clinical Research

Thesis Option

Technical Electives: six credits from elective list
Six credits must be earned in thesis work

Non-thesis Option

Technical Electives: fifteen credits from elective list
Three credits must be earned in Master's Project

Technical Elective

RAD 500 Diagnostic Physics
RAD 501 Nuclear Medicine Imaging
RAD 505 Anatomy and Physiology: Diagnostic Imaging Prospective
RAD 601 MR Imaging / MR Spectroscopy
RAD 602 CT Imaging / X-Rays / Ultrasound
RAD 651 Special Problems in Medical Informatics
EEN 512 Object-Oriented Software Engineering
EEN 534 Computer Communication Networks
EEN 548 Machine Learning
EEN 591 High-Speed Networking
EEN 593 Object-Oriented Programming

Technical Elective (Continued)

EEN 597 Neural Networks
EEN 621 Object-Oriented Database Systems
EEN 653 Pattern Recognition
EEN 656 Information Theory
BME 502 Unified Medical Science II
BME 511 Clinical Engineering
BME 580 Biomedical Instrumentation
BME 622 Biomedical Signal Processing
CBA 505 Neuroanatomy
BMB 506 Biochemistry & Molecular Biology
BMB 508 Biochemistry & Molecular Biology Lab
MTH 529 Computer Graphics

Admission

Admission of a student to the University of Miami for any semester does not imply that such student will be re-enrolled in any succeeding academic semesters. All those wishing to take courses for graduate credit, whether or not they wish to become candidates for the degree, must make application for admission directly to the department. The applicant's file includes:

(1) Completed application form
(2) Official transcript of all college work previously taken
(3) Official score report of the Graduate Record Examination (GRE) taken within five years
(4) Three letters of recommendation sent directly to the department
(5) Official score report of the Test of English as a Foreign Language (TOEFL) for any international applicant whose native language is not English
(6) Application fee of $35.00

Fellowships, tuition scholarship, and assistantships in research or instruction are available for qualified students.

3.b Dual Degree Programs

Dual degree programs are being designed to allow qualified students to pursue either a combined B.S. in Computer Engineering / M.S. in Medical Informatics or combined B.S. in Biomedical Engineering / M.S. in Medical Informatics. The B.S. Computer Engineering / M.S. Medical Informatics program has been approved by the department of Electrical and Computer Engineering and forwarded to the College of Engineering for approval. The dual degree program B.S. Biomedical Engineering / M.S. Medical Informatics is currently under consideration. Detailed description of these programs is attached.

4. FACULTY

Program Director

Dr. Mansur R. Kabuka	Department of Electrical & Computer Engineering/Department of Radiology

Program Committee

Committee Chairperson

Dr. Robert W. Rubin	Vice Provost and Deputy Dean, Research and Graduate Studies

Dr. Jeffery Augenstein	Department of Surgery/Ryder Trauma Center
Dr. Judy Bean	Department of Epidemiology and Public Health
Dr. Ronald G. Clark	Department of Cell Biology and Anatomy
Dr. Laurence B. Gardner	Department of Medicine
Dr. Ozcan Ozdamar	Department of Biomedical Engineering
Dr. Pradip M. Pattany	Department of Radiology
Dr. Robert M. Quencer	Department of Radiology
Dr. Stuart A Stein	Departments of Neurology, Medicines and Pediatrics

Program Faculty

Judy Bean, Ph.D.	Department of Epidemiology and Public Health
Ronal E. Block, Ph.D.	Department of Radiology
Brian Charles Bowen, Ph.D., M.D.	Department of Radiology
Ronald G. Clark, Ph.D.	Department of Cell Biology and Anatomy
John Collins, Ph.D.	Department of Electrical & Computer Engineering
Francis Donahue, D.O.	Department of Radiology
Christos Douligeris, Ph.D.	Department of Electrical & Computer Engineering
Joel Elliot Fishman, M.D., Ph.D.	Department of Radiology
Keneth Goodman, Ph.D.	Director, Forum for Bioethics and Philosophy
Abdulmehdy M. Jabir, M.Phil.	Department of Radiology
Mansur R. Kabuka, Ph.D.	Department of Electrical & Computer Engineering/Department of Radiology
George Kutty, Ph.D.	Center for Medical Imaging and Medical Informatics
Ronald Charles Joseph, M.D.	Department of Radiology
Ozcan Ozdamar, Ph.D.	Department of Biomedical Engineering
Pradip M. Pattany, Ph.D.	Department of Radiology
Reeza Rossie,M.S.E.E.	Medical Networks, School of Medicine
George N. Sfakinakis, M.D.	Department of Radiology
Frank Sauer, M.S.Comp.Sc.	Center for Medical Imaging and Medical Informatics
Frank Stitt,M.D.	Department of Epidemiology and Public Health
David Schwartz, M.D.	Department of Radiology
Stuart A Stein, M.D.	Departments of Neurology, Medicines and Pediatrics
Wonhee Sull, Ph.D.	Center for Medical Imaging and Medical Informatics
Arun Thakore, Ph.D.	Department of Electrical & Computer Engineering
Martin Trafler, Ph.D.	Department of Radiology
Sherif M. Waly, Ph.D.	Center for Medical Imaging and Medical Informatics
Thomas Williams	Assoc Director of Systems Integration & Access, Louis Calder Memorial Library
Tzay Young, Ph.D.	Department of Electrical & Computer Engineering

5. BIBLIOGRAPHY

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Association of American Medical Colleges,. "Medical Education in the Information Age," Proceedingd of a Symposium on Medical Informatics, Washington D.C., 1986.

Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, Americal Medical Informatics Association, November, 1991, Washington, DC

Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority," JAMA, February 1990, Vol 263, No 8.

National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

World Health Organization, "Informatics and Telematics in Health: Present and Potential Uses," Geneva, 1988.

Harvard University — **Massachusetts Institute of Technology** — **New England Medical Center**

MEDICAL INFORMATICS RESEARCH TRAINING

Predoctoral and postdoctoral training opportunities in Medical Informatics are now available in an expanded joint Boston-area program. Supported by a grant from the National Library of Medicine, and administered by the Health Science and Technology (HST) Division of Harvard Medical School (HMS) and Massachusetts Institute of Technology (MIT), this program involves participation by several well established medical informatics research groups at HMS, MIT, Harvard School of Public Health, Brigham and Women's Hospital, Massachusetts General Hospital, and Tufts New England Medical Center.

GENERAL: Fellowships provide stipend, tuition, and travel funds, and are typically for two- to three-year periods. Trainees are primarily associated with a particular research group, depending on interests. In addition, the program provides many opportunities for educational, research, and collegial/social interaction among the faculty, students, and fellows of the training sites. A wide variety of course offerings at Harvard, MIT, and Tufts, seminars, journal clubs, and other forums for exchange of information provide all trainees with opportunities to learn about the variety of work occurring at the various laboratories and in the affiliated institutions, as well as in the larger field of medical informatics.

RESEARCH OPPORTUNITIES: The participating research groups and their principal areas of activity are indicated below. In-depth involvement and assumption of project responsibility are encouraged, both at predoctoral and postdoctoral levels. A large associated faculty participate through the research activities of each of the training sites. We also encourage the fellows to develop projects that may involve unique collaborative relationships.

DECISION SYSTEMS GROUP
Robert A. Greenes, M.D., Ph.D., Director
Brigham and Women's Hospital
75 Francis Street, Boston, MA 02115
(617) 732-6281 FAX (617) 732-6317
Email: greenes@harvard.edu or greenes@harvard.BITNET
(Postdoctoral research training)
- *medical decision support*
- *knowledge representation*
- *computer-aided medical education*
- *radiologic informatics*
- *guideline incorporation in clinical systems*
- *object-oriented design & software architectures*

MEDICAL COMPUTER SCIENCE
Peter Szolovits, Ph.D., Director
Dept. of Elec. Eng./Computer Sci.
Massachusetts Inst. of Technology
545 Technology Square, Cambridge, MA 02139
(617) 253-3476 FAX (617) 258-8682
Email: psz@medg.lcs.mit.edu
(Pre/postdoctoral degree candidates)
- *medical knowledge representation*
- *clinical decision making*

LAB. OF COMPUTER SCIENCE
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Massachusetts General Hospital
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Boston, MA 02114
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Email: obarnett@hstbme.mit.edu
(Postdoctoral research training)
- *clinical decision making*
- *medical student education*
- *student/physician workstation design*
- *problem-based knowledge access*
- *ambulatory computer-based medical records*
- *implementation/evaluation of guidelines*

DIV. OF CLINICAL DECISION MAKING
Stephen G. Pauker, M.D., Director
New England Medical Center
750 Washington Street, Boston, MA 02111
(617) 956-5910 FAX (617) 956-4838
Email: sgp@medg.lcs.mit.edu
(Postdoctoral research training)
- *clinical informatics*
- *clinical decision analysis in individual patients*
- *cost-effectiveness and health policy analysis*
- *guideline development*
- *clinical decision support*

HEALTH DECISION SCIENCES
Milton Weinstein, Ph.D., Director
Dept. of Health Policy & Mgt
Harvard School of Public Health
677 Huntington Avenue, Boston, MA 02115
(617) 432-1090 FAX (617) 432-4494
Email: mcw@biostat.harvard.edu
(Pre/postdoctoral degree candidates)
- *cost-effectiveness analysis of health care practice*
- *assessment of medical technologies*
- *medical decision making*
- *outcome modeling*

COURSES AND DEGREES: Courses for research trainees may be selected from a wide range of Harvard, Tufts, and MIT offerings. M.Sc. and Ph.D. degrees are offered in EE/CS at MIT and Health Decision Science at Harvard School of Public Health (HSPH).

TRAINEE QUALIFICATIONS: For postdoctoral training, prior M.D. (ideally also completion of all or most of residency training), or Ph.D. in a relevant discipline required. Predoctoral candidates must concurrently apply for admission to the corresponding doctoral degree program at MIT or HSPH. For all candidates, previous computer experience strongly preferred. *The participating institutions are Equal Opportunity/Affirmative Action Employers. Women and minorities are encouraged to apply.*

FOR FURTHER INFORMATION: To obtain more information about the program and its various components, or to apply, contact the Program Office at the address given below. You may also contact the directors of individual components directly, who will forward your correspondence and application materials to the Program Office.

MEDICAL INFORMATICS RESEARCH TRAINING
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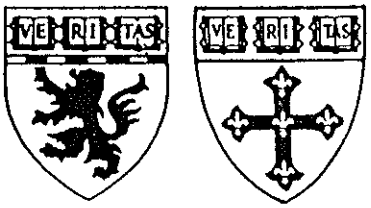
Harvard University — Massachusetts Institute of Technology — New England Medical Center



MEDICAL INFORMATICS RESEARCH TRAINING

OPPORTUNITIES

in the

DECISION SYSTEMS GROUP

Robert A. Greenes, M.D., Ph.D., Director

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September 2, 1991

Introduction

The Harvard-MIT-NEMC Research Training Program in Medical Informatics is funded by the National Library of Medicine (NLM) and provides predoctoral and postdoctoral training through affiliation of trainees with 5 participating research units in medical informatics in the Boston area, and a coordinated set of additional opportunities for collegial and educational interaction among the groups. Trainees participate in a variety of jointly sponsored seminars, journal clubs, research symposia, and informal courses. Electronic mail is used to facilitate communication among the groups.

The various program components are each described in separate documents. This document describes the specific activities of the Decision Systems Group, Brigham and Women's Hospital.

The Decision Systems Group

The Decision Systems Group (DSG) is a research unit in medical informatics at Brigham and Women's Hospital. The DSG carries on a broad range of research activities, focused on the general themes of medical education and decision support, as described below. The major goal of research training at the DSG is to enable the trainees to acquire direct research experience through involvement in on-going medical informatics projects of the laboratory. The involvement can occur at all levels, from design, to development, implementation, evaluation, and dissemination of computer applications in medicine. The primary emphasis is on assumption by the trainees of project responsibility, and the opportunity to present the work both locally and at national meetings, and in publications. Our objective is that individuals leaving the program be

well positioned to launch their careers as independent investigators in the field of medical informatics.

Academic course work is encouraged to supplement the research experience, usually one course per semester, at Harvard School of Public Health (usually in Biostatistics, Decision Sciences, or Computer Science), or at the Computer Science Departments in the Harvard Faculty of Arts and Sciences or at Massachusetts Institute of Technology. A number of the fellows maintain their clinical skills by "moonlighting" at various Harvard-affiliated clinical facilities.

Robert A. Greenes, Director of the DSG, has an M.D. degree and Ph.D. in computer science from Harvard, and is Associate Professor of Radiology at Brigham and Women's Hospital, where he directed the Computer Science Division in the Department for eight years, before establishing the DSG. Particular interests have been focused on the development of methods for decision support and education for clinical problem solving. Emphasis has been the use of the computer for knowledge management and selective knowledge retrieval, analytic measures of performance of diagnostic procedures, strategies for clinical workup and management, user inerfaces for clinical record keeping, radiologic image management, and development of systems architectures and tools to support application composition from network-based information resources and group cooperative work. Greenes is also a member of the faculty of the Department of Biostatistics, Harvard School of Public Health, and of the Health Science and Technology Division (HST), Harvard Medical School and MIT, where he is Director of Academic Computing. The DSG is responsible for computer-based education development and support for the HST track of the Harvard Medical School curriculum, and has joint responsiblity with the LCS for support of the remainder of the HMS curriculum.

Overview: The DSG staff consists of computer scientists and physicians who carry on a variety of research and development projects in the application of desktop workstations to medical decision making and education. Highlights of some of the many activities at the DSG include:

- Cooperative development, with other centers, of a *Unified Medical Language System (UMLS)*, sponsored by the National Library of Medicine. Particular areas of activity are the development of a descriptive language and taxonomy for indexing of multimedia information resources, concept-based retrieval of textual materials from free text query, and semantic-net based reasoning about images.

- Exploration of the use of *clinical algorithms* as an organizing strategy for an electronic knowledge resource for clinical medicine, as a means of providing guidelines, and as an aid to assessing quality of care. One of our major interests is in characterizing cost effective workup strategies for patient care.

- Development of flexible user interfaces for recording of clinical notes, capitalizing on problem-based structure, algorithmic flow, and user personal preferences.

- Development of *clinical skill-building and problem-solving simulations* that give physicians and students the experience with understanding complex interrelationships that forms the basis for clinical judgment and decision making. This includes multimedia instructional applications that integrate history, physical examination, laboratory, radiologic, and other procedures, in a realistic fashion.

- Design and evaluation of *digital-imaging-based tutorial techniques* for helping radiologists to develop their pattern recognition and interpretation skills. A particular focus currently is mammographic interpretation.

- Exploration of advanced *software engineering methodologies* for data and knowledge management. The emphasis is on authoring and presentation tools to facilitate development and use of applications that integrate a variety of data and knowledge resources, as typical of those described above.

Goals: As detailed in the accompanying sections, a major component of our software development effort is focused on providing multi-modal education and decision support tools. The approach to medical education at Harvard emphasizes problem-based learning and access to information tools. Continuing education and clinical decision making require access to many of the same kinds of capabilities, thus forming a logical continuum of applications. For information tools to be effective, we believe they must:

- provide access to a wide variety of data and knowledge, that may exist in many different formats—including images, video sequences, sounds, animations, lists, textual descriptions, database records, and analytic and inference procedures

- enable these resources to be incorporated in a variety of contexts—such as tutorial exercises, case-based problem solving, examination and testing, gaming, textual browsing, and natural language query

- facilitate use of the same resources in different contexts, i.e., "repurposing"—to foster sharing, to enable developments that builds upon the work of others, and to avoid continually "reinventing the wheel"

Research Support: Besides the Research Training Program in Medical Informatics, a number of other funded research activities are being carried out by the Decision Systems Group. Greenes is a principal investigator on NLM-funded contract research to develop a Unified Medical Language System (UMLS). This involves development of a uniform metathesaurus or taxonomy of medical concepts and relations, as a basis for facilitating the linking of disparate applications and the development of consistent approaches to medical knowledge base development. A variety of tools are being developed as part of this research, as noted above.

Greenes is Principal Investigator on an NLM-supported investigation of the use of computer systems for knowledge management. This research involves development of knowledge organization, access, and display methods and tools, and the development of medical content that utilize these methods and tools. The objective is to facilitate problem-oriented access to knowledge by physicians and students. This funding supports the development of an information management architecture known as DeSyGNER (Decision Systems Group Nucleus of Extensible Resoruces) which facilitates authoring and composition of applications from network based information resources. Collaborative development of this platform in conjunction with major computer systems vendors is currently being pursued.

Greenes is Principal Investigator of a National Cancer Institute project aimed at facilitating development of pattern recognition and interpretive skills by radiologists through the use of a computer-based digital imaging system which provides experience in recognizing pertinent image features and in combining them appropriately into diagnostic categories.

The DSG is also engaged in working with medical publishers and with Walter Reed Army Medical Center in developing methods for effective utilization of textbooks in electronic form. Issues relate to query, browsability, human interface, superposition of conceptual schemas, incorporation of hyperlinking, and preservation of context when viewing portions of a textbook in isolation.

Another major activity of the DSG is participation in the Northeast Medical School Educational Consortium, and organization of eleven medical schools in the northeastern United States, the focus of which is development of platforms, strategies, and procedures for sharing and cooperative development of software and content archives. Many of the DSG's systems development

work is aimed at fostering modularization, sharing, and integration of disparate information resources.

Finally, the DSG participates in a newly formed Center for Applied Medical Information Systems (CAMIS) at Brigham and Women's Hospital, where the focus is on more effective clinical access to educational and decision support resources, recording of clinical notes, order entry, and guideline monitoring.

Resources available to the Decision Systems Group, Brigham and Women's Hospital, include the electronic mail systems of the Department of Radiology VAX VMS computers (including one VAX 780, one 8600, two MicroVAX II computers, and two Sun 4 workstations), the Harvard Medical School Novell Network with cc:Mail, and the HST Sun 4 computer at MIT. The DSG also has 22 Macintosh IIci and Macintosh IIfx computers, each with 170 megabyte hard disks; two Macintosh file servers; one each Digital Equipment Corporation 5000 and 3100 workstations; and 3 Laserwriter printers. All computers are on the Ethernet and have INTERNET and BITNET access. Peripheral storage is provided by several large capacity hard disks in the 350 MB to 750 MB range, a Pinnacle 6.5 GB magnetic-optical (MO) disk juke box, a Pinnacle 650 MB MO single drive system, several Syquest cartridge drive systems, and a Micronetics DAT drive for backup. All computers have color display, and 10 of them have 19" color monitors. Other peripherals include a BarneyScan color slide digitizer, a Konica Radiographic Laser Scanner (owned in conjunction with the Radiology Department), a flatbed scanner, a digital video frame grabber, videodisc player, PC-VCR video playback unit, an InFocus color LCD panel projection system, and a Tektronix Phaser PX color printer.

Principal Current Projects of the DSG

In the sections below, we briefly highlight a number of research areas in which the DSG is engaged, to indicate the kinds of problems in which its trainees and staff have particular interest and expertise. The strengths of these programs is in the collaborative arrangements with a wide variety of participating departments and institutions.

UMLS: Unified Medical Language System Development

The goals of the UMLS research are to provide a consistent framework for indexing and retrieval of medical knowledge. This framework is desired as a means for allowing hitherto independent applications to be more readily interfaced, and to facilitate the development and use of electronic knowledge resources and personal reference files. This research involves a spectrum of activities:

(a) development of semantic net editing and display tools, and tools for consistency checking; searching and browsing the net; query formulation; and translation from/to existing vocabularies;

(b) development of medical concepts and relations for a semantic net representation of the UMLS metathesaurus, involving both top-down design; bottom-up design; and combinations of these approaches;

(c) theory and methodology research, focusing on methods for identifying and suggesting relations between terms in the semantic net, as an aid to query formulation; heuristic selection of landmarks for fish-eye display; and evaluation of semantic-net-based display/query methodology versus traditional methods for searching the biomedical literature; and

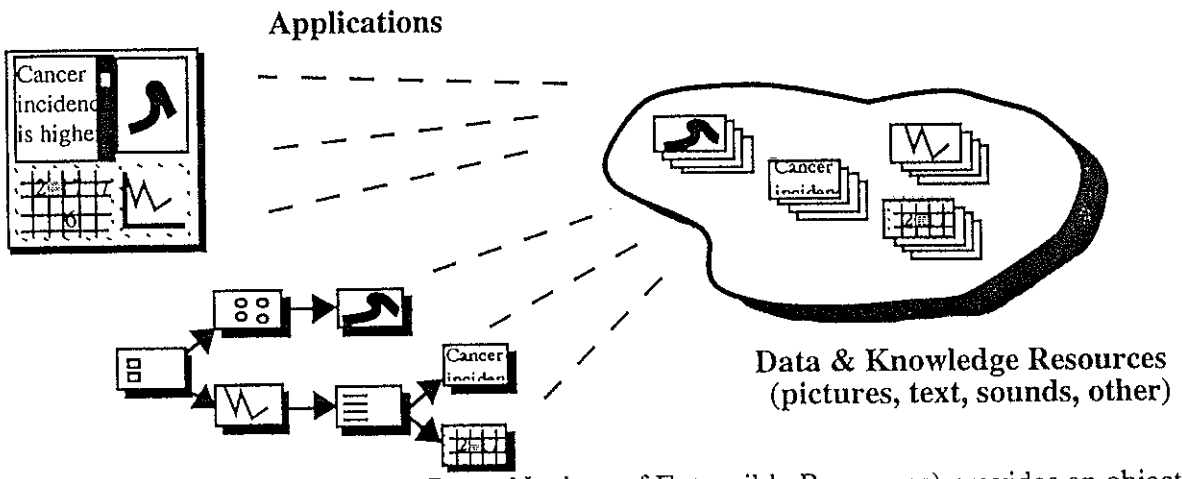
(d) coordination with other UMLS participants, through organizing and convening workshops of UMLS semantic net collaborators; facilitate communication, interchange, and cooperation; collecting contributions to the net and reviewing feedback; performing a curator function for semantic net maintenance; and provision of tools for interchange and review of content among collaborators.

A number of the DSG fellows and staff are participating in aspects of this research. **Robert C. McClure, M.D.**, is responsible for organization of the semantic net to support image

content description. **Luke Sato, M.D.,** is engaged in developing a descriptive taxonomy for neurologic disease that relates structural and functional components. **Andre Marquis** is developing image archive management tools. **Ed Pattison-Gordon** is building and refining semantic net editing and browsing tools. A former fellow, **William Hersh, M.D.,** with whom we continue to collaborate in his current capacity as a faculty member at the Oregon Health Science University, developed SAPHIRE, a natural language front-end that maps a query into concepts for more precise retrieval. We are seeking to utilize SAPHIRE's interface for a variety of information resources with which we are working.

DeSyGNER: Mulitmodal Authoring & Presentation Environment

This project, a major research focus of the DSG, involves the development of capabilities for organization of medical knowledge by building a comprehensive authoring and presentation environment, known as DeSyGNER (Decision Systems Group Nucleus of Extensible Resources). The major premise of DeSyGNER is that useful data and knowledge resources may exist in a variety of forms, maintained by experts in the particular domains to which they relate. Applications to support such activities as self-directed learning, decision making, browsing, or query need to access and utilize these various data and knowledge resources. Moreover, the applications need the ability to "compose" the data and knowledge into formats or structures for presentation and navigation that are suitable for their particular purposes.



DeSyGNER (Decision Systems Group Nucleus of Extensible Resources) provides an object-oriented software architecture for "dynamic assembly" of modular information resources into application compositions, such as page layouts, tutorials, electronic textbooks, case simulation exercises, question/answer quizzes, or consultation sessions. Content may be unstructured text, pictorial information, e.g., clinical algorithms or diagrams, or structured content, e.g., disease, findings, or drug data bases. In addition, it may be dynamic procedural components, e.g., simulations, quantitative analyses, expert system modules, or script-based data base retrieval, e.g., from a literature data base. The knowledge potentially available is structured as a web of nodes and links, with the content associated with each node under the control of a specific tool for producing and displaying it (e.g., a hypertext tool, an animation tool, a spreadsheet tool, a simulation, an expert system, a telecommunications tool, or a data base retrieval tool). DeSyGNER is a successor of Explorer-2, an implementation improving on its prototype, Explorer-1, which provided a shell for browsing through the nodes and links; selecting particular nodes and links based on keywords associated with each and filtered by contextual descriptors characterizing the user and/or the problem setting; and invoking modular tools for retrieving and/or producing content and displaying it.

Content of nodes is displayed in multiple windows on a microcomputer workstation. Selection of "hotspots" within a window, i.e., choosing a particular term or topic of interest, permits the user to branch to other windows providing additional details, by passing the request to the DeSyGNER shell. Thus the user is able to peruse topics as desired, both to answer specific problems as well as to browse through the knowledge base to satisfy curiosity.

DeSyGNER provides a formal method for utilizing independently developed data and knowledge resources, and composing them into various application formats. As such, it enables development to build upon the work of others, and to facilitate sharing and collaboration. Furthermore, it is extensible, providing a framework which can encompass a growing range of capabilities, as needs increase. DeSyGNER is being developed for use in our own application projects, as well as a potential software platform for more widespread use.

Knowledge resources developed for use with Explorer-2, which was a predecessor of DeSyGNER, include CASPER, an electronic textbook for diagnostic workup strategy selection; several chapters from medical textbooks (Principles of Ambulatory Medicine, Williams and Wilkins, publishers; and Scientific American Medicine); and QMR, an expert system for differential diagnosis (based on Internist-1, and implemented in the Explorer-2 environment with the cooperation of R.Miller and J.Myer of the University of Pittsburgh). Current work is aimed at (a) further electronic textbook adaptations, (b) case presentation libraries for education and decision support in radiology and pathology, and (c) training of interpretation skills in radiology.

The current and proposed future UMLS effort are highly relevant to this kind of knowledge management environment. As new knowledge is continually added to knowledge bases, either by a single author, or particularly in a multi-author environment, knowledge content units need to be indexed to permit them to be accessible when relevant. A user should be able to retrieve specific knowledge content by combinations of free text query, menu selection, and selection of hotspots within content windows. In all cases, the pertinent content should be identifiable by the system, through the use of a common method for indexing it. Selected knowledge should similarly be indexable by the user for his or her personal filing system.

Robert C. McClure, M.D., is a current postdoctoral fellow who is participating in the development of this system with the objective of interfacing the UMLS browsing capabilities into it. **James McClay, M.D.,** is implementing a flow control shell for composition of information resources in an algorithmic format. Primary software development of DeSyGNER is being carried out by **Stephan Deibel, David Tarabar, Edward Pattison-Gordon,** and **Andre Marquis.**

Algorithms: Generation, validation, and application for education, decision making, and order entry

The clinical algorithm has become a very popular way of describing approaches to a wide variety of clinical problem solving tasks. Nonetheless, algorithms have several limitations that have limited their acceptability. Among these limitations are that they do not embody all of the various considerations that may pertain to a particular patient; they do not allow for equally valid alternative approaches to a problem; and they are insensitive to the order in which data are acquired, not adjusting to the prior availability of data which may be required only later in a particular algorithm.

Several of these limitations could be overcome if one considers a potentially very large algorithm with branches covering all possible eventualities. While such an algorithm is not practical to represent on paper, and would be unwieldy to display, it could be represented in a computer system. Indeed, the logical flow that would result from execution of an expert system could be embodied in a sufficiently large algorithm. With a sufficiently flexible user interface, an algorithm display could be dynamically generated, which only displays those branches pertinent to a specific situation. Prior data could cause certain branches to automatically be taken, and their logic collapsed into subsequent nodes. Sections of algorithms could be represented by single boxes

indicating higher level designations of the goals of those sections, and expanded only if the user wishes to see the details, thus providing a zoom/dezoom capability. Prior probability information could be used to anticipate which branches of an algorithm should be pre-expanded versus collapsed.

Dynamic generation of an algorithm thus offers a potential for succinctly embodying pertinent aspects of a clinical problem under program control. In addition, an algorithm, whether used literally as a prescription for care or not, can be used as framework for presenting the logical approach to a clinical problem. Thus it forms a kind of graphical topical outline to the problem. Each box in an algorithm can potentially be linked to explanatory material that provides information about the rationale and purpose of the action or conclusion in the box, including pertinent references, and can also be used as a cross-reference for additional pertinent material. A box, for example, in the workup of hypertensive emergency, which seeks to determine whether there is evidence of end-organ damage, might lead to information about the kinds of end-organ damage that should be considered (cardiac, renal, retinal, cerebral), ways of assessing them (including pertinent tests and illustrations of medical images), etc. A box indicating the use of a beta-blocking drug could link to a table indicating the available agents, their relative advantages and disadvantages, dosage schedules, side effects and contraindications.

The DSG is currently exploring the application of the clinical algorithm as an organizing strategy for an electronic knowledge resource for primary care and emergency medicine, as well as its use in diagnostic procedure ordering (see CASPER below). Several groups in the Harvard medical area are involved in the development of clinical algorithms and offer the potential for collaboration in this work, including the Brigham and Women's Hospital Emergency Service and the Harvard Community Health Plan. As a potentially large multi-author collaborative activity, again the resources of a UMLS would be extremely useful for its organization. Initial work in this project was done by a former DSG trainee, **Thomas Abendroth, M.D.**, now a faculty member at Hershey Medical Center. Current work is being carried out by trainees **Richard Shiffman, M.D.**, and **James McClay, M.D.**, as well as by a foreign postdoctoral student, **Isao Kamae, M.D.** Shiffman is exploring the relationship between decision tables and decision trees, in determining alternative algorithmic sequences. McClay is developing authoring and user interface tools for algorithm development and use in the Brigham's emergency room setting. Kamae is exploring the selection of optimal algorithms by modeling a decision problem as a finite state automaton.

CASPER (Computer Aided Selection of Procedures and Evaluation of Results) is a knowledge base of diagnostic strategies for a wide variety of common clinical problems based, in part, on a handbook of diagnostic strategy assembled by the Brigham and Women's Hospital Department of Radiology. CASPER gives information about general patient characteristics for a specific clinical problem, the approach to workup, a flow chart of the clinical algorithm, and data about the various tests available, including preparation requirements, advantages and limitations, and quantitative data about test performance. In addition, "what if..." procedures can be invoked to analyze the value of a proposed test for a specific patient. The database in CASPER is from 1986, and is in the process of being revised. The CASPER knowledge base was developed with the aim that it be an entry point to a wide variety of other content material and procedures, relating to differential diagnosis, pathophysiology of the diseases, and decision making concepts used in prospective test assessment. A particular interest is its potential use as a guidance system for radiology procedure ordering as part of a hospital information system.

Clinical Record Keeping

As part of the DSG's involvement in CAMIS (the new Brigham and Women's Hospital Center for Applied Medical Information Systems), we are developing approaches to capturing of clinical notes as part of an automated medical record. Our primary focus at present is on those

structured notes that can be facilitated by use of templates, such as radiology reports and other procedures (ECGs, endoscopy, and surgical notes). The approach being taken is to structure the decision process involved in characterizing a patient by use of an algorithmic format, and then within branch points of the algorithm to provide the detailed data items unique to each branch point. This provides a "coarse chunking" mechanism which enables considerable tailoring yet does not sacrifice speed and efficiency (which would be the case if more aggressive branching were done).

We are also experimenting with a variety of formats for presentation, including tabular outline format, prose narrative, flow chart display. The approach is designed to allow adaptation to a variety of input methods, including keyboard, mouse, and voice selection. Finally, we are exploring ways to ensure that the clinical terms chosen correspond to controlled taxonomy terms in our evolving UMLS semantic net.

This project is the principal focus of one fellow, **Douglas Bell, M.D.,** and is also being contributed to by another fellow, **James McClay, M.D.,** and by **Edward Pattison-Gordon.**

Computer-Based Education

The DSG is engaged in a variety of projects in support of medical student and continuing medical education.

Clinical Skill Building. Knowledge resources that are also considered useful are those that give physicians and students experience with understanding complex inter-relationships that form a basis for clinical judgment and decision making. The Decision Systems Group is exploring several kinds of scenarios in which these needs occur, and developing tools to support them. Clinical skill building has been addressed in two areas involving cardiology, cardiac auscultation and electrocardiographic interpretation. In both cases, programs have been designed to simulate clinical situations, to aid the student in identifying pertinent characteristics, recognizing patterns, and understanding the bases for their interpretation. HeartLab, now in use at over 75 medical schools, gives the student experience in detecting and recognizing heart sounds by simulated auscultation, first by allowing user selection of sound characteristics and abnormalities, and second, by generating unknown cases for user interpretation. Selected review material is made available to augment the exercises. EKGLab has recently been completed, to provide similar experience in recognizing and interpreting electrocardiographic abnormalities. These programs, which have been widely praised, were developed by a former postdoctoral trainee of the DSG, now a staff member, **Bryan P. Bergeron, M.D.,** and are distributed through a medical text-book publisher.

Radiology Interpretation. Another project now underway is aimed at training radiologists in the interpretation of mammographic images. Previous work by collaborators at BBN Laboratories has demonstrated that significant differences exist between the quality of interpretations by experts versus non-experts, and that a computer-based clustering model based on features identified by experts in the images can augment performance of non-experts to a level comparable to that of the experts. The research now underway is aimed at training non-experts to perform at expert levels by providing computer-based experience. The intent of this system is to enhance pattern recognition and interpretation skills through intelligent tutoring. The system is aimed at providing users with experience in recognizing pertinent image features and in combining them appropriately into diagnostic categories, with an initial focus on mammographic interpretation, an area in which skill levels and efficiency need to be raised because screening is effective and widely used, and the workload is expected to increase significantly. The DSG is developing an optical disk library of mammographic images that illustrate specific features as well

as a library of cases with known diagnoses. Under control of the instructional system, users' abilities to recognize and correctly rate features in images is assessed, and their ability to properly weight features in arriving at a diagnosis is determined. Errors in performance in either skill are remedied by feedback to the user of didactic content, performance graphs, and additional pertinent case material. This project is a joint effort between the DSG and BBN Laboratories, Inc., in Cambridge, MA, and involves **Andre Marquis, Robert A. Greenes, M.D, Ph.D., David Getty, Ph.D., John A. Swets, Ph.D.**, and others.

Other applications of the above approach relate to creating image teaching files for selective retrieval by students and residents in radiology and pathology in a variety of domains, and for incorporating medical images in other knowledge bases. We are building a computer-based radiology teaching library capability, both internally at Brigham & Women's Hospital, and in conjunction with the Radiology Information Systems Consortium (RISC). The project involves development of a standard data base describing patients, examinations, images, findings, and diagnoses; an image description taxonomy for indexing the findings and diagnoses, and a retrieval, case presentation, and browsing environment based on the DeSyGNER tools of the DSG. A digital image presentation entity, developed by **Lincoln Stein,. M.D., Ph.D.**, supports 12-bit gray scale image presentation, in low or high resolution modes, with selective magnification, using virtual memory to retrieve high resolution portions under a roving "magnifying lens" cursor, brightness and contrast manipulation, and "grease pencil" markup of the images. The images can be incorporated into either hypermedia or tutorial protocol-based presentations, and cases can be located by keyword-based query.

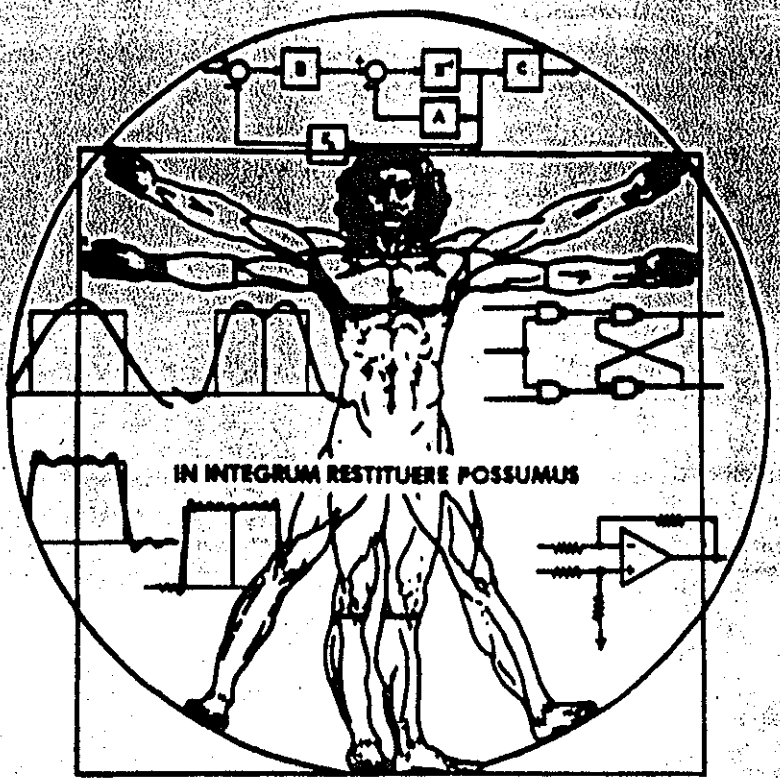
Case-Based Problem Solving. Clinical problem solving exercises have long been used as a way of providing simulated experience in clinical medicine, and multimedia capabilities now available extend the potential for realism of these exercises. In addition, with the use of hypermedia methodologies, it is now possible to link components of a clinical case — e.g., the tests, the images (or sounds, or tracings) of the actual results, or the textual descriptions of findings — with other related information. This information can amplify on the tests themselves, the range of possible results that could alternatively have been obtained, the differential diagnoses of any particular findings, or the profiles of diseases in the differentials, and can provide discussions and references about the diseases. Thus the case problem solving exercise may have potential for more than providing practice with making clinical judgments; it may offer an alternative paradigm for accessing much of the same medical content traditionally delivered in didactic lectures and in textbook presentations.

We have implemented, and continue to refine, an authoring environment for case problem-solving exercises that enables access to multimedia presentation of clinical results, and related clinical and pathophysiologic content material—CaseBase. CaseBase has been developed by **Mark S. Dichter, M.D., Bryan P. Bergeron, M.D.**, and **Robert A. Greenes, M.D., Ph.D.** CaseBase has been used thus far to develop case-based simulations in cardiovascular pathophysiology, with the participation of **John T. Fallon, M.D, Ph.D.** These patient simulations give students experience in recognizing heart sounds and EKG tracings, in interpreting CT, plain film, and echo sequences, in assessing pathologic specimens, and in diagnosing and managing patients. We are currently distributing CaseBase to cooperating institutions who agree to share cases developed with it. A major interest is to evaluate student trajectories through the case, as a way of assessing use and effectiveness of particular problem solving strategies.

Medical Imaging Self-Assessment. Properly designed and implemented computer-based instructional materials that use gaming techniques—competition, scoring, time constraints, lively audio feedback, and colorful graphics —can serve a dual purpose. Not only can such educational resources provide students with a wealth of meaningful data, but they can also foster a degree of emotive involvement in the material that no other presentation modality can do.

To assess the applicability of a gaming environment in the teaching of cardiac pathophysiology, a graphically-oriented game, PathGame, was developed for first-year medical students

enrolled in the Health Sciences and Technology Division of Harvard and M.I.T., by **Bryan P. Bergeron, M.D., John T. Fallon, M.D., Ph.D.,** and **A. Nicholas Morse**. Evaluation of the program strongly suggests that, for certain types of materials, this easily implemented mode of computer-based instruction is a viable alternative and supplement to other designs. We believe this approach has considerable applicability to radiology education as well, and are planning to develop a set of radiologic imaging self-assessment materials. The tool itself could readily be used by others planning similar activities. Dr. Bergeron has also incorporated a neural net model into the program, which is being used to dynamically evaluate student performance as a way of selecting questions to challenge the student at a level appropriate for his/her skill level.



DEPARTMENT OF BIOMEDICAL ENGINEERING

THE SCHOOL OF MEDICINE

THE UNIVERSITY OF NORTH CAROLINA at CHAPEL HILL

STUDENT GUIDE

AUGUST 1993

APPENDIX VII

MEDICAL INFORMATICS TRACK

The field of Medical Informatics deals with the concepts and principles underlying acquisition, processing, and presentation of information in support of medical practice and education. The Medical Informatics track is relatively new, with the first students admitted in the 1991-92 academic year. In 1992, a training grant from the National Library of Medicine awarded jointly to Duke and UNC established the Duke-UNC Medical Informatics Training program. This grant places in the Research Triangle area one of the ten federally sponsored medical informatics training programs in the country, and the only such program in the southeast. UNC students in the Medical Informatics track are part of this training program. Support for students is available through the training grant. More detailed information about studies in medical informatics is available on request.

The faculty's research interests span a wide range of topics. The topics of major emphasis are:

- development of clinical data and knowledge bases, and the presentation of information from these resources so as to positively affect medical decision making;
- applications of advanced image processing techniques to diagnosis and treatment planning;
- studies of the reasoning processes of clinicians and the impact of information technology on patient care;
- application of advanced information technology to education in the basic and clinical sciences.

Four UNC medical informatics core courses, with full implementation beginning the fall of 1992, are described at the end of the appendix. Many pertinent courses are offered at Duke and it is expected that students will take some of their coursework there through cross-registration.

FACULTY:

In the broadest sense, the program faculty includes approximately 50 individuals with interest in medical informatics at UNC and Duke. The program faculty with appointments in biomedical engineering or who play a major teaching role in informatics core courses at UNC include:

Friedman*	Downs	J. Hammond
Hsiao	Tsui	Cronenberger
Charlton	Lucas	Michael
McNutt	Pizer	de Bliek
Beard		

* Program director.

PROGRAMS OF STUDY:

Predoctoral Training: The following is a typical academic program leading to the PhD for a student with an engineering or mathematics background. This program assumes that the student has knowledge of advanced calculus for engineering applications. (Students lacking this experience will need to take MATH 128 prior to taking the qualifying examination.) Elective experiences will be selected in consultation with the student's advisor. The Biomedical Engineering qualifying exam will typically be taken in January of the second year. Course credit hours appear in parentheses.

First Year (29 credit hours)

Fall Semester

BMME 100 - Introduction to Biomedical Engineering (1)
BMME 170 - Introduction to Medical Informatics (Duke/UNC joint course: 3)
BIOS 135 - Probability and Statistics (4)
PHYS 140 - Human Physiology (5)

Spring Semester

BMME 121 - Digital Signal Processing (3)
BMME 1aa - Medical Information Systems (4)
BMME 270 - Research and Evaluation Methods in Medical Informatics (3)
BMME 111 - Biomedical Instrumentation (3)

Summer

BMME 231 - Special Topics in Biomedical Engineering (Internship: 3)

Second Year (24 credit hours)

Fall Semester

BMME 2bb - Clinical Reasoning & Decision Making (3)
BMME 120 - Real Time Computer Applications (3)
BME 399 (Duke) - Computer-based Patient Records (3)
Elective - (3)*

Spring Semester

LIBS 256 - Database Systems (3)
BME 241 (Duke) - Artificial Intelligence in Medicine (3)
Elective - (3)*
Elective - (3)*

Later Years
Electives as directed by student interests and to prepare for dissertation research.

*Elective must be 200-level at UNC or 300-level at Duke.

Postdoctoral Training: The curriculum for doctorally trained health professionals unfolds over two years. Most course requirements for the MS degree will be completed in the first year, providing a basis for a second year weighted toward project and thesis work which are a vital component of the program. Students will take the qualifying examination in January of the second year. Health professionals seeking a terminal masters degree may petition to take a modified version of this examination. Graduates of this two year program will be able to carry out a practical development project from conception to documentation, and to conduct original research. To these ends, each student will undertake an extended internship in the summer to complete the development project; the masters thesis will be a focused work of original research completed in the second year.

A typical postdoctoral trainee's program is described below:

First Year (24 hours)

Fall Semester

BMME 100 - Introduction to Biomedical Engineering (1)
BMME 170 - Introduction to Medical Informatics (Duke/UNC: 3)
BIOS 135 - Probability and Statistics (4)
BMME 2bb - Clinical Reasoning & Decision Making (3)

Spring Semester

BMME 1aa - Medical Information Systems (4)
BMME 121 - Digital Signal Processing (3) *or* BMME 111 Biomedical Instrumentation (3)

BMME 270 - Research and Evaluation Methods in Medical Informatics (3)

Summer

BMME 231 - Special Topics in Biomedical Engineering (Internship: 3)

2nd Year (18 hours)

Fall Semster

BMME 120 - Real Time Computer Applications (3)
BME 399 (Duke) - Computer-based Patient Records (3)
BMME 393 - Thesis (3)

Spring Semester

BME 241 (Duke) - Artificial Intelligence in Medicine (3)
BMME 393 - Thesis (3)
Elective (3)

Other Courses: For electives or as substitutes for some of the courses listed above, students might choose:

BME 399 (Duke) - Data and Knowledge Representation in Clinical Information Systems
BME XXX (Duke) - Networking (3)
BMME 141, 142 - Medical Imaging I and II (3 hours per semester)
COMP 230 - Database Management Systems (3)
COMP 254 - Picture Processing and Pattern Recognition (3)
COMP 255 - Computer Vision (3)
EDCI 211 - Instructional Systems Development (3)
INLS 257 - User Interface Design (3)
PHYS 101,102 - Introductory Electronics (3 hours per semester)

UNC MEDICAL INFORMATICS CORE COURSES

BMME 170 INTRODUCTION TO MEDICAL INFORMATICS (3). This introductory course will be offered jointly with Duke and will enroll all entering medical informatics students at both institutions. It will be taught at UNC and Duke in alternate years. A review of existing information systems for supporting inpatient and ambulatory care. The course will contrast and compare the requirements of systems supporting these two different medical environments. A major focus of the course will be on the clinical requirements of these systems. The financial and administrative requirements will also be presented. Modules on communication, medical records, intensive care units, radiology, pharmacy, surgery, anatomic and clinical pathology, etc. will be presented. FALL 1993, HALES (at Duke); FALL 1994, J. HAMMOND (at UNC);

BMME 1aa MEDICAL INFORMATION SYSTEMS (4). Students will be introduced to the rudiments of database constuction, including entity-relationship diagrams and with emphasis on special representation issues raised by medical information. Students will develop databases and will work with SQL as well as with form/screen generation languages. Special attention will be given to issues of system reliability, data security, and to the storage and retrieval of images and other non-traditional data types. Course activities will involve a combination of classroom instruction and project work. SPRING, BEARD *(Initial offering in 1993-94.)*

BMME 2bb CLINICAL REASONING AND DECISION MAKING (3). This course will have two distinct components. This first will address structured approaches to clinical decision making, including Bayes' Theorem and expected utility theory, decision trees, clinical algorithms, and belief networks and influence diagrams. Students will model and analyze actual clinical problems using these techniques and will learn to employ computer-based tools (spreadsheet techniques and the DECISION-MAKER program) in these analyses. The second component of the course will address research on clinical reasoning drawn from cognitive psychology and related fields. Topics to be covered include: models of human problem-solving, expert-novice differences and the development of clinical expertise, and knowledge representation. The final session of the course will seek to relate the decision theoretic and cognitive approaches to clinical reasoning. FALL, de BLIEK, DOWNS *(Initial offering in 1993-94)*

BMME 270 RESEARCH AND EVALUATION METHODS IN MEDICAL INFORMATICS (3). This course recognizes that the classical approaches to experimental research are difficult to apply in medical informatics. Topics to be covered include: quasi-experiments, with emphasis on design and appropriate choice of statistical analyses; correlational and other non-experimental research techniques, with an introduction to factor analysis and causal modeling; and descriptive techniques including qualitative research approaches. As each research approached is introduced, students will be exposed to the data collection methods widely used in that approach (eg. interviews and observation in qualitative research). Examples of these techniques from the medical informatics literature will be introduced and analyzed by students. SPRING, FRIEDMAN

Postdoctoral Fellowships
in
Medical Informatics
University of Missouri

Postdoctoral fellowships are available for qualified applicants seeking academic training in medical informatics. Medical informatics is the application of computers to health care. Medical informatics goes beyond the use of the computer as a computational tool and extends into the process of knowledge representation, acquisition, storage, retrieval, and manipulation largely to support reasoning, decision-making, and learning.

Successful candidates may have a variety of backgrounds. Some applicants will have an MD, DO or DVM degree and be near completion of a residency in a medical or veterinary specialty. Other candidates might have a PhD in electrical engineering, computer science, information science, and be interested in health applications; or would have a PhD in molecular biology or biological sciences, with interests in computer science. Still other candidates might have a PhD in biostatistics, or educational psychology, with course work in health related areas.

Fellowships would be for two to three years, and fellows could obtain a PhD or Master's degree.

Fellows will receive a stipend ranging from $18,600 to $32,300, depending on experience and prior training. The fellowship waives most if not all of the costs of tuition and fees. Fellows also receive travel funds to participate in certain scientific meetings.

Applicants should submit a transcript of their graduate and undergraduate work, a Curriculum Vitae, three letters of reference, a two-page typed statement indicating their past achievements in medical, computer, health science, library, mathematics/statistics, and education areas, and a statement indicating their commitment to and interest in an academic career in medical informatics.

Successful candidates can expect to begin study in July or August 1994, select a mentor in their area of interest to work on research projects, and take interdisciplinary course work leading to an understanding of medical informatics.

We particularly invite women and minority applicants. All fellowships are subject to availability of federal funding. Fellowship recipients must be U.S. citizens or permanent residents of the U.S.

For further information contact:
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Medical Informatics Group
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Columbia, MO 65211
314-882-6966 FAX 314-884-4270
MUCCGW.MIGJOYCE@SSGATE.MISSOURI.EDU

Applications are considered until positions are filled. For priority consideration, send application by January 1.

Medical Informatics Training at the University of Missouri

605 Lewis Hall
Columbia, Missouri 65211
314 882-6966

The University of Missouri offers a flexible program to train postdoctoral and predoctoral candidates for an academic career in medical informatics. A three-month fellowship for medical and veterinary students desiring a short research experience is also offered.

The training program and curriculum prepares individuals to develop, use, and evaluate applications of innovative information methods and computers in the health care environment. The program emphasizes the synthesis, retrieval, organization, and effective management and communication of knowledge. The core curriculum consists of seven courses from five different divisions. The MU program has ten core faculty (and numerous clinical faculty) with diverse backgrounds and active research programs.

Upon completion of the program, all fellows are expected to have basic competency in decision support systems, computer networks, expert systems, artificial intelligence, medical subject analysis, database management systems, and applied statistics. Graduating trainees should be qualified for an academic career in medical informatics upon completion. They should be particularly expert in the field represented by their research projects.

Fellows learn about current research by sharing their projects and by hearing invited speakers at weekly seminars and journal club. These meetings teach trainees writing and oral reporting skills in defending their own position and in analyzing other's projects. Trainees specifically discuss methods of experimental design for informatics research.

All fellows choose to work with a senior researcher on medical informatics projects. Current projects include:

- Expert systems, reminder systems, knowledge based systems
- High Performance Communications and Computing (HPCC)
- Clinician and student workstations
- Multimedia systems for education and clinical uses
- Full-text information retrieval and search heuristics
- Molecular biology computing
- Applications of the Unified Medical Language System
- Integrated Advanced Information Management Systems
- Cognitive processing models
- Computer assisted continuous quality improvement
- Computer vision and image analysis
- Computer generated cardiac profiles in health and disease
- Randomized controlled clinical trials of information interventions
- Meta-analysis of controlled information service trials
- Computers in the integration of clinical and business functions.

Postdoctoral fellows will receive advanced training in information system development and medical informatics research. Since medical informatics training involves many disciplines, the fellows are offered a broad range of projects within and outside the Medical Informatics Group. Strong liaisons are present with the Schools/Programs of Medicine, Nursing, Health Services Management, Library and Information Science, Veterinary Medicine, Health Related Professions, Computer Engineering, Industrial Engineering, Computer Science, Statistics, Education, Molecular Biology, Sociology, and Anthropology. In collaboration with a faculty mentor, fellows develop independent projects which including writing of proposals, system development, evaluation, and publications.

Additionally, postdoctoral fellows holding clinical doctorates (MD, DO, DVM, DDS, etc.) could obtain an advanced degree: 1) A Ph.D. in Electrical and Computer Engineering, in Industrial Engineering, or in Educational and Counseling Psychology, 2) A Master's degree in the above fields or in Computer Science, Health Services Management, Biostatistics, Nursing, or Library and Information Science.

Predoctoral fellows are required to obtain a Ph.D. depending upon their interests and background. For example, a person wishing to emphasize artificial intelligence, computer vision, or image analysis would pursue a doctoral degree in Electrical and Computer Engineering (ECE). All Ph.D. programs allow for considerable work in outside areas. A candidate in Educational and Counseling Psychology could take work in biological science, in Computer Science, and in ECE, etc. The courses to be taken are worked out by the candidate jointly with the candidate's faculty advisory committee, according to the candidate's interests and goals. Predoctoral fellows must be accepted by an academic department at MU.

Short term fellows (3-6 months) will work with a senior researcher on a research project of mutual interest. Short term fellows must be students currently enrolled in Medical or Veterinary Medical School.

All fellows must be U.S. citizens. Minority trainees may apply for additional support.

For further information, contact:

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Medical Informatics Training

at the

University of Missouri

September, 1993

Joyce A. Mitchell, Ph.D., Director and Professor
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Medical Informatics Training at the University of Missouri

Postdoctoral fellows and predoctoral fellows

We accept 2 postdoctoral fellows, 2 predoctoral fellows, and one short term traineeship per year. The short term traineeship will be used by students currently enrolled in medical or veterinary medical school. We will maintain a steady state at 4 to 6 postdoctoral fellows and 3 to 4 predoctoral fellows. Fellows who are M.D.'s, D.O.'s and D.V.M.'s will not have any clinical responsibilities. Both predoctoral and postdoctoral trainees need to demonstrate satisfactory competence as shown by completion of the core courses below and complete a research project and other courses as outlined by their advisory committee.

Areas of possible interdisciplinary research projects in computer science and electrical engineering include computer networking, radiographic image transmission, computer vision, artificial intelligence, expert systems, and neural networks. Areas of possible research projects in health education include analysis of problem-solving skills in computer based instruction, performance support systems, perception, cognitive processing, semantic networks, and computer recognition of natural language. Projects in data management for patient care include patient chart development, integration of text files with image processing, image compression and analysis, and integrated advanced information management. Projects in library and information science would concentrate on health topics.

Trainees will be directly involved with research, commensurate with the usual standards for master's or doctoral-level work. Minority trainees could apply for additional support. Trainees should be qualified for an academic career in Medical Informatics upon completion. They should be particularly expert in the field represented by their research project.

Core requirements

The purpose of the curriculum is to prepare individuals for an academic career in Medical Informatics. It emphasizes the synthesis, retrieval, organization, and effective management and communication of knowledge.

- We expect that all applicants would have basic competency in molecular biology, and in applied statistics.

- All successful fellows would have mastered the skills and knowledge represented by the following seven core courses; MA candidates in Library Science would take 4 of the 7.

(1) HSM 430 (VSM 430, LIS 430) Computer Applications in Health Care (3). Overview of the field of medical informatics.

(2) CS 380 Computer Networks (3). Computer networking, protocols and standards, routing algorithms and congestion avoidance.

(3) ECE 457 Machine Intelligence (3). Formal languages in relation to natural language processing; formal languages, graphs, and image processing.

OR

CS 321 Expert systems (3). Introduction to expert system shells. Students create prototype expert systems under close supervision by faculty experts.

(4) ECE 474 Artificial Intelligence (3). Concepts, theories and models pertaining to neural nets, pattern recognition, learning systems and programmed problem solving.

OR

CS 325 Artificial intelligence I (3). Concepts and theories of intelligent systems. Introduction to Lisp and Prolog. Applications to game playing, theorem proving, natural understanding, and expert systems.

OR

HSM 470 Decision Support and Analysis in Health Care. To be offered beginning January 1995.

(5) LS 416 Medical subject analysis (3). Medical terminology comprehension, indexing policies, and searching procedures for NLM data bases, cataloging, and classification; UMLS structure and terminology. Exploration of UMLS using the Macintosh version.

(6) CS 365 Database Management Systems (3). Concepts of database systems emphasizing relational models. Other topics include network and hierarchical data models, entity-relationship design, and case studies. Project work involves a modern DBMS.

OR

IS 412 Information storage and retrieval (3). Techniques and models in an automated environment, automatic indexing, classification, bibliometrics, and database management systems.

(7) Biochem 399, Biotechnology information retrieval (2). Searching online databases of current scientific and patent literature, searching for and using chemical structure data, manipulating DNA and protein sequence information, building molecular models using computer graphics.

- During their education, Medical Informatics trainees attend a weekly research symposium. Trainees present one or two research papers a year to get opinions and critiques about their work and to learn of other ongoing research. These meetings teach trainees writing and oral reporting skills in defending their own position and in analyzing other's projects. Trainees specifically discuss methods of effective experimental design for informatics research. Trainees also participate in a Journal Club. Trainees also hear invited speakers.

- All successful candidates, including any non-degree candidates, will have completed and published a research project on a health care topic in Medical Informatics under the supervision of a senior faculty researcher.

- One of the core directors sees that each trainee joins with a research preceptor as soon as possible, and formally meets with each trainee quarterly to see that the trainee is proceeding on schedule.

Degrees

UM does not offer a degree specifically in Medical Informatics, but does offer a flexible program to train people for an academic career in Medical Informatics. Postdoctoral fellows have three choices. First, postdoctoral fellows could obtain a Ph.D. in (a) Electrical and Computer Engineering, or in (b) Industrial Engineering, or in (c) Educational and Counseling Psychology, or in (d) Nursing. As a second option, they could instead obtain a Master's degree in the above fields or in Computer Science, Library Science, Health Services Management, or statistics. Third, some postdoctoral fellows might qualify for an academic career in Medical Informatics by taking selected courses that did not lead to a degree. These postdoctoral fellows would still need to demonstrate skills and knowledge in molecular biology and statistics, complete the core courses, and complete a research project supervised by a senior researcher.

Predoctoral fellows could obtain a Ph.D. depending upon their interests and background. For example, a person wishing to emphasize artificial intelligence, expert systems, bioengineering, computer vision, neural networks, or image analysis would pursue a doctoral degree in Electrical and Computer Engineering (ECE). We would expect that most candidates would pursue the degree in ECE since this is the most established path. However, all of these Ph.D. programs allow for considerable work in outside areas so that a candidate in Educational and Counseling Psychology would take work in biological science, in Computer Science, and in ECE, etc. The courses to be taken are worked out by the candidate jointly with the candidate's faculty advisory committee, according to the candidate's interests and goals. It is not unusual for candidates in interdisciplinary programs to cross departmental lines to take courses offered by other departments. Predoctoral fellows can also pursue a Masters of Arts degree in Library and Information Science. This degree would allow for a specialization in health sciences librarianship.

We illustrate a sample postdoctoral student, an M.D. with a residency in Pediatrics, David Jones, who has a strong demonstrated interest in medical informatics and who decides to train for an academic career in medical informatics at the master's level, with a degree in computer science, emphasizing expert systems. One of the three directors suggests he talk with Drs. Brent, Franck, Furbee, Hahn, Hile, and Reid to learn of their current research. Dr. Blackwell becomes his major advisor and Dr. Furbee agrees to serve on the graduate advisory committee from an outside discipline. Dr. Jones and his core advisor work out a list of courses that assure competent training for a Medical Informatics career. His graduate committee approves his proposed course work. Dr. Jones takes 12 hours of prerequisites in computer science to take the core courses, and 6 hours of learning theory in Educational and Counseling Psychology. Dr. Mitchell meets with him quarterly to monitor and evaluate his work by discussing his test grades, papers, and work pressure. He also attends the research symposia and journal clubs, and presents one or two papers a year at the symposia. His graduate committee approves his thesis topic on expert systems to teach parents how to cope with events that occur in their child's life, depending upon the child's previous history. He presents his research at the research seminar and submits a manuscript for publication in an informatics journal. Upon successful completion of his course work and thesis, he receives the M.S. degree. We do not intend that M.D.s will have any clinical responsibilities while serving as a Medical Informatics fellow. However, because of the nature of his research, Dr. Jones attends clinic one afternoon a week and works with faculty in Child Health and in Psychiatry.

Now we illustrate a predoctoral student, Karen Smith, in library/information science. She comes to MU with an undergraduate major in biology and several years as a paraprofessional in an academic health sciences library. Upon admission to the program she is advised by Dr. Berk to apply for one of the Informatics traineeships. When she is chosen she begins at once to plan her two-year program. Because

of her previous work she is able to pass the competency tests for two of the courses required for the SLIS degree. Thus, she will be able to incorporate two of the Informatics core courses into her plan of study for the master's degree. Her SLIS program will include the 9 hours in health sciences librarianship (including Medical Subject Analysis) and 9 hours in information science. She is also able to include a 3-credit internship in the Library Systems Office under the direction of Dr. Kurt Kopp, a former Informatics trainee. Her research project can also be included in her plan of study. In addition she will take the other core courses in informatics. Shortly after selection as a trainee she is encouraged to talk with Dr. Mitchell, Hahn, Blackwell, Sievert and Brent. She chooses to work with Dr. Sievert on a project of managing and integrating academic information systems. During the 2 years she participates in the seminars and journal clubs. She presents papers on her research, does a poster session at the Annual Conference of the Medical Library Association, and enters the student paper competition at the annual SCAMC (Symposium on Computer Applications in Medical Care). At the completion of the program she will receive her master's degree in library science. She will apply for the intern program at NLM and will also seek a position as a systems librarian in an academic health sciences library.

Research Opportunities

We briefly describe examples of significant research projects available for trainees.

- Professors Mitchell, Marilyn Sanford (Physical Therapy), John Reid, John Wedman, Ellis Ingram, and Richard Robinson are working on projects in cognitive science, learning theory, and multi-media. The AI/Learn project to teach medical students and physical therapy students concepts and discrimination skills in rheumatology and rehabilitation has completed a formative evaluation phase and is completing a summative evaluation phase under a 5-year grant from U.S. Department of Education. Other current research projects include the identification of problem solving skills using think-aloud protocols, and the analysis of educational text for patients using a text variable--person variable interaction model. A newly funded project began in 1993 focused on intelligent performance support systems for use by patients. A trainee in this area may wish to pursue a degree in Curriculum and Instruction or Computer Science.

- Professors Sievert and McKinin are studying full-text information retrieval, and in particular the problem of search heuristics and their precision and recall and comparison to structured abstracts under a grant from NLM. The School of Library and Information Science with its program in medical librarianship adds a uniqueness to the proposed training program. MLS students and computer science trainees can work with Dr. Mitchell on managing and integrating information systems. These activities are ongoing in the School of Medicine and in the School of Veterinary Medicine, and relate to the enhancements of the health sciences fiber optic network and IAIMS planning.

- Based in the Dalton Research Center, the multidisciplinary Laboratory for Applied Expert Systems Research (LAESR) members share a common interest in Expert Systems. They teach the Expert Systems course in Computer Science, and they and their students design expert system projects. Drs. Benfer, Brent, and Furbee co-authored Expert Systems, 1991, published by Sage. This same research team has developed expert systems supported by outside funding for investigative reporting, and forensic anthropology. The LAESR researchers bring a breadth of professional experience including

Duke University • University of North Carolina
Training Program in Medical Informatics

The Duke - UNC medical informatics training program, supported by the National Library of Medicine, prepares students for research and development careers focused on the application of information technology to health care. The Duke - UNC program is one of ten such programs funded by the NLM and the only program in the southeast.

Training positions are available each year at the predoctoral and postdoctoral levels. Predoctoral training is typically three or more years in duration, leading to the Ph.D. degree. Predoctoral students will typically have baccalaureate level training in engineering or an appropriate field of science. Postdoctoral training is typically two years in duration, leading to the M.S. degree. Postdoctoral trainees can be physicians or other health professionals holding doctoral degrees.

The program director for Duke University is Dr. W. Edward Hammond; the director for UNC is Dr. Charles P. Friedman.

A Program Exploiting the Strengths of Two Universities: Each trainee in the Duke - UNC program will matriculate as a graduate student at one of the two universities. Duke and UNC are 11 miles apart in the Research Triangle area of North Carolina. Program activities are highly integrated, so that all trainees can benefit from the faculty expertise and research resources of both institutions. All students can meet degree requirements through course work across the full range of graduate-level offerings at both institutions since there are full cross-registration privileges. Laboratories and research projects at both sites will be available to all students for research internship and dissertation experiences. Masters and doctoral committees can be interinstitutional as well. A bi-weekly program seminar series involves students and faculty from both institutions and alternates meeting place between the two institutions.

Curriculum: Medical informatics is a broad, interdisciplinary field and the training curricula reflect that structure. The Duke - UNC program stresses both the basic sciences underlying medical informatics and an equally important body of practical knowledge necessary to design and implement computer applications that function in support of health care. The program also stresses the methods used to study rigorously the effectiveness of these information technology applications. To these ends, degree programs include courses specifically addressing topics in medical informatics; courses in biomedical engineering, computer science, information science, biostatistics, and other basic disciplines; electives tailored to each student's special interests; and internships that provide experience with computer applications installed in clinical settings. Thesis/dissertation work is required for all degrees.

Trainees at both institutions enroll as graduate students in the Department of Biomedical Engineering, in a designated medical informatics program track. More specific information about the curriculum is available on request.

Program Faculty: At each institution, the program faculty consists in part of a core group serving as primary advisors to students and offering the courses that address topics within medical informatics. This core group is complemented by a larger group of affiliated faculty with relevant research interests and spanning many departments at the two schools. These affiliated faculty members are available to students for project, thesis, and dissertation work; and for specialized guided reading courses. In all, the program faculty includes 25 from 13 departments at Duke, and 29 faculty members representing 16 departments at UNC.

At Duke, areas of special faculty interest include:

- development and support of computer-based medical record and hospital information systems;
- implementation of IAIMS (Integrated Academic Information Management Systems) within the academic medical center;
- medical instrumentation and real-time patient monitoring;
- development and use of clinical research databanks.

At UNC, areas of special faculty interest include:

- development of clinical data and knowledge bases, and the presentation of information from these resources to positively influence medical decision making;
- applications of advanced image processing techniques to diagnosis and treatment planning;
- studies of the reasoning processes of clinicians and the impact of information technology on patient care;
- application of advanced information technology to education in the basic and clinical sciences.

Current Trainees: In 1993-94, there are thirteen medical informatics trainees across the two institutions. Many students in the program receive full tuition and stipend support from the National Library of Medicine training grant, while other students receive support from research assistantships provided by academic departments affiliated with the program. The current students are a diverse group including physicians and non-physicians with interests ranging from decision support to imaging to business/financial aspects of informatics. Most but not all students are full time.

Application Process: Qualified applicants are invited to apply to the Department of Biomedical Engineering, specifying their interest in the medical informatics track, at either or both institutions. For postdoctoral trainees, no specific medical informatics or computer science background is required. Trainees accepted by both institutions will be offered a position in one of the two sites acording to the trainee's stated preference for instutional site and each site's level of preference for that trainee.
UNC.

For more information:

At *Duke*

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Box 2914
Duke University Medical Center
Durham, NC 27710-2914

Phone: (919) 684-6421
Fax: (919) 684-8675
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At *UNC*:

Dr. Charles P. Friedman
322 MacNider Building
University of North Carolina
School of Medicine
Chapel Hill, NC 27599-7530

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E-mail: cpf@med.unc.edu

Medical Informatics Training Program

Introduction

The Duke/UNC Medical Informatics Training Program was established in 1991 through grant funding from the National Library of Medicine. Though recently formed, the program draws upon more than 25 years of research experience in medical informatics at Duke. Duke's longstanding strengths include: computer-based medical records, implementation of IAIMS, medical instrumentation, and patient monitoring. These achievements are complemented by UNC's equally longstanding strengths in imaging and radiologic treatment planning, the application of information and cognitive sciences, and the development and management of clinical databases. The Duke program offers predocotoral and postdoctoral opportunities for applicants from medical and engineering/computer science backgrounds. The training program is structured so that trainees benefit from the strengths of both institutions. The joint program creates an environment that offers a unique opportunity for trainees to participate in cutting-edge research in the application of information technology to both patient care and education.

Duke University

The administrative structure, the geography of the campus, and the attitudes the faculty and staff create an environment at Duke that is conducive to multidisciplinary programs such as medical informatics. Several multidisciplinary investigative laboratories at Duke have contributed significantly to the field of medical informatics.

In 1967, a Division of Biomedical Engineering was established, supported financially by both the Schools of Engineering and Medicine. The division has since become an independent department in the School of Engineering. Biomedical engineering investigators are housed within the medical center, managing a laboratory with trainees from both medicine and engineering, and having full access to the resources of the medical center.

In the early 1970s, from seed money received from the NLM to establish a joint M.D./Ph.D. program in Computer Science, Duke established an independent Department of Computer Science. From the beginning, that department has had close ties with the medical school with a medical school division headed by a physician and housed in the medical center. The pattern of faculty investigators based full-time in the medical center with a mixture of trainees from computer science and medical training programs continues today and is augmented by the addition of the Medical Informatics Training Program.

Medical Informatics at Duke

In the middle 1960s, Duke was involved, with IBM, in a research project known as the Clinical Decision Support System. From this time on, Duke University Medical Center

has not only been involved in research in the field now known as medical informatics, but has demonstrated strong interest and commitment to medical computing projects.

One area of research grew out of the MIRU projects of the late 1960s. A group within the Division of Cardiology developed a research database for individuals seen at Duke Medical Center having a diagnosis of coronary artery disease. This research database, referred to as the living textbook of medicine, has been a leader in methods for extracting knowledge from computerized databases.

In the mid-1970s, a group of researchers at Duke developed the Duke Hospital Information System (DHIS). This system, marketed by IBM as PCS, is still one of the most implemented HISs in the world. DHIS provides patient registration, admission-discharge-transfer (ADT), order entry, laboratory results reporting, accounting and billing functionality at terminals located throughout the medical center campus.

Duke is also the home of The Medical Record (TMR). Since 1968, on-going research into developing a computer-based medical record has driven the development of what is now one of the premier computer-based medical record systems in the country. Originally developed for the ambulatory care setting, TMR has expanded to the inpatient setting including Labor and Delivery Unit and the Surgical Intensive Care Unit at Duke. Recent work has involved the bridging of inpatient and outpatient into one continuous computerized patient record for the Bone Marrow Transplant Unit. Most of the trainees are housed in the TMR Laboratory. This provides for hands-on experience with operational systems in a clinical environment.

Bringing all of these resources together for the benefit of researchers, clinicians and patients is the focus of the Duke Integrated Academic Information Management System (IAIMS) initiative. Duke University Medical Center is a recipient of National Library of Medicine (NLM) funding for an IAIMS Phase III Implementation Grant. The implementation process provides for of demonstrations of full IAIMS function in each of four user domain (administration, education, patient care and research) as well as the extension of a critical mass of IAIMS functions to all users. The IAIMS project also includes the development of new techniques of user support and the evaluation of system effectiveness.

The awarding in 1991 of NLM funding for an institutional training program represents the capstone of medical informatics research at Duke. More than 25 years of experience are brought to bare in the training of new medical informatics researchers. The institution of the training program established a formal pathway for trainees with an interest in medical computing to receive advanced training at an institution that has been on the forefront of medical informatics research.

Faculty

W. Edward Hammond, PhD
Professor, Division of Biometry and Medical Informatics, Department of Community and Family Medicine
Professor, Biomedical Engineering
Director, Medical Informatics Training Program

Dr. Ed Hammond is the director of the Duke Medical Informatics Training Program. His primary appointment is in the Department of Community and Family Medicine. Dr. Hammond shares responsibility for the medical informatics courses taught in the medical center and for the third year activities in medical informatics. His secondary appointment is in the Department of Biomedical Engineering, where he teaches courses in medical informatics. Dr. Hammond brings to the program a unique combination of engineering, computer science, administration, education, and medical background. He is experienced in networking (hardware and software), in database and database design, in programming languages, in decision support and in the computer-based medical record. Dr. Hammond has taught courses and given tutorials in these areas for many years. For over twenty years, Dr. Hammond was been developing the internationally known computer-based medical record system, The Medical Record (TMR).

Dr. Hammond's research has focused on producing medical informatics products which can be used in the real world. Problems encountered in these practical laboratories produce excellent topics for research. In addition, this environment provides opportunities for developing, applying and understanding design techniques and evaluation methodologies.

Dr. Hammond has been very active nationally and internationally in medical informatics. He is a member of the Board of Directors of the American Medical Informatics Association, has served as Chairman of the Health Level 7 standards group, is president-elect of the American College of Medical Informatics, and is out-going chairman of SIGBIO. He is active as a consultant for many groups in medical informatics, including the Summit Task Force for restructuring the aims and goals of the American Medical Record Association. He was a co-leader of the recent workshop on Current Topics in Medical Informatics in the area of health care management. He is a member of the International Medical Informatics Association's Working Group 10 on Hospital Information Systems.

Joseph W. Hales, PhD
Assistant Research Professor, Division of Biometry and Medical Informatics, Department of Community and Family Medicine
Assistant Professor, Biomedical Engineering
Associate Director, Medical Informatics Training Program

Dr. Hales is Associate Director of the Training Program at Duke and serves on the Joint Training Program Committee. Dr. Hales earned a PhD in Medical Informatics from

the University of Utah. His background is in electrical and computer engineering and his training emphasized clinical information system design and applications of decision support technology to quality assurance.

Dr. Hales' primary appointment is in Community and Family Medicine. His current research focuses on the integration of institutional computing resources under IAIMS and applications of decision support using TMR. As Associate Director, Dr. Hales is responsible for program information, student communications, and logistics of the academic program.

David B. Pryor, MD
Associate Professor, Division of Cardiology, Department of Medicine

Dr. Pryor is the Principal Investigator for the Duke IAIMS grant and also the Principal Investigator for the AHCPR PORT in chronic ischemic heart disease. Dr Pryor has served as director of the Duke Cardiology Databank and has made significant contributions to medical informatics research at Duke. His current research efforts focus on the application of clinical databases to outcomes research.

William E. Wilkinson, PhD

Associate Professor, Division of Biometry and Medical Informatics
Adjunct Associate Professor, Institute of Statistics and Decision Sciences
Chief, Division of Biometry and Medical Informatics, Department of Community and Family Medicine

As chief of the divisional home of medical informatics at Duke, Dr. Wilkinson serves as a member of the Joint Training Program Committee. He brings to the program a strong computer background combined with statistics and research design.

Related Faculty

Biochemistry
Russel E. Kaufman, MD
David C. Richardson, PhD

Biomedical Engineering
Roger C. Barr, PhD
Olaf T. Von Ramm, PhD

Biometry
Frank E. Harrell, PhD
Lawrence H. Muhlbaier, PhD
Kerry L. Lee, PhD

Business Administration
Aleda V. Roth, PhD

Cancer Center Biostatistics
Steve George, PhD

Cardiology
Daniel B. Mark, MD
Robert M. Califf, MD

Center for Health Policy Research and Education
David B. Matchar, MD

Community & Family Medicine
James L. Michener, MD
Reginald D. Carter, PhD

Computer Science
Frank Starmer, PhD

Institute of Statistics and Decision Sciences
Michael West, PhD
Don S. Burdick, PhD

Radiology
G. Allen Johnson, PhD

Rheumatology
John R. Rice, MD
Rex M. McCallum, MD

Sanford Institute of Public Policy
Bruce Kuniholm, PhD
Duncan Yaggy, PhD

Program Tracks

The Medical Informatics Training Program is composed of two tracks: predoctoral and postdoctoral. The predoctoral program leads to a doctoral degree in biomedical engineering with a focus in medical informatics. Applicants to the predoctoral program should have either a baccalaureate degree in biology, chemistry, computer science, engineering, mathematics or physics with an emphasis on the use of computers in problem solving; or be pursuing a combined M.D./Ph.D. The predoctoral program is intended to provide four years of training.

Postdoctoral candidates may elect to pursue a Master of Science Degree in Biomedical Engineering or elect not to seek a degree. Students accepted in the postdoctoral program are primarily MDs who wish to devote a period of time to an intensive study of medical informatics. Generally they will have completed residency training. The postdoctoral program is intended to be a two year program.

Admissions process

Application for admission to the training program is through the Graduate School. Potential applicants should obtain application materials directly from the Graduate

Admissions Office. These materials may be obtained by writing to the address given below or by calling (919) 684-3913.

Office of Admissions
Graduate School
Duke University
Durham, NC 27706

Students seeking admission as non-degree candidates should request further information from the Division of Medical Informatics at the address below or by calling (919) 684-6421.

Division of Medical Informatics
Box 2914
Duke University Medical Center
Durham, NC 27710

Clarity of career orientation will be the single most important factor in trainee selection. The program is intended to train career investigators in medical informatics. Other factors that will be considered include standard test scores (e.g., GRE or MCAT) and undergraduate grades, also availability of funding.

Funding

Funded fellowships are available each year through a grant from the National Library of Medicine. Funding includes tuition and a living allowance. Potential applicants should be aware that the National Library of Medicine restricts the award of fellowships to US citizens and permanent residents.

Participation in the training program is not limited to those accepted as NLM fellows. Potential applicants are encouraged to seek alternative funding sources, such as extramural grants from NLM or other branches of the National Institutes of Health, other government agencies, such as the Agency for Health Care Policy and Research (AHCPR) or from private foundations, such as the Robert Wood Johnson Foundation.

Program of Study

Each trainee's program is tailored to suit the individual needs of the trainee. Course offerings taught by core faculty provide a foundation in the primary disciplines that comprise medical informatics. Additionally, coursework is intended to address deficiencies in a trainee's background and provide a starting point for focused study in the trainee's selected area of specialization. The support faculty offer instruction and research direction in a broad

range of educational activities including science, engineering, medicine, and administration. Trainees should seek the direction and guidance of their faculty advisor in selecting the courses best suited to the thrust of the trainees research. Formal approval of the program of study is required by the student's committee. In addition to coursework, each trainee will design and execute a research project leading to the completion of a thesis or dissertation.

As part of the joint program, all Duke trainees join with the trainees from UNC for a biweekly seminar. Speakers include faculty of the Duke and UNC programs, invited speakers and trainees. The seminar serves as a forum for presenting work in progress and provides trainees with an opportunity to meet support faculty and share ideas between the programs.

Additional University and Departmental requirements pertaining to minimum credits per semester and residency may need to be met in order to remain eligible for fellowship funding and to graduate. Trainees should consult the current *Bulletin of Duke University, Graduate School* and the appropriate department for current policies.

Predoctoral Program

The first year consists primarily of course work; the second year includes course work with the introduction of some research activities. The third and fourth years are devoted primarily to research. Each program is tailored to suit the individual needs of the trainee. The following sample program illustrates a possible sequence of studies. Course descriptions are included with this guide.

Initial year of graduate work. Trainees take courses to fill in areas in mathematics, engineering, or computer science which were not sufficiently covered during the student's undergraduate experience. During the first summer, all predoctoral trainees, except medical students, take MED 204, Introduction to Clinical Medicine.

BME 243 Introduction to Medical Informatics	3 units
CPS 221 Numerical Analysis	3 units
CPS 241 Database Methodology	3 units
BME 205 Microprocessors and Digital Instruments	4 units
EE 206 Digital Signal Processing	3 units
CPS 215 Artificial Intelligence	3 units

Second Year. Course selection is based on individual background to provide a firm foundation in the disciplines that make up medical informatics. Trainees are expected to pick a dissertation topic during the second semester of the second year. The remainder of the trainee's time is spent on medical informatics research.

PHS 200 Medical Physiology	5 units
BME 265 Computer Network	3 units
CPS 252 Computer Systems Organization	3 units
CFM 234 Artificial Intelligence in Medicine	3 units
BME 233 Modern Diagnostic Imaging Systems	3 units
EE 251 Pattern Classification and Recognition	3 units

Third and fourth year. During the third and fourth year, trainees devote a larger portion of their time to dissertation research during the academic year and full-time to research during the summer.

CFM 211 Probability and Statistical Inference	3 units
CFM 213 Research Data Management	3 units
CPS XXX Computer Science Elective	3 units
BME XXX Biomedical Engineering Elective	3 units
Biomedical Science Elective	4 units

The graduate school requires 60 units of course credit for doctoral candidates. Trainees should plan carefully to meet this requirement so that significant time can be devoted to research during the latter part of the program.

Postdoctoral Program:

Trainees in the postdoctoral program generally have a biomedical background and are, in most cases, physicians. Only mature candidates who have definitive career objectives in medical informatics research are accepted for this program. The program is designed to provide a two year integrated experience through course work and research experience.

Course work is designed to provide an overview of medical informatics together with a foundation in the area(s) of informatics relevant to the trainee's research goals.

All postdoctoral trainees are required to take BME 243 - Introduction to Medical Informatics. This one semester, overview course presents the vocabulary and the basic principles of artificial intelligence, biostatics, database methods, decision theory, epidemiology, hardware design and instrumentation, imaging, signal analysis, networking, simulation and modeling, and systems development.

Although there are no formal prerequisites for postdoctoral trainees, they are expected to have designed a research training project prior to the beginning of their program in conjunction with a faculty sponsor.

LIST OF COURSES

In addition to the courses listed by number, the following courses are being offered as Advanced Topics (BME 265) or Special Readings (BME 399) at Duke until they are approved, are in planning, or are offered through UNC:

Computer-based Medical Records. Introduction to the principles of computer-based medical records using TMR as a model (*Hammond*).
Knowledge Representation. Design and structure of clinical data and knowledge structures (*Hales*).
Research and Evaluation Methods. (*Friedman, UNC*).
Clinical Reasoning and Decision Making. (*de Bliek, UNC*).
Software Engineering. (*UNC*).

Biomedical Engineering (BME)

BME 205 **MICROPROCESSORS AND DIGITAL INSTRUMENTS.** Design of microcomputer-based devices including both hardware and software considerations of system design. Primary emphasis on hardware aspects, including a progression through initial design, prototype construction in the laboratory, testing of prototypes to locate and correct faults and final design evaluation. Evaluation includes examination of complexity, reliability, and cost. Design and construction oriented toward biomedical devices or instruments that require dedicated microcomputers., usually operating in real time. C-L: CFM 235.

BME 333 **BIOMEDICAL IMAGING.** The underlying concepts and instrumentation of several medical imaging modalities. Review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray radiography (conventional film-screen imaging and modern electronic imaging), computerized tomography (including the theory of reconstruction), and nuclear magnetic resonance imaging.

BME 241 **ARTIFICIAL INTELLIGENCE IN MEDICINE.** Basic concepts of Artificial Intelligence (AI) and in-depth examination of medical applications of AI. Knowledge of heuristic programming; brief examination of the classic AI programming languages (LISP and PROLOG) and AI programming; a study of rule-based systems and cognitive models. C-L: CFM 234.

BME 243 **INTRODUCTION TO MEDICAL INFORMATICS.** An in-depth study of the use of computers in biomedical applications. Hardware, software, and applications programming. Data collection, analysis, and presentation studied within application areas such as monitoring, medical records, computer-aided diagnoses, computer-aided instruction, M.D.-assistance programs, laboratory processing, wave form analysis, hospital information systems, and medical information systems. Available alternating years at Duke.

BME 244 **MATHEMATICAL MODELS OF PHYSIOLOGICAL SYSTEMS.** Mathematical modeling and computer simulation of physiological and other biomedical systems. Formulation of quantitative models of physiological processes using methods drawn from a variety of engineering disciplines including transport phenomena, feedback control, and continuum mechanics. Digital techniques for the solution of coupled nonlinear equations, emphasizing systems of ordinary and

partial differential equations. Selected readings from the literature covering current models of cardiovascular, renal, neural, respiratory, and sensory systems.

BME 264 **MEDICAL INSTRUMENT DESIGN.** General principles of signal acquisition, amplification processing, recording and display in medical instruments. Emphasis on system design, construction and evaluation techniques. Methods of real-time signal processing reviewed and implemented in the laboratory. Each student will design, construct, and demonstrate a functional medical instrument and collect and analyze data with that instrument. Formal write-ups and presentations of each project required.

Business Administration (BA)

BA 510 **BAYESIAN INFERENCE AND DECISION.** Methods of Bayesian inference and statistical decision theory, with emphasis on the general approach of modeling inferential and decision-making problems as well as the development of specific procedures for certain classes of problems. Topics include subjective probability, Bayesian inference and prediction, natural-conjugate families of distributions, Bayesian analysis for various processes, Bayesian estimation and hypothesis testing, comparisons with classical methods, decision-making criteria, utility theory,value of information, and sequential decision making. C-L: SDS 221.

BA 525 **BEHAVIORAL DECISION THEORY.** Examines the development of research in individual and group decision behavior. Major emphasis is given to theoretical developments and empirical research, with a range of articles assigned for each topic. The basic topic areas include (1) decision problem structuring, (2) thinking about uncertainties, (3) risk taking, (4) dealing with conflicting values, and (5) combining individual judgments into a group decision. C-L SDS 231.

BA 564 **EXPERIMENTAL DESIGN AND ANALYSIS SEMINAR.** Examines issues in the design and analysis of experiments. Emphasis on analysis of variance (ANOVA), starting with the basis ANOVA model and examining multiple factor designs, blocking designs, nested models, within subject designs, repeated measure designs, and analysis of covariance.

BA 571 **OPERATIONS STRATEGY SEMINAR.** Recent developments in the strategy of operations in both the manufacturing and service sectors. Topics include the focused factory concept, Japanese manufacturing philosophy, technological policy toward new process development and toward new product introduction, vertical integration, choice of capacity and location, industry analysis, and the impact of government regulation. Emphasis on the development of hypotheses about strategic topics and the empirical means by which they can be tested.

BA 572 **SEMINAR IN OPERATIONAL AND TECHNOLOGICAL TACTICS.** Current issues in the day-to-day management of manufacturing and service delivery systems. Topics include material requirements planning, capacity requirements planning, quality of work life projects, productivity measurement and enhancement, implementation of new product introductions and production process modifications, quality assurance, production planning and scheduling, and logistics. Concentration on the substance of recent developments, the generation and test of hypotheses about tactical issues, and the applicability of various optimization techniques to the advance of operation tactics.

Computer Science (CPS)

CPS 201 **PROGRAMMING LANGUAGES.** Information binding, data structures and storage, control structures, recursion, execution environments, input/output; syntax and semantics of languages; study of PL/1, Fortran, Algol, APL, LISP, SNOBOL, and SIMULA; exercises in programming.

CPS 212 **INTRODUCTION TO SCIENTIFIC COMPUTING.** Practical introduction for graduate students and faculty to computer resources that facilitate scientific research: scientific word processing (Tex and LaTex), symbolic manipulation programs, software tools, numerical software packages, and graphics. Case studies used to illustrate these resources. For noncomputer scientists.

CPS 215 **ARTIFICIAL INTELLIGENCE.** Heuristic versus algorithmic methods; programming of games such as chess; theorem proving and its relation to correctness of programs; readings in simulation of cognitive processes, problem solving, semantic memory, analogy, adaptive learning.

CPS 221 **NUMERICAL ANALYSIS.** Error analysis, interpolation and spline approximation, numerical differentiation and integration, solutions of linear systems, nonlinear equations, and ordinary differential equations. C-L: SDS 273.

CPS 241 **DATA BASE METHODOLOGY.** Basic concepts and principles. Relational, hierarchical, and network approaches to data organization; data entry and query language support for data base systems; theories of data organization; security and privacy issues.

CPS 252 **COMPUTER SYSTEMS ORGANIZATION.** Hardware and software aspects. Processor, memory, device, and communication subsystems; case studies of hardware system organization, e.g., parallel, associative, fault-tolerant; organization of software systems to exploit hardware systems organization; economic and reliability aspects of various hardware organizations.

CPS 276 **COMMUNICATION, COMPUTATION, AND MEMORY IN BIOLOGICAL SYSTEMS.** Communication and memory in biological systems: in voltage sensitive ion channels, hormone-receptor interactions, and initiation and control of RNA/DNA synthesis. Models of signaling and memory are developed and related to electronic signaling schemes.

Community and Family Medicine (CFM)

CFM 211 **PROBABILITY AND STATISTICAL INFERENCE.** Laws of probability, probability distributions, descriptive statistics, graphical displays of relationships, philosophy of statistical tests, tests for differences in central tendency, paired comparisons and correlation. Parametric and non-parametric procedures. Simple linear regression and one-way analysis of variance. Type I and Type II errors and problems of multiple comparisons.

CFM 212 **DESIGN OF ETIOLOGICAL, CLINICAL AND EXPERIMENTAL STUDIES.** General principles of study design. Observational studies, including descriptive (correlational, case report, cross-sectional) studies, cohort and case-control designs, their relative advantages and statistical methods used in their analysis. Classical designs (parallel group, randomized block, and cross-over) will be surveyed. Introduction to controlled clinical trials and to sequential design strategies.

CFM 213 **RESEARCH DATA MANAGEMENT AND STATISTICAL COMPUTING.** Database management considerations and file structures for collecting and organizing research data. Uses IBM-PCs, DataEase, and SAS for examples.

CFM 217 **CLINICAL DECISION ANALYSIS.** Using formal methods for analyzing complex patient management problems. Structuring problems as trees. Applying data from the literature to estimate the likelihood of outcomes. Quantitating the value of health outcomes. Calculating the strength of preference for one strategy over others. Decision analysis as a guide to clinical research and as a policy tool.

CFM 234 **ARTIFICIAL INTELLIGENCE IN MEDICINE.** C-L: BME 265.

CFM 235 **MICROPROCESSORS AND DIGITAL INSTRUMENTS.** C-L: BME 205.

CFM 236 **DIGITAL COMPUTERS AND THEIR APPLICATION IN AMBULATORY CARE.** For students desiring an intensive exposure to medical computer application. The flexible format of the course permits a variety of projects in computer medicine. Examples include projects in medical databases; interactive patient interviewing; computer-aided instruction; patient/physician education; data collection, organization, retrieval, display, and analysis; and M.D.-assist programs. Opportunities exist for activities at Pickens Family Practice in Durham, Duke/FAHEC Family Medicine Center in Fayetteville and other sites.

CFM 240 **EPIDEMIOLOGIC METHODS IN PRIMARY CARE RESEARCH.** This is a survey course covering basic principles and methods of epidemiologic research and their application to primary care populations. Topics covered in this course include refining a research question, methods of reviewing the literature, ethical considerations in research involving human subjects and the basic types of study design in epidemiology. Other concepts of design, analysis and interpretation of data to be covered include errors in statistical inference, bias, confounding, interaction, and epidemiologic inference. Methods of questionnaire design and data collection will be studied as well as the logistics of study implementation, and basic methods of data analysis. Course activities include lecture, directed readings and discussions of research questions chosen by the students in consultation with the instructors. Students are required to prepare a detailed study proposal by the end of the term. Interested students should consult with the instructor at least two months before the beginning of the term.

CFM 245 **ORGANIZATION AND MANAGEMENT OF AMBULATORY CARE CENTERS.** A series of seminars to discuss ambulatory care systems. Material covered will be of interest to all students who will work in an office setting. Emphasis will be placed on the group practice as a mechanism for providing ambulatory health services. Topics of discussion will include the conceptual basis for organizing ambulatory care centers; center objectives; automated subsystems for registration, appointments, diagnostic studies, health providers and managers; marketing; human relations; professional recruitment and group selection; financial forecasting and budgeting. During the second term discussions will center around specific areas of interest with participation in direct application.

CFM 271 **THE COMPUTER TEXTBOOK OF MEDICINE.** Students will participate in the ongoing development of a computerized database in cardiovascular disease. They will participate in research concerning the diagnosis, treatment, and prognosis of patients with coronary artery disease, and they will learn how to make predictions about outcome based on test results of patients on the cardiology service.

Electrical Engineering (EE)

EE 189 **IMAGE PROCESSING.** Basic concepts of the manipulation and analysis of images by computer, linear operations on pictures, Fourier transform and 2-D-Z-transform, hexagonal sampling theorem, image transforms, image enhancement, image filtering and restoration, image coding, matching, segmentation, representation and description. Project presentation by students.

EE 243 **PATTERN CLASSIFICATION AND RECOGNITION.** Parameter estimation and supervised learning; nonparametric techniques; linear discriminant functions; clustering; language theory related to pattern recognition; examples from areas such as character and severe weather recognition, classification of community health data, recognition of geometrical configurations, algorithms for recognizing low resolution touch-sensor array signatures and 3-D objects.

EE 281 **RANDOM SIGNALS AND NOISE.** Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection and parameter estimation.

EE 282 **DIGITAL SIGNAL PROCESSING.** Introduction to the fundamentals of processing signals by digital techniques with applications to practical problems. Discrete time signals and systems, elements of the Z-transform, discrete Fourier transforms, digital filter design techniques, fast Fourier transforms, and discrete random signals.

EE 285 **SIGNAL DETECTION AND EXTRACTION THEORY.** Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory.

Institute of Statistics and Decision Science (SDS)

SDS 213 **INTRODUCTION TO STATISTICAL METHODS.** Emphasis on classical techniques of hypothesis testing and point and interval estimation, using the binomial, normal, t,F and chi square distributions.

SDS 221 **BAYESIAN INFERENCE AND DECISION.** C-L: BA 510.

SDS 226 **BAYESIAN ANALYSIS AND STATISTICAL DECISION THEORY.** Formulation of decision problems; criteria for optimality: maximum expected utility and minimax. Axiomatic foundations of expected utility; coherence and the axioms of probability (the Dutch Book theorem). Elicitation of probabilities and utilities. The value of information. Estimation and hypothesis testing as decision problems: risk, sufficiency, completeness and admissibility. Stein estimation. Bayes decision functions and their properties. Minimax analysis and improper priors. Decision theoretic Bayesian experimental design. Combining evidence and group decisions.

SDS 231 **BEHAVIORAL DECISION THEORY.** C-L BA 525.

SDS 244 **INTRODUCTION TO LINEAR MODELS.** Geometric interpretation, multiple regression, analysis of variance, experimental design, analysis of covariance.

SDS 245 **INTRODUCTION TO MULTIVARIATE STATISTICS.** Multinormal distributions, multivariate general linear model, Hotelling's T2 statistic, Roy union-intersection principle, principal components, canonical analysis, factor analysis.

SDS 273 **NUMERICAL ANALYSIS.** C-L: CPS 221.

Medicine (MED)

MED 204 **INTRODUCTION TO CLINICAL MEDICINE.** This seven week course occurs in late summer following the completion of the first year basic science curriculum. It is short but an intensive course designed to provide the necessary skills and knowledge basic to function in a clinical environment. The three major areas that are covered include: (1) history, physical examination, problem formulation; (2) laboratory diagnosis, and (3) radiology diagnosis. In each of these three areas, didactic materials are presented in a morning lecture format and are complemented by afternoon sessions in smaller groups with "hands on" experience. The course also includes a brief introduction to the topic of human sexuality.

Public Policy Studies (PPS)

PPS 221 **DECISION ANALYSIS FOR PUBLIC POLICYMAKERS.** Methods for structuring decision dilemmas and decomposing complex problems, assessing the probabilities of uncertain consequences of alternative decisions, appraising the decision maker's preferences for these consequences and for re-examining the decision.

PPS 222 **STATISTICS AND DATA ANALYSIS FOR PUBLIC POLICYMAKERS.** Sampling theory, Bayesian statistics, and regression analysis. Examples from problems in health care, transportation, crime, urban affairs, and politics.

PPS 231 **QUANTITATIVE EVALUATION METHODS.** Problems in quantifying policy target variables such as unemployment, crime, and poverty. Experimental and nonexperimental methods for evaluating the effect of public programs, including topics in experimental design, regression analysis, and simulation.

UNIVERSITY OF Miami

Tarek M. Khalil
Dean

CDFHI

MEMORANDUM

May 11, 1995

TO: Dr. Kamal Yacoub
Chair, Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Response to Memoranda of 4/28/95

The interdepartmental M.S. Program with concentration in Medical Informatics is organized as an interdepartmental program under the auspices of the Graduate School's interdisciplinary and interdepartmental programs. The title modification of the M.S. concentration in Occupational Ergonomics and Safety is proposed for an existing interdepartmental concentration. As approved by the Senate and Board of Trustees in 1975, the Graduate Council is empowered to act on interdepartmental and interdisciplinary programs.

The change of the title for the Ph.D. program in Ergonomics to "Ergonomics and Human Factors" was sent to the College of Engineering for approval. Once this approval is received, we will forward it to the Senate for consideration of the change.

TMK/msb

cc: Dr. Luis Glaser
Dr. Bernard Fogel
Dr. Robert Rubin
Dr. Lewis Temares
Graduate Council

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

P.22

Item B4

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: Dr. Tarek M. Khalil
Dean, Graduate School

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 28, 1995

SUBJECT: M.S. in Medical Informatics

This is in reference to the new M.S. program in Medical Informatics submitted by the Department of Radiology in the School of Medicine. You informed me that the Graduate Council approved this program and yet I do not find any mention of the program being approved by the Medical School Council which is empowered to act on such matters on behalf of the faculty of the School of Medicine. Such approval is necessary before submission to the Graduate Council and eventually to the Faculty Senate.

KY/b

cc: Dean Bernard Fogel
School of Medicine

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

UNIVERSITY OF Miami

CDFHI

FACULTY SENATE

2 1995

Tarek M. Khalil
Dean

MEMORANDUM

April 17, 1995

TO: Dr. Kamal Yacoub, Chairman
Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics Program

As per your request, I am enclosing herewith a copy of the proposal for the interdepartmental program on Medical Informatics. If you may need any additional information, please let me know.

TMK/msb

Enclosure

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

UNIVERSITY OF Miami

Vice Provost for Research and Deputy Dean for Research and Graduate Studies
P.O. Box 016960 (R64), 1600 N.W. 10 Avenue, Miami, Florida 33101

M E M O R A N D U M

TO: Dr. Tarek Khalil, Dean of The Graduate School

FROM: Robert W. Rubin, Vice Provost and Deputy Dean

SUBJ: Medical Informatics Program

DATE: 3-2-95

This is to confirm that the School of Medicine is committed to the hard dollar costs for the new Medical Informatics program budget (enclosed). These are the responsibility of the Department of Radiology. The hard dollar amount is $105,000/yr. The other expenses listed ($191,165/yr.) represent cost shared salaries which have been agreed to by the respective administrators. The revenue figures quoted are of course estimates but appear reasonable. There will be a complicated split of revenues between the Department of Radiology and the College of Engineering which will be negotiated after we have some experience with the student mix. From an institutional standpoint I am prepared to live with the figures presented in the enclosed proposed 5 yr. budget. Thank you.

Administrative Offices
Suite 1148
(305) 547-5706
Fax: (305) 547-3549

Graduate Studies
Suite 1070
(305) 547-6406
Fax: (305) 547-3593

Research Administration
Suite 1149
(305) 547-6232
Fax: (305) 548-4611

FIVE YEAR PROFORMA: GRADUATE PROGRAM IN MEDICAL INFORMATICS
Department of Radiology
University of Miami School of Medicine

**D R A F T **

First year expenses:

Program Faculty	FTE Base salary	Rate	Program Cost	Funded Cost
Kabuka, Mansur	75,690	25%	18,923	0
Clark, Ronald	59,911	25%	14,978	14,978
Goodman, Mark	75,000	15%	11,250	11,250
Mathews, George	41,000	15%	6,150	0
Pattany, Fred	89,280	15%	13,392	0
Sauer, Frank	38,000	15%	5,700	0
Stitt, Frank	130,000	15%	19,500	19,500
Waly, Sherif	35,000	15%	5,250	0
Younis, Akmal	50,000	15%	7,500	0
Non-clin faculty CFB @		26.80%	27,508	12,255
Administrator	22,000	50%	11,000	0
Staff CFB @		27.25%	2,998	0
Fellowships: 3	9,000		27,000	27,000
Brochure			6,000	6,000
Clerical; misc. supplies			2,017	2,017
Incremental space			0	0
Instruction materials			3,000	3,000
Recruitment			6,000	6,000
Contingency			3,000	3,000
			191,165	105,000
FIVE YEARS EXPENSE (without annual increase)			955,824	524,999

REVENUE (also without annual increase)

Yr 1:	10 students; 3 on fellowship =	7	14,000	98,000
Yr 2:	10 incremental students =	17	14,000	238,000
Yr 3:	15 incremental students (1) =	22	14,000	308,000
Yr 4:	20 incremental students (2)=	32	14,000	448,000
Yr 5:	Status quo =	32	14,000	448,000
				1,540,000

(1) 10 students graduated; total students enrolled = 25 students; 3 of which are on fellowship
(2) 35 total students enrolled; 3 of which on fellowship

UNIVERSITY OF Miami

MEMORANDUM

DATE: March 7, 1995

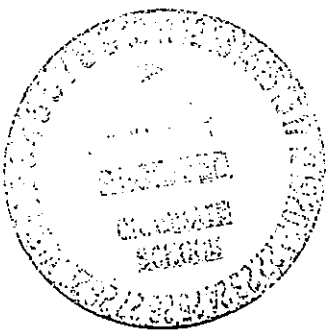
TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Dr. M. Lewis Temares

RE: Proposal for the Establishment of a M.S. Program in Medical Informatics

The College of Engineering and its Dean fully endorse and support the joint program with the School of Medicine to establish a M.S. Program in Medical Informatics.

MLT:fc



College of Engineering
Office of the Dean
P.O. Box 248294
Coral Gables, Florida 33124-0620
305-284-2404
Fax: 305-284-3815

MEDICAL INFORMATICS M.S. PROPOSAL REPORT

Subcommittee members:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, Meteorology and Physical Oceanography
Dr. E. Saltzman, Marine and Atmospheric Chemistry
Dr. D. Sarkar, Mathematics

The Graduate School's Physical Sciences Committee met with Vice Provost Robert Rubin and Dr. Mansur Kabuka from the Department of Radiology on April 3, 1995 to discuss the proposed Interdepartmental Program leading to an M.S. degree in Medical Informatics. The exchange centered around the proposal for the program put together by the department. Overall, the committee found that the plans for the program were well laid out and that the medical school has a strong commitment to the financial support of this program. The curriculum makes wide use of existing courses and blends the talents of the Engineering School and the Radiology Department in a creative manner.

Comparison of the program's offering with similar programs at other universities were provided in the report. The balance between computer oriented training, data base courses, and introduction to medical sciences mirrors these other programs. Concern was expressed over the requirement of 36 thesis track hours and 39 non-thesis hours in the program. The committee was especially concerned over the extra six to nine hours being a disincentive for students coming up through biomedical engineering or the proposed joint B.S. in Computer Engineering and M.S. in Medical Informatics Program. A suggestion was made to require a "minimum" of 30 hours plus additional course work in the various core areas. This would allow students with prior backgrounds in the core course areas to complete the curriculum while making use of their prior training. A short discussion was also held on future growth in the program. The need for care in tuning courses in this rapidly growing field was acknowledged. It was pointed out that the program may wish to expand to Ph.D. offerings within a three to five year time frame. Dr. Rubin brought up the issue that this program might produce more of a professional degree serving the medical community with M.S. practitioners rather than necessarily growing into a specialty academic field at the Ph.D. level. The committee encouraged the department to return to Council with a short report on the development of the program within two years and looks forward to hearing plans for the longer term goals of this effort.

In summary, the committee enthusiastically supports the new program and wishes it luck in fulfilling its goals over the next few years.

April 12, 1995

UNIVERSITY OF Miami

M E M O R A N D U M

March 22, 1995

TO: *Subcommittee on Programs and Degrees*
Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: *Tarek M. Khalil Dean*
The Graduate School

SUBJECT: *Medical Informatics M.S. Program*

A meeting has been scheduled for Monday, April 3 at 9:00 a.m. in the Ferre Building Conference Room 3rd. floor to discuss the establishment of an Interdepartmental M.S. Program in Medical Informatics.

Thank you for your participation.

TMK:nb

Copy to: Dr. John W. Brown

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax 305-284-5441

UNIVERSITY OF
Miami

MEMORANDUM

March 2, 1995

TO: Subcommittee on Programs & Degrees Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: Dr. Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics M.S. Program

I am enclosing, for your information, a copy of a proposal for the establishment of an Interdepartmental M.S. Program in Medical Informatics.

A meeting will be scheduled soon to discuss this proposal.

TMK:nb

Enclosure

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
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5-YEAR PROFORMA: MEDICAL INFORMATICS M.S. PROGRAM

FIRST YEAR EXPENSES

Program Faculty	% Effort
Mansur Kabuka (Director)	25%
Frank Stitt	15%
Kenneth Goodman	15%
Ron Clarke (Assoc. Director)	25%
Pradip Pattany	15%
George Mathews	15%
Akmal Younis	15%
Frank Sauer	15%
Sherif Waly	15%
Administrator	100%
3 fellowships	
Subtotal	**$180K**
Brochure	6K
Recruitment costs	6K
Instruction materials	8K
Supplies/miscellaneous	5K
Contingency	3K
Subtotal	**$28K**
Contingency	3K
FIRST YEAR TOTAL	**$208k**
TOTAL 5 YEAR COSTS	**$1,040,000**

YEAR 1

10 student 3 of which are on fellowship
Revenue **$98K**

YEAR 2

10 incremental students
Revenue **$238K**

YEAR 3

15 incremental students
Revenue **$308K**

10 students graduated from the program
Total students enrolled = 25 students; 3 of which are on fellowship

YEAR 4

20 incremental students
Revenue **$448K**

Total students enrolled = 35 students; 3 of which on fellowship

YEAR 5

Status Quo **$448K**

*The difference in the balance is expected to be offset from other activities, e.g., certificate programs and off campus programs.

Proposal for the Establishment of a M.S. Program in Medical Informatics

Department of Radiology
School of Medicine

1. RATIONALE

The rapidly growing knowledge base in the medical field is vast and encompasses both scientific knowledge and the day-to-day business of providing healthcare. To understand the medical user's complex needs, information scientists need formal training in the healthcare environment to implement complicated information science techniques. It is crucial to identify the processes in healthcare which could benefit most from information technology because a broad brush approach could be costly and inhibit progress. Recently, **the Association of American Medical Colleges formed the Steering Committee** to evaluate the status of medical informatics in the United States. The Steering Committee on the Evaluation of Medical Information Science in Medical Education concluded that medical informatics is basic to the understanding and practice of modern medicine. One recommendation of this committee indicates that medical informatics should become an integral part of the medical curriculum.

This proposal is developed to offer a M.S. degree in Medical Informatics. It is in the best interests of the University, the community of the southeast region, and the students that a M.S. degree in medical informatics be established.

The World Health Organization report on "Informatics and Telematics in Health" stresses that managerial decision-making in health care requires accurate, reliable, relevant, and timely information. It further notes that the health worker of the year 2000 is likely to be a person with immediate access to a large amount of data along with analytical decision support routines to assist in decision making. These needs will require advanced research and development in the areas of database, statistical data analysis, data storage, validation, retrieval, presentation, and distribution, decision support systems, knowledge-bases, artificial intelligence and neural networks. Multidisciplinary expertise is required to achieve the essential level of knowledge in these areas.

The program curriculum is developed to reflect the interdisciplinary structure of the medical informatics field. The program is designed to prepare individuals to develop, use, and evaluate applications of information technology in the health care environment. The program also stresses the methods used to study the effectiveness of information technology applications. The proposed M.S. degree is an interdepartmental program between the School of Medicine and the College of Engineering which will be hosted by the Department of Radiology.

What is Medical Informatics?

Medical Informatics is the scientific field that deals with medical information, data, and knowledge. It deals with the concepts and principles of acquiring, processing, and presenting information to support medical practice, problem solving and decision making in the health care industry. Medical Informatics touches on all basic and applied fields in medical science and is closely related to modern information technologies including computing and

communication. Medical informatics has emerged as a new discipline due to a number of factors, including advances in computing and communications technology, an increasing awareness that the medical knowledge base is unmanageable by traditional methods, and a growing conviction that knowledge retrieval and expert decision making are important to modern medicine. Modern technologies enable the capture and organization of medical user requirements. Challenges in developing and using these technologies in healthcare include developing enterprise integration tools to translate information, helping users determine what information they need, and facilitating information flow across the healthcare enterprise. Also, using technology requires developing business modeling techniques to define and analyze the relationships among the different processes in providing healthcare.

Knowledge of computer engineering is a major element of the medical informatics. However, effective research and development in this area also requires practical knowledge and fundamental research in cognitive science, clinical medicine, basic medical sciences, biostatistics, epidemiology, hospital organization, hospital financing and reimbursement, management and decision sciences, and medical ethics. In such an interdisciplinary field, students must be exposed to these diverse topics.

Medical informatics spans a wide range of activities that includes, but is not limited to:

(1) basic research and exploratory experiments
(2) applied research and evaluation of approaches
(3) technological development for specific user needs
(4) deployment of practical applications
(5) planning and policy development for using information technology in health care and medical education

Medical Informatics Education

A recent study by Gassert et al (1991)* indicated the increased demand for graduate level education in medical informatics. The results of a survey of accredited hospitals of 300 beds or more in 19 states demonstrated that all institutions use computer technology in health care practice and/or administration. Almost three-fourths of the hospitals already allocate one or more budgeted positions for managers of information systems. An additional 50% of the respondents foresaw a need for such positions in their institutions within two years. Virtually all respondents saw some need for a graduate program.

Currently, the number of graduate medical informatics programs (M.S. and Ph.D.) nation wide is limited. Although academic units of medical informatics are established at only a few institutions in the United States, increasing numbers of schools are considering this activity.

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* Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC.

The following is a partial list of the medical informatics programs available in the United States:

1. Columbia University: Post-Doctoral training program in Medical Informatics

2. Duke University/University of North Carolina: MS, PhD, and Post Doctoral programs in Medical Informatics

3. Harvard University/Massachusetts Institute of Technology/New England Medical Center: MS, PhD, and Post-Doctoral in Medical Informatics

4. Stanford University: MS, PhD, and Post-Doctoral program in Medical Information Science

5. University of Missouri: MS in Library and Information Science, PhD in Medical Informatics, Post-Doctoral program in Medical Informatics, and short term (3-6 months) training for medical and veterinary students

The proposed program within the University of Miami would provide individuals with the skills and expertise needed for applying the concepts and knowledge of medical informatics in health care and academic medical research, development, and education. The proposed program will offer degrees to individuals with career commitments to applying computer engineering and related disciplines to the field of medicine. The University of Miami is well poised to offer new programs in Medical Informatics at the graduate level. This program will have a strong core curriculum in computer engineering, as well as concentrations in biological and physical sciences. The strengths of the Medical School in these areas will differentiate the University of Miami from other regional universities such as Florida International University and Florida Atlantic University. This will provide a significant leverage in attracting quality students to the program. In addition, the program will have the unique opportunity to draw upon the resources of the Medical School to offer significant exposure to research and applications in medicine. **In addition, currently no graduate programs in medical informatics exist in Florida, while only a few exist in the nation. The university will have a tremendous edge for attracting students by being the first to offer such a program in the state, as well as the advantage of being closely associated with a renowned medical school.**

Rationale for Success

The ability to introduce a new program in medical informatics successfully arises from the following factors:

(1) Because we have the faculty from both the School of Medicine and the College of Engineering needed to carry the program, there will be almost no extra costs for starting the new program.

(2) The new program would promote interdisciplinary research and development by providing a natural environment for interaction between faculty from the School of Medicine and the College of Engineering.

(3) Existing courses, as well as courses under development, can be used as part of the curriculum. This presents a tremendous recruiting tool for attracting students interested in medical careers.

(4) State-of-the-art laboratories for medical imaging, medical informatics, multimedia, and software engineering exist at the university and are great incentives for attracting students.

(5) Multimedia interactive educational tools and curricula will be developed using sophisticated new teaching methods to enhance the learning environment.

(6) The development projects in progress at the medical school in networking, electronic imaging, and medical information systems can be used to teach students and interact with the medical faculty via electronic communications and video-conferencing capabilities.

(7) The interdisciplinary focus of the current research and development work conducted by the Center for Medical Imaging and Medical Informatics is an important tool for attracting students interested in research opportunities.

(8) Industry partners involved with current research and development work are interested in establishing co-op programs in the new program areas.

(9) As mentioned earlier, no universities in Florida, and only a few in the nation, offer graduate programs in medical informatics.

1.a Exact Title of Degree

Master of Science in Medical Informatics

1.b Purpose and Goals of Degree

The purpose of the degree is to prepare qualified candidates to serve the needs of the health care industry, academic, research and government institutions. The program is designed to provide students with the skills and knowledge required to deal with basic and applied research, development, and the deployment of innovative technologies in the medical fields.

1.c Assessment of Demand and Job Market

The expanding applications of computing techniques into medical environments requires well-trained individuals to design, develop, select, and manage the medical-computing system. Modern developments in health care and computer industries dictate the need for skilled personnel to design research programs and carry out the experimental and developmental activities in both industries.

Many computer companies (for example Hewlett-Packard, the world's largest medical equipment maker) have established healthcare groups. According to National Institute of Standards and Technology (NIST), Arnst et al (1994)* estimated that the market of healthcare information system would reach $13 billion by the year 1998.

The Department of Health and Human Services estimates that a nationwide electronic healthcare information network could provide a savings that are expected to exceed $100 billion over the next eight years. According to the NIST (1994), healthcare is the fastest growing market in the computer field. It is estimated that hospitals will spend $6.7 billion a year on information systems in 1996, a 36.7% increase over 1993.**

The success of developing these services requires interdisciplinary research and development projects in both health care settings and computer industry and demands leaders who can effectively bridge the two fields. The demand for such professionals, with proper training in Medical Informatics, has been escalated in the recent years in both health care and advanced technology industries.

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* Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104-106.

** National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

As mentioned earlier, the survey conducted by Gassert et al (1991) indicated the increased demand for graduate level education in medical informatics. According to Greenes and Shortliffe (1990)* , researchers with formal training in medical informatics are a rare breed. The need for programs that combine medical informatics training with curricula that encompass the multidisciplinary areas of expertise, is recognized by many institutions. The increased awareness of the importance of this field of study has been motivated by the efforts of National Library of Medicine to support these programs. Greenes and Shortliffe indicate that the demand for medical informatics specialists surpasses the supply of skilled professionals.

The proposed program will provide graduates the opportunity to join research facilities in the area of medical information systems. Also, it will enable students to pursue medical education degrees after graduation.

1.d Relationship to Other Cognate Fields

This new program will complement existing biomedical engineering and biomedical activities at the university by expanding its application from biomedical devices to medical information sciences. In addition, graduates will have the opportunity to work as engineers and scientists in medically related fields, or in medical informatics careers. The program also will service the needs of the medical school for candidates who are proficient in computer engineering and science, as these skills become increasingly important for using sophisticated medical equipment and medical computer systems.

1.e Relationship to Undergraduate Programs

Students who wish to pursue degrees within the current undergraduate Computer Engineering and Biomedical Engineering programs will continue to do so. However, in addition to the graduate program in Medical Informatics, **dual degree** programs are being designed to allow qualified students to pursue a combined B.S. in Computer Engineering / M.S. in Medical Informatics or a combined B.S. in Biomedical Engineering / M.S. in Medical Informatics.

The dual B.S. Computer Engineering / M.S. Medical Informatics program has been approved by the department of Electrical and Computer Engineering and forwarded to the College of Engineering for approval. The dual degree program in B.S. Biomedical Engineering / M.S. Medical Informatics is currently under consideration.

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* Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority", JAMA, February 1990, Vol 263, No 8.

2. PHYSICAL RESOURCES

2.a Library Holdings

The Otto G. Richter Library and the Medical School Library have a very large collection of materials that are very useful for the programs in medical informatics. Since the medical informatics area are interdisciplinary in nature, the subjects covered are common with several other departments which expand the library holdings and budget allocation by subject area.

A partial listing of journals and periodicals available in medical informatics and related disciplines are given below. No additional journals is needed at this time.

Academic and Library Computing
Acronyms Administration
Advanced Technology Libraries
Advances in Bioengineering
Advances in Biomedical Engineering
AIweek
American Documentation
American Journal of Medical Electronics
AMIA News : Newsletter of the American Medical Informatics Association
Annual Review of Biophysics
Annual Review of Information Science
Applied Artificial Intelligence
ASAIO Journal
ASAIO Transactions
Audiovisual Instruction with/Instructional Resources
Biodegradation
Biomedical Communications
Biomaterials, Artificial Cells
BIOSIS
Biomaterials, Medical Devices
Biomedical Engineering
Biomedical Instrumentation
Biotechnology
Biotechnology and Bioengineering
Biotechnology Letters
Bulletin of Prosthetics Research
Byte
Campus-wide Information Systems
Chemical Journals Online Bulletin
Clinical Physics
Computers and Biomedical Research
Computers and Medicine

Computers in Biology and Medicine
Computers in Libraries
Computers in Eyecare Ophthalmology
Electronic Library
Eyecare Technology Ophthalmology
Human Factors
IEEE Engineering in Medicine and Biology
IEEE Transactions on Biomedical Electronics
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Systems, Man, and Cybernetics
IEEE Transactions on Medical Imaging
Information, News, Sources
Information Retrieval & Library
Interactive Healthcare Newsletter
International Journal of Bio-medical Engineering
IRE Transactions on Medical Electronics
ISI Online News
ISA Journal
Issues in Science and Technology
Journal of the American Medical Association
Journal of Biocommunication
Journal of Biomechanics
Journal of Biomedical Materials
Journal of Cardiovascular Diagnosis
Journal of Cardiovascular Techniques
Journal of Documentation
Journal of Clinical Engineering
Journal of Fermentation Technology
Journal of Medical Engineering
Journal of Rehabilitation Research
Journal of Rehabilitation Research and Development (clinical supplement)
Library Network/MEDLARS
M.D. Computing
MacUser
Medical & Biological Engineering
Medical Instrumentation
Medical Research Engineering
MEDLARS/Network Technical Bulletin
MedLink Archives
Methods of Information in Medicine
Modern Trends in Biomechanics
NLM Technical Bulletin
Online Libraries and Microcomputer
Physicians Video Guide
Physiological Measurement

PsycInfo News
Weekly Government Abstracts. Bi Reference
Trends in Biotechnology

2.b Laboratory Facilities

Image Processing and Multimedia Laboratory

The Image Processing and Multimedia Laboratory provide the ultimate environment for both research and development in the fields of image processing, scientific visualization, and multimedia applications. The hardware offered by the lab consists of numerous Sun SPARC 10 end user graphical workstations, PC's, a Sun 690 file server, a Sun SPARC 1000 file server and various peripherals, such as color printers, postscript printers, slide maker, optical disk jukeboxes for massive storage,..etc, all connected to a high speed FDDI network. Most of the end user workstations are equipped with microphones and video cameras for use with multimedia applications. Software tools used in the laboratory include: Khoros, AVS, Ptech, Ontos, MatLab, and various software libraries to support the research and development of algorithms in image processing, visualization, video editing, multimedia, and advanced networking like ATM and ISDN, necessary to support distributed multimedia applications.

Medical Informatics Laboratory

The Medical Informatics Laboratory (MIL) provides the client/server computing foundation required to support the medical information and imaging functions for the Center for Medical Imaging and Medical Informatics (CMIAMI). MIL is composed of several Sun SPARC 1000 servers with multiprocessor capabilities, four to eight processors, and 150 GB of fiber channel attached hard disk drives. The servers are intended to provide heavy computing services for both teaching and research applications. In addition, these servers allow the access of medical images for analysis and diagnosis purposes as well as supporting database servers for the development of medical information system applications. The MIL contains several Sun SPARC 5 and SPARC 20 workstations with multi-monitor support (1,2,4, or 8 monitors). These workstations play the client role in computing environment of the MIL. They function as the gateway for accessing the 2D & 3D imaging capabilities and the medical information system for both research and development purposes.

Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy Laboratory

The Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) Laboratory located at the MRI building houses three whole body MRI systems, 1.0T HPQ and 1.5T HPQ clinical scanners, a 1.5T Edge Research Scanner to be used for basic MR research and advanced clinical research.

Computed Tomography, X-Rays, and Ultrasound Laboratory

The Computed Tomography, X-Rays, and Ultrasound Laboratory has 5 CT scanners, 6 fluoro-machines, 3 vascular laboratories, 1 neuro-suite and 8 c-arms, in addition to a large number of mammographic general-purpose and mobile x-ray machines.

Nuclear Medicine Laboratory

The Nuclear Medicine Laboratory of the University of Miami School of Medicine/Jackson Memorial Medical Center is equipped with one triple head SPECT camera, 2 dual head SPECT cameras, 2 single head SPECT camera, 7 stationary camera and 2 mobile systems. All cameras are networked. Also available are counting devices and a radio-pharmacological preparation laboratory.

Other Laboratories

Software Engineering Laboratory
Digital Signal Processing Laboratory
Computer Aided Engineering Laboratory
Microprocessor Laboratory
Electronics and Measurement Laboratory
Communication Laboratory

3. CURRICULUM

3.a Master of Science in Medical Informatics

The proposed program curricula is designed to reflect the broad, interdisciplinary field of medical informatics. The program stresses both the basic sciences of medical informatics and the practical knowledge necessary to design and implement computer applications and modern information technology in the medical field. The program is designed to fit variety of backgrounds from science, chemistry, biology and engineering undergraduate majors. The following is a list of the required and elective courses:

Core Courses

RAD 604 Medical Informatics
RAD 508 Computer-Based Medical Records
EEN 592 Medical Imaging
EEN 537 Principles of Artificial Intelligence (Project: Artificial Intelligence in Medicine)
EEN 523 Principles of Database Systems (Project: Database Management for Medical Applications)
BME 501 Unified Medical Science I / PHS 512 Systematic Physiology
EPH 502 Biostatistics II / EPH 6xx Clinical Research

Thesis Option

Technical Electives: six credits from elective list
Six credits must be earned in thesis work

Non-thesis Option

Technical Electives: fifteen credits from elective list
Three credits must be earned in Master's Project

Technical Elective

RAD 500 Diagnostic Physics
RAD 501 Nuclear Medicine Imaging
RAD 505 Anatomy and Physiology: Diagnostic Imaging Prospective
RAD 601 MR Imaging / MR Spectroscopy
RAD 602 CT Imaging / X-Rays / Ultrasound
RAD 651 Special Problems in Medical Informatics
EEN 512 Object-Oriented Software Engineering
EEN 534 Computer Communication Networks
EEN 548 Machine Learning
EEN 591 High-Speed Networking
EEN 593 Object-Oriented Programming

Technical Elective (Continued)

EEN 597 Neural Networks
EEN 621 Object-Oriented Database Systems
EEN 653 Pattern Recognition
EEN 656 Information Theory
BME 502 Unified Medical Science II
BME 511 Clinical Engineering
BME 580 Biomedical Instrumentation
BME 622 Biomedical Signal Processing
CBA 505 Neuroanatomy
BMB 506 Biochemistry & Molecular Biology
BMB 508 Biochemistry & Molecular Biology Lab
MTH 529 Computer Graphics

Admission

Admission of a student to the University of Miami for any semester does not imply that such student will be re-enrolled in any succeeding academic semesters. All those wishing to take courses for graduate credit, whether or not they wish to become candidates for the degree, must make application for admission directly to the department. The applicant's file includes:

(1) Completed application form
(2) Official transcript of all college work previously taken
(3) Official score report of the Graduate Record Examination (GRE) taken within five years
(4) Three letters of recommendation sent directly to the department
(5) Official score report of the Test of English as a Foreign Language (TOEFL) for any international applicant whose native language is not English
(6) Application fee of $35.00

Fellowships, tuition scholarship, and assistantships in research or instruction are available for qualified students.

3.b Dual Degree Programs

Dual degree programs are being designed to allow qualified students to pursue either a combined B.S. in Computer Engineering / M.S. in Medical Informatics or combined B.S. in Biomedical Engineering / M.S. in Medical Informatics. The B.S. Computer Engineering / M.S. Medical Informatics program has been approved by the department of Electrical and Computer Engineering and forwarded to the College of Engineering for approval. The dual degree program B.S. Biomedical Engineering / M.S. Medical Informatics is currently under consideration. Detailed description of these programs is attached.

4. FACULTY

Program Director

Dr. Mansur R. Kabuka	Department of Electrical & Computer Engineering/Department of Radiology

Program Committee

Committee Chairperson

Dr. Robert W. Rubin	Vice Provost and Deputy Dean, Research and Graduate Studies

Dr. Jeffery Augenstein	Department of Surgery/Ryder Trauma Center
Dr. Judy Bean	Department of Epidemiology and Public Health
Dr. Ronald G. Clark	Department of Cell Biology and Anatomy
Dr. Laurence B. Gardner	Department of Medicine
Dr. Ozcan Ozdamar	Department of Biomedical Engineering
Dr. Pradip M. Pattany	Department of Radiology
Dr. Robert M. Quencer	Department of Radiology
Dr. Stuart A Stein	Departments of Neurology, Medicines and Pediatrics

Program Faculty

Judy Bean, Ph.D.	Department of Epidemiology and Public Health
Ronal E. Block, Ph.D.	Department of Radiology
Brian Charles Bowen, Ph.D., M.D.	Department of Radiology
Ronald G. Clark, Ph.D.	Department of Cell Biology and Anatomy
John Collins, Ph.D.	Department of Electrical & Computer Engineering
Francis Donahue, D.O.	Department of Radiology
Christos Douligeris, Ph.D.	Department of Electrical & Computer Engineering
Joel Elliot Fishman, M.D., Ph.D.	Department of Radiology
Keneth Goodman, Ph.D.	Director, Forum for Bioethics and Philosophy
Abdulmehdy M. Jabir, M.Phil.	Department of Radiology
Mansur R. Kabuka, Ph.D.	Department of Electrical & Computer Engineering/Department of Radiology
George Kutty, Ph.D.	Center for Medical Imaging and Medical Informatics
Ronald Charles Joseph, M.D.	Department of Radiology
Ozcan Ozdamar, Ph.D.	Department of Biomedical Engineering
Pradip M. Pattany, Ph.D.	Department of Radiology
Reeza Rossie,M.S.E.E.	Medical Networks, School of Medicine
George N. Sfakinakis, M.D.	Department of Radiology
Frank Sauer, M.S.Comp.Sc.	Center for Medical Imaging and Medical Informatics
Frank Stitt,M.D.	Department of Epidemiology and Public Health
David Schwartz, M.D.	Department of Radiology
Stuart A Stein, M.D.	Departments of Neurology, Medicines and Pediatrics
Wonhee Sull, Ph.D.	Center for Medical Imaging and Medical Informatics
Arun Thakore, Ph.D.	Department of Electrical & Computer Engineering
Martin Trafler, Ph.D.	Department of Radiology
Sherif M. Waly, Ph.D.	Center for Medical Imaging and Medical Informatics
Thomas Williams	Assoc Director of Systems Integration & Access, Louis Calder Memorial Library
Tzay Young, Ph.D.	Department of Electrical & Computer Engineering

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Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, Americal Medical Informatics Association, November, 1991, Washington, DC

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National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

World Health Organization, "Informatics and Telematics in Health: Present and Potential Uses," Geneva, 1988.

Harvard University — **Massachusetts Institute of Technology** — **New England Medical Center**

MEDICAL INFORMATICS RESEARCH TRAINING

Predoctoral and postdoctoral training opportunities in Medical Informatics are now available in an expanded joint Boston-area program. Supported by a grant from the National Library of Medicine, and administered by the Health Science and Technology (HST) Division of Harvard Medical School (HMS) and Massachusetts Institute of Technology (MIT), this program involves participation by several well established medical informatics research groups at HMS, MIT, Harvard School of Public Health, Brigham and Women's Hospital, Massachusetts General Hospital, and Tufts New England Medical Center.

GENERAL: Fellowships provide stipend, tuition, and travel funds, and are typically for two- to three-year periods. Trainees are primarily associated with a particular research group, depending on interests. In addition, the program provides many opportunities for educational, research, and collegial/social interaction among the faculty, students, and fellows of the training sites. A wide variety of course offerings at Harvard, MIT, and Tufts, seminars, journal clubs, and other forums for exchange of information provide all trainees with opportunities to learn about the variety of work occurring at the various laboratories and in the affiliated institutions, as well as in the larger field of medical informatics.

RESEARCH OPPORTUNITIES: The participating research groups and their principal areas of activity are indicated below. In-depth involvement and assumption of project responsibility are encouraged, both at predoctoral and postdoctoral levels. A large associated faculty participate through the research activities of each of the training sites. We also encourage the fellows to develop projects that may involve unique collaborative relationships.

DECISION SYSTEMS GROUP
Robert A. Greenes, M.D., Ph.D., Director
Brigham and Women's Hospital
75 Francis Street, Boston, MA 02115
(617) 732-6281 FAX (617) 732-6317
Email: greenes@harvard.edu or greenes@harvard.BITNET
(Postdoctoral research training)
- *medical decision support*
- *knowledge representation*
- *computer-aided medical education*
- *radiologic informatics*
- *guideline incorporation in clinical systems*
- *object-oriented design & software architectures*

MEDICAL COMPUTER SCIENCE
Peter Szolovits, Ph.D., Director
Dept. of Elec. Eng./Computer Sci.
Massachusetts Inst. of Technology
545 Technology Square, Cambridge, MA 02139
(617) 253-3476 FAX (617) 258-8682
Email: psz@medg.lcs.mit.edu
(Pre/postdoctoral degree candidates)
- *medical knowledge representation*
- *clinical decision making*

LAB. OF COMPUTER SCIENCE
G. Octo Barnett, M.D., Director
Massachusetts General Hospital
50 Staniford Street, 5th Floor
Boston, MA 02114
(617) 726-3939 FAX (617) 726-8481
Email: obarnett@hstbme.mit.edu
(Postdoctoral research training)
- *clinical decision making*
- *medical student education*
- *student/physician workstation design*
- *problem-based knowledge access*
- *ambulatory computer-based medical records*
- *implementation/evaluation of guidelines*

DIV. OF CLINICAL DECISION MAKING
Stephen G. Pauker, M.D., Director
New England Medical Center
750 Washington Street, Boston, MA 02111
(617) 956-5910 FAX (617) 956-4838
Email: sgp@medg.lcs.mit.edu
(Postdoctoral research training)
- *clinical informatics*
- *clinical decision analysis in individual patients*
- *cost-effectiveness and health policy analysis*
- *guideline development*
- *clinical decision support*

HEALTH DECISION SCIENCES
Milton Weinstein, Ph.D., Director
Dept. of Health Policy & Mgt
Harvard School of Public Health
677 Huntington Avenue, Boston, MA 02115
(617) 432-1090 FAX (617) 432-4494
Email: mcw@biostat.harvard.edu
(Pre/postdoctoral degree candidates)
- *cost-effectiveness analysis of health care practice*
- *assessment of medical technologies*
- *medical decision making*
- *outcome modeling*

COURSES AND DEGREES: Courses for research trainees may be selected from a wide range of Harvard, Tufts, and MIT offerings. M.Sc. and Ph.D. degrees are offered in EE/CS at MIT and Health Decision Science at Harvard School of Public Health (HSPH).

TRAINEE QUALIFICATIONS: For postdoctoral training, prior M.D. (ideally also completion of all or most of residency training), or Ph.D. in a relevant discipline required. Predoctoral candidates must concurrently apply for admission to the corresponding doctoral degree program at MIT or HSPH. For all candidates, previous computer experience strongly preferred. *The participating institutions are Equal Opportunity/Affirmative Action Employers. Women and minorities are encouraged to apply.*

FOR FURTHER INFORMATION: To obtain more information about the program and its various components, or to apply, contact the Program Office at the address given below. You may also contact the directors of individual components directly, who will forward your correspondence and application materials to the Program Office.

MEDICAL INFORMATICS RESEARCH TRAINING
ATTN: Dr. Robert Greenes
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Harvard University — Massachusetts Institute of Technology — New England Medical Center

MEDICAL INFORMATICS RESEARCH TRAINING

OPPORTUNITIES

in the

DECISION SYSTEMS GROUP

Robert A. Greenes, M.D., Ph.D., Director

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September 2, 1991

Introduction

The Harvard-MIT-NEMC Research Training Program in Medical Informatics is funded by the National Library of Medicine (NLM) and provides predoctoral and postdoctoral training through affiliation of trainees with 5 participating research units in medical informatics in the Boston area, and a coordinated set of additional opportunities for collegial and educational interaction among the groups. Trainees participate in a variety of jointly sponsored seminars, journal clubs, research symposia, and informal courses. Electronic mail is used to facilitate communication among the groups.

The various program components are each described in separate documents. This document describes the specific activities of the Decision Systems Group, Brigham and Women's Hospital.

The Decision Systems Group

The Decision Systems Group (DSG) is a research unit in medical informatics at Brigham and Women's Hospital. The DSG carries on a broad range of research activities, focused on the general themes of medical education and decision support, as described below. The major goal of research training at the DSG is to enable the trainees to acquire direct research experience through involvement in on-going medical informatics projects of the laboratory. The involvement can occur at all levels, from design, to development, implementation, evaluation, and dissemination of computer applications in medicine. The primary emphasis is on assumption by the trainees of project responsibility, and the opportunity to present the work both locally and at national meetings, and in publications. Our objective is that individuals leaving the program be

well positioned to launch their careers as independent investigators in the field of medical informatics.

Academic course work is encouraged to supplement the research experience, usually one course per semester, at Harvard School of Public Health (usually in Biostatistics, Decision Sciences, or Computer Science), or at the Computer Science Departments in the Harvard Faculty of Arts and Sciences or at Massachusetts Institute of Technology. A number of the fellows maintain their clinical skills by "moonlighting" at various Harvard-affiliated clinical facilities.

Robert A. Greenes, Director of the DSG, has an M.D. degree and Ph.D. in computer science from Harvard, and is Associate Professor of Radiology at Brigham and Women's Hospital, where he directed the Computer Science Division in the Department for eight years, before establishing the DSG. Particular interests have been focused on the development of methods for decision support and education for clinical problem solving. Emphasis has been the use of the computer for knowledge management and selective knowledge retrieval, analytic measures of performance of diagnostic procedures, strategies for clinical workup and management, user inerfaces for clinical record keeping, radiologic image management, and development of systems architectures and tools to support application composition from network-based information resources and group cooperative work. Greenes is also a member of the faculty of the Department of Biostatistics, Harvard School of Public Health, and of the Health Science and Technology Division (HST), Harvard Medical School and MIT, where he is Director of Academic Computing. The DSG is responsible for computer-based education development and support for the HST track of the Harvard Medical School curriculum, and has joint responsiblity with the LCS for support of the remainder of the HMS curriculum.

Overview: The DSG staff consists of computer scientists and physicians who carry on a variety of research and development projects in the application of desktop workstations to medical decision making and education. Highlights of some of the many activities at the DSG include:

- Cooperative development, with other centers, of a *Unified Medical Language System (UMLS)*, sponsored by the National Library of Medicine. Particular areas of activity are the development of a descriptive language and taxonomy for indexing of multimedia information resources, concept-based retrieval of textual materials from free text query, and semantic-net based reasoning about images.

- Exploration of the use of *clinical algorithms* as an organizing strategy for an electronic knowledge resource for clinical medicine, as a means of providing guidelines, and as an aid to assessing quality of care. One of our major interests is in characterizing cost effective workup strategies for patient care.

- Development of flexible user interfaces for recording of clinical notes, capitalizing on problem-based structure, algorithmic flow, and user personal preferences.

- Development of *clinical skill-building and problem-solving simulations* that give physicians and students the experience with understanding complex interrelationships that forms the basis for clinical judgment and decision making. This includes multimedia instructional applications that integrate history, physical examination, laboratory, radiologic, and other procedures, in a realistic fashion.

- Design and evaluation of *digital-imaging-based tutorial techniques* for helping radiologists to develop their pattern recognition and interpretation skills. A particular focus currently is mammographic interpretation.

- Exploration of advanced *software engineering methodologies* for data and knowledge management. The emphasis is on authoring and presentation tools to facilitate development and use of applications that integrate a variety of data and knowledge resources, as typical of those described above.

Goals: As detailed in the accompanying sections, a major component of our software development effort is focused on providing multi-modal education and decision support tools. The approach to medical education at Harvard emphasizes problem-based learning and access to information tools. Continuing education and clinical decision making require access to many of the same kinds of capabilities, thus forming a logical continuum of applications. For information tools to be effective, we believe they must:

- provide access to a wide variety of data and knowledge, that may exist in many different formats—including images, video sequences, sounds, animations, lists, textual descriptions, database records, and analytic and inference procedures

- enable these resources to be incorporated in a variety of contexts—such as tutorial exercises, case-based problem solving, examination and testing, gaming, textual browsing, and natural language query

- facilitate use of the same resources in different contexts, i.e., "repurposing"—to foster sharing, to enable developments that builds upon the work of others, and to avoid continually "reinventing the wheel"

Research Support: Besides the Research Training Program in Medical Informatics, a number of other funded research activities are being carried out by the Decision Systems Group. Greenes is a principal investigator on NLM-funded contract research to develop a Unified Medical Language System (UMLS). This involves development of a uniform metathesaurus or taxonomy of medical concepts and relations, as a basis for facilitating the linking of disparate applications and the development of consistent approaches to medical knowledge base development. A variety of tools are being developed as part of this research, as noted above.

Greenes is Principal Investigator on an NLM-supported investigation of the use of computer systems for knowledge management. This research involves development of knowledge organization, access, and display methods and tools, and the development of medical content that utilize these methods and tools. The objective is to facilitate problem-oriented access to knowledge by physicians and students. This funding supports the development of an information management architecture known as DeSyGNER (Decision Systems Group Nucleus of Extensible Resoruces) which facilitates authoring and composition of applications from network based information resources. Collaborative development of this platform in conjunction with major computer systems vendors is currently being pursued.

Greenes is Principal Investigator of a National Cancer Institute project aimed at facilitating development of pattern recognition and interpretive skills by radiologists through the use of a computer-based digital imaging system which provides experience in recognizing pertinent image features and in combining them appropriately into diagnostic categories.

The DSG is also engaged in working with medical publishers and with Walter Reed Army Medical Center in developing methods for effective utilization of textbooks in electronic form. Issues relate to query, browsability, human interface, superposition of conceptual schemas, incorporation of hyperlinking, and preservation of context when viewing portions of a textbook in isolation.

Another major activity of the DSG is participation in the Northeast Medical School Educational Consortium, and organization of eleven medical schools in the northeastern United States, the focus of which is development of platforms, strategies, and procedures for sharing and cooperative development of software and content archives. Many of the DSG's systems development

work is aimed at fostering modularization, sharing, and integration of disparate information resources.

Finally, the DSG participates in a newly formed Center for Applied Medical Information Systems (CAMIS) at Brigham and Women's Hospital, where the focus is on more effective clinical access to educational and decision support resources, recording of clinical notes, order entry, and guideline monitoring.

Resources available to the Decision Systems Group, Brigham and Women's Hospital, include the electronic mail systems of the Department of Radiology VAX VMS computers (including one VAX 780, one 8600, two MicroVAX II computers, and two Sun 4 workstations), the Harvard Medical School Novell Network with cc:Mail, and the HST Sun 4 computer at MIT. The DSG also has 22 Macintosh IIci and Macintosh IIfx computers, each with 170 megabyte hard disks; two Macintosh file servers; one each Digital Equipment Corporation 5000 and 3100 workstations; and 3 Laserwriter printers. All computers are on the Ethernet and have INTERNET and BITNET access. Peripheral storage is provided by several large capacity hard disks in the 350 MB to 750 MB range, a Pinnacle 6.5 GB magnetic-optical (MO) disk juke box, a Pinnacle 650 MB MO single drive system, several Syquest cartridge drive systems, and a Micronetics DAT drive for backup. All computers have color display, and 10 of them have 19" color monitors. Other peripherals include a BarneyScan color slide digitizer, a Konica Radiographic Laser Scanner (owned in conjunction with the Radiology Department), a flatbed scanner, a digital video frame grabber, videodisc player, PC-VCR video playback unit, an InFocus color LCD panel projection system, and a Tektronix Phaser PX color printer.

Principal Current Projects of the DSG

In the sections below, we briefly highlight a number of research areas in which the DSG is engaged, to indicate the kinds of problems in which its trainees and staff have particular interest and expertise. The strengths of these programs is in the collaborative arrangements with a wide variety of participating departments and institutions.

UMLS: Unified Medical Language System Development

The goals of the UMLS research are to provide a consistent framework for indexing and retrieval of medical knowledge. This framework is desired as a means for allowing hitherto independent applications to be more readily interfaced, and to facilitate the development and use of electronic knowledge resources and personal reference files. This research involves a spectrum of activities:

(a) development of semantic net editing and display tools, and tools for consistency checking; searching and browsing the net; query formulation; and translation from/to existing vocabularies;

(b) development of medical concepts and relations for a semantic net representation of the UMLS metathesaurus, involving both top-down design; bottom-up design; and combinations of these approaches;

(c) theory and methodology research, focusing on methods for identifying and suggesting relations between terms in the semantic net, as an aid to query formulation; heuristic selection of landmarks for fish-eye display; and evaluation of semantic-net-based display/query methodology versus traditional methods for searching the biomedical literature; and

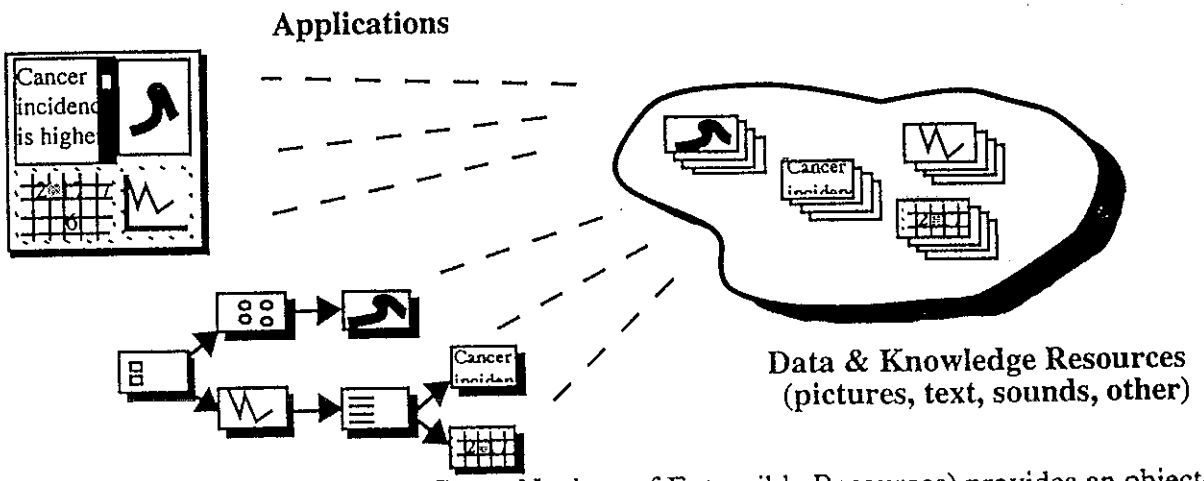
(d) coordination with other UMLS participants, through organizing and convening workshops of UMLS semantic net collaborators; facilitate communication, interchange, and cooperation; collecting contributions to the net and reviewing feedback; performing a curator function for semantic net maintenance; and provision of tools for interchange and review of content among collaborators.

A number of the DSG fellows and staff are participating in aspects of this research. **Robert C. McClure, M.D.**, is responsible for organization of the semantic net to support image

content description. **Luke Sato, M.D.,** is engaged in developing a descriptive taxonomy for neurologic disease that relates structural and functional components. **Andre Marquis** is developing image archive management tools. **Ed Pattison-Gordon** is building and refining semantic net editing and browsing tools. A former fellow, **William Hersh, M.D.,** with whom we continue to collaborate in his current capacity as a faculty member at the Oregon Health Science University, developed SAPHIRE, a natural language front-end that maps a query into concepts for more precise retrieval. We are seeking to utilize SAPHIRE's interface for a variety of information resources with which we are working.

DeSyGNER: Mulitmodal Authoring & Presentation Environment

This project, a major research focus of the DSG, involves the development of capabilities for organization of medical knowledge by building a comprehensive authoring and presentation environment, known as DeSyGNER (Decision Systems Group Nucleus of Extensible Resources). The major premise of DeSyGNER is that useful data and knowledge resources may exist in a variety of forms, maintained by experts in the particular domains to which they relate. Applications to support such activities as self-directed learning, decision making, browsing, or query need to access and utilize these various data and knowledge resources. Moreover, the applications need the ability to "compose" the data and knowledge into formats or structures for presentation and navigation that are suitable for their particular purposes.



DeSyGNER (Decision Systems Group Nucleus of Extensible Resources) provides an object-oriented software architecture for "dynamic assembly" of modular information resources into application compositions, such as page layouts, tutorials, electronic textbooks, case simulation exercises, question/answer quizzes, or consultation sessions. Content may be unstructured text, pictorial information, e.g., clinical algorithms or diagrams, or structured content, e.g., disease, findings, or drug data bases. In addition, it may be dynamic procedural components, e.g., simulations, quantitative analyses, expert system modules, or script-based data base retrieval, e.g., from a literature data base. The knowledge potentially available is structured as a web of nodes and links, with the content associated with each node under the control of a specific tool for producing and displaying it (e.g., a hypertext tool, an animation tool, a spreadsheet tool, a simulation, an expert system, a telecommunications tool, or a data base retrieval tool). DeSyGNER is a successor of Explorer-2, an implementation improving on its prototype, Explorer-1, which provided a shell for browsing through the nodes and links; selecting particular nodes and links based on keywords associated with each and filtered by contextual descriptors characterizing the user and/or the problem setting; and invoking modular tools for retrieving and/or producing content and displaying it.

Content of nodes is displayed in multiple windows on a microcomputer workstation. Selection of "hotspots" within a window, i.e., choosing a particular term or topic of interest, permits the user to branch to other windows providing additional details, by passing the request to the DeSyGNER shell. Thus the user is able to peruse topics as desired, both to answer specific problems as well as to browse through the knowledge base to satisfy curiosity.

DeSyGNER provides a formal method for utilizing independently developed data and knowledge resources, and composing them into various application formats. As such, it enables development to build upon the work of others, and to facilitate sharing and collaboration. Furthermore, it is extensible, providing a framework which can encompass a growing range of capabilities, as needs increase. DeSyGNER is being developed for use in our own application projects, as well as a potential software platform for more widespread use.

Knowledge resources developed for use with Explorer-2, which was a predecessor of DeSyGNER, include CASPER, an electronic textbook for diagnostic workup strategy selection; several chapters from medical textbooks (Principles of Ambulatory Medicine, Williams and Wilkins, publishers; and Scientific American Medicine); and QMR, an expert system for differential diagnosis (based on Internist-1, and implemented in the Explorer-2 environment with the cooperation of R.Miller and J.Myer of the University of Pittsburgh). Current work is aimed at (a) further electronic textbook adaptations, (b) case presentation libraries for education and decision support in radiology and pathology, and (c) training of interpretation skills in radiology.

The current and proposed future UMLS effort are highly relevant to this kind of knowledge management environment. As new knowledge is continually added to knowledge bases, either by a single author, or particularly in a multi-author environment, knowledge content units need to be indexed to permit them to be accessible when relevant. A user should be able to retrieve specific knowledge content by combinations of free text query, menu selection, and selection of hotspots within content windows. In all cases, the pertinent content should be identifiable by the system, through the use of a common method for indexing it. Selected knowledge should similarly be indexable by the user for his or her personal filing system.

Robert C. McClure, M.D., is a current postdoctoral fellow who is participating in the development of this system with the objective of interfacing the UMLS browsing capabilities into it. **James McClay, M.D.,** is implementing a flow control shell for composition of information resources in an algorithmic format. Primary software development of DeSyGNER is being carried out by **Stephan Deibel, David Tarabar, Edward Pattison-Gordon,** and **Andre Marquis.**

Algorithms: Generation, validation, and application for education, decision making, and order entry

The clinical algorithm has become a very popular way of describing approaches to a wide variety of clinical problem solving tasks. Nonetheless, algorithms have several limitations that have limited their acceptability. Among these limitations are that they do not embody all of the various considerations that may pertain to a particular patient; they do not allow for equally valid alternative approaches to a problem; and they are insensitive to the order in which data are acquired, not adjusting to the prior availability of data which may be required only later in a particular algorithm.

Several of these limitations could be overcome if one considers a potentially very large algorithm with branches covering all possible eventualities. While such an algorithm is not practical to represent on paper, and would be unwieldy to display, it could be represented in a computer system. Indeed, the logical flow that would result from execution of an expert system could be embodied in a sufficiently large algorithm. With a sufficiently flexible user interface, an algorithm display could be dynamically generated, which only displays those branches pertinent to a specific situation. Prior data could cause certain branches to automatically be taken, and their logic collapsed into subsequent nodes. Sections of algorithms could be represented by single boxes

indicating higher level designations of the goals of those sections, and expanded only if the user wishes to see the details, thus providing a zoom/dezoom capability. Prior probability information could be used to anticipate which branches of an algorithm should be pre-expanded versus collapsed.

Dynamic generation of an algorithm thus offers a potential for succinctly embodying pertinent aspects of a clinical problem under program control. In addition, an algorithm, whether used literally as a prescription for care or not, can be used as framework for presenting the logical approach to a clinical problem. Thus it forms a kind of graphical topical outline to the problem. Each box in an algorithm can potentially be linked to explanatory material that provides information about the rationale and purpose of the action or conclusion in the box, including pertinent references, and can also be used as a cross-reference for additional pertinent material. A box, for example, in the workup of hypertensive emergency, which seeks to determine whether there is evidence of end-organ damage, might lead to information about the kinds of end-organ damage that should be considered (cardiac, renal, retinal, cerebral), ways of assessing them (including pertinent tests and illustrations of medical images), etc. A box indicating the use of a beta-blocking drug could link to a table indicating the available agents, their relative advantages and disadvantages, dosage schedules, side effects and contraindications.

The DSG is currently exploring the application of the clinical algorithm as an organizing strategy for an electronic knowledge resource for primary care and emergency medicine, as well as its use in diagnostic procedure ordering (see CASPER below). Several groups in the Harvard medical area are involved in the development of clinical algorithms and offer the potential for collaboration in this work, including the Brigham and Women's Hospital Emergency Service and the Harvard Community Health Plan. As a potentially large multi-author collaborative activity, again the resources of a UMLS would be extremely useful for its organization. Initial work in this project was done by a former DSG trainee, **Thomas Abendroth, M.D.**, now a faculty member at Hershey Medical Center. Current work is being carried out by trainees **Richard Shiffman, M.D.**, and **James McClay, M.D.**, as well as by a foreign postdoctoral student, **Isao Kamae, M.D.** Shiffman is exploring the relationship between decision tables and decision trees, in determining alternative algorithmic sequences. McClay is developing authoring and user interface tools for algorithm development and use in the Brigham's emergency room setting. Kamae is exploring the selection of optimal algorithms by modeling a decision problem as a finite state automaton.

CASPER (Computer Aided Selection of Procedures and Evaluation of Results) is a knowledge base of diagnostic strategies for a wide variety of common clinical problems based, in part, on a handbook of diagnostic strategy assembled by the Brigham and Women's Hospital Department of Radiology. CASPER gives information about general patient characteristics for a specific clinical problem, the approach to workup, a flow chart of the clinical algorithm, and data about the various tests available, including preparation requirements, advantages and limitations, and quantitative data about test performance. In addition, "what if..." procedures can be invoked to analyze the value of a proposed test for a specific patient. The database in CASPER is from 1986, and is in the process of being revised. The CASPER knowledge base was developed with the aim that it be an entry point to a wide variety of other content material and procedures, relating to differential diagnosis, pathophysiology of the diseases, and decision making concepts used in prospective test assessment. A particular interest is its potential use as a guidance system for radiology procedure ordering as part of a hospital information system.

Clinical Record Keeping

As part of the DSG's involvement in CAMIS (the new Brigham and Women's Hospital Center for Applied Medical Information Systems), we are developing approaches to capturing of clinical notes as part of an automated medical record. Our primary focus at present is on those

structured notes that can be facilitated by use of templates, such as radiology reports and other procedures (ECGs, endoscopy, and surgical notes). The approach being taken is to structure the decision process involved in characterizing a patient by use of an algorithmic format, and then within branch points of the algorithm to provide the detailed data items unique to each branch point. This provides a "coarse chunking" mechanism which enables considerable tailoring yet does not sacrifice speed and efficiency (which would be the case if more aggressive branching were done).

We are also experimenting with a variety of formats for presentation, including tabular outline format, prose narrative, flow chart display. The approach is designed to allow adaptation to a variety of input methods, including keyboard, mouse, and voice selection. Finally, we are exploring ways to ensure that the clinical terms chosen correspond to controlled taxonomy terms in our evolving UMLS semantic net.

This project is the principal focus of one fellow, **Douglas Bell, M.D.,** and is also being contributed to by another fellow, **James McClay, M.D.,** and by **Edward Pattison-Gordon.**

Computer-Based Education

The DSG is engaged in a variety of projects in support of medical student and continuing medical education.

Clinical Skill Building. Knowledge resources that are also considered useful are those that give physicians and students experience with understanding complex inter-relationships that form a basis for clinical judgment and decision making. The Decision Systems Group is exploring several kinds of scenarios in which these needs occur, and developing tools to support them. Clinical skill building has been addressed in two areas involving cardiology, cardiac auscultation and electrocardiographic interpretation. In both cases, programs have been designed to simulate clinical situations, to aid the student in identifying pertinent characteristics, recognizing patterns, and understanding the bases for their interpretation. HeartLab, now in use at over 75 medical schools, gives the student experience in detecting and recognizing heart sounds by simulated auscultation, first by allowing user selection of sound characteristics and abnormalities, and second, by generating unknown cases for user interpretation. Selected review material is made available to augment the exercises. EKGLab has recently been completed, to provide similar experience in recognizing and interpreting electrocardiographic abnormalities. These programs, which have been widely praised, were developed by a former postdoctoral trainee of the DSG, now a staff member, **Bryan P. Bergeron, M.D.,** and are distributed through a medical text-book publisher.

Radiology Interpretation. Another project now underway is aimed at training radiologists in the interpretation of mammographic images. Previous work by collaborators at BBN Laboratories has demonstrated that significant differences exist between the quality of interpretations by experts versus non-experts, and that a computer-based clustering model based on features identified by experts in the images can augment performance of non-experts to a level comparable to that of the experts. The research now underway is aimed at training non-experts to perform at expert levels by providing computer-based experience. The intent of this system is to enhance pattern recognition and interpretation skills through intelligent tutoring. The system is aimed at providing users with experience in recognizing pertinent image features and in combining them appropriately into diagnostic categories, with an initial focus on mammographic interpretation, an area in which skill levels and efficiency need to be raised because screening is effective and widely used, and the workload is expected to increase significantly. The DSG is developing an optical disk library of mammographic images that illustrate specific features as well

as a library of cases with known diagnoses. Under control of the instructional system, users' abilities to recognize and correctly rate features in images is assessed, and their ability to properly weight features in arriving at a diagnosis is determined. Errors in performance in either skill are remedied by feedback to the user of didactic content, performance graphs, and additional pertinent case material. This project is a joint effort between the DSG and BBN Laboratories, Inc., in Cambridge, MA, and involves **Andre Marquis, Robert A. Greenes, M.D, Ph.D., David Getty, Ph.D., John A. Swets, Ph.D.**, and others.

Other applications of the above approach relate to creating image teaching files for selective retrieval by students and residents in radiology and pathology in a variety of domains, and for incorporating medical images in other knowledge bases. We are building a computer-based radiology teaching library capability, both internally at Brigham & Women's Hospital, and in conjunction with the Radiology Information Systems Consortium (RISC). The project involves development of a standard data base describing patients, examinations, images, findings, and diagnoses; an image description taxonomy for indexing the findings and diagnoses, and a retrieval, case presentation, and browsing environment based on the DeSyGNER tools of the DSG. A digital image presentation entity, developed by **Lincoln Stein,. M.D., Ph.D.**, supports 12-bit gray scale image presentation, in low or high resolution modes, with selective magnification, using virtual memory to retrieve high resolution portions under a roving "magnifying lens" cursor, brightness and contrast manipulation, and "grease pencil" markup of the images. The images can be incorporated into either hypermedia or tutorial protocol-based presentations, and cases can be located by keyword-based query.

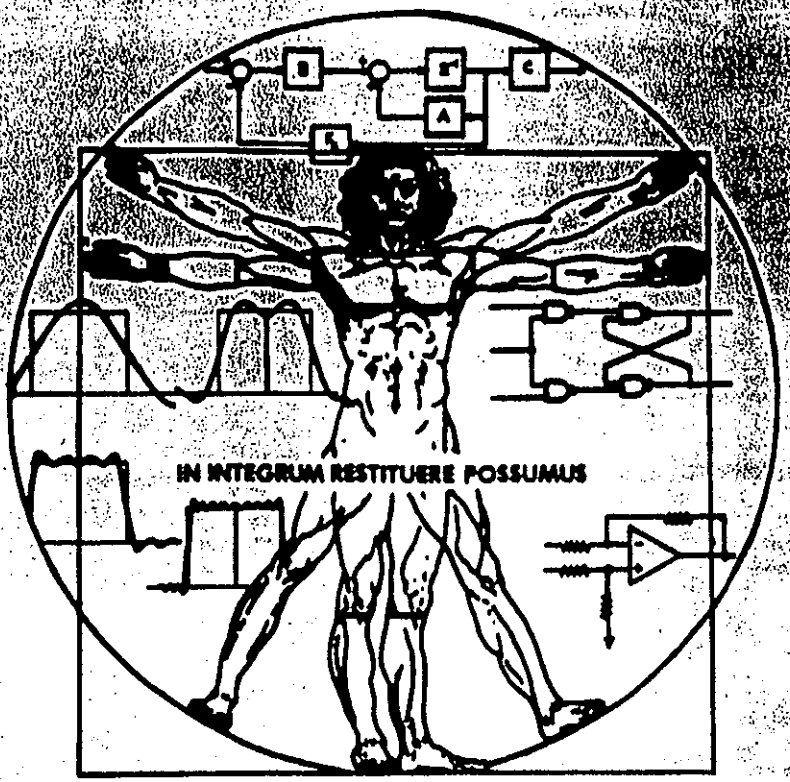
Case-Based Problem Solving. Clinical problem solving exercises have long been used as a way of providing simulated experience in clinical medicine, and multimedia capabilities now available extend the potential for realism of these exercises. In addition, with the use of hypermedia methodologies, it is now possible to link components of a clinical case — e.g., the tests, the images (or sounds, or tracings) of the actual results, or the textual descriptions of findings — with other related information. This information can amplify on the tests themselves, the range of possible results that could alternatively have been obtained, the differential diagnoses of any particular findings, or the profiles of diseases in the differentials, and can provide discussions and references about the diseases. Thus the case problem solving exercise may have potential for more than providing practice with making clinical judgments; it may offer an alternative paradigm for accessing much of the same medical content traditionally delivered in didactic lectures and in textbook presentations.

We have implemented, and continue to refine, an authoring environment for case problem-solving exercises that enables access to multimedia presentation of clinical results, and related clinical and pathophysiologic content material—CaseBase. CaseBase has been developed by **Mark S. Dichter, M.D., Bryan P. Bergeron, M.D.**, and **Robert A. Greenes, M.D., Ph.D.** CaseBase has been used thus far to develop case-based simulations in cardiovascular pathophysiology, with the participation of **John T. Fallon, M.D, Ph.D.** These patient simulations give students experience in recognizing heart sounds and EKG tracings, in interpreting CT, plain film, and echo sequences, in assessing pathologic specimens, and in diagnosing and managing patients. We are currently distributing CaseBase to cooperating institutions who agree to share cases developed with it. A major interest is to evaluate student trajectories through the case, as a way of assessing use and effectiveness of particular problem solving strategies.

Medical Imaging Self-Assessment. Properly designed and implemented computer-based instructional materials that use gaming techniques—competition, scoring, time constraints, lively audio feedback, and colorful graphics —can serve a dual purpose. Not only can such educational resources provide students with a wealth of meaningful data, but they can also foster a degree of emotive involvement in the material that no other presentation modality can do.

To assess the applicability of a gaming environment in the teaching of cardiac pathophysiology, a graphically-oriented game, PathGame, was developed for first-year medical students

enrolled in the Health Sciences and Technology Division of Harvard and M.I.T., by **Bryan P. Bergeron, M.D., John T. Fallon, M.D., Ph.D., and A. Nicholas Morse**. Evaluation of the program strongly suggests that, for certain types of materials, this easily implemented mode of computer-based instruction is a viable alternative and supplement to other designs. We believe this approach has considerable applicability to radiology education as well, and are planning to develop a set of radiologic imaging self-assessment materials. The tool itself could readily be used by others planning similar activities. Dr. Bergeron has also incorporated a neural net model into the program, which is being used to dynamically evaluate student performance as a way of selecting questions to challenge the student at a level appropriate for his/her skill level.



DEPARTMENT OF BIOMEDICAL ENGINEERING

THE SCHOOL OF MEDICINE

THE UNIVERSITY OF NORTH CAROLINA at CHAPEL HILL

STUDENT GUIDE

AUGUST 1993

APPENDIX VII

MEDICAL INFORMATICS TRACK

The field of Medical Informatics deals with the concepts and principles underlying acquisition, processing, and presentation of information in support of medical practice and education. The Medical Informatics track is relatively new, with the first students admitted in the 1991-92 academic year. In 1992, a training grant from the National Library of Medicine awarded jointly to Duke and UNC established the Duke-UNC Medical Informatics Training program. This grant places in the Research Triangle area one of the ten federally sponsored medical informatics training programs in the country, and the only such program in the southeast. UNC students in the Medical Informatics track are part of this training program. Support for students is available through the training grant. More detailed information about studies in medical informatics is available on request.

The faculty's research interests span a wide range of topics. The topics of major emphasis are:

- development of clinical data and knowledge bases, and the presentation of information from these resources so as to positively affect medical decision making;
- applications of advanced image processing techniques to diagnosis and treatment planning;
- studies of the reasoning processes of clinicians and the impact of information technology on patient care;
- application of advanced information technology to education in the basic and clinical sciences.

Four UNC medical informatics core courses, with full implementation beginning the fall of 1992, are described at the end of the appendix. Many pertinent courses are offered at Duke and it is expected that students will take some of their coursework there through cross-registration.

FACULTY:

In the broadest sense, the program faculty includes approximately 50 individuals with interest in medical informatics at UNC and Duke. The program faculty with appointments in biomedical engineering or who play a major teaching role in informatics core courses at UNC include:

Friedman*	Downs	J. Hammond
Hsiao	Tsui	Cronenberger
Charlton	Lucas	Michael
McNutt	Pizer	de Bliek
Beard		

* Program director.

PROGRAMS OF STUDY:

Predoctoral Training: The following is a typical academic program leading to the PhD for a student with an engineering or mathematics background. This program assumes that the student has knowledge of advanced calculus for engineering applications. (Students lacking this experience will need to take MATH 128 prior to taking the qualifying examination.) Elective experiences will be selected in consultation with the student's advisor. The Biomedical Engineering qualifying exam will typically be taken in January of the second year. Course credit hours appear in parentheses.

First Year (29 credit hours)

Fall Semester

BMME 100 - Introduction to Biomedical Engineering (1)
BMME 170 - Introduction to Medical Informatics (Duke/UNC joint course: 3)
BIOS 135 - Probability and Statistics (4)
PHYS 140 - Human Physiology (5)

Spring Semester

BMME 121 - Digital Signal Processing (3)
BMME 1aa - Medical Information Systems (4)
BMME 270 - Research and Evaluation Methods in Medical Informatics (3)
BMME 111 - Biomedical Instrumentation (3)

Summer

BMME 231 - Special Topics in Biomedical Engineering (Internship: 3)

Second Year (24 credit hours)

Fall Semester

BMME 2bb - Clinical Reasoning & Decision Making (3)
BMME 120 - Real Time Computer Applications (3)
BME 399 (Duke) - Computer-based Patient Records (3)
Elective - (3)*

Spring Semester

LIBS 256 - Database Systems (3)
BME 241 (Duke) - Artificial Intelligence in Medicine (3)
Elective - (3)*
Elective - (3)*

Later Years
Electives as directed by student interests and to prepare for dissertation research.

*Elective must be 200-level at UNC or 300-level at Duke.

Postdoctoral Training: The curriculum for doctorally trained health professionals unfolds over two years. Most course requirements for the MS degree will be completed in the first year, providing a basis for a second year weighted toward project and thesis work which are a vital component of the program. Students will take the qualifying examination in January of the second year. Health professionals seeking a terminal masters degree may petition to take a modified version of this examination. Graduates of this two year program will be able to carry out a practical development project from conception to documentation, and to conduct original research. To these ends, each student will undertake an extended internship in the summer to complete the development project; the masters thesis will be a focused work of original research completed in the second year.

A typical postdoctoral trainee's program is described below:

First Year (24 hours)

Fall Semester

BMME 100 - Introduction to Biomedical Engineering (1)
BMME 170 - Introduction to Medical Informatics (Duke/UNC: 3)
BIOS 135 - Probability and Statistics (4)
BMME 2bb - Clinical Reasoning & Decision Making (3)

Spring Semester

BMME 1aa - Medical Information Systems (4)
BMME 121 - Digital Signal Processing (3) *or* BMME 111 Biomedical Instrumentation (3)

BMME 270 - Research and Evaluation Methods in Medical Informatics (3)

Summer

BMME 231 - Special Topics in Biomedical Engineering (Internship: 3)

2nd Year (18 hours)

Fall Semster

BMME 120 - Real Time Computer Applications (3)
BME 399 (Duke) - Computer-based Patient Records (3)
BMME 393 - Thesis (3)

Spring Semester

BME 241 (Duke) - Artificial Intelligence in Medicine (3)
BMME 393 - Thesis (3)
Elective (3)

Other Courses: For electives or as substitutes for some of the courses listed above, students might choose:

BME 399 (Duke) - Data and Knowledge Representation in Clinical Information Systems
BME XXX (Duke) - Networking (3)
BMME 141, 142 - Medical Imaging I and II (3 hours per semester)
COMP 230 - Database Management Systems (3)
COMP 254 - Picture Processing and Pattern Recognition (3)
COMP 255 - Computer Vision (3)
EDCI 211 - Instructional Systems Development (3)
INLS 257 - User Interface Design (3)
PHYS 101,102 - Introductory Electronics (3 hours per semester)

Postdoctoral Fellowships
in
Medical Informatics
University of Missouri

Postdoctoral fellowships are available for qualified applicants seeking academic training in medical informatics. Medical informatics is the application of computers to health care. Medical informatics goes beyond the use of the computer as a computational tool and extends into the process of knowledge representation, acquisition, storage, retrieval, and manipulation largely to support reasoning, decision-making, and learning.

Successful candidates may have a variety of backgrounds. Some applicants will have an MD, DO or DVM degree and be near completion of a residency in a medical or veterinary specialty. Other candidates might have a PhD in electrical engineering, computer science, information science, and be interested in health applications; or would have a PhD in molecular biology or biological sciences, with interests in computer science. Still other candidates might have a PhD in biostatistics, or educational psychology, with course work in health related areas.

Fellowships would be for two to three years, and fellows could obtain a PhD or Master's degree.

Fellows will receive a stipend ranging from $18,600 to $32,300, depending on experience and prior training. The fellowship waives most if not all of the costs of tuition and fees. Fellows also receive travel funds to participate in certain scientific meetings.

Applicants should submit a transcript of their graduate and undergraduate work, a Curriculum Vitae, three letters of reference, a two-page typed statement indicating their past achievements in medical, computer, health science, library, mathematics/statistics, and education areas, and a statement indicating their commitment to and interest in an academic career in medical informatics.

Successful candidates can expect to begin study in July or August 1994, select a mentor in their area of interest to work on research projects, and take interdisciplinary course work leading to an understanding of medical informatics.

We particularly invite women and minority applicants. All fellowships are subject to availability of federal funding. Fellowship recipients must be U.S. citizens or permanent residents of the U.S.

For further information contact:
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Applications are considered until positions are filled. For priority consideration, send application by January 1.

Medical Informatics Training at the University of Missouri

605 Lewis Hall
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The University of Missouri offers a flexible program to train postdoctoral and predoctoral candidates for an academic career in medical informatics. A three-month fellowship for medical and veterinary students desiring a short research experience is also offered.

The training program and curriculum prepares individuals to develop, use, and evaluate applications of innovative information methods and computers in the health care environment. The program emphasizes the synthesis, retrieval, organization, and effective management and communication of knowledge. The core curriculum consists of seven courses from five different divisions. The MU program has ten core faculty (and numerous clinical faculty) with diverse backgrounds and active research programs.

Upon completion of the program, all fellows are expected to have basic competency in decision support systems, computer networks, expert systems, artificial intelligence, medical subject analysis, database management systems, and applied statistics. Graduating trainees should be qualified for an academic career in medical informatics upon completion. They should be particularly expert in the field represented by their research projects.

Fellows learn about current research by sharing their projects and by hearing invited speakers at weekly seminars and journal club. These meetings teach trainees writing and oral reporting skills in defending their own position and in analyzing other's projects. Trainees specifically discuss methods of experimental design for informatics research.

All fellows choose to work with a senior researcher on medical informatics projects. Current projects include:

- Expert systems, reminder systems, knowledge based systems
- High Performance Communications and Computing (HPCC)
- Clinician and student workstations
- Multimedia systems for education and clinical uses
- Full-text information retrieval and search heuristics
- Molecular biology computing
- Applications of the Unified Medical Language System
- Integrated Advanced Information Management Systems
- Cognitive processing models
- Computer assisted continuous quality improvement
- Computer vision and image analysis
- Computer generated cardiac profiles in health and disease
- Randomized controlled clinical trials of information interventions
- Meta-analysis of controlled information service trials
- Computers in the integration of clinical and business functions.

Medical Informatics Training

at the

University of Missouri

September, 1993

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Medical Informatics Training at the University of Missouri

Postdoctoral fellows and predoctoral fellows

We accept 2 postdoctoral fellows, 2 predoctoral fellows, and one short term traineeship per year. The short term traineeship will be used by students currently enrolled in medical or veterinary medical school. We will maintain a steady state at 4 to 6 postdoctoral fellows and 3 to 4 predoctoral fellows. Fellows who are M.D.'s, D.O.'s and D.V.M.'s will not have any clinical responsibilities. Both predoctoral and postdoctoral trainees need to demonstrate satisfactory competence as shown by completion of the core courses below and complete a research project and other courses as outlined by their advisory committee.

Areas of possible interdisciplinary research projects in computer science and electrical engineering include computer networking, radiographic image transmission, computer vision, artificial intelligence, expert systems, and neural networks. Areas of possible research projects in health education include analysis of problem-solving skills in computer based instruction, performance support systems, perception, cognitive processing, semantic networks, and computer recognition of natural language. Projects in data management for patient care include patient chart development, integration of text files with image processing, image compression and analysis, and integrated advanced information management. Projects in library and information science would concentrate on health topics.

Trainees will be directly involved with research, commensurate with the usual standards for master's or doctoral-level work. Minority trainees could apply for additional support. Trainees should be qualified for an academic career in Medical Informatics upon completion. They should be particularly expert in the field represented by their research project.

Core requirements

The purpose of the curriculum is to prepare individuals for an academic career in Medical Informatics. It emphasizes the synthesis, retrieval, organization, and effective management and communication of knowledge.

- We expect that all applicants would have basic competency in molecular biology, and in applied statistics.

- All successful fellows would have mastered the skills and knowledge represented by the following seven core courses; MA candidates in Library Science would take 4 of the 7.

(1) HSM 430 (VSM 430, LIS 430) Computer Applications in Health Care (3). Overview of the field of medical informatics.

Degrees

UM does not offer a degree specifically in Medical Informatics, but does offer a flexible program to train people for an academic career in Medical Informatics. Postdoctoral fellows have three choices. First, postdoctoral fellows could obtain a Ph.D. in (a) Electrical and Computer Engineering, or in (b) Industrial Engineering, or in (c) Educational and Counseling Psychology, or in (d) Nursing. As a second option, they could instead obtain a Master's degree in the above fields or in Computer Science, Library Science, Health Services Management, or statistics. Third, some postdoctoral fellows might qualify for an academic career in Medical Informatics by taking selected courses that did not lead to a degree. These postdoctoral fellows would still need to demonstrate skills and knowledge in molecular biology and statistics, complete the core courses, and complete a research project supervised by a senior researcher.

Predoctoral fellows could obtain a Ph.D. depending upon their interests and background. For example, a person wishing to emphasize artificial intelligence, expert systems, bioengineering, computer vision, neural networks, or image analysis would pursue a doctoral degree in Electrical and Computer Engineering (ECE). We would expect that most candidates would pursue the degree in ECE since this is the most established path. However, all of these Ph.D. programs allow for considerable work in outside areas so that a candidate in Educational and Counseling Psychology would take work in biological science, in Computer Science, and in ECE, etc. The courses to be taken are worked out by the candidate jointly with the candidate's faculty advisory committee, according to the candidate's interests and goals. It is not unusual for candidates in interdisciplinary programs to cross departmental lines to take courses offered by other departments. Predoctoral fellows can also pursue a Masters of Arts degree in Library and Information Science. This degree would allow for a specialization in health sciences librarianship.

We illustrate a sample postdoctoral student, an M.D. with a residency in Pediatrics, David Jones, who has a strong demonstrated interest in medical informatics and who decides to train for an academic career in medical informatics at the master's level, with a degree in computer science, emphasizing expert systems. One of the three directors suggests he talk with Drs. Brent, Franck, Furbee, Hahn, Hile, and Reid to learn of their current research. Dr. Blackwell becomes his major advisor and Dr. Furbee agrees to serve on the graduate advisory committee from an outside discipline. Dr. Jones and his core advisor work out a list of courses that assure competent training for a Medical Informatics career. His graduate committee approves his proposed course work. Dr. Jones takes 12 hours of prerequisites in computer science to take the core courses, and 6 hours of learning theory in Educational and Counseling Psychology. Dr. Mitchell meets with him quarterly to monitor and evaluate his work by discussing his test grades, papers, and work pressure. He also attends the research symposia and journal clubs, and presents one or two papers a year at the symposia. His graduate committee approves his thesis topic on expert systems to teach parents how to cope with events that occur in their child's life, depending upon the child's previous history. He presents his research at the research seminar and submits a manuscript for publication in an informatics journal. Upon successful completion of his course work and thesis, he receives the M.S. degree. We do not intend that M.D.s will have any clinical responsibilities while serving as a Medical Informatics fellow. However, because of the nature of his research, Dr. Jones attends clinic one afternoon a week and works with faculty in Child Health and in Psychiatry.

Now we illustrate a predoctoral student, Karen Smith, in library/information science. She comes to MU with an undergraduate major in biology and several years as a paraprofessional in an academic health sciences library. Upon admission to the program she is advised by Dr. Berk to apply for one of the Informatics traineeships. When she is chosen she begins at once to plan her two-year program. Because

At Duke, areas of special faculty interest include:

- development and support of computer-based medical record and hospital information systems;
- implementation of IAIMS (Integrated Academic Information Management Systems) within the academic medical center;
- medical instrumentation and real-time patient monitoring;
- development and use of clinical research databanks.

At UNC, areas of special faculty interest include:

- development of clinical data and knowledge bases, and the presentation of information from these resources to positively influence medical decision making;
- applications of advanced image processing techniques to diagnosis and treatment planning;
- studies of the reasoning processes of clinicians and the impact of information technology on patient care;
- application of advanced information technology to education in the basic and clinical sciences.

Current Trainees: In 1993-94, there are thirteen medical informatics trainees across the two institutions. Many students in the program receive full tuition and stipend support from the National Library of Medicine training grant, while other students receive support from research assistantships provided by academic departments affiliated with the program. The current students are a diverse group including physicians and non-physicians with interests ranging from decision support to imaging to business/financial aspects of informatics. Most but not all students are full time.

Application Process: Qualified applicants are invited to apply to the Department of Biomedical Engineering, specifying their interest in the medical informatics track, at either or both institutions. For postdoctoral trainees, no specific medical informatics or computer science background is required. Trainees accepted by both institutions will be offered a position in one of the two sites acording to the trainee's stated preference for instutional site and each site's level of preference for that trainee.
UNC.

For more information:

At *Duke*

Dr. W. Edward Hammond
Box 2914
Duke University Medical Center
Durham, NC 27710-2914

Phone: (919) 684-6421
Fax: (919) 684-8675
E-mail: hammo001@mc.duke.edu

At *UNC*:

Dr. Charles P. Friedman
322 MacNider Building
University of North Carolina
School of Medicine
Chapel Hill, NC 27599-7530

Phone: (919) 966-3641
Fax: (919) 962-2027
E-mail: cpf@med.unc.edu

Medical Informatics Training Program

Introduction

The Duke/UNC Medical Informatics Training Program was established in 1991 through grant funding from the National Library of Medicine. Though recently formed, the program draws upon more than 25 years of research experience in medical informatics at Duke. Duke's longstanding strengths include: computer-based medical records, implementation of IAIMS, medical instrumentation, and patient monitoring. These achievements are complemented by UNC's equally longstanding strengths in imaging and radiologic treatment planning, the application of information and cognitive sciences, and the development and management of clinical databases. The Duke program offers predocotoral and postdoctoral opportunities for applicants from medical and engineering/computer science backgrounds. The training program is structured so that trainees benefit from the strengths of both institutions. The joint program creates an environment that offers a unique opportunity for trainees to participate in cutting-edge research in the application of information technology to both patient care and education.

Duke University

The administrative structure, the geography of the campus, and the attitudes the faculty and staff create an environment at Duke that is conducive to multidisciplinary programs such as medical informatics. Several multidisciplinary investigative laboratories at Duke have contributed significantly to the field of medical informatics.

In 1967, a Division of Biomedical Engineering was established, supported financially by both the Schools of Engineering and Medicine. The division has since become an independent department in the School of Engineering. Biomedical engineering investigators are housed within the medical center, managing a laboratory with trainees from both medicine and engineering, and having full access to the resources of the medical center.

In the early 1970s, from seed money received from the NLM to establish a joint M.D./Ph.D. program in Computer Science, Duke established an independent Department of Computer Science. From the beginning, that department has had close ties with the medical school with a medical school division headed by a physician and housed in the medical center. The pattern of faculty investigators based full-time in the medical center with a mixture of trainees from computer science and medical training programs continues today and is augmented by the addition of the Medical Informatics Training Program.

Medical Informatics at Duke

In the middle 1960s, Duke was involved, with IBM, in a research project known as the Clinical Decision Support System. From this time on, Duke University Medical Center

Community & Family Medicine
James L. Michener, MD
Reginald D. Carter, PhD

Computer Science
Frank Starmer, PhD

Institute of Statistics and Decision Sciences
Michael West, PhD
Don S. Burdick, PhD

Radiology
G. Allen Johnson, PhD

Rheumatology
John R. Rice, MD
Rex M. McCallum, MD

Sanford Institute of Public Policy
Bruce Kuniholm, PhD
Duncan Yaggy, PhD

Program Tracks

The Medical Informatics Training Program is composed of two tracks: predoctoral and postdoctoral. The predoctoral program leads to a doctoral degree in biomedical engineering with a focus in medical informatics. Applicants to the predoctoral program should have either a baccalaureate degree in biology, chemistry, computer science, engineering, mathematics or physics with an emphasis on the use of computers in problem solving; or be pursuing a combined M.D./Ph.D. The predoctoral program is intended to provide four years of training.

Postdoctoral candidates may elect to pursue a Master of Science Degree in Biomedical Engineering or elect not to seek a degree. Students accepted in the postdoctoral program are primarily MDs who wish to devote a period of time to an intensive study of medical informatics. Generally they will have completed residency training. The postdoctoral program is intended to be a two year program.

Admissions process

Application for admission to the training program is through the Graduate School. Potential applicants should obtain application materials directly from the Graduate

range of educational activities including science, engineering, medicine, and administration. Trainees should seek the direction and guidance of their faculty advisor in selecting the courses best suited to the thrust of the trainees research. Formal approval of the program of study is required by the student's committee. In addition to coursework, each trainee will design and execute a research project leading to the completion of a thesis or dissertation.

As part of the joint program, all Duke trainees join with the trainees from UNC for a biweekly seminar. Speakers include faculty of the Duke and UNC programs, invited speakers and trainees. The seminar serves as a forum for presenting work in progress and provides trainees with an opportunity to meet support faculty and share ideas between the programs.

Additional University and Departmental requirements pertaining to minimum credits per semester and residency may need to be met in order to remain eligible for fellowship funding and to graduate. Trainees should consult the current *Bulletin of Duke University, Graduate School* and the appropriate department for current policies.

Predoctoral Program

The first year consists primarily of course work; the second year includes course work with the introduction of some research activities. The third and fourth years are devoted primarily to research. Each program is tailored to suit the individual needs of the trainee. The following sample program illustrates a possible sequence of studies. Course descriptions are included with this guide.

Initial year of graduate work. Trainees take courses to fill in areas in mathematics, engineering, or computer science which were not sufficiently covered during the student's undergraduate experience. During the first summer, all predoctoral trainees, except medical students, take MED 204, Introduction to Clinical Medicine.

BME 243 Introduction to Medical Informatics	3 units
CPS 221 Numerical Analysis	3 units
CPS 241 Database Methodology	3 units
BME 205 Microprocessors and Digital Instruments	4 units
EE 206 Digital Signal Processing	3 units
CPS 215 Artificial Intelligence	3 units

Second Year. Course selection is based on individual background to provide a firm foundation in the disciplines that make up medical informatics. Trainees are expected to pick a dissertation topic during the second semester of the second year. The remainder of the trainee's time is spent on medical informatics research.

LIST OF COURSES

In addition to the courses listed by number, the following courses are being offered as Advanced Topics (BME 265) or Special Readings (BME 399) at Duke until they are approved, are in planning, or are offered through UNC:

Computer-based Medical Records. Introduction to the principles of computer-based medical records using TMR as a model (*Hammond*).
Knowledge Representation. Design and structure of clinical data and knowledge structures (*Hales*).
Research and Evaluation Methods. (*Friedman, UNC*).
Clinical Reasoning and Decision Making. (*de Bliek, UNC*).
Software Engineering. (*UNC*).

Biomedical Engineering (BME)

BME 205 MICROPROCESSORS AND DIGITAL INSTRUMENTS. Design of microcomputer-based devices including both hardware and software considerations of system design. Primary emphasis on hardware aspects, including a progression through initial design, prototype construction in the laboratory, testing of prototypes to locate and correct faults and final design evaluation. Evaluation includes examination of complexity, reliability, and cost. Design and construction oriented toward biomedical devices or instruments that require dedicated microcomputers., usually operating in real time. C-L: CFM 235.

BME 333 BIOMEDICAL IMAGING. The underlying concepts and instrumentation of several medical imaging modalities. Review of applicable linear systems theory and relevant principles of physics. Modalities studied include X-ray radiography (conventional film-screen imaging and modern electronic imaging), computerized tomography (including the theory of reconstruction), and nuclear magnetic resonance imaging.

BME 241 ARTIFICIAL INTELLIGENCE IN MEDICINE. Basic concepts of Artificial Intelligence (AI) and in-depth examination of medical applications of AI. Knowledge of heuristic programming; brief examination of the classic AI programming languages (LISP and PROLOG) and AI programming; a study of rule-based systems and cognitive models. C-L: CFM 234.

BME 243 INTRODUCTION TO MEDICAL INFORMATICS. An in-depth study of the use of computers in biomedical applications. Hardware, software, and applications programming. Data collection, analysis, and presentation studied within application areas such as monitoring, medical records, computer-aided diagnoses, computer-aided instruction, M.D.-assistance programs, laboratory processing, wave form analysis, hospital information systems, and medical information systems. Available alternating years at Duke.

BME 244 MATHEMATICAL MODELS OF PHYSIOLOGICAL SYSTEMS. Mathematical modeling and computer simulation of physiological and other biomedical systems. Formulation of quantitative models of physiological processes using methods drawn from a variety of engineering disciplines including transport phenomena, feedback control, and continuum mechanics. Digital techniques for the solution of coupled nonlinear equations, emphasizing systems of ordinary and

Computer Science (CPS)

CPS 201 **PROGRAMMING LANGUAGES.** Information binding, data structures and storage, control structures, recursion, execution environments, input/output; syntax and semantics of languages; study of PL/1, Fortran, Algol, APL, LISP, SNOBOL, and SIMULA; exercises in programming.

CPS 212 **INTRODUCTION TO SCIENTIFIC COMPUTING.** Practical introduction for graduate students and faculty to computer resources that facilitate scientific research: scientific word processing (Tex and LaTex), symbolic manipulation programs, software tools, numerical software packages, and graphics. Case studies used to illustrate these resources. For noncomputer scientists.

CPS 215 **ARTIFICIAL INTELLIGENCE.** Heuristic versus algorithmic methods; programming of games such as chess; theorem proving and its relation to correctness of programs; readings in simulation of cognitive processes, problem solving, semantic memory, analogy, adaptive learning.

CPS 221 **NUMERICAL ANALYSIS.** Error analysis, interpolation and spline approximation, numerical differentiation and integration, solutions of linear systems, nonlinear equations, and ordinary differential equations. C-L: SDS 273.

CPS 241 **DATA BASE METHODOLOGY.** Basic concepts and principles. Relational, hierarchical, and network approaches to data organization; data entry and query language support for data base systems; theories of data organization; security and privacy issues.

CPS 252 **COMPUTER SYSTEMS ORGANIZATION.** Hardware and software aspects. Processor, memory, device, and communication subsystems; case studies of hardware system organization, e.g., parallel, associative, fault-tolerant; organization of software systems to exploit hardware systems organization; economic and reliability aspects of various hardware organizations.

CPS 276 **COMMUNICATION, COMPUTATION, AND MEMORY IN BIOLOGICAL SYSTEMS.** Communication and memory in biological systems: in voltage sensitive ion channels, hormone-receptor interactions, and initiation and control of RNA/DNA synthesis. Models of signaling and memory are developed and related to electronic signaling schemes.

Community and Family Medicine (CFM)

CFM 211 **PROBABILITY AND STATISTICAL INFERENCE.** Laws of probability, probability distributions, descriptive statistics, graphical displays of relationships, philosophy of statistical tests, tests for differences in central tendency, paired comparisons and correlation. Parametric and non-parametric procedures. Simple linear regression and one-way analysis of variance. Type I and Type II errors and problems of multiple comparisons.

CFM 212 **DESIGN OF ETIOLOGICAL, CLINICAL AND EXPERIMENTAL STUDIES.** General principles of study design. Observational studies, including descriptive (correlational, case report, cross-sectional) studies, cohort and case-control designs, their relative advantages and statistical methods used in their analysis. Classical designs (parallel group, randomized block, and cross-over) will be surveyed. Introduction to controlled clinical trials and to sequential design strategies.

Electrical Engineering (EE)

EE 189 **IMAGE PROCESSING.** Basic concepts of the manipulation and analysis of images by computer, linear operations on pictures, Fourier transform and 2-D-Z-transform, hexagonal sampling theorem, image transforms, image enhancement, image filtering and restoration, image coding, matching, segmentation, representation and description. Project presentation by students.

EE 243 **PATTERN CLASSIFICATION AND RECOGNITION.** Parameter estimation and supervised learning; nonparametric techniques; linear discriminant functions; clustering; language theory related to pattern recognition; examples from areas such as character and severe weather recognition, classification of community health data, recognition of geometrical configurations, algorithms for recognizing low resolution touch-sensor array signatures and 3-D objects.

EE 281 **RANDOM SIGNALS AND NOISE.** Introduction to mathematical methods of describing and analyzing random signals and noise. Review of basic probability theory joint, conditional, and marginal distributions; random processes. Time and ensemble averages, correlation, and power spectra. Optimum linear smoothing and predicting filters. Introduction to optimum signal detection and parameter estimation.

EE 282 **DIGITAL SIGNAL PROCESSING.** Introduction to the fundamentals of processing signals by digital techniques with applications to practical problems. Discrete time signals and systems, elements of the Z-transform, discrete Fourier transforms, digital filter design techniques, fast Fourier transforms, and discrete random signals.

EE 285 **SIGNAL DETECTION AND EXTRACTION THEORY.** Introduction to signal detection and information extraction theory from a statistical decision theory viewpoint. Subject areas covered within the context of a digital environment are decision theory, detection and estimation of known and random signals in noise, estimation of parameters and adaptive recursive digital filtering, and decision processes with finite memory. Applications to problems in communication theory.

Institute of Statistics and Decision Science (SDS)

SDS 213 **INTRODUCTION TO STATISTICAL METHODS.** Emphasis on classical techniques of hypothesis testing and point and interval estimation, using the binomial, normal, t,F and chi square distributions.

SDS 221 **BAYESIAN INFERENCE AND DECISION.** C-L: BA 510.

SDS 226 **BAYESIAN ANALYSIS AND STATISTICAL DECISION THEORY.** Formulation of decision problems; criteria for optimality: maximum expected utility and minimax. Axiomatic foundations of expected utility; coherence and the axioms of probability (the Dutch Book theorem). Elicitation of probabilities and utilities. The value of information. Estimation and hypothesis testing as decision problems: risk, sufficiency, completeness and admissibility. Stein estimation. Bayes decision functions and their properties. Minimax analysis and improper priors. Decision theoretic Bayesian experimental design. Combining evidence and group decisions.

SDS 231 **BEHAVIORAL DECISION THEORY.** C-L BA 525.

SDS 244 **INTRODUCTION TO LINEAR MODELS.** Geometric interpretation, multiple regression, analysis of variance, experimental design, analysis of covariance.

CDFHI

UNIVERSITY OF Miami

FACULTY SENATE
2 1995

Tarek M. Khalil
Dean

MEMORANDUM

April 17, 1995

TO: Dr. Kamal Yacoub, Chairman
Faculty Senate

FROM: Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics Program

As per your request, I am enclosing herewith a copy of the proposal for the interdepartmental program on Medical Informatics. If you may need any additional information, please let me know.

TMK/msb

Enclosure

The Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax: 305-284-5441

UNIVERSITY OF Miami

Vice Provost for Research and Deputy Dean for Research and Graduate Studies
P.O. Box 016960 (R64), 1600 N.W. 10 Avenue, Miami, Florida 33101

M E M O R A N D U M

TO: Dr. Tarek Khalil, Dean of The Graduate School

FROM: Robert W. Rubin, Vice Provost and Deputy Dean RWR

SUBJ: Medical Informatics Program

DATE: 3-2-95

This is to confirm that the School of Medicine is committed to the hard dollar costs for the new Medical Informatics program budget (enclosed). These are the responsibility of the Department of Radiology. The hard dollar amount is $105,000/yr. The other expenses listed ($191,165/yr.) represent cost shared salaries which have been agreed to by the respective administrators. The revenue figures quoted are of course estimates but appear reasonable. There will be a complicated split of revenues between the Department of Radiology and the College of Engineering which will be negotiated after we have some experience with the student mix. From an institutional standpoint I am prepared to live with the figures presented in the enclosed proposed 5 yr. budget. Thank you.

Administrative Offices
Suite 1148
(305) 547-5706
Fax: (305) 547-3549

Graduate Studies
Suite 1070
(305) 547-6406
Fax: (305) 547-3593

Research Administration
Suite 1149
(305) 547-6232
Fax: (305) 548-4611

FIVE YEAR PROFORMA: GRADUATE PROGRAM IN MEDICAL INFORMATICS
Department of Radiology
University of Miami School of Medicine

DRAFT

First year expenses:

Program Faculty	FTE Base salary	Rate	Program Cost	Funded Cost
Kabuka, Mansur	75,690	25%	18,923	0
Clark, Ronald	59,911	25%	14,978	14,978
Goodman, Mark	75,000	15%	11,250	11,250
Mathews, George	41,000	15%	6,150	0
Pattany, Fred	89,280	15%	13,392	0
Sauer, Frank	38,000	15%	5,700	0
Stitt, Frank	130,000	15%	19,500	19,500
Waly, Sherif	35,000	15%	5,250	0
Younis, Akmal	50,000	15%	7,500	0
Non-clin faculty CFB @		26.80%	27,508	12,255
Administrator	22,000	50%	11,000	0
Staff CFB @		27.25%	2,998	0
Fellowships: 3	9,000		27,000	27,000
Brochure			6,000	6,000
Clerical; misc. supplies			2,017	2,017
Incremental space			0	0
Instruction materials			3,000	3,000
Recruitment			6,000	6,000
Contingency			3,000	3,000
			191,165	105,000
FIVE YEARS EXPENSE (without annual increase)			955,824	524,999

REVENUE (also without annual increase)

Yr 1:	10 students; 3 on fellowship =	7	14,000	98,000
Yr 2:	10 incremental students =	17	14,000	238,000
Yr 3:	15 incremental students (1) =	22	14,000	308,000
Yr 4:	20 incremental students (2)=	32	14,000	448,000
Yr 5:	Status quo =	32	14,000	448,000
				1,540,000

(1) 10 students graduated; total students enrolled = 25 students; 3 of which are on fellowship
(2) 35 total students enrolled; 3 of which on fellowship

UNIVERSITY OF Miami

MEMORANDUM

DATE: March 7, 1995

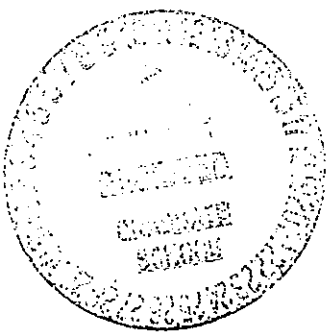
TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Dr. M. Lewis Temares

RE: Proposal for the Establishment of a M.S. Program in Medical Informatics

The College of Engineering and its Dean fully endorse and support the joint program with the School of Medicine to establish a M.S. Program in Medical Informatics.

MLT:fc



College of Engineering
Office of the Dean
P.O. Box 248294
Coral Gables, Florida 33124-0620
305-284-2404
Fax: 305-284-3815

MEDICAL INFORMATICS M.S. PROPOSAL REPORT

Subcommittee members:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, Meteorology and Physical Oceanography
Dr. E. Saltzman, Marine and Atmospheric Chemistry
Dr. D. Sarkar, Mathematics

The Graduate School's Physical Sciences Committee met with Vice Provost Robert Rubin and Dr. Mansur Kabuka from the Department of Radiology on April 3, 1995 to discuss the proposed Interdepartmental Program leading to an M.S. degree in Medical Informatics. The exchange centered around the proposal for the program put together by the department. Overall, the committee found that the plans for the program were well laid out and that the medical school has a strong commitment to the financial support of this program. The curriculum makes wide use of existing courses and blends the talents of the Engineering School and the Radiology Department in a creative manner.

Comparison of the program's offering with similar programs at other universities were provided in the report. The balance between computer oriented training, data base courses, and introduction to medical sciences mirrors these other programs. Concern was expressed over the requirement of 36 thesis track hours and 39 non-thesis hours in the program. The committee was especially concerned over the extra six to nine hours being a disincentive for students coming up through biomedical engineering or the proposed joint B.S. in Computer Engineering and M.S. in Medical Informatics Program. A suggestion was made to require a "minimum" of 30 hours plus additional course work in the various core areas. This would allow students with prior backgrounds in the core course areas to complete the curriculum while making use of their prior training. A short discussion was also held on future growth in the program. The need for care in tuning courses in this rapidly growing field was acknowledged. It was pointed out that the program may wish to expand to Ph.D. offerings within a three to five year time frame. Dr. Rubin brought up the issue that this program might produce more of a professional degree serving the medical community with M.S. practitioners rather than necessarily growing into a specialty academic field at the Ph.D. level. The committee encouraged the department to return to Council with a short report on the development of the program within two years and looks forward to hearing plans for the longer term goals of this effort.

In summary, the committee enthusiastically supports the new program and wishes it luck in fulfilling its goals over the next few years.

April 12, 1995

UNIVERSITY OF Miami

M E M O R A N D U M

March 22, 1995

TO: *Subcommittee on Programs and Degrees*
Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: *Tarek M. Khalil Dean*
The Graduate School

SUBJECT: *Medical Informatics M.S. Program*

A meeting has been scheduled for Monday, April 3 at 9:00 a.m. in the Ferre Building Conference Room 3rd. floor to discuss the establishment of an Interdepartmental M.S. Program in Medical Informatics.

Thank you for your participation.

TMK:nb

Copy to: Dr. John W. Brown

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax 305-284-5441

UNIVERSITY OF Miami

MEMORANDUM

March 2, 1995

TO: Subcommittee on Programs & Degrees Group III:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, MPO
Dr. E. Saltzman, MAC
Dr. D. Sarkar, Mathematics

FROM: Dr. Tarek M. Khalil, Dean
The Graduate School

SUBJECT: Medical Informatics M.S. Program

I am enclosing, for your information, a copy of a proposal for the establishment of an Interdepartmental M.S. Program in Medical Informatics.

A meeting will be scheduled soon to discuss this proposal.

TMK:nb

Enclosure

Graduate School
P.O. Box 248125
Coral Gables, Florida 33124-2220
305-284-4154
Fax 305-284-5441

5-YEAR PROFORMA: MEDICAL INFORMATICS M.S. PROGRAM

FIRST YEAR EXPENSES

Program Faculty	% Effort
Mansur Kabuka (Director)	25%
Frank Stitt	15%
Kenneth Goodman	15%
Ron Clarke (Assoc. Director)	25%
Pradip Pattany	15%
George Mathews	15%
Akmal Younis	15%
Frank Sauer	15%
Sherif Waly	15%
Administrator	100%
3 fellowships	
Subtotal	**$180K**
Brochure	6K
Recruitment costs	6K
Instruction materials	8K
Supplies/miscellaneous	5K
Contingency	3K
Subtotal	**$28K**
Contingency	3K
FIRST YEAR TOTAL	**$208k**
TOTAL 5 YEAR COSTS	**$1,040,000**

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: President Edward T. Foote II

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 12, 1996

SUBJECT: Faculty Senate Legislation #95008(B) -
Establishment of the M.S. Degree in Medical Informatics

The Faculty Senate, at its meeting of April 1, 1996, voted to approve the M.S. Degree in Medical Informatics (FS #95008(B). The text of the legislation is attached for your review.

This legislation is forwarded to you for your action.

4/30/96

Kamal,
I approve.
Thanks.

KY\b

Attachment

cc: Provost Luis Glaser
Dean Tarek Khalil, Graduate School
Dean John Clarkson, School of Medicine
Dean Lewis Temares, College of Engineering
Professor Mansur Kabuka, Engineering and Radiology

325 Ashe-Admin. Bldg.
Coral Gables, Florida 33124-4634
305-284-3721
Fax 305-284-5515

CAPSULE: Faculty Senate Legislation #95008(B) - Establishment of the M.S. Degree in Medical Informatics

RESPONSE BY THE PRESIDENT: DATE: 4/30/96

APPROVED: [signature]

OFFICE OR INDIVIDUAL TO IMPLEMENT OR PUBLISH: [signature]

EFFECTIVE DATE OF LEGISLATION: _____

NOT APPROVED AND REFERRED TO: _____

REMARKS (IF NOT APPROVED): _____

_____

_____

_____

Report to the Faculty Senate on a Proposal for a M.S. Program in Medical Informatics

From: Ad hoc committee on Medical Informatics
Ozcan Ozdamar, Ph.D., Dept. Biomedical Engineering, Chairperso
Mark O'Connell, M.D., Dept. Medicine
Dilip Sarkar, Ph.D., Dept. Mathematics and Computer Science

Date: February 14, 1996

We strongly endorse the development of a post-graduate degree program in medical informatics at the University of Miami and we unanimously recommend the faculty senate approve the proposed program with the following changes. We feel these changes would strengthen the program and help ensure its success in coming years.

1. The program described on page 14 of the proposal is composed of professors from the departments of electrical and computer engineering, radiology and administrative representatives (dean or designee, ex-officio). As rightfully stated in the proposal, medical informatics is a broad field with an interdisciplinary character and the program committee should reflect this nature. We recommend that representatives from the departments of biomedical engineering, computer science, biostatistics, and clinical departments at the medical school also be included in the program committee.

2. The expanded program committee must meet at least once every semester to review the status of the program and the students in the program.

3. The educational plan for those required core courses not yet in existence must be defined. This effort would greatly benefit from the expanded multidepartmental representation suggested for the program committee.

   We also recognize that the proposed curriculum can be further strengthened by inclusion of relevant courses offered in other departments such as biomedical engineering, computer science, and

biostatistics. We recommend that the expanded program committee closely examine the curriculum and make necessary revisions to include additional relevant courses. Such changes will not only make the program stronger but will increase the efficiency of the university by eliminating redundant courses and increasing enrollment in existing ones.

4. The program should develop a mechanism for quality assessment and improvement. A thorough review of the program's strengths and weaknesses should be completed at the end of each of the first 2 years and provided to the faculty senate.

5. Enrolled students should be provided with comprehensive and aggressive career counseling and develop placement services to ensure their successful progress after graduation. This will obviously enhance the attractiveness of the program for future enrollees.

ADDENDUM
TO THE
PROPOSAL FOR A
MASTER OF SCIENCE DEGREE IN
MEDICAL INFORMATICS

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiology.
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineering
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineering
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

Faculty members from the following departments or schools as appointed by their respective deans:

- Biomedical Engineering
- Computer Science (Department of Mathematics and Computer Science)
- Business
- Medicine (Clinical Departments outside Department of Radiology)

The program Committee will be responsible for academic aspects of the program such as curriculum, admissi standards, approval for graduation and, student petitions. The committee will be chaired by the Program Dire who will be responsible for administration of the program.

UNIVERSITY OF
Miami

MEMORANDUM

DATE: October 4, 1995

TO: Dr. Tarek M. Khalil, Dean, Graduate School

FROM: Bernard J. Fogel, M.D., Dean, School of Medicine
and
Dr. M. Lewis Temares, Dean, College of Engineering

RE: Proposal for a Master of Science Degree in Medical Informatics

---

Attached is a proposal for an interdisciplinary Master of Science Degree in Medical Informatics between the Department of Radiology, and the Department of Electrical and Computer Engineering, College of Engineering. This proposal was approved unanimously by the faculty of the Department of Radiology on August 29, 1995, and by the faculty of the College of Engineering and the Council of the School of Medicine on September 27, 1995.

We endorse this proposal, including the proposed annual budget of approximately $105,000. Please initiate the process of getting this proposal approved. We would like to promote this program as soon as possible and have it included in the AY96 University Bulletin.

The program will be administered by the Department of Radiology at the School of Medicine, chaired by Robert M. Quencer, M.D., and by Dr. Mansur Kabuka, Director and Administrator of the program, with an advisory committee of the two deans and two faculty from each school/college. Please contact either Dean Fogel or Dean Temares with any questions on this proposed degree program.

Thank you in advance for your efforts on our behalf.

Attachment
cc: Dr. Luis Glaser
Dr. Samuel S. Lee
Dr. Thomas D. Waite
Dr. Tzay Y. Young
Dr. Mansur Kabuka
Robert M. Quencer, M.D.

Senior Vice President for Medical Affairs and Dean
P.O. Box 016099
Miami, Florida 33101
305-243-6545 Fax 305-243-4888

MEDICAL INFORMATICS M.S. PROPOSAL REPORT

Subcommittee members:

Dr. A. Namini, Civil Engineering
Dr. D. Olson, Meteorology and Physical Oceanography
Dr. E. Saltzman, Marine and Atmospheric Chemistry
Dr. D. Sarkar, Mathematics

The Graduate School's Physical Sciences Committee met with Vice Provost Robert Rubin and Dr. Mansur Kabuka from the Department of Radiology on April 3, 1995 to discuss the proposed Interdepartmental Program leading to an M.S. degree in Medical Informatics. The exchange centered around the proposal for the program put together by the department. Overall, the committee found that the plans for the program were well laid out and that the medical school has a strong commitment to the financial support of this program. The curriculum makes wide use of existing courses and blends the talents of the Engineering School and the Radiology Department in a creative manner.

Comparison of the program's offering with similar programs at other universities were provided in the report. The balance between computer oriented training, data base courses, and introduction to medical sciences mirrors these other programs. Concern was expressed over the requirement of 36 thesis track hours and 39 non-thesis hours in the program. The committee was especially concerned over the extra six to nine hours being a disincentive for students coming up through biomedical engineering or the proposed joint B.S. in Computer Engineering and M.S. in Medical Informatics Program. A suggestion was made to require a "minimum" of 30 hours plus additional course work in the various core areas. This would allow students with prior backgrounds in the core course areas to complete the curriculum while making use of their prior training. A short discussion was also held on future growth in the program. The need for care in tuning courses in this rapidly growing field was acknowledged. It was pointed out that the program may wish to expand to Ph.D. offerings within a three to five year time frame. Dr. Rubin brought up the issue that this program might produce more of a professional degree serving the medical community with M.S. practitioners rather than necessarily growing into a specialty academic field at the Ph.D. level. The committee encouraged the department to return to Council with a short report on the development of the program within two years and looks forward to hearing plans for the longer term goals of this effort.

In summary, the committee enthusiastically supports the new program and wishes it luck in fulfilling its goals over the next few years.

April 12, 1995

Proposal for a Master of Science Degree in Medical Informatics

Department of Radiology
School of Medicine

Department of Electrical
and Computer Engineering
College of Engineering

Hosted by

Department of Radiology

School of Medicine

1. RATIONALE

The rapidly growing knowledge base in the medical field is vast and encompasses both scientific knowledge and the day–to–day business of providing healthcare. To understand the medical user's complex needs, information scientists need formal training in the healthcare environment to implement complicated information science techniques. It is crucial to identify the processes in healthcare which could benefit most from information technology because a broad brush approach could be costly and inhibit progress. Recently, **the Association of American Medical Colleges formed the Steering Committee** to evaluate the status of medical informatics in the United States. The Steering Committee on the Evaluation of Medical Information Science in Medical Education concluded that medical informatics is basic to the understanding and practice of modern medicine. One recommendation of this committee indicates that medical informatics should become an integral part of the medical curriculum.

The World Health Organization report on "Informatics and Telematics in Health" stresses that managerial decision–making in healthcare requires accurate, reliable, relevant, and timely information. It further notes that the health worker of the year 2000 is likely to be a person with immediate access to a large amount of data along with analytical decision support routines to assist in decision making. These needs will require advanced research and development in the areas of database, statistical data analysis, data storage, validation, retrieval, presentation, distribution, decision support systems, knowledge–bases, artificial intelligence and neural networks. Multidisciplinary expertise is required to achieve the essential level of knowledge in these areas.

This proposal develops the offering of a M.S. degree in Medical Informatics. It is in the best interests of the University, the community of the southeast region, and the students that a M.S. degree in medical informatics be established.

The program is designed to prepare individuals to develop, use, and evaluate applications of information technology in the health care environment. The program also stresses the methods used to study the effectiveness of information technology applications.

What is Medical Informatics?

Medical Informatics is the scientific field that deals with medical information, data, and knowledge. It deals with the concepts and principles of acquiring, processing, and presenting information to support medical practice, problem solving and decision making in the healthcare industry. Medical Informatics touches on all basic and applied fields in medical science and is closely related to modern information technologies including computing and communication. Medical informatics has emerged as a new discipline due to a number of factors, including advances in computing and communications technology, an increasing awareness that the medical knowledge base is unmanageable by traditional methods, and a growing conviction that knowledge retrieval and expert decision making are important to modern medicine. Modern technologies enable the capture and organization of medical user requirements. Challenges in developing and using these technologies in healthcare include developing enterprise integration tools to translate information, helping users determine what information they need, and facilitating information flow across the healthcare enterprise. Also, using technology requires developing business modeling techniques to define and analyze the relationships among the different processes in providing healthcare.

Knowledge of computers is a major element of the medical informatics. However, effective research and development in this area also requires practical knowledge and fundamental research in cognitive science, clinical medicine, basic medical sciences, biostatistics, epidemiology, hospital organization, hospital financing and reimbursement, management and decision sciences, and medical ethics. In such an interdisciplinary field, students must be exposed to these diverse topics.

Medical informatics spans a wide range of activities that includes, but is not limited to:

(1) basic research and exploratory experiments
(2) applied research and evaluation of approaches
(3) technological development for specific user needs
(4) deployment of practical applications
(5) planning and policy development for using information technology in health care and medical education

Medical Informatics Education

A recent study by Gassert et al (1991)* indicated the increased demand for graduate level education in medical informatics. The results of a survey of accredited hospitals of 300 beds or more in 19 states demonstrated that all institutions use computer technology in healthcare practice and/or administration. Almost three–fourths of the hospitals already allocate one or more budgeted positions for managers of information systems. An additional 50% of the respondents foresaw a need for such positions in their institutions within two years. Virtually all respondents saw some need for a graduate program.

Currently, the number of graduate medical informatics programs (M.S. and Ph.D.) nation wide is limited. Although academic units of medical informatics are established at only a few institutions in the United States, an increasing number of schools is considering this activity.

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* Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC.

The following is a partial list of the medical informatics programs available in the United States:

1. Columbia University: Post–Doctoral training program in Medical Informatics

2. Duke University/University of North Carolina: MS, PhD, and Post Doctoral programs in Medical Informatics

3. Harvard University/Massachusetts Institute of Technology/New England Medical Center: MS, PhD, and Post–Doctoral program in Medical Informatics

4. Stanford University: MS, PhD, and Post–Doctoral program in Medical Information Science

5. University of Missouri: MS in Library and Information Science, PhD in Medical Informatics, Post–Doctoral program in Medical Informatics, and short term (3–6 months) training for medical and veterinary students

The proposed program within the University of Miami would provide individuals with the skills and expertise needed for applying the concepts and knowledge of medical informatics in healthcare and academic medical research, development, and education. The proposed program will offer degrees to individuals with career commitments to applying computer engineering and related disciplines to the field of medicine. The University of Miami is well poised to offer new programs in Medical Informatics at the graduate level. This program will have a strong core curriculum in computer engineering, as well as concentrations in biological and physical sciences. The strengths of the Medical School in these areas will differentiate the University of Miami from other regional universities such as Florida International University and Florida Atlantic University. This will provide a significant leverage in attracting quality students to the program. In addition, the program will have the unique opportunity to draw upon the resources of the Medical School to offer significant exposure to research and applications in medicine. **In addition, currently no graduate programs in medical informatics exist in Florida, while only a few exist in the nation. The university will have a tremendous edge for attracting students by being the first to offer such a program in the state, as well as the advantage of being closely associated with a renowned medical school.**

Rationale for Success

The ability to introduce a new program in medical informatics successfully arises from the following factors:

(1) As mentioned earlier, no universities in Florida, and only a few in the nation, offer graduate programs in medical informatics.

(2) Industry partners involved with current research and development work are interested in establishing co–op programs in the new program areas.

(3) State–of–the–art laboratories exist at the University, both at the School of Medicine and on the Coral Gables campus, and are great incentives for attracting students.

(4) Existing courses, as well as courses under development, can be used as part of the curriculum. This presents a tremendous recruiting tool for attracting students interested in medical careers.

(5) The new program will promote interdisciplinary research by providing a natural environment for interaction between faculty from various departments.

1.a Exact Title of Degree

Master of Science Degree in Medical Informatics

1.b Purpose and Goals of Degree

The purpose of the degree is to prepare qualified candidates to serve the needs of the healthcare industry, academic, research and government institutions. The program is designed to provide students with the skills and knowledge required to deal with basic and applied research and development, and the deployment of innovative technologies in the medical fields. In addition, the program will allow students to pursue their medical education and is designed to accommodate the premedical curricula and medical school admission requirements.

1.c Assessment of Demand and Job Market

The expanding applications of computing techniques into medical environments requires well–trained individuals to design, develop, select, and manage the medical–computing system. Modern developments in healthcare and computer industries dictate the need for skilled personnel to design research programs and carry out the experimental and developmental activities in both industries.

Many computer companies (for example Hewlett–Packard, the world's largest medical equipment maker) have established healthcare groups. According to National Institute of Standards and Technology (NIST), Arnst et al (1994)* estimated that the market of healthcare information systems would reach $13 billion by the year 1998.

The Department of Health and Human Services estimates that a nationwide electronic healthcare information network could provide a savings expected to exceed $100 billion over the next eight years. According to the NIST (1994), healthcare is the fastest growing market in the computer field. It is estimated that hospitals will spend $6.7 billion a year on information systems in 1996, a 36.7% increase over 1993.**

The success of developing these services requires interdisciplinary research and development projects in both healthcare settings and computer industry and demands leaders who can effectively bridge the two fields. The demand for such professionals, with proper training in Medical Informatics, has escalated in recent years in both healthcare and advanced technology industries.

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* Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104–106.

** National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

As mentioned earlier, the survey conducted by Gassert et al (1991) indicated the increased demand for graduate level education in medical informatics. According to Greenes and Shortliffe (1990)* , researchers with formal training in medical informatics are a rare breed. The need for programs that combine medical informatics training with curricula that encompass multidisciplinary areas of expertise, is recognized by many institutions. The increased awareness of the importance of this field of study has been motivated by the efforts of the National Library of Medicine to support these programs. Greenes and Shortliffe indicate that the demand for medical informatics specialists surpasses the supply of skilled professionals.

The proposed program will provide graduates the opportunity to join research facilities in the area of medical information systems. Also, it will enable students to pursue medical education degrees after graduation.

1.d Relationship to Other Cognate Fields

This new program will complement existing biomedical engineering and biomedical activities at the university by expanding its application from biomedical devices to medical information sciences. In addition, graduates will have the opportunity to work as engineers and scientists in medically related fields, or in medical informatics careers. The program also will service the needs of the medical school for candidates who are proficient in computer engineering and science, as these skills become increasingly important for using sophisticated medical equipment and medical computer systems.

* Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority", JAMA, February 1990, Vol 263, No 8.

2. PHYSICAL RESOURCES

2.a Library Holdings

The Otto G. Richter Library and the Medical School Library have a very large collection of materials that are very useful for the programs in medical informatics. Since the medical informatics area are interdisciplinary in nature, the subjects covered are common with several other departments which expand the library holdings and budget allocation by subject area.

A partial listing of journals and periodicals available in medical informatics and related disciplines are given below. No additional journals are needed at this time.

Academic and Library Computing
Acronyms Administration
Advanced Technology Libraries
Advances in Bioengineering
Advances in Biomedical Engineering
AIweek
American Documentation
American Journal of Medical Electronics
AMIA News : Newsletter of the American Medical Informatics Association
Annual Review of Biophysics
Annual Review of Information Science
Applied Artificial Intelligence
ASAIO Journal
ASAIO Transactions
Audiovisual Instruction with/Instructional Resources
Biodegradation
Biomedical Communications
Biomaterials, Artificial Cells
BIOSIS
Biomaterials, Medical Devices
Biomedical Engineering
Biomedical Instrumentation
Biotechnology
Biotechnology and Bioengineering
Biotechnology Letters
Bulletin of Prosthetics Research
Byte
Campus–wide Information Systems
Chemical Journals Online Bulletin
Clinical Physics
Computers and Biomedical Research
Computers and Medicine
Computers in Biology and Medicine
Computers in Libraries
Computers in Eyecare Ophthalmology
Electronic Library

Eyecare Technology Ophthalmology
Human Factors
IEEE Engineering in Medicine and Biology
IEEE Transactions on Biomedical Electronics
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Systems, Man, and Cybernetics
IEEE Transactions on Medical Imaging
Information, News, Sources
Information Retrieval & Library
Interactive Healthcare Newsletter
International Journal of Bio–medical Engineering
IRE Transactions on Medical Electronics
ISI Online News
ISA Journal
Issues in Science and Technology
Journal of the American Medical Association
Journal of Biocommunication
Journal of Biomechanics
Journal of Biomedical Materials
Journal of Cardiovascular Diagnosis
Journal of Cardiovascular Techniques
Journal of Documentation
Journal of Clinical Engineering
Journal of Fermentation Technology
Journal of Medical Engineering
Journal of Rehabilitation Research
Journal of Rehabilitation Research and Development (clinical supplement)
Library Network/MEDLARS
M.D. Computing
MacUser
Medical & Biological Engineering
Medical Instrumentation
Medical Research Engineering
MEDLARS/Network Technical Bulletin
MedLink Archives
Methods of Information in Medicine
Modern Trends in Biomechanics
NLM Technical Bulletin
Online Libraries and Microcomputer
Physicians Video Guide
Physiological Measurement
PsycInfo News
Weekly Government Abstracts. Bi Reference
Trends in Biotechnology

2.b Laboratory Facilities

Image Processing and Multimedia Laboratory

The Image Processing and Multimedia Laboratory provide the ultimate environment for both research and development in the fields of image processing, scientific visualization, and multimedia applications. The hardware offered by the lab consists of numerous Sun SPARC 10 end user graphical workstations, PC's, a Sun 690 file server, a Sun SPARC 1000 file server and various peripherals, such as color printers, postscript printers, slide maker, optical disk jukeboxes for massive storage, etc., all connected to a high speed FDDI network. Most of the end user workstations are equipped with microphones and video cameras for use with multimedia applications. Software tools used in the laboratory include: Khoros, AVS, Ptech, Ontos, MathLab, and various software libraries to support the research and development of algorithms in image processing, visualization, video editing, multimedia, and advanced networking like ATM and ISDN, necessary to support distributed multimedia applications.

Medical Informatics Laboratory

The Medical Informatics Laboratory (MIL) provides the client/server computing foundation required to support the medical information and imaging functions for the Center for Medical Imaging and Medical Informatics (CMIAMI). MIL is composed of several Sun SPARC 1000 servers with multiprocessor capabilities, four to eight processors, and 150 GB of fiber channel attached hard disk drives. The servers are intended to provide heavy computing services for both teaching and research applications. In addition, these servers allow the access of medical images for analysis and diagnosis purposes as well as supporting database servers for the development of medical information system applications. The MIL contains several Sun SPARC 5 and SPARC 20 workstations with multi–monitor support (1,2,4, or 8 monitors). These workstations play the client role in the computing environment of the MIL. They function as the gateway for accessing the 2D & 3D imaging capabilities and the medical information system for both research and development purposes.

Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy Laboratory

The Magnetic Resonance Imaging (MRI) and Magnetic Resonance Spectroscopy (MRS) Laboratory located at the MRI building houses three whole body MRI systems, 1.0T HPQ and 1.5T HPQ clinical scanners, a 1.5T Edge Research Scanner to be used for basic MR research and advanced clinical research.

Computed Tomography, X–Rays, and Ultrasound Laboratory

The Computed Tomography, X–Rays, and Ultrasound Laboratory has 5 CT scanners, 6 fluoro–machines, 3 vascular laboratories, 1 neuro–suite and 8 c–arms, in addition to a large number of mammographic general–purpose and mobile x–ray machines.

Nuclear Medicine Laboratory

The Nuclear Medicine Laboratory of the University of Miami School of Medicine/Jackson Memorial Medical Center is equipped with one triple head SPECT camera, 2 dual head SPECT cameras, 2 single head SPECT camera, 7 stationary camera and 2 mobile systems. All cameras are networked. Also available are counting devices and a radio–pharmacological preparation laboratory.

Other Laboratories

Software Engineering Laboratory
Digital Signal Processing Laboratory
Computer Aided Engineering Laboratory
Microprocessor Laboratory
Electronics and Measurement Laboratory
Telecommunication and Networking Laboratory
Other Laboratories on Coral Gables Campus

3. CURRICULUM

The proposed program curriculum is designed to reflect the broad, interdisciplinary field of medical informatics. This program is offered by the School of Medicine in conjunction with the College of Engineering. It stresses both the basic sciences of medical informatics and the practical knowledge necessary to design and implement computer applications and modern information technology in the medical field.

The program offers both a 30 credit hour thesis option (including 6 credits thesis work), as well as a 36 credit hour non–thesis option. The program consists of a core of four courses (listed below) and two groups of courses A and B (also listed below). Each student must take the four core courses as well as two courses from Group A and two courses from Group B. All pre–requisites for all courses must be satisfied (see Graduate Bulletin). In addition, students selecting the thesis option must complete 6 credits of thesis work. Students selecting the non–thesis option must complete an additional four courses selected from Group A and/or Group B and/or the group of courses listed under elective courses.

Students lacking the appropriate computer background need to makeup for this deficiency by taking the appropriate courses from the courses listed under deficiency courses. Students who had any of the courses as part of their undergraduate program should make appropriate substitution to meet the credit requirements.

Required courses: (all students, thesis/non–thesis)

RAD 604 Medical Informatics
RAD 608 Computer–Based Medical Records
EEN 592 Medical Imaging / RAD 510 Medical Imaging
EPH 502 Biostatistics II or EPH 6xx Clinical Research

Group A (6 credits minimum)

EEN 512 Object–Oriented Software Engineering
EEN 523 Principles of Database Systems (Project: Database Management of Medical Applications)
EEN 537 Principles of Artificial Intelligence (Project: Artificial Intelligence in Medicine)
EEN 547 Expert Systems
EEN 621 Object–Oriented Database Systems
EEN 534 Computer Communications Networks

Group B (6 credits minimum)

BME 501 Unified Medical Science I
BME 502 Unified Medical Science II
PHS 512 Systemic Physiology
CBA 505 Neuroanatomy
RAD 505 Anatomy and Physiology: Diagnostic Imaging Prospective
BMB 506 Fundamentals of Biochemistry and Molecular Biology
BMB 508 Biochemistry and Molecular Biology Lab
BMB 509 Molecular Biology of the Gene I
MIC 501 Medical Microbiology
MIC 524 Microbial and Molecular Genetics
MIC 612 Pathobiology I

Deficiency Requirements

EEN 118 Introduction to C and Software Engineering
EEN 317 Engineering Data Structures in C++

Elective Courses (including but not limited to):

RAD 500 Diagnostic Physics
RAD 501 Nuclear Medicine Imaging
RAD 601 MR Imaging / MR Spectroscopy
RAD 602 CT Imaging / X–Rays / Ultrasound
RAD 651 Special Problems in Medical Informatics
EEN 538 Introduction to Digital Image Processing
EEN 548 Machine Learning
EEN 591 High–Speed Networking
EEN 597 Neural Networks
EEN 653 Pattern Recognition
EEN 656 Information Theory
BME 511 Clinical Engineering
BME 580 Biomedical Instrumentation
BME 622 Biomedical Signal Processing
MTH 529 Computer Graphics

Admission

Admission of a student to the University of Miami for any semester does not imply that such student will be re–enrolled in any succeeding academic semesters. All those wishing to take courses for graduate credit, whether or not they wish to become candidates for the degree, must submit an application for admission directly to the program director at:

University of Miami,
Department of Radiology
1150 N.W. 14th Street, Suite 301
Miami, Fl., 33136

This graduate program is open to persons with a background in computer science, chemistry, physical science, biology, mathematics, or engineering

The applicant's file includes:

(1) Completed application form
(2) Official transcript of all college work previously taken
(3) Official score report of the Graduate Record Examination (GRE) taken within five years
(4) Three letters of recommendation sent directly to the department
(5) Official score report of the Test of English as a Foreign Language (TOEFL) for any international applicant whose native language is not English
(6) Application fee of $35.00

Fellowships, tuition scholarship, and assistantships in research or instruction are available for qualified students.

4. PROGRAM COMMITTEE

Mansur R. Kabuka (Program Director)	Professor of Electrical & Computer Engineering and Radiology.
John Collins, Ph.D.	Assistant Professor, Dept. of Electrical & Computer Engineering.
Christos Douligeris, Ph.D.	Associate Professor, Dept. of Electrical & Computer Engineering.
Brian C. Bowen, M.D. Ph.D.	Assistant Professor, Dept. of Radiology.
Pradip M. Pattany, Ph.D.	Research Assistant Professor, Dept. of Radiology.
Dean or designee, ex officio	School of Medicine
Dean or designee, ex officio	College of Engineering

The program Committee will be responsible for academic aspects of the program such as curriculum, admission standards, approval for graduation and, student petitions. The committee will be chaired by the Program Director who will be responsible for administration of the program.

5. BIBLIOGRAPHY

Arnst, C., and Zellner, W., "Hospitals attack a crippler: paper," Business Week, 21 February 1994, pp 104–106.

Association of American Medical Colleges,. "Medical Education in the Information Age," Proceedings of a Symposium on Medical Informatics, Washington D.C., 1986.

Gassert, C.A., Mills, M.E., and Heller, B.R., "Doctoral Specialization in Nursing Informatics," Proceedings of the fifth annual symposium on computer applications in medical care, American Medical Informatics Association, November, 1991, Washington, DC

Greenes, R.A., and Shortliffe, E.H., "Medical Informatics: An Emerging Academic Discipline and Institutional Priority," JAMA, February 1990, Vol 263, No 8.

National Institute of Standards and Technology "Information Infrastructure for Healthcare," Department of Commerce, Technology Administration, May 1994.

World Health Organization, "Informatics and Telematics in Health: Present and Potential Uses," Geneva, 1988.

FIVE-YEAR PROFORMA: GRADUATE PROGRAM IN MEDICAL INFORMATICS
UNIVERSITY OF MIAMI SCHOOL OF MEDICINE

25-Sep-95

First year expenses/Department of Radiology:

Program Faculty	Base salary	Effort	Program Cost	Program Incremental Cost
Kabuka, Mansur; Director		25%		0
Bowen, Brian		10%		0
Fishman, Joel		10%		0
Georgiou, Michalakis		10%		0
Goodman, Kenneth		20%		7,267
Hussain, Basit		15%		0
John, Nigel		15%		0
Pattany, Fred		15%		0
TBA-teaching		15%		7,500
TBA-teaching		15%		7,500
Younis, Akmal		15%		0
Non-clinical faculty CFB @		26.80%		5,968
Sub-total			138,477	28,235
Administrator	28,000	100%	28,000	28,000
Staff CFB @		27.25%	7,630	7,630
Fellowships: 2	9,000		18,000	18,000
Brochure			6,000	6,000
Clerical, misc. supplies			2,000	5,000
Instruction materials			3,135	3,135
Recruitment			6,000	6,000
Contingency			3,000	3,000
Radiology Sub-total			212,242	105,000

First year expenses/Department of Electrical and Computer Engineering:

Kabuka, Mansur		25%		0
Collins, John		25%		0
Douligeris, Christos		25%		0
TBA		25%		0
		1.0 FTE	64,000	0
Non-clinical faculty CFB @		26.80%	17,152	0
Electrical and Computer Engineering Sub-total			81,152	0

FIVE YEARS EXPENSE (without annual increase) 525,000

REVENUE (also without annual increase)

Yr 1:	10 students; 2 on fellowship =	8	16,000	112,000
Yr 2:	10 incremental students =	18	16,000	288,000
Yr 3:	15 incremental students (1) =	23	16,000	368,000
Yr 4:	20 incremental students (2)=	33	16,000	528,000
Yr 5:	Status quo =	33	16,000	528,000
				1,824,000

(1) 10 students graduated; total students enrolled = 25 students; 2 of which are on fellowship
(2) 35 total students enrolled; 2 of which on fellowship

PLEASE NOTE

The original proposal included resumes for the following U. M. faculty members

Dr. Mansur R. Kabuka; Professor of Computer Engineering and Radiology

Dr. Brian Charles Bowen; Assistant Professor of Radiology

Dr. Pradip M. Pattany; Research Assistant Professor of Radiology

Dr. George N. Sfakinakis; Professor of Radiology

Dr. Christos Douligeris; Associate Professor of Electrical and Computer Engineering

Dr. John Collins; Assistant Professor of Computer Engineering

The full proposal included these resumes and other correspondence forwarded to the members of the ad hoc Committee appointed by the Faculty Senate Chair to review the proposal and send recommendations to the Senate (see first two pages)

The full proposal will be at hand during the Senate meeting

RAD 604

Medical Informatics

Course Description

Computer applications in health care, hospital information, information management, radiology, patient monitoring, decision support, pharmacy, and laboratory information. Hardware and software issues, security, and standards. Ethical and social issues in medical informatics.

Textbook

Edward Shortliffe and Leslie Perreault, Medical Informatics, Addison-Wesley, 1990.

Topics

1. Medical Informatics
2. Medical Data: Its acquisition, storage, and use
3. Clinical decision-support
4. Essential concepts for medical computing
5. Patient monitoring
6. Hardware and software
7. Medical Information Systems:
   - Hospital information systems
   - Laboratory information systems
   - Pharmacy systems
   - Radiology systems
   - Clinical decision support systems
   - Medical record systems
   - Health assessment systems
8. Standards
   - Health Level Seven (HL7)
   - Digital Imaging and Communication in Medicine (DICOM)
   - International Classification of Diseases (ICD-9-CM)
   - Common Object Request Broker Architecture (CORBA)
9. Security and privacy
10. Ethical and social issues in medical informatics

RAD 608

Computer-Based Medical Records

Course Description

Survey of existing Computerized Patient Record (CPR) systems. Requirements and procedures for CPR development and implementation. Technological building blocks for CPR systems. Legal aspects of computer-based patient records and record systems.

References

1. Richard Dick and Elaine Steen, The Computer-Based Patient Record, National Academy Press, 1992.
2. Computer-Based Medical Systems, Proceedings of the IEEE Symposium, 1993-1996.

Topics

1. The patient record
2. Strengths and weaknesses of paper patient records
3. The computer-based patient record technology
4. Clinical assessment
5. Software issues and software quality
6. CPR development and implementation
7. Integration of clinical data
8. Legal aspects of CPR

Approval of the Minutes

The minutes were corrected by substituting "...transcripts show that the degree was formerly awarded by the College of Arts and Sciences" in the fourth line of page 3. The minutes were approved as corrected. Excused absences were approved for Professors Brown, Criss, Fishman, Lopez-Gottardi, Peterson, Savage, Swain, Varona and Whelan.

M.S. Program in Medical Informatics (Second Reading)

The Chair reviewed the background of the proposal for the M.S. in Medical Informatics and the two additional requirements set by the Senate. Information on the enlarged oversight committee and the two new core courses was included with the agenda. It was *moved* and seconded to approve the program. The *motion carried.*

Following the vote, there was discussion regarding the evaluation of new graduate programs. It was *moved* and seconded to have the Provost report back to the Senate in three years on the status of new programs, after consultation with the Graduate School. The *motion carried* by a vote of 23 in favor and 7 opposed. It was suggested that the Chair request the Dean of the Graduate School to inform the Senate of the results of every review which takes place.

Uniformity in Employee Benefits

Mr. David Lieberman, Senior Vice President, spoke about an apparent contradiction between the *Faculty Manual* and actual practice concerning the fringe benefits enjoyed by the Medical School clinical faculty. Clinical faculty dependent tuition and clinical faculty enrolled in the UM Care plan, particularly the out-of-network benefit, are the main issues of concern. Mr. Lieberman presented the following questions for examination over the summer: "1) Is this an employee benefit, or is it simply a component of salary increase? 2) Are the revenues which fund this in fact sufficiently unique from other University revenues that it can be concluded that this use is appropriate? 3) Can and should this arrangement be restructured to take it outside the University; and if so, what are the ramifications of so doing--is it a precedent we want to set, or should we simply not care what a group of faculty do with their salaries? 4) Can or should the arrangement be changed but with the understanding that if a department wants to provide additional salary for an agreed-upon purpose, it's acceptable? The present system is probably more formal. It certainly results in cross-subsidization, but a different system might be more decentralized, more discretionary. 5) Should a similar opportunity be extended to other faculty, administrators, and staff? The utilization and costs would be more difficult to predict, but if the utilization rate were the same as that of clinical faculty, it could cost 3-4% of salaries, that we'd have

#9508

SYNOPSIS OF ACTIONS

taken by the

Executive Committee

University of Miami Board of Trustees

Tuesday, December 17, 1996

APPROVED Faculty Senate Legislation #95011(A), Amendment to Section A2.4 of the Faculty Charter, regarding librarian faculty voting rights.

APPROVED the establishment of the following degree programs: B.S. in Environmental Engineering; M.S. in Medical Informatics; and M.S. in Neuroscience.

AUTHORIZED the senior vice president for Business and Finance or the vice president and treasurer to take the actions necessary to transfer the assets under management by TCW/Cursitor Eaton to Templeton and Warburg, Pincus.

DELEGATED to the Investments Committee the power to redistribute assets among approved investment managers and within policy guidelines.

AUTHORIZED the president, the senior vice president for Business and Finance, and/or the assistant vice president for Facilities Administration to enter into contracts and make purchases on behalf of the University in an amount not to exceed $1,900,000 for the design phase of Option II of The Miami Project to Cure Paralysis.

APPROVED the increase in design scope of the Professional Arts Office Building to approximately 150,000 square feet, along with an increase in parking and a total project cost of $23,000,000, and **AUTHORIZED** the president, the senior vice president for Business and Finance, and/or the assistant vice president for Facilities Administration to enter into contracts and make purchases on behalf of the University in an amount not to exceed $850,000 for the design phase of the project, contingent upon a timetable demonstrating that the building can be completed so that Dominion Tower leases need not be renewed.

APPROVED, with one amendment, the University's Speaker Policy for Student Activity Fee Funded Student Organizations as recommended by the Student Affairs Committee.

APPROVED the exchange of approximately $9 million of 1996 University Bonds for tax-exempt Dade County Educational Facilities Authority (DCEFA) bonds.

Item B4

UNIVERSITY OF Miami

FACULTY SENATE

MEMORANDUM

TO: Dr. Tarek M. Khalil
Dean, Graduate School

FROM: Kamal Yacoub
Chair, Faculty Senate

DATE: April 28, 1995

SUBJECT: M.S. in Medical Informatics

This is in reference to the new M.S. program in Medical Informatics submitted by the Department of Radiology in the School of Medicine. You informed me that the Graduate Council approved this program and yet I do not find any mention of the program being approved by the Medical School Council which is empowered to act on such matters on behalf of the faculty of the School of Medicine. Such approval is necessary before submission to the Graduate Council and eventually to the Faculty Senate.

KY/b

cc: Dean Bernard Fogel
School of Medicine

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