

MELS'83

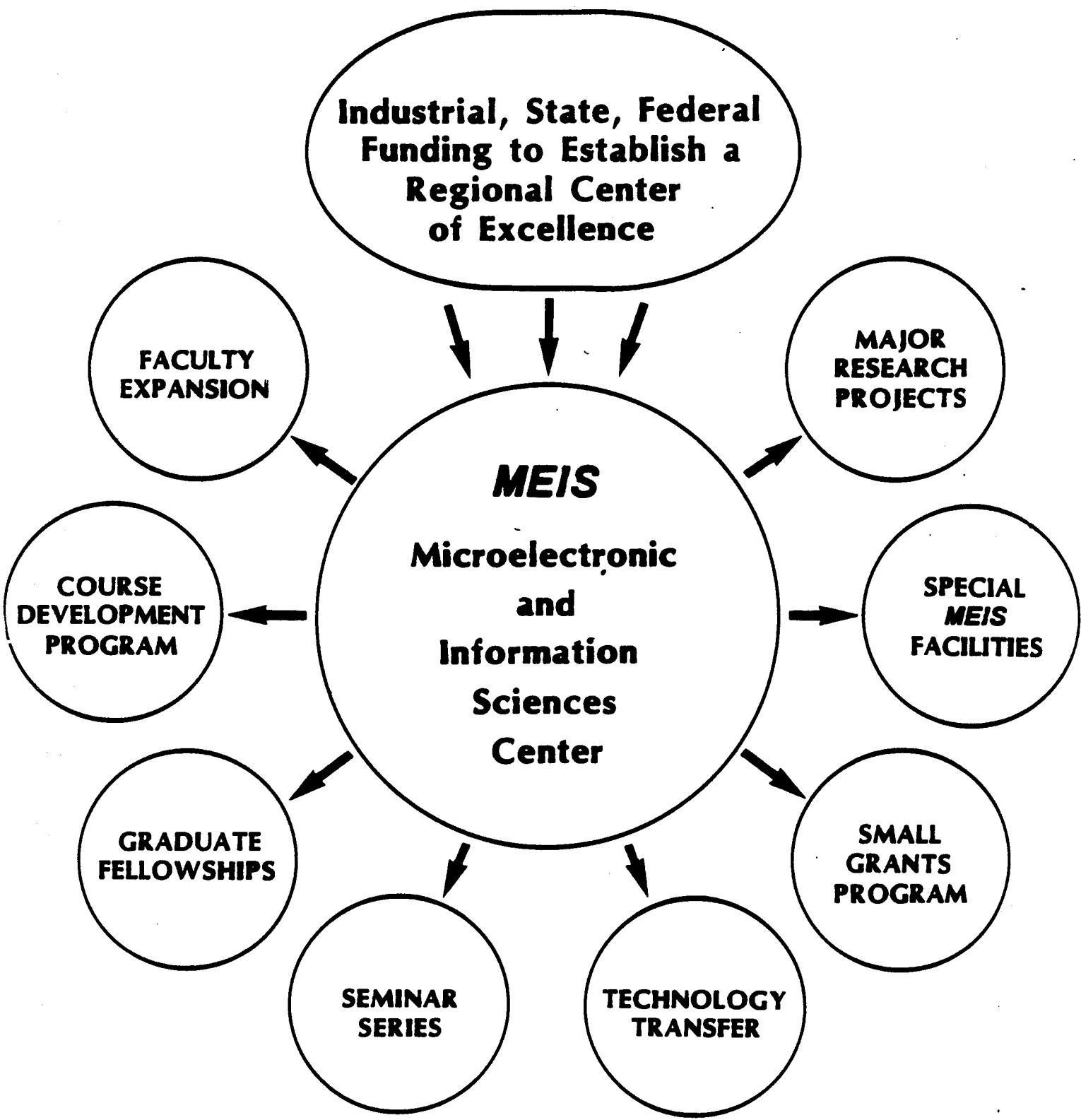
**MICROELECTRONIC &
INFORMATION SCIENCES CENTER**



**INSTITUTE OF TECHNOLOGY
UNIVERSITY OF MINNESOTA**

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

MSB
MSBS
9/3/88



GOALS OF MEIS

SPONSOR AND CONDUCT RESEARCH AT THE FRONTIERS OF MICROELECTRONIC AND INFORMATION SCIENCES.

STRENGTHEN THE EDUCATIONAL OFFERINGS OF THE UNIVERSITY OF MINNESOTA IN THESE SCIENCES.

PROVIDE ACTIVE INTERPLAY BETWEEN THOSE SEEKING DISCOVERY AND THOSE MAKING APPLICATIONS.

INDUSTRIAL SPONSORS OF MEIS

1979 \$2M GRANT FROM CONTROL DATA CORPORATION

1981 \$2M GRANT COMMITTED BY HONEYWELL

\$1M GRANT COMMITTED BY SPERRY

1982 \$1M GRANT COMMITTED BY 3M

MAJOR MEIS PROJECTS

- USER** **ULTRASMALL ELECTRONIC TECHNOLOGY**
- PACE** **PROCESSOR ARRAY CONCEPTS FOR ENGINEERING**
- DASE** **DESIGN AUTOMATION AND SOFTWARE ENGINEERING**
- 3D** **THREE-DIMENSIONAL INTEGRATED CIRCUIT RESEARCH**

USER PROJECT

**A RESEARCH PROGRAM ON MICROELECTRONIC MATERIALS
FOR ULTRASMALL ELECTRONIC TECHNOLOGY**

***FORMATION AND PHYSICAL PROPERTIES OF VERY
THIN FILMS AND VERY NARROW WIRES***

***ELECTRON TRANSPORT IN FILMS, WIRES, AND SUB-
MICRON DEVICES***

***DEVELOPMENT OF CHEMICAL TECHNIQUES FOR THE
SYNTHESIS OF MATERIALS FOR ULTRASMALL DEVICES***

USER PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC	RESEARCHER	DEPARTMENT
MATERIALS SCIENCE EXPERIMENTS USING SYNCHROTRON RADIATION	R. HEXTER	CHEMISTRY
POLYMER RESISTS	W. MILLER	CHEMISTRY
POLYMER FORCES AND ADHESION	S. PRAGER M. TIRRELL	CHEMISTRY CHEM. ENG. & MATS. SCI.
DE-NOVO SYNTHESIS OF MICROSTRUCTURES	L. MILLER	CHEMISTRY
IN-SITU STUDIES OF EPITAXIAL GROWTH ON GaAs	P. COHEN	ELEC. ENG.
ELECTRON TRANSPORT	D. DAHLBERG B. HOEFFLINGER G. ROBINSON M. SHUR	PHYSICS ELEC. ENG.

USER PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC	RESEARCHER	DEPARTMENT
CHEMICAL REACTION CYCLING OF MICROSTRUCTURES	L. SCHMIDT	CHEM. ENG & MATS. SCI.
NONEQUILIBRIUM PROPERTIES AND DEFECTS	O. VALLS C. DAS GUPTA	PHYSICS
ELECTRON INTERACTION AND DEFECTS IN SOLIDS	C. CAMPBELL C. DAS GUPTA	PHYSICS
EQUILIBRIUM PROPERTIES OF THE GAS-SOLID INTERFACE	A. GOLDMAN	PHYSICS
LIQUID CRYSTAL PHASE TRANSITIONS	I. HWANG	ELEC. ENG.

USER PROJECT (CONTINUED)

FUNDING AND PLANS

1982-83 MEIS INITIATION GRANT \$250K

**PROPOSAL CURRENTLY BEING CONSIDERED BY
DIGITAL EQUIPMENT CORPORATION**

	FIRST YEAR	SECOND YEAR	THIRD YEAR
DEC	\$1,000K	\$1,000K	\$1,000K
MEIS	400K	250K	250K
TOTAL FUNDS	1,400K	1,250K	1,250K

PACE PROJECT

**RESEARCH PROGRAM ON PROCESSOR ARRAY
CONCEPTS FOR ENGINEERING**

BETTER TOOLS FOR VLSI DESIGN

***EMULATE OR SIMULATE A STAND-ALONE
WORKSTATION***

***USE INNOVATIVE ALGORITHMS EXECUTED
ON ADVANCED COMPUTATIONAL STRUCTURES***

PAGE PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC	RESEARCHER	DEPARTMENT
ARRAY ARCHITECTURES	R. KAIN	ELEC. ENG.
FAULT -TOLERANT DESIGN	L. KINNEY I. HWANG	
SUPPORTING TECHNOLOGY	B. HOFFFLINGER	
ALGORITHM DEVELOPMENT	S. SAHNI	COMP. SCI.

PACE PROJECT (CONTINUED)
FUNDING AND PLANS

1982-83 MEIS INITIATION GRANT \$125K

PRELIMINARY CONTACT WITH \$ 1,200K
DARPA AND PLANNED CONTACT
WITH NSF. WILL PROPOSE THREE-
YEAR PROJECT IN COLLAB-
ORATION WITH INDUSTRY

DASE PROJECT

**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***

DASE PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC	RESEARCHER	DEPARTMENT
LANGUAGES AND SYSTEMS SOFTWARE FOR HIGH PERFORMANCE COMPUTING	K. MALY P.AFSHARI, V. BERZINS, D.DU, P. BORGWARDT, S. BRUELL, J. CARLIS, O. IBARRA	COMP. SCI.
HIGH PERFORMANCE ARCHITECTURES	S. SAHNI, P.AFSHARI, P. BORGWARDT, D. DU, S. BRUELL, O. IBARRA	
APPLICATIONS OF HIGH PERFORMANCE COMPUTERS	S. SAHNIA, V. BERZINS, D. BOLEY, J.B. ROSEN, W. THOMPSON	

DASE PROJECT (CONTINUED)
FUNDING AND PLANS

1982-83 MEIS INITIATION GRANT	\$ 125K
PROPOSAL BEING SUBMITTED TO THE NATIONAL SCIENCE FOUNDATION. FIVE YEAR PROGRAM AT \$1M PER YEAR	\$5,000K

3D PROJECT

A RESEARCH PROGRAM ON 3-DIMENSIONAL INTEGRATED CIRCUITS

***VERY HIGH DENSITY 3-DIMENSIONAL COMPLEMENTARY
MOS TECHNOLOGY***

***3-DIMENSIONAL SILICON INTEGRATED CIRCUITS WITH
SPUTTER EPITAXY AND JUNCTION ISOLATION***

***3-DIMENSIONAL ION BEAM AND HETEROJUNCTION
PROCESSES***

3-DIMENSIONAL DEVICE MODELING

3D PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC	RESEARCHER	DEPARTMENT
VERTICAL, PLANARIZED CMOS INTEGRATED CIRCUITS AND SYSTEMS	B. HOFFFLINGER A. TUSZYNSKI M. LIU G. WEHNER R. WARNER	ELEC. ENG.
BJT AND FET MODELING	M. SHUR A. NUSSBAUM B. HOFFFLINGER R. WARNER	
SILICON 3D ICS USING SPUTTER EPITAXY	R. WARNER G. WEHNER A. TUSZYNSKI	

3D PROJECT (CONTINUED)

TOPICS AND RESEARCHERS

TOPIC

RESEARCHER

DEPARTMENT

**ION BEAM TECHNOLOGY FOR
INTEGRATED CIRCUITS**

**P. COHEN
R. WARNER**

ELEC. ENG.

HETEROJUNCTION ISOLATION

**A. NUSSBAUM
M. SHUR**

ACOUSTIC MICROSCOPY

**R. MUELLER
W. ROBBINS**

3D PROJECT

A RESEARCH PROGRAM ON 3-DIMENSIONAL INTEGRATED CIRCUITS

***VERY HIGH DENSITY 3-DIMENSIONAL COMPLEMENTARY
MOS TECHNOLOGY***

***3-DIMENSIONAL SILICON INTEGRATED CIRCUITS WITH
SPUTTER EPITAXY AND JUNCTION ISOLATION***

***3-DIMENSIONAL ION BEAM AND HETEROJUNCTION
PROCESSES***

3-DIMENSIONAL DEVICE MODELING

SPECIAL MEIS FACILITIES

VLSI DESIGN LABORATORY (CALMA)

MICROELECTRONICS LABORATORY

SYNCHRON RADIATION X-RAY BEAMLIN

VLSI DESIGN LABORATORY (CALMA)

PRINCIPAL COORDINATOR: , PROFESSOR ALFONS TUSZYNSKI, E.E.

**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 \$50K PER YEAR.
EQUIPPED BY A GENERAL ELECTRIC GIFT VALUED AT \$600K
AND HOUSED IN IN SPACE REMODELLED BY MEIS FOR \$90K.**

MICROELECTRONICS LABORATORY

PRINCIPAL COORDINATOR: PROFESSOR GARY ROBINSON, E.E.

***A FACILITY FOR RESEARCH AND INSTRUMENTATION IN
MICROELECTRONIC MATERIALS, DEVICES AND INTEGRATED
CIRCUITS.***

***SUPPORTED BY FEDERAL GRANTS, CHARGES FOR SERVICES
TO THE INDUSTRIAL AND UNIVERSITY COMMUNITY, THE
CORPORATE AFFILIATES PROGRAM IN ELECTRICAL ENG-
INEERING, AND MEIS. MEIS IS PROVIDING \$350K AND THE
UNIVERSITY OF MINNESOTA \$200K FOR REMODELLING.***

SYNCHROTRON RADIATION X-RAY BEAMLINE

PRINCIPAL COORDINATOR: PROFESSOR JOHN WEAVER, CEMS

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 \$250K AND ARGONNE NATIONAL LABORATORY \$250K TO PURCHASE THE BEAMLINE.

SMALL GRANTS PROGRAM

MEIS AWARDED NINE SMALL GRANTS (ABOUT \$20,000 EACH) AS SEED OR MATCHING MONEY TO ENCOURAGE INDIVIDUAL PROFESSORS OR SMALL GROUPS TO APPLY TO EXTERNAL AGENCIES FOR GRANTS IN MEIS AREAS.

TOPIC	RESEARCHER	DEPT.	MEIS REQUEST	SOURCE/TIME
DESIGN AND ANALYSIS OF A NETWORK COMPUTER	S. BRUELL P. AFSHARI	CS	\$20K	\$140K/NSF/2YRS
AUTOMATIC ERROR RECOVERY IN ROBOT PROGRAMMING LANGUAGES	M. GINI	CS	\$20K	\$48K/NSF/2YRS
EXPERIMENTAL AND THEORETICAL STUDIES OF CHEMICAL VAPOR DEPOSITION PROCESSES	K. JENSEN	CEMS	\$20K	\$184/NSF/3YRS
LANGUAGE-DIRECTED COMPUTER DESIGN FOR PROLOG AND MODULA-2	P. BORGWARDT	CS	\$18K	\$ 48K/NSF/2YRS

SMALL GRANTS PROGRAM (CONTINUED)

TOPIC	RESEARCHER	DEPT.	MEIS	REQUEST/SOURCE/TIME
SOME ASPECTS ON AN IN SITU INTEGRATED CIRCUIT FABRICATION TECHNOLOGY	W. PERIA	EE	\$20K	\$150K/NSF/1YR
ALGORITHMIC STUDY OF COMBINATORIAL PROBLEMS	S. SAHNI	CS	\$20K	\$190K/NSF/30MO* 155K/ONR/30MO*
PROBLEMS IN COMPUTATIONAL COMPLEXITY	O. IBARRA	CS		\$190K/NSF/36MO*
MODELLING OF MULTILAYERED MODULATION DOPED FETS	M. SHUR	EE	\$20K	\$246K/NSF/3YRS 50K/HONEYWELL/3YRS
SURFACE FORCES APPARATUS	M. TIRRELL	CEMS	\$15K	\$89K/NSF-DOD/1YR*
STUDIES OF ELECTRONIC AND STRUCTURAL INTERACTIONS AT METAL AND SEMICONDUCTOR SURFACES AND INTERFACES...	J. WEAVER	CEMS	\$20K	\$109K/ARO/18MO* 274K/ONR/36MO* 262K/DOD/EQUIP.* 450K/NSF/42MO*

*** AWARDED**

TECHNOLOGY TRANSFER

WORKSHOPS AND SHORTCOURSES, E.G.,

**TEST TECHNOLOGY WORKSHOP TO BE HELD AT OCTOBER
1983 IEEE MEETING (ORGANIZER: A. TUSZYNSKI)**

SYMPOSIA, E.G.

**SYMPOSIUM ON ELECTRONIC PROPERTIES AND MICROELECTRONIC
APPLICATIONS OF ORGANIC THIN FILMS (ORGANIZER: L. MILLER)**

**VISITATIONS AND GROUP LEVEL SEMINAR EXCHANGES
BETWEEN UNIVERSITY AND INDUSTRIAL RESEARCHERS**

**SUMMER JOBS IN LOCAL INDUSTRY
FOR MEIS GRADUATE STUDENTS**

PUBLICATIONS IN REVIEWED LITERATURE

MEIS SEMINAR SERIES

**CREATED TO BRING IN SPEAKERS OF INTERNATIONAL
REPUTATIONS IN AREAS RELEVANT TO MEIS**

**AIM OF SEMINARS IS TO HELP SET AND CALIBRATE
STANDARDS OF EXCELLENCE IN THE AREAS OF MEIS**

1983 CORNERSTONE LECTURE

BY

**MR. WILLIAM NORRIS, CHAIRMAN OF THE BOARD
AND CHIEF EXECUTIVE OFFICER**

CONTROL DATA CORPORATION

ON

"TECHNOLOGICAL COOPERATION: A NATIONAL IMPERATIVE"

MEIS GRADUATE FELLOWSHIP PROGRAM

**GOAL IS TO ATTRACT HIGHLY QUALIFIED GRADUATE STUDENTS IN
MICROELECTRONIC AND INFORMATION SCIENCES**

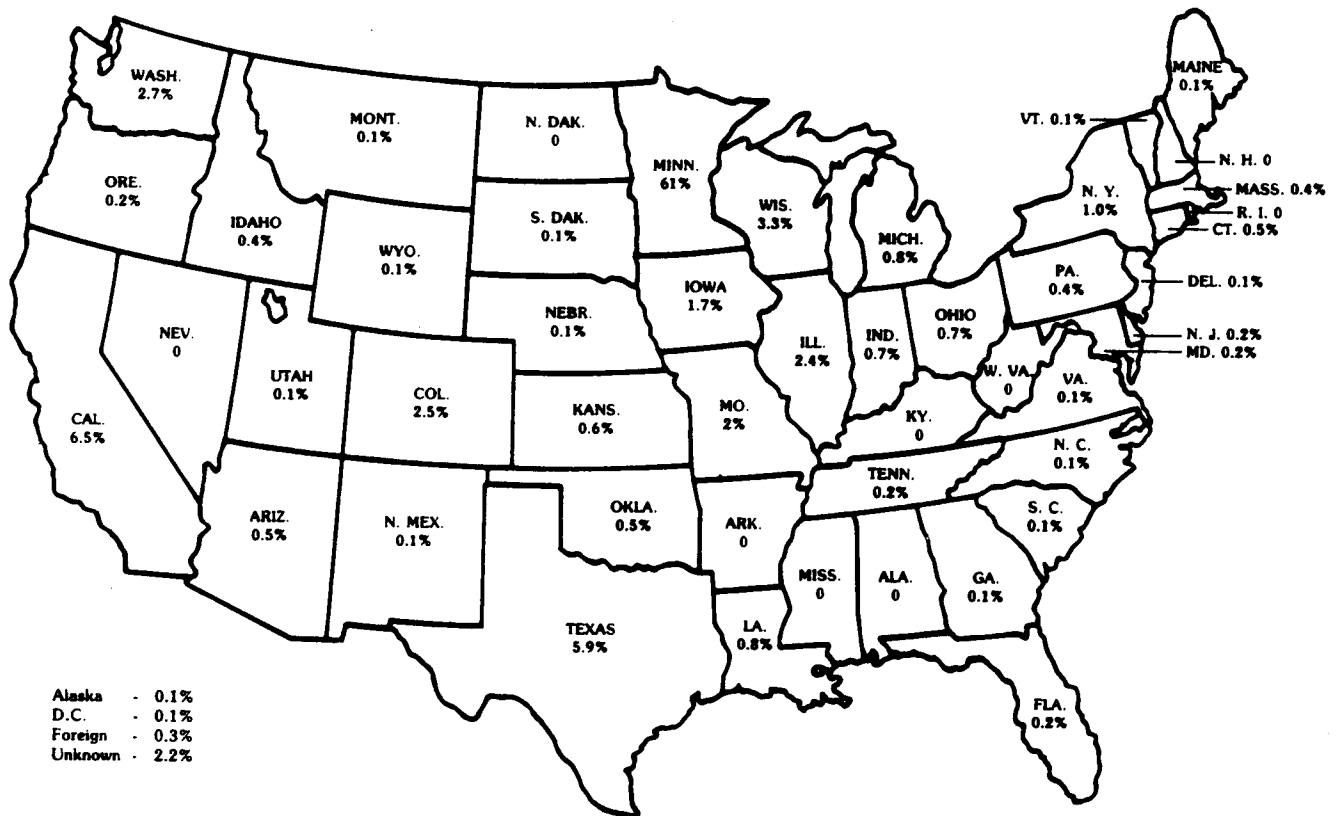
1983-84 AWARD IS FEES AND TUITION AND \$8200 FOR NINE MONTHS

A TOTAL OF 35 MEIS FELLOWSHIPS HAVE BEEN AWARDED

	1982-83	1983-84
CHEMICAL ENGINEERING AND MATERIALS SCIENCE	0	2
CHEMISTRY	1	2
COMPUTER SCIENCE	7	6
ELECTRICAL ENGINEERING	9	5
PHYSICS	1	2

MINNESOTA HOLDING POWER DISTRIBUTION OF FIRST POSITIONS: INSTITUTE OF TECHNOLOGY BACCALAUREATES

Figure C-1



From a February, 1983 MHTC report.

COURSE DEVELOPMENT

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

- 5013 INTRODUCTION TO ELECTRONIC PROPERTIES OF MATERIALS
MATS. SCI. Quantum mechanics of electronic interactions in
 atoms, molecules and solids. Introduction to modern
 techniques to examine electronic solids.
- 8213-8214 ELECTRONIC PROPERTIES OF MATERIALS
MATS. SCI. Graduate level band theory of solids, their surfaces
 and interfaces.

COURSE DEVELOPMENT
COMPUTER SCIENCE

- 5180-5181 SOFTWARE ENGINEERING
CSci. Train managers/designers for multi-person software projects. Team design projects include span life cycle - central design database - and advanced technologies
- 5280-5281 COMPUTER AIDED DESIGN
CSci. Train developers of design automation systems. Individual assignments include hardware. Description languages and key design automation algorithms.

COURSE DEVELOPMENT
ELECTRICAL ENGINEERING

- EE 3351 INTRODUCTION TO LOGIC DESIGN AND MICROPROCESSORS
Boolean algebra and logic gates. Combinational logic and design examples. Sequential logic and design of sequential logic systems. Basic computer organization and assembly language programming. Instruction types and addressing modes. Subroutines. Integral laboratory.
- EE 3352 MICROPROCESSORS
Programmable logic devices, memory devices, and microprocessors. Input/output for a microprocessor and peripheral devices. Interrupt driver input/output. Design of microprocessor-based systems. Integral laboratory.
- EE 5571 VLSI SYSTEMS
System architecture and circuit configuration in the design automation perspective.
- EE 5572 VLSI CIRCUIT DESIGN
Circuit design techniques in theory and practice for MOS, CMOS, and BJT circuits. Interactive design and design automation tools for circuit, logic, and layout.

COURSE DEVELOPMENT
ELECTRICAL ENGINEERING (CONTINUED)

- EE 5573 TEST AND DIAGNOSTICS
Circuit modeling, test-program generation, and actual testing of MOS, CMOS, and BJT devices. Yield analysis, parametric testing, and adverse analysis.
- EE 5574 VLSI TECHNOLOGY
Engineering of BJT, MOS, and CMOS devices. VLSI processes. Process and device modeling. Test structures. Design rules.
- EE 5575 VLSI DESIGN LABORATORY
Multi-project chip designs based on EE 5572. Processor elements - CLA Adder, Static CMOS Adder and Booth-Wallace Multiplier. Signal Processing. Switched capacitor A/D convertor, adaptive filter, flash A/D converter, and precision modules.
- EE 5576 VLSI DEVICE MODELING
Process and device characterization. Advanced modeling and scaling considerations for BJT, MOS, and CMOS devices. Process fluctuations and yield statistics.

COURSE DEVELOPMENT
ELECTRICAL ENGINEERING (CONTINUED)

- EE 5670 BASIC MICROELECTRONICS
Experimental and theoretical studies of the basic physical processes used in microelectronic device fabrication. Transistor and integrated circuit layout, fabrication, and evaluation.
- EE 8451 DESIGN AUTOMATION OF VLSI DIGITAL SYSTEMS

EXPANSION OF FACULTY IN MEIS AREAS

COMPUTER SCIENCE

**DR. PARVEZ AFSHARI, ASSISTANT PROFESSOR.
RESEARCH INTERESTS IN COMPUTER
ARCHITECTURE**

**DR. PETER BORGWARDT, ASSISTANT PROFESSOR.
RESEARCH INTERESTS IN VLSI DESIGN
AND COMPUTER ARCHITECTURE**

**DR. MARIA GINI, ASSISTANT PROFESSOR.
RESEARCH INTERESTS IN ARTIFICIAL
INTELLIGENCE AND ROBOTICS**

EXPANSION OF FACULTY IN MEIS AREA (CONTINUED)

ELECTICAL ENGINEERING

***DR. IN HWANG, ASSISTANT PROFESSOR.
RESEARCH INTERESTS IN ERROR DETECTION
AND CORRECTION IN COMPUTER SYSTEMS***

***DR. MAREK PERKOWSKI, VISITING PROFESSOR.
RESEARCH INTERESTS IN COMPUTER-AIDED
LOGIC AND LAYOUT DESIGN***

EXPANSION OF FACULTY IN MEIS AREAS (CONTINUED)

CHEMICAL ENGINEERING AND MATERIALS SCIENCE

**DR. JOHN WEAVER, PROFESSOR.
RESEARCH INTERESTS IN ELECTRONIC
MATERIALS, X-RAY BEAMLINE SPECTROSCOPY**

**DR. ALFONSO FRANCIOSI, ASSISTANT PROFESSOR.
RESEARCH INTERESTS IN THE ELECTRONIC
PHYSICS OF SEMICONDUCTOR/METAL
INTERFACES.**

MEIS FUNDING RESOURCES

COMPANY SPONSORS

CONTROL DATA CORPORATION	\$2M
HONEYWELL, INC.	2M
SPERRY	1M
3M	1M

INCOME ACCRUAL ON MEIS FUND	1M
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EXTERNAL RESEARCH GRANTS AWARDED 1982-83

NATIONAL SCIENCE FOUNDATION	.85M
DEPARTMENT OF DEFENSE	.85M
SEMICONDUCTOR RESEARCH CORPORATION	.45M

1983-85 LEGISLATIVE SPECIAL	1.2M
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UNIVERSITY OF MINNESOTA

MICROELECTRONICS LABORATORY	.20M
COMMITMENT TO CONVERT 11 MEIS STARTUP POSITIONS TO STATE BUDGET - TOTAL VALUE ABOUT \$300K/YR	

TOTAL \$10.55M

1982-1983 ALLOCATIONS

**Industrial, State, Federal
Funding to Establish a
Regional Center
of Excellence**

