MIT Program Offers Dual MS Degrees in Engineering and Management

A unique two-year program at the Massachusetts Institute of Technology offers students an opportunity to receive simultaneous master's degrees—one from the Sloan School of Management and one from a department in the School of Engineering. Participants can earn the degrees in 24 months under a very directed, intense academic program that is substantially more demanding than that leading to a regular master of science degree.

The program, Leaders for Manufacturing, is designed to educate a new generation of manufacturing leaders by combining management and engineering education. Graduates of the program will have both the technical and managerial skills required to lead sophisticated manufacturing projects and operations that take advantage of the latest technologies.

Prof. Lester C. Thurow, dean of the Sloan School, said executives with such a background could help U.S. business regain its competitive edge. "Today, most top managers in Europe and Japan have a technical education, while most U.S. managers don't," he said. "As a result, foreign companies have been more willing to take risks on new technologies."*

The master's program is part of a larger educational and research partnership between MIT and nine manufacturing corporations:

Aluminum Company of America
The Boeing Company
Digital Equipment Corporation
Eastman Kodak Company
Hewlett-Packard Company
Johnson & Johnson
Motorola Inc.
Polaroid Corporation
United Technologies Corporation

The cooperative program is intended to identify the critical issues and knowledge base needed for manufacturing leadership.

MIT plans to establish the principles that will be taught in the program, and ultimately practiced in industry, through multidisciplinary investigations of all phases of the manufacturing process—design, development, production, marketing, delivery, and service. In order to guarantee the practical focus and usefulness of the initiative, the industrial partners are actively participating in both the educational developments and the research projects. Eventually, 10-15% of the faculty in the MIT Schools of Engineering and Management will be directly involved in the program.

According to Prof. Gerald L. Wilson, dean of the School of Engineering, "Students in the program will be required to spend up to six months in an industrial manufacturing environment under close faculty and industrial supervision, modeled after our Chemical Engineering Practice School and Engineering Cooperative Programs. It is a marvelous opportunity for academia and industrial practioners to learn from one another, and for us to formulate the principles for educational innovation."

Twenty Manufacturing Fellows will be selected for the program beginning in 1989. Each will receive a full-tuition grant and a monthly stipend of about $930 for the 24-month period.

For additional information, contact: Leaders for Manufacturing Program Office Massachusetts Institute of Technology Room 9-319 Cambridge, MA 02139 Telephone: (617) 253-1055 Fax (617) 253-1462

**Editor's Note: See the text of Thurow's plenary address at the 1988 MRS Fall Meeting, "Maintaining Technological Leadership in a World Economy," on p. 43.*

Irish Government Funds Optronics Initiative

In January 1989 the Irish Government launched the "Optronics-Ireland" initiative, aimed at the development, coordination, and marketing of Irish optoelectronics products.

The program, proposed and directed jointly by Liam Kelly of the National Microelectronics Research Centre (NMRC) and John Hegarty of Trinity College Dublin, is being administered by Eolas, the Irish Science and Technology Agency.

The bulk of the funding will be used to establish an Optronics Materials and Device Centre at the NMRC (£1.25 million), an Optronics Laser Centre at Trinity College (£1.25 million), and also support laboratories at the physics departments of University College Dublin, University College Galway, and the National Institute of Higher Education in Dublin. The total project funding over the first three years is more than £3 million, and the scheduled expenditure of £1.12 million for the first year has been formally approved.

Optronics Ireland seeks to provide Ire-

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land with a coordinated core of expertise and research in one of the fastest growing sectors of the electronics industry. Estimated world markets in optoelectronics exceed $8 billion, of which components account for 25% and annual growth sales are 20-30%.

The NMRC expertise is in semiconductor device fabrication, which claims a market of $1.24 billion worldwide £350 million in Europe.

The new infrastructure will form the base for establishing an indigenous optoelectronics manufacturing industry and is expected to strengthen the ability of development agencies to attract international investment.

Optoelectronics technology is used in a wide range of domestic and industrial products ranging from optical disk players to fiber optic telecommunications and lasers. Heavy investment in Ireland has already been made in the technology by Telecom Eireann. The Optronics Ireland initiative is expected to stimulate considerable downstream employment and industrial development.

I.W.B.

S.P. Shah Cited for Contributions to Concrete Technology

Surendra P. Shah, professor of civil engineering and director of the new National Science Foundation Center for Advanced Cement-Based Materials at Northwestern University (Illinois), will receive the American Concrete Institute's Arthur R. Anderson Award. The award will be presented at the group's 1989 spring convention in Atlanta, Georgia.

Shah will receive the award for "outstanding contribution to the advancement of knowledge of concrete as a construction material." Shah was also cited for "effectively transmitting to the profession the results of his and others' research on the applications of classical fracture mechanics to concrete and fiber-reinforced concrete."

An expert in concrete, structural engineering and building materials, Shah has been particularly involved with constitutive relationships, failure and fracture of concrete, nonlinear fracture mechanics applied to rock, fiber-reinforced concrete, high-strength concrete, impact and impulsive loading, and the behavior of concrete structures subjected to seismic excitation.

Shah, who has published more than 250 papers, has been a visiting professsor at the Technical University of Denmark and the University of Sydney. He was a NATO Senior Visiting Scientist to France in 1986 and served on a Danish government advisory committee on concrete research that same year.

Shah joined the Northwestern faculty in 1981. He holds degrees from B.V.M. College in India, Lehigh University, and Cornell University.

High Voltage Engineering to Purchase Analytical Products Group

High Voltage Engineering Europa B.V. (Amersfoort, Netherlands) has signed a letter of intent with Genus Inc. (Mountain View, California) to purchase the Analytical Products Group from Genus' Ion Technology Division (Newburyport, Massachusetts).

The Analytical Products Group markets and services ion beam technology equipment for the scientific, educational and industrial communities and was part of General Ionex Corporation.

High Voltage Engineering Europa B.V. is a wholly owned subsidiary of High Voltage Engineering Corporation (USA). It specializes in the development and manufacture of particle accelerators and systems for ion implantation and ion beam analysis, and has more than 40 years experience in this field.

Through the acquisition High Voltage Engineering Europa B.V. positions itself as a major and highly diverse particle accelerator manufacturer for the scientific and industrial research communities.

Piezoelectric Polymer Forms Heart of Inexpensive Bolt-Sized Accelerometer

Using a piezoelectric film of polyvinylidene fluorine (PVF-2), Sandia National Laboratories has developed a low- cost accelerometer that can measure and survive changes in velocity generating forces hundreds of thousands of times greater than the force of gravity.

The instrument, intended primarily to help anti-ship missiles distinguish between the shock of anti-aircraft fire from contact with the intended target, is extremely sensitive and could be manufactured for $10 or less. Sandia researchers say the device is operational over a wide temperature range, and the design could be modified to meet a variety of applications.

The heart of the accelerometer is a piezoelectric polymer material—an extremely thin film of PVF-2—that generates electrical energy in response to changes in mechanical forces. The instrument is generally in-

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stalled inside the head of a bolt that has been machined to produce a circular well. The PVF film is cemented to the bottom of the cavity, and a weight mass of tungsten carbide is glued to the top of the film. The mass is capped with a special microcircuit that amplifies any charge generated by the film.

In many applications, the tungsten carbide mass can be omitted. In some specific cases, the microcircuit itself can be omitted because the PVF-2 would provide sufficient mass and/or signal output to perform the desired function.

Currently no similar device is available for missile applications, and because the design can easily be modified, the accelerometer might have other applications.

For example, by changing the type of weight mass, the maximum output of the device could be tailored to specific gravity forces. Used in automotive airbag systems, this might help the car distinguish between a collision and a bump in the parking lot.

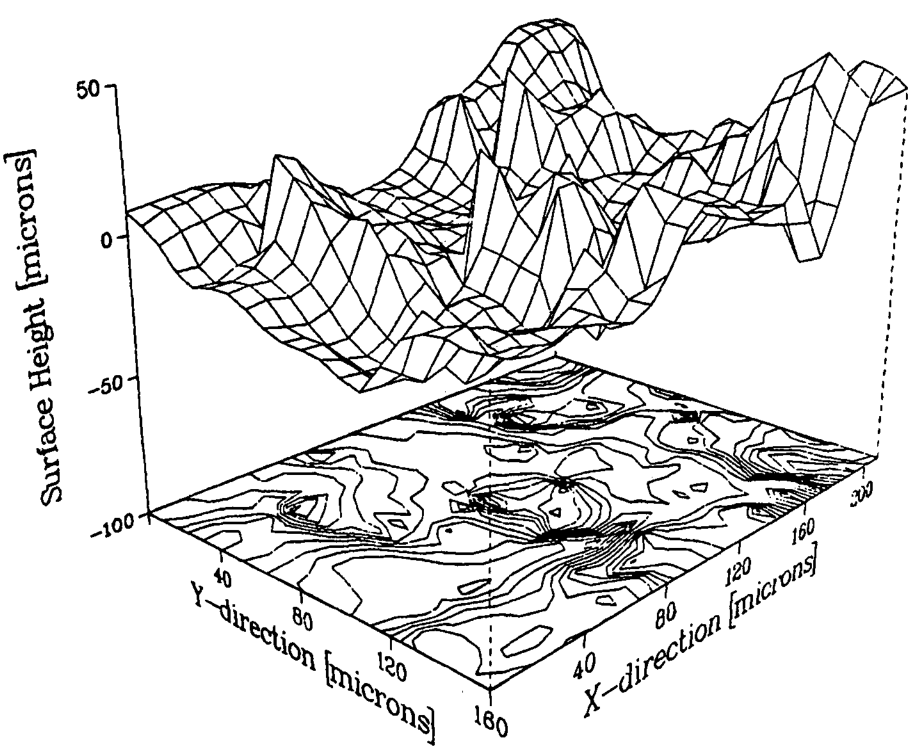
Other scientists at Sandia are using shock test research to test PVF-2 materials which require even more sensitivity. A newly perfected piezoelectric shock sensor, developed in France, has expanded the range of shock stress measurements. The sensor permits study of more intense and shorter duration shock events than previous sensors.

3-D Stereo Imaging Applied to Fracture Studies

Stereographic imaging, like that used to make old-fashioned stereoscopes and children's 3-D viewers, is being combined with advanced image analyzers and computing to give Los Alamos National Laboratory scientists a closer look at how and why materials break.

The technique provides a precise way to measure such features as the roughness of a fractured surface and the total area of the surface. The technique can be especially valuable in the design of new composite ceramics impregnated with tiny "whiskers" that increase strength and toughness without adding much weight.

The method begins with two pictures of a fractured surface that are taken a few degrees apart. These "stereo pairs," which can be taken with optical equipment or a scanning electron microscope, produce a 3-D picture of the whole surface or any portion of it.



Roughness map shows the fracture surface of a composite of molybdenum disilicide and silicon carbide "whiskers" added to increase the material's high-temperature strength and room-temperature toughness. The sample was tested at 1,400°C. The map was generated with a supercomputer by D. Carter of Los Alamos National Laboratory.

"Then, using a computer program and image analyzer, you can digitize the picture and obtain the height of every feature with respect to a reference point," said David Carter of the Materials Technology: Metallurgy and Ceramics Group at Los Alamos. "With this information, you can make a 3-D graph of the surface and calculate the roughness parameters," he continued. Carter, a materials scientist, first applied the procedure in studies for his master's thesis.

Clarkson University Plans Microcontamination Control Center

A clean room is the first step in the development of a center at Clarkson University for identifying and controlling microcontamination.

Tentatively called the Center for Particulate Control in Process Equipment and located on the university's campus at Potsdam, New York, the clean room will house research attempting to solve the problems of silicon wafer contamination by deposits of particles invisible to the eye. Valued at about $300,000 and funded primarily by IBM, the room will be used to develop processes to remove particles less than 1 micron from the wafers.

Once a chip circuit is printed on a wafer it ends up costing about $20,000. Clarkson researchers say that 50% of all silicon wafers are discarded because of submicron particles that can't be removed from the chips. Thus, substantial savings are possible if the discard rate can be reduced.

With this facility, Clarkson will be the only university in the United States with a Class 10-rated clean room, which means there are no more than 10 particles larger than half a micron in a cubic foot of space. As the center develops, further work will be done to identify contaminants and determine what they are, where they come from, and how to control them. Clarkson officials expect the results to be of interest not only to the semiconductor industry, but to the pharmaceutical, aerospace, and photographic film industries as well.

Probe Continuously Monitors Electroplating Solutions

A tuned frequency impedence probe developed by materials specialists at Sandia National Laboratories can continuously monitor the additive concentration of the chemical bath solutions used for electroplating. The electronic instrument was developed to improve process monitoring and control by ensuring that chemical baths maintain proper amounts of organic

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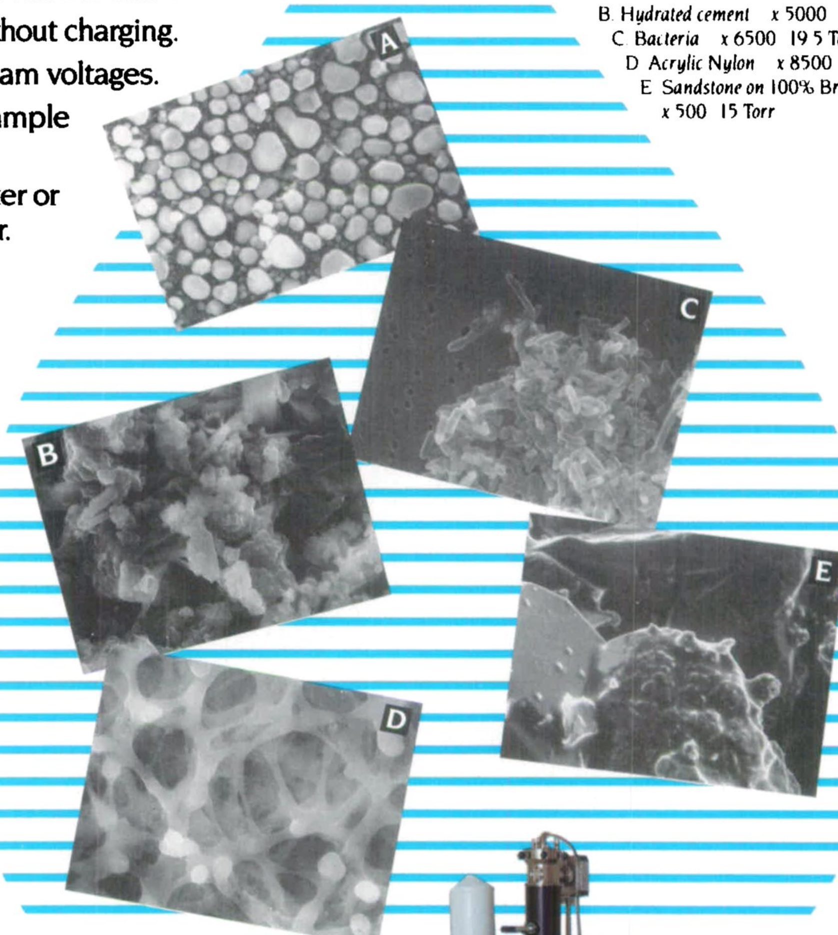

A. *Gold on carbon* x 50,000 12.2 Torr
B. *Hydrated cement* x 5000 13 5 Torr
C. *Bacteria* x 6500 19 5 Torr
D. *Acrylic Nylon* x 8500 18.5 Torr
E. *Sandstone on 100% Brine* x 500 15 Torr

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additives.

A working prototype of the probe has been built, tested, and used successfully for electroplating, but the technology has not yet been transferred for commercial development. A U.S. patent is expected soon.

The prototype has three wire electrodes that can be incorporated in a flow-through electrochemical cell or in a submersible wand. The working electrode and the counter electrode are made from platinum or gold. The reference electrode is made from the metal being deposited (the prototype was copper).

Wires lead from each electrode to an electronic box that generates two types of wave forms. As the wave forms are generated, the instrument measures the phase shift between the voltage and the current.

"This phase shift is a very sensitive measure of the concentration of organic species on the probe surface," explains William D. Bonivert, one of the probe's co-developers. "As the organic level goes up and down in the bath, so does the phase shift, and the instrument is designed to put out a voltage that is proportional to the shift," he continued.

Los Alamos Researchers Test Short Wavelength Lasers

Using a light refraction phenomenon called total-external reflectance could make short-wavelength lasers far more efficient and ease the way toward new lasers that use shorter, invisible wavelengths not normally available in conventional lasers.

Researchers at Los Alamos National Laboratory say this application could open the way for lasers that operate in the extreme ultraviolet range using very short wavelengths. Such laser beams will greatly enhance the study of fundamental properties of materials, which absorb the beams rather than reflect them as other lasers do.

In developing the new technology, the Los Alamos team has built upon Soviet research in total-external reflectance (TER), a phenomenon that occurs when a light beam crosses the boundary between one medium and another with a lower index of refraction.

A laser beam traveling across a vacuum, which is one medium, to a second medium that induces TER, such as aluminum or silicon, will be highly reflected when it hits the second medium at a steep enough angle—and thus can dramatically increase its power output.

Recent Los Alamos tests of a unique nine-planed aluminum mirror using extreme ultraviolet light demonstrated an unprecedented reflectance of 89%—about three times higher than any other reflector at such short wavelengths.

Impediments to high reflectance, such as absorption caused by an oxide layer forming on the mirror surface when water vapor or air get into the laser cavity, must be avoided.

The Los Alamos approach entails firing free electrons through a "wiggler" that has magnets that change the direction the electrons are moving. This causes the electron to release energy in the form of light, producing a laser beam.

While free-electron laser technology is being researched for possible use in the U.S. Strategic Defense Initiative, the technology also has many biomedical, chemical, and materials science applications.

New Device Sputters Metal Coatings with Increased Speed and Uniformity

A new device offering greater speed and uniformity in metal plating through ion beam sputtering has been developed and patented by Donald J. Sharp of Sandia National Laboratories.

By using a hollow cylindrical target, Sharp's device improves the uniformity of deposition when materials are sputtered onto a substrate. Most ion sputtering devices use a flat target, and the result is not uniform.

The cylindrical target geometry offers several advantages:

- Ions strike the target material at a glance, kicking up more debris than they do when hitting the target head on, thereby resulting in faster deposition;
- The positively biased ion bombardment at one end of the negatively biased cylinder produces a steady beam of metal for plating flat substrates like silicon wafers; and
- By introducing ion beams from both ends of the cylinder it is possible to plate spherical or odd-shaped objects suspended inside.

The invention was inspired by the need

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to put down a uniform coating on the microballoons used in Sandia's particle beam fusion accelerator. The new device proved inappropriate for the microballoons, but the technology appears promising when a very high rate of sputtered deposition is important, or when it is desirable to clean the substrate immediately before plating.

With a target cylinder at ground potential and the substrate biased negatively, the positively biased ion beam will pass through the center of the cylinder and strike the substrate. This will clean the substrate with ion bombardment immediately before plating begins, simply by switching a negative charge of approximately 2 kV back over to the cylinder. Deposition can then take place on a freshly cleaned substrate, ensuring optimum adhesion.

D.R. Ulrich Receives Strategic Defense Award

Donald R. Ulrich, a structural chemist for the U.S. Air Force Office of Scientific Research, was awarded the American Defense Preparedness Association's Strategic Defense Award for 1988. Ulrich is senior program director in AFOSR's Directorate of Chemical and Atmospheric Sciences, Bolling Air Force Base, Washington, DC.

Ulrich was recognized for his "pioneering contributions to the science of processing materials for applications in space defense technology." His management skills were also recognized "for creating a contract research effort of unequaled productivity in revolutionary concepts for the design and production of polymers, ceramics and composites."

Ulrich was cited for his contributions to ultrastructure processing, sol-gel science, chemical processing of ceramics, polymer alloys and blends, ordered polymers and composites, nonlinear optical polymers, and multifunctional materials.

A member of the Materials Research Society, Ulrich has been a symposium organizer and proceedings editor for the MRS symposia on "Better Ceramics Through Chemistry" and "Electronic Packaging Materials Science II." He is also a co-organizer for the 1989 MRS Spring Meeting symposium on, "Processing Science of Advanced Ceramics," and the 1989 MRS Fall Meeting symposium on "Multi-Functional Materials."

Ulrich earned his bachelor's, master's, and doctoral degrees in ceramic engineering from Rutgers University. He also has a BA in liberal arts from Rutgers and completed postdoctoral work in electrical engineering at the University of Minnesota.

Desktop Program Calculates Interactions of Rough Surfaces

Working with guidance from the U.S. Department of Energy tribology project at Argonne National Laboratory, engineers at SKF Corporation have developed a desktop computer program to calculate the interactions of rough surfaces. The program is called "Ruffian," an acronym for Rough Interface Analysis.

According to Allan Michaels, assistant manager of the tribilogy project, "It calculates the microtopological and mechanical properties of round and flat surfaces in either stationary or moving contact."

"The program is of primary use to the bearings, gear and engine manufacturing industries," said Michaels. "It performs computations for solid bodies in contact for specified loads, roughness, and separations," he continued. It also calculates temperatures generated at contact point, and its usefulness for predicting wear has already been established in experiments conducted by SKF for the U.S. Navy.

Co-developers of the probe are Bonivert, Joseph C. Farmer, and John T. Hachman.

APS Names Fellows, MRS Represented

The American Physical Society recently announced a select list of newly elected Fellows. The honor of APS Fellowship is reserved for members "who have contributed to the advancement of physics by independent, original research, or who have rendered some other special service to the cause of the sciences."

Among the newly elected Fellows are 17 members of the Materials Research Society:

- Division of Atomic, Molecular, and Optical Physics

James B. Gerardo, "For scientific contributions in gaseous electronics, electron dynamics in plasmas, laser physics, plasma physics, and laser analytical measurement methods."

Richard A. Gottscho, "For new insights into the mechanisms of rf plasmas, and for new spectroscopic techniques for their characterization."

Harvey A. Gould, "For contributions to understanding strong-field QED effects in highly ionized atoms and for setting the experimental upper limit on the electron electric dipole moment."

- Division of Condensed Matter Physics

Robert J. Cava, "For contributions to the materials physics of ceramic superconductors."

Kenneth A. Jackson, "For contributions to crystal growth theory and for experimental investigations of growth and instability phenomena."

Hiroshi Kamimura, "For contributions to the theoretical understanding of electron states in solid state systems and for promoting closer ties between the Physical Society of Japan and the American Physical Society."

John R. Kirtley, "For theoretical and experimental contributions elucidating electron tunneling and the interaction of electrons with photons and phonons."

Bennett C. Larson, "For x-ray scattering studies of defects in crystals and of the melting-crystallization transition."

Hadis Morkoc, "For numberous innovative contributions in molecular beam epitaxial growth of semiconductor structures."

Stephen L. Sass, "For the use of x-ray diffraction to advance our understanding of the structure of crystalline grain boundaries."

Dale W. Schaeffer, "For experiments on the structures and dynamics of complex fluids and for studies of fractal structures in varied condenses matter systems."

Thomas A. Witten, "For theoretical contributions to our understanding of stochastic diffusive growth, colloidal aggregation, and polymer statistics."

Donald J. Wolford, "For advances in fundamental understanding of defects and electronic properties of semiconductors."

- Division of High Polymer Physics

Hugh R. Brown, "For the development of novel and powerful experimental methods for investagating crazing in polymers."

Barry L. Farmer, "For his leadership role in computer modeling of polymer conformations, structures, defects, crystallization, diffusion, and relaxations."

Hyuk Yu, "For his versatile investigations on light scattering in polymer solutions, polymers at interfaces and biological systems, especially applications of forced Rayleigh scattering."

- Materials Physics Topical Group

Elton N. Kaufmann, "For development and application of a broad range of techniques such as nuclear and electron resonance spectroscopies and ion beam analysis to fundamental studies in materials science." □

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