

MELS

**MICROELECTRONIC &
INFORMATION SCIENCES
CENTER**



**INSTITUTE OF TECHNOLOGY
UNIVERSITY OF MINNESOTA**



**MICROELECTRONIC &
INFORMATION SCIENCES
CENTER**

**Institute of Technology
University of Minnesota**

**227 Lind Hall/207 Church Street SE
Minneapolis, MN 55455
612/376-9122**

TABLE OF CONTENTS

Organization	5
Laboratory Facilities	6
Research	7
1984 MEIS Team Pinnacle Projects	8
1982-83 MEIS Major Projects	10
Small Grants Program	12
Education	14
MEIS Initiated Faculty Expansion	14
Graduate Fellowship	15
MEIS Initiated Courses	15
Technology Transfer	16
Technical Reports	16
Seminar Series	17
Special Lectures	17
Financials	18
MEIS Expenditure Authorization	18
Balance Sheet	19
Notes	19

For the MEIS Center,

1983 was a year of transition from start-up phase to implementation phase. A full range of research, education and technology transfer programs has been initiated and implemented. The goals of these programs are:

- Sponsoring and conducting research at the frontiers of microelectronic and information sciences
- Strengthening the educational offerings of the University of Minnesota in these sciences
- Providing active interplay between those seeking discovery and those making applications

During 1983 a multi-year implementation plan was established for the MEIS Center. This plan includes:

- Identifying research projects and focusing MEIS resources on these
- Recruiting and retaining excellent faculty
- Recruiting outstanding graduate students
- Supporting the development of new courses of special value to the MEIS community
- Providing mechanisms for technology transfer

The Center expects to reach steady-state funding and achieve full implementation by 1985, at which time additional private and state sponsorship is anticipated.

Microelectronic and Information Sciences Center 1983 Sponsors

Control Data Corporation

Honeywell, Inc.

Sperry

3M

University of Minnesota

Federal and Other Agencies

State of Minnesota

Organization

Since November 1982 the MEIS Center has been directed by an Executive Committee assisted by an Executive Director.

Management

The Executive Committee is comprised of the heads of the Chemical Engineering and Materials Science, the Computer Science and the Electrical Engineering departments, Dr. H. Ted Davis, Dr. Kurt Maly, and Dr. E. Bruce Lee, respectively. The Executive Director, Dr. Martha Russell, was hired in April. The Executive Committee reports to the Management Board and receives advice and evaluation from the Technical Coordinating Committee.

In the design and implementation of its present programs, the MEIS center has benefited from the departmental representation and administration afforded by the heads. In 1984 it was decided by the Management Board that the Executive Committee has served its purpose and that the MEIS Center is sufficiently well established to attract a Director. The Director will be expected to provide strong, full-time technical and administrative leadership in the realization of the research and educational goals of MEIS and to broaden its funding base. The present position of Executive Director will be reclassified as Associate Director.

Space and Facilities

The MEIS Center's main office complex is located in remodeled space in Lind Hall.

Also in Lind Hall is the VLSI Engineering Design Laboratory equipped with a CALMA CHIPS 220 system operated for research, coursework, and service in VLSI engineering.

MEIS co-owns and co-operates, with Argonne National Laboratory, a Synchrotron X-Ray Beamline Facility located in Stoughton, Wisconsin. It is available to the MEIS community for research in photoelectron spectroscopy and x-ray lithography. A photoelectron spectroscopy laboratory integrated with this facility is located in the Mines and Metallurgy Building.

MEIS shares with the Electrical Engineering Department the operation and use of the newly remodelled Microelectronics Laboratory located in the Electrical Engineering Building. The laboratory is used for research, coursework, and service in microelectronic materials and device fabrication and characterization.

Laboratory Facilities

VLSI Design Laboratory

A facility for VLSI Engineering Design research and coursework. Through the UNITE Program the industrial community has access to this facility.

Operated by MEIS at a cost of about \$60,000 per year. Equipped by a General Electric gift of a CALMA GDSII and housed in space remodelled by MEIS for \$90,000.

Description

CALMA GDSII, three stations
Versetec plotter, 42"
Manuals and software available in the lab
Project Assistant available for assistance

Availability

MEIS researchers have essentially free access to the lab.

Principal Coordinator: Dr. Alfons Tuszynski, EE

Microelectronics Laboratory

A facility for research and instrumentation in microelectronic materials, devices and integrated circuits.

Laboratory is supported by federal grants, charges for services to the industrial and university community, the corporate affiliates program in Electrical Engineering, and MEIS. MEIS is providing \$350,000 and the University of Minnesota \$200,000 for remodelling. MEIS contributes \$25,000 per year for operation.

Description

Mask making: lithography; diffusion, CVD, ion implantation metallization; assembly & testing devices; and service systems.

Permanent technical staff includes a full-time professional process

engineer and several part-time assistants. Laboratory staff assist faculty and are responsible for installation and maintenance of the equipment.

Availability

Use is scheduled through the Laboratory Manager, Mr. Steve Gilbert.

Scheduled completion of remodeling March 1984.

Principal Coordinator: Dr. Bill Robbins, EE

Synchrotron Radiation X-Ray Beamline

A research facility providing tunable, monochromatic radiation for conducting electron spectroscopy and x-ray lithography.

Supported by federal grants, Argonne National Laboratory and MEIS. MEIS furnished \$250,000 and Argonne National Laboratory \$250,000 to purchase and install the beamline.

Description

State-of-the-art beamline on synchrotron radiation source

1 GeV electron storage ring

Functions to provide monochromatic radiation for $5 < h\nu < 1000\text{eV}$.

Manuals will be written after instrument is commissional.

Availability

No fees for MEIS researchers.

Beamline can be scheduled according to time available. Minnesota has 5 months beamtime per year.

Instrumentation will be available for use June 1984.

Principal Coordinator: Dr. John Weaver, CEMS

Research

The MEIS Center's two-pronged research program has generated over \$4 million in external support for University of Minnesota researchers.

One component of the MEIS Center's research program awards funds to several interdisciplinary, team research programs. Four major research projects were awarded for 1983. These projects received \$625,000 in seed money for groups of faculty having complementary research interests to establish collaborative research activities and to prepare proposals for integrated team projects.

Proposals developed by these and other groups were considered for a second round of major funding, awarded in December 1983. This second round awarded \$800,000 in a combination of seed and matching funds for integrated team projects in 1984. These awards carry a multi-year commitment from the MEIS Center, based on favorable annual review, plans for the next year, and availability of funds. It is the expectation of the MEIS Center that these projects will develop pinnacles of research excellence at the University of Minnesota and that the identity of the MEIS Center will be established in these areas.

The second component of the MEIS Center's research sponsorship, the Small Grants Program, is now in its second cycle. The objectives of this program are to attract University of Minnesota faculty to actively conduct research in the microelectronic and information sciences and to accelerate the development of successful individual research activities. A secondary goal of the small grants program is to nucleate additional team projects.

In 1982-83, the first round of small grant funding awarded

\$175,000 in a combination of seed and matching grants to 11 faculty members. These scientists secured an additional \$2,199,000 in outside funding for their research activities. In 1983-84, the second round of MEIS small grant funding has promised \$210,000 in matching funds to 13 faculty members.

Over 50 publications have been generated by faculty members sponsored through the MEIS Center's 1983 research programs. Many professors have given presentations on MEIS-sponsored research at scientific symposia and conferences--both national and international. In addition, several graduate students have already begun publishing and presenting results of their thesis research.

Buttressing the MEIS Center's research programs and supporting its educational programs are several laboratory facilities in the Institute of Technology (See description of laboratory facilities). Three of these were strengthened during 1983. Additional courses in VLSI design and test were added to optimize usage of the VLSI Design Laboratory and its CALMA II system. At the Synchrotron X-ray Beamline Laboratory, which is jointly sponsored by the MEIS Center and Argonne National Laboratories, the assembly of the beamline was begun and the facility is now being used for MEIS-sponsored research. In addition, major renovation of the Microelectronics Laboratory was co-sponsored by the MEIS Center and the University of Minnesota with completion expected in 1984.

Representatives from MEIS member companies participated with university faculty in assessing laboratory facilities and in identifying additional instrumentation needed to fully equip MEIS sponsored research efforts. Shared use of laboratory facilities by U of M faculty and industrial scientists was explored by industry-university task forces. Several MEIS sponsored research projects were conducted using laboratory facilities of MEIS member companies.

1984 MEIS Team Pinnacle Projects

III-V Compounds and High Speed Devices

The objective of this research project is to incorporate new methods of surface and interface preparation of GaAs and related III-V semiconductors into new solid-state devices which will have an impact on high-speed integrated circuits. This project will integrate basic materials research with device fabrication and device performance, including:

1. Scientifically fundamental and technologically relevant studies of metal-GaAs interface properties, with emphasis on electronic and structural modifications as interfacial chemical and physical parameters are changed, to lead to new methods of surface-interface control.
2. Implementation of these new surface interface preparation methods on III-V device structures using molecular beam epitaxy (MBE) and metal-organic chemical vapor deposition (MOCVD), thereby immediately exploiting the scientific developments.
3. Characterization and performance evaluation of III-V field-effect devices incorporating advances made possible by interface modification and synthesis.

\$300,000 has been awarded for 1984.

Researcher	Department
Alfonzo Franciosi	Chem Eng and Mat Sci
Klavs Jensen	Chem Eng and Mat Sci
Michael Shur	Elec Eng
John Weaver	Chem Eng and Mat Sci

Intelligent Systems

This project focuses on the development of high performance computing systems which incorporate human reasoning techniques. One emphasis concerns the determination of spatial relationships based on motion of the sensor and/or motion of objects. Signal detection analysis will be used to develop a technique which provides partial, qualitative specification of the scene properties. A second emphasis in expert diagnostic systems will investigate and develop expert systems for fault diagnosis using both causal reasoning and diagnostic reasoning.

The research planned for this pinnacle will have applications to such areas as robotics, vehicle navigation, construction of fault localization programs for complex systems, CAD/CAM systems, and more powerful AI systems. Industry-university collaboration on aspects of the research, development of new courses, and collaboration with faculty at other universities are included in plans for this project.

\$200,000 has been awarded for 1984.

Researcher	Department
Paul Johnson	Mgmt Sci
William Thompson	Comp Sci
Harry Wechsler	Elec Eng
Albert Yonas	Child Psych

High-Performance Integrated Circuits

This work addresses the conceptual, theoretical, and analytical innovations, and the modeling and fabrication methods that point toward the long-term goal of monolithic 3-D integration. Using semiconductor physics, fabrication technology, circuit design, system architecture, and product testing, this group will address high-performance integrated circuits in four projects.

1. Design and modeling of devices, circuits, and heterojunctions. Modeling includes analytical and numerical micro and macro techniques. Testability and yield-reliability issues will also be addressed.
2. Use of sputter epitaxy to achieve monocrystalline silicon films with the goals of studying growth variables, doping-control techniques, and properties of epitaxial PN junctions: achieving lateral doping patterns will be accomplished using a combination of shadow-mask definition and atomic-plane doping.
3. Studying the combined use of a steered ion beam and MBE in growing crystals, as a function on ion energy, crystal orientation, crystal growth rate, and atmosphere in the chamber.
4. Refinement and use of laser-scanned acoustic microscopy for the nondestructive imaging of subsurface features in integrated monoliths, and the evaluation of such images for testing purposes.

\$300,000 has been awarded for 1984.

Researcher	Department
Phil Cohen	Elec Eng
R. Mueller	Elec Eng
Allen Nussbaum	Elec Eng
William Robbins	Elec Eng
Alfons Tuszyński	Elec Eng
Ray Warner	Elec Eng
G. Wehner	Elec Eng

Artificially Structured Materials for Microelectronics Electronics Planning Group

This group is developing a team project which will study electrical and magnetic properties of multilayer heterostructure and thin films, characterize the morphology, defects, electronic structure and chemical composition of such structures, and develop new techniques for synthesis of artificial materials.

\$50,000 seed funds awarded for January through May, 1984.

Researcher	Department
Paul Barbara	Chemistry
Charles Campbell	Physics
E.D. Dahlberg	Physics
John Evans	Chemistry
E.A. Franciosi	Chem Eng and Mat Sci
F. William Gerberich	Chem Eng and Mat Sci
Allen Goldman	Physics
Robert Hexter	Chemistry
Larry Miller	Chemistry
Lanny Schmidt	Chem Eng and Mat Sci
Oriol Valls	Physics

1982-83 MEIS Major Projects

3-D Integrated Circuits

Goals

- Devise transistor and circuit configurations that lend themselves to three-dimensional, all-semiconductor implementation
- Demonstrate feasibility on methods for realizing such structures
- Participate in development of nearer-term 3-D technologies, such as stacked CMOS
- Advance the art of modeling devices relevant to both IC categories
- Develop quantitative diagnostic tools

Funding Activities

MEIS Initiation Grant 1982-83: \$125,000

Grants obtained from external sources totaled \$511,400. Sources included DOE, SRC, NSF, ECD, M/A COM, McDonnell-Douglas, Honeywell and NOSC.

Proposals totaling \$1,575,600 were submitted to NSF, ONR, SRC, the U.S. Air Force and ARO.

Equipment Acquisitions

IBM Instruments Inc. System 9000 Computer and Hard-disk Drive Sputtering System Components for Silicon Deposition

Staff

9 Professors
 5 MS - Candidate Students
 8 Ph.D. - Candidate Students
 3 Technicians
 2 Adjunct Personnel

Department: Electrical Engineering

Topic	Researcher
Ion Beam Technology for Integrated Circuits	P. Cohen R. Warner
Heterojunction Isolation	A. Nussbaum M. Shur
Acoustic Microscopy	R. Mueller W. Robbins
Vertical, Planarized CMOS Integrated Circuits and Systems	B. Hoefflinger A. Tuszynski M. Liu G. Wehner R. Warner
BJT AND FET Modeling	M. Shur A. Nussbaum B. Hoefflinger R. Warner
Silicon 3D IC Using Sputter Epitaxy	R. Warner G. Wehner A. Tuszynski

Processor Array Concepts

Goal

Better tools for VLSI design using innovative algorithms executed on advanced computational structures

Funding Activities

MEIS Initiation Grant 1982-83: \$125,000

Grants received from U of M Graduate School and NOSC totalled \$57,800.

Proposals submitted to NSF, SRC and DARPA totalled \$1,512,600.

Equipment Acquisitions

1 Workstation
 4 Desktop Workstations with Peripherals
 3 Interactive Colorgraphics Workstations
 1 Color Display
 1 42" Plotter
 1 Integrated Circuit Tester
 1 Programmable Data Generator
 1 Micromanipulator Probe Station

Staff

6 Professors
 11 MS - Candidate Students
 9 Ph.D. - Candidate Students

Departments: Electrical Engineering, Computer Science

Topic	Researcher
Array Architectures	R. Kain
Fault-Tolerant Design	L. Kinney H. Hwang
Supporting Technology	B. Hoefflinger A. Tuszynski
Algorithm Development	S. Sahni

Design Automation and Software Engineering

Goals

Develop efficient algorithms for a variety of computer applications

Develop and evaluate concepts related to high-performance computing for:

- Languages and systems software for high-performance computing
- High-performance architectures
- Applications of high-performance computers

Funding Activities

MEIS Initiation Grant: \$125,000

Proposals submitted to NSF totalled \$5,140,000.

Equipment Acquisitions

2 Workstations

1 Array Processor

Fortran 77 Compiler for Array Processor

Staff

9 Professors

7 MS - Candidate Students

7 Ph.D. - Candidate Students

Department: Computer Science

Topic	Researcher
Languages and Systems Software for High-Performance Computing	K. Maly P. Afshari V. Berzins D. Du P. Borgwardt S. Bruell J. Carlis O. Ibarra
High-Performance Architectures	S. Sahni P. Afshari P. Borgwardt D. Du S. Bruell O. Ibarra
Applications of High-Performance Computers	S. Sahni V. Berzins D. Boley B.J. Rosen W. Thompson

Ultrasmall Electronic Research

Goals

Formation and physical properties of very thin films and very narrow wires

Electron transport in films, wires, and submicron devices

Development of chemical techniques for the synthesis of Materials for ultrasmall devices

Funding Activities

MEIS Initiation Grant: \$250,000

Grants obtained from DOD and NRO totalled \$160,000.

Proposals submitted to agencies and industry totalled \$585,000.

Staff

15 Professors

2 Undergraduate Researchers

5 MS and Ph.D. - Candidate Students

4 Postdoctoral Students

Departments: Physics, Chemistry, Chemical Engineering and Materials Science, Electrical Engineering

Topic	Researcher
Chemical Reaction Cycling of Microstructures	L. Schmidt
Nonequilibrium Properties and Defects	O. Valls
Electron Interaction and Defects in Solids	C. Campbell C. DasGupta
Equilibrium Properties of the Gas-Solid Interface	A. Goldman
Liquid Crystal Phase Transitions	C.C. Huang
Material Science Experiments Using Synchrotron Radiation	R. Hexter
Polymer Resists	W. Miller M. Tirrell
De-Novo Synthesis of Microstructures	L. Miller
In-Situ Studies of Epitaxial Growth on GaAs	P. Cohen
Electron Transport	D. Dahlberg

Small Grants Program

In 1984, MEIS awarded 11 small grants (\$20,000 maximum) as matching money to encourage individual professors and small groups to apply to external agencies for grants in MEIS areas. In 1983, nine small grants were awarded as seed or matching funds. These 1983 awards leveraged \$2,199,000 in external funds for research in these areas.

1984 MEIS Small Grants

Topic	Researcher/Dept.	MEIS	Req./Source
Study of Electromigration in Metal Films with the Help of 1/f Noise	A. van der Ziel	\$19,000	\$87,000/SRC
Evaluation of Caching and Design of VLSI Architecture for PROLOG	P. Borgwardt, CS P. Afshari, CS	\$20,000	\$149,000/NSF
Microscopic Control of Semiconductor Inter-face Reactivity	A. Franciosi, CEMS	\$20,000	\$85,000/ONR
Magnetically Soft, Highly Magnetostrictive Thin Films	W.P. Robbins	\$15,000	\$68,000/NSF
Artificial Barrier Superconducting Junctions with Refractory Electrodes	A. Goldman, Phys	\$20,000	\$110,000/ONR
Investigation of Nonlinear GaAs Distributed Structures with Application of ULTRA-Microwave Integrated Circuits	K. Champlin, EE	\$20,000	\$90,000/NSF
Characterizing and Synthesizing Chiral Smectic C Materials for Fast-Switching Device Applications	C.C. Huang, Phys	\$20,000	\$45,000/3M
Dynamically Reconfigurable Networks within VLSI Wafers	R. Kain, EE Dr. Kinney, EE	\$18,000	\$156,000/ NSF/SRC
Reflection High-Energy Electron Diffraction Studies of Epitaxial Growth	P. Cohen, EE	\$20,000	\$87,000/ NSF/ONR
A New Reactor for Experimental and Modeling Studies of Plasma Deposition Processes	K. Jensen, CEMS	\$20,000	\$60,000/ NSF/ARO
Research on Stable Processible Conducting Polymers for Electronic Applications	S. Wellinghoff, CEMS	\$18,000	\$50,000/ONR /NSF/AFSOR
	TOTAL	\$210,000	

1983 MEIS Small Grants

Topic	Researcher/Dept.	MEIS	Req./Source
Design and Analysis of a Network Computer	S. Bruell, CS P. Afshari, CS	\$20,000	\$140,000/NSF
Automatic Error Recovery in Robot Programming Languages	M. Gini, CS	\$20,000	\$48,000/NSF
Experimental and Theoretical Studies of Chemical Vapor Deposition Processes	K. Jensen, CEMS	\$20,000	\$184,000/NSF*
Language-Directed Computer Design for PROLOG and Modula-2	P. Borgwardt, CS	\$18,000	\$48,000/NSF
Some Aspects on an In Situ Integrated Circuit Fabrication Technology	W. Peria, EE	\$20,000	\$150,000/NSF
Algorithmic Study of Combinational Problems	S. Sahni, CS	\$20,000	\$190,000/NSF* \$155,000/ONR*
Problems in Computational Complexity	O. Ibarra, CS		\$190,000/NSF*
Modeling of Multi-layered Modulation Doped FETS	M. Shur, EE	\$20,000	\$246,000/NSF* \$50,000/Honeywell*
Surface Forces Apparatus	M. Tirrell, CEMS	\$15,000	\$89,000/NSF-DOD*
Studies of Electronic and Structural Interactions at Metal and Semiconductor Surfaces and Interfaces	J. Weaver, CEMS	\$20,000	\$109,000/ARO* \$274,000/ONR* \$262,000/DOD* \$450,000/NSF*
	TOTAL	\$173,000	\$2,199,000*

*Awarded

Education

Through a strategy of cost sharing leading to integration into University of Minnesota recurring support, educational programs are sponsored by the MEIS Center. These have focused on expanding faculties, augmenting course offerings, and attracting quality students to the graduate programs.

Baccalaureate degrees related to the microelectronic and information sciences are offered in many programs. In addition, masters and doctoral degrees are awarded for study in the following research program areas:

Artificial Intelligence and Robotics
 Computer Aided Design
 Computer Languages and Architecture
 Computer Systems
 Corrosion in Microelectronic Materials
 Device Physics and Modeling
 Heterojunctions and Schottky Barriers
 Integrated Logic Circuits: Design and Fabrication
 Laser Annealing
 Lithography
 Microelectronic and Magnetic Materials Processing
 Software Engineering
 Solid State Physics
 Superconductivity
 Surface and Interface Electronic Interactions
 Surface Chemistry and Physics
 Testing, Packaging and Reliability
 Ultrasmall Electronic Devices and Systems

In the 5 departments receiving MEIS research sponsorship during 1983, 54 graduate students and 4 postdoctoral assistants were supported by MEIS funds.

MEIS Initiated Faculty Expansion

Seven new faculty positions were initiated by the MEIS Center through a three-year program of cost sharing and integration into U of M faculty support. Six of these faculty came to the U of M for the 1982-83 year. The seventh person arrived for the 1983-84 year. Additional hiring plans have been developed and will add 4 faculty positions in Computer Science and a Director of the MEIS Center in 1984.

Department	Name	Research Interest
Computer Science	Dr. Parviz Afshari	Computer Architecture
Computer Science	Dr. Peter Borgwardt	VLSI Design and Computer Architecture
Computer Science	Dr. Maria Gini	Artificial Intelligence and Robotics
Electrical Engineering	Dr. In Hwang	Error Detection and Correction in Computer Systems
Electrical Engineering	Dr. Marek Perkowski	Computer-aided Logic and Layout Design
Chemical Engineering and Materials Science	Dr. John Weaver	Electronic Materials, X-Ray Beamline Spectroscopy
Chemical Engineering and Materials Science	Dr. Alfonso Franciosi	Electronic Physics of Semiconductor Metal Interfaces

Graduate Fellowship Program

The goals of the MEIS Graduate Fellowship Program are to attract highly qualified graduate students in microelectronic and information sciences, to acquaint them with MEIS industrial sponsors, and to encourage them to study areas represented in MEIS sponsored research. A total of 35 MEIS Fellowships have been awarded. The 1983-84 awards included \$8,200 plus tuition and fees for nine months. The 1984-85 awards will offer a stipend of \$10,000 plus nine months' tuition and fees. Continued support is available for MEIS Fellowship recipients as research assistantships with faculty members sponsored by MEIS research programs.

The first round of MEIS Graduate Fellowship recipients completed their first year of graduate study in 1982-83 and selected among academic and industrial research opportunities for summer employment. Most of these returned to continue work on their doctoral degrees, many with thesis topics in pinnacle areas. A second round of MEIS fellowships was awarded and brought 18 graduate students to the U of M to begin their study in the fall of 1983. Sixteen MEIS fellowships are available for 1984-85.

MEIS Initiated Courses in Microelectronic and Information Sciences

Department	Course
Chemical Engineering	5902-Microelectronics Processing
Chemical Engineering	8403-Chemical Bonding at Surfaces
Materials Science	5013-Introduction to Electronic Properties
Materials Science	8213-Electronic Properties of Materials
Materials Science	8214-Electronic Properties of Materials
Computer Science	5180-Software Engineering I
Computer Science	5181-Software Engineering II
Computer Science	5280-Computer Aided Design I
Computer Science	5281-Computer Aided Design II
Computer Science	8199-Research Seminar in Design Databases
Computer Science	8499-Topics in VLSI
Computer Science	8599-Topics in Robotics
Computer Science	8799-Seminar in Physical Database Design
Computer Science	8799-Software Engineering
Computer Science	8799-Topics in Database Design
Computer Science	8799-Topics in Programming Languages
Electrical Engineering	3352-Microprocessors
Electrical Engineering	5150-Electrical Engineering Materials
Electrical Engineering	5511-Digital Filters and Signal Processing
Electrical Engineering	5571-VLSI Systems
Electrical Engineering	5572-VLSI Circuit Design
Electrical Engineering	5573-Test and Diagnostics
Electrical Engineering	5574-VLSI Technology
Electrical Engineering	5575-VLSI Design Laboratory
Electrical Engineering	5576-VLSI Device Modeling
Electrical Engineering	5654-High-Speed, Compound Semiconductor Devices
Electrical Engineering	5660-Semiconductor Properties and Devices
Electrical Engineering	5666-Magnetic Properties of Materials and Applications
Electrical Engineering	5670-Basic Microelectronics
Electrical Engineering	5702-Stochastic Processes and Optimum Filtering
Electrical Engineering	5750-Topics in Systems Analysis
Electrical Engineering	5852-Digital Computer Systems
Electrical Engineering	8250-Advanced Control Topics
Electrical Engineering	8451-Advanced Topics in Electrical Engineering

Technology Transfer

The MEIS Center's technology transfer program was initiated during 1983 to complement the dissemination of research results in open scientific literature.

Activities in the technology transfer program have focused on building and maintaining the flow of information and technologies between the MEIS member companies and the University of Minnesota and on shortening the time from discovery to application. The technology transfer program addresses these goals through direct communication among scientists, through MEIS Technical Reports, and through dissemination of a newsletter.

The MEIS Seminar Series was kicked off in June 1983 and that fall began a regularly scheduled series of invited speakers. Designed to bring in scientists of international reputation to set and calibrate standards of excellence in the microelectronic and information sciences, the seminars have attracted faculty, students and industrial scientists and have been broadcast live and interactive over the University of Minnesota's UNITE program.

The MEIS Center's 1983 technology transfer program has also included a workshop on "Curriculum for Test Technology" and a symposium on "Organic Compounds in Microelectronics." Both events brought together scientists representing industry and academia from Minnesota, nationally and internationally to discuss state-of-the-art research and education.

In addition to seminars and workshops, the MEIS Center has arranged meetings between University faculty and scientists from individual companies to discuss technical issues of mutual interest. Poster sessions of MEIS sponsored research were presented at a meeting of the Semiconductor Research Corporation and at MEIS '83, an open house describing programs of the MEIS Center. In order to make information about faculty research expertise available to the MEIS technical community, the MEIS Center has developed a directory of faculty research interests.

A series of technical reports of MEIS sponsored research was begun in 1983. These reports serve as preprints of papers accepted for publication and offer an expedient way to circulate early results before journal publication. The MEIS Newsletter, which is distributed nationally, is circulated every other month and carries information about programs of the MEIS Center, including the availability of MEIS Technical Reports.

MEIS Technical Reports 1983

1. "A Three-Dimensional-CMOS Design Methodology," by B. Hoefflinger, S.T. Liu, and B. Vajdic
2. "An Interface Catalytic Effect: Cr at the Si(111)-Au Interface," by A. Franciosi, D.G. O'Neill, and J.H. Weaver
3. "A Systolic Design Rule Checker," by R. Kane and S. Sahni
4. "Modelling of Chemical Vapor Deposition Reactors for the Fabrication of Microelectronic Devices," by K.F. Jensen
5. "Tunneling Anomalies and the Coexistence of Ferromagnetism and Superconductivity in ErRh4B4 Films," by A.M. Goldman, A.M. Kadin, L-J. Lin, and C.P. Umbach
6. "Nature of the Smectic-A-Smectic-C Transition Near a Nematic- Smectic-A-Smectic-C Multicritical Point," by C.C. Huang and S.C. Lien
7. "Performance Bounds on Multiprocessor Schedules," by R.Y. Kain and A.A. Raie
8. "Parasitic MESFET in (Al,Ga)As/GaAs Modulation Doped FETs and MODFET Characterization," by K. Lee, M. Shur, T.J. Drummond, and H. Morkoc

Seminar Series

Name	Affiliation	Topic
William Norris	Control Data Corporation	Technological Cooperation: A National Imperative
King-ning Tu	IBM	Interdiffusion of Thin Films
Don Pederson	UC Berkeley	Computer Aided Design
Rolf Landauer	IBM	Physical Limitations of Computational Processes
Scott Kirtpatrick	IBM	Optimization in Computer Design and Statistical Mechanics
W.E. Spicer	Stanford	Surfaces and Interfaces on an "Atomic" Scale: GaAs, InP, GaSp
Dick Foss	Mosaid	MOS Memory
James Meindl	Stanford	VLSI and Beyond
Jack Kilby	Consultant	Creativity in Engineering

Special Lectures

Name	Affiliation	Topic
Per Brinch Hansen	University of Southern California	Systematic Programming in Edison
Tim Anderson	University of Florida	Applications of Thermodynamics to Processing Group III-V Semiconductors
Dennis Hess	UC Berkeley	Plasma Enhanced Deposition of Tungsten Films
Raj Reddy	Carnegie-Mellon University	Artificial Intelligence and Manufacturing
P.B. Ghate	Texas Instruments	Failure Mechanisms in Quality and Reliability in Circuits

FINANCIALS

MEIS Center Expenditure Authorization

	To 6/83	7/82-6/83
Graduate Fellowship Program	\$212,000	\$212,000
Course Development		190,000
Computer Science	140,000	
Electrical Engineering	50,000	
Faculty Expansion 1,2		245,000
Computer Science	110,000	
Electrical Engineering	110,000	
Materials Science	25,000	
Major Projects		625,000
Ultra Small Electronic Research	250,000	
Processor Array Con- cepts for Engineering	125,000	
Three Dimensional Circuit Technology	125,000	
Design Automation Software Technology	125,000	
Small Grants Program	175,000	175,000
MEIS Laboratory Facilities		399,827
Microelectronic Laboratory		
Operation	76,241	
Renovation 3	358,867	
Synchrotron X-Ray		
Beamline Laboratory	250,000	
Instrumentation and Operation 4		
VLSI Laboratory		
Instrumentation	140,000	
Operation	89,860	
MEIS Central Office Remodeling and Computerization	29,774	29,774
IT Development Office	52,000	20,000
Director Search	15,000	
Seminars	10,000	10,000
MEIS Executive Committee	20,000	20,000
MEIS Promotion	5,000	5,000
MEIS Administration	252,830	116,457
TOTAL	\$2,746,572	\$2,048,058

Balance Sheet

TO 6/82	
Contributions	\$3,450,000
Interest Income	944,605
Expenditure Authorizations	(1,247,524)
<hr/>	
7/82 - 6/83	
MEIS Balance Forward 6/82	\$3,147,081
Contributions	700,000
Interest Income 5	321,236
Market Change 6	(998)
Expenditure Authorizations	(2,048,148)
<hr/>	
Research funds leveraged through MEIS sponsorship	4,312,254
<hr/>	
7/83 - 6/84	
MEIS Balance Forward 6/83	\$2,119,171
University of Minnesota Contribution 7	
Industry Pledges Receivable 7/83-6/85	2,350,000
State of Minnesota Legislative Appropriation Receivable 1983-85	1,200,000
Expenditure Authorizations	(2,210,000)
<hr/>	

Notes

- MEIS funds for faculty expansion include full salary for first year, half salary second year. University of Minnesota funds will pay for half salary in second year and full salary in succeeding years.
- Salary money only. Fringe and moving expenses authorized in addition to this.
- Plus \$200,000 from University of Minnesota.
- Matched by Argonne Laboratory.
- Average annualized return of 9.4%.
- Bank of America at 8.73% , purchased 7/30/82.
- The University of Minnesota has committed funds for:

Renovation of Microelectronic Laboratory	\$300,000
Convert 11 MEIS-initiated faculty positions to U of M recurring positions	550,000/yr
Special research funds from Graduate School	17,800
Remodeling Microelectronics Materials Lab Complex	75,000
Salaries of faculty members receiving MEIS research funds	

Management Board

Dean Ettore Infante, Chairman
Dr. Gerald Dineen, Honeywell, Inc.
Mr. David Turcotte, Sperry
Dr. Ennio Fatuzzo, 3M
Mr. John Lacey, Control Data Corporation
Dr. Robert Hexter
Dean Robert Holt
Dr. H. Ted Davis
Dr. Kurt Maly
Dr. Bruce Lee
Dr. Martha Russell
Dr. Ken Keller, Ex Officio
Ms. Elaine Battles, Ex Officio

Technical Coordinating Committee

Dr. Allen Goldman, Physics
Dr. Richard Kain, Electrical Engineering
Dr. John Weaver, Chemical Engineering and Materials Science
Dr. William Franta, Computer Science
Dr. Krzysztof Burhardt, 3M
Dr. Wallace Lindemann, Control Data Corporation
Dr. William Sackett, Honeywell, Inc.
Mr. Larry Walker, Sperry
Dr. H. Ted Davis, MEIS, Chairman
Dr. Martha Russell, MEIS, Vice Chairman

Executive Group

Dr. H. Ted Davis, Executive Committee Chairman, Chemical Engineering
and Materials Science Department Head
Dr. Kurt Maly, Executive Committee, Computer Science Department Head
Dr. Bruce Lee, Executive Committee, Electrical Engineering Department Acting Head
Dr. Martha Russell, Executive Director

MELS



INSTITUTE OF TECHNOLOGY
UNIVERSITY OF MINNESOTA

227 Lind Hall / 207 Church Street S.E.
Minneapolis, Minnesota 55455
612/376-9122