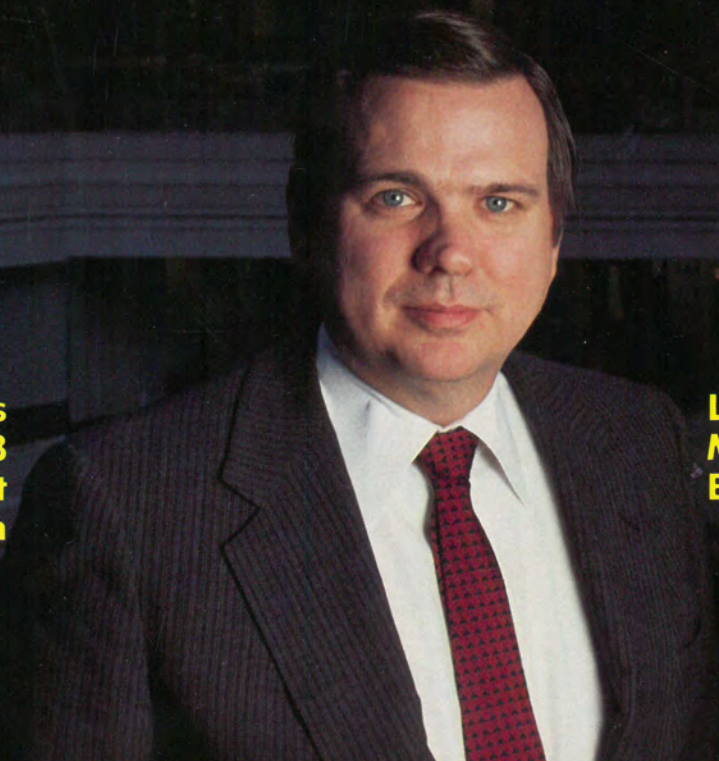




MIT

MANAGEMENT



**Bain & Co.'s
EVP Vern Altman SM '73
Talks about
strategy at Bain**

**Leaders for
Manufacturing —
Bold new MIT program**

**Annual Report
1987-1988
Pages 39-60**

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A program that could change the world

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LEADERS FOR

A program that could

Applied technology. Digital Equipment Corporation's Storage Heads business located in Shrewsbury, MA is responsible for the supply of magnetic Read/Write heads for all Digital-manufactured tape and disk drives. Pictured, the first Leaders for Manufacturing class in the RA90 Head/Arm assembly process, the newest large disk drive offered by Digital Equipment Corporation. The Shrewsbury manufacturing process is an MRP II Class A certified facility.

MICHAEL LUTCH



MANUFACTURING

change the world

“WE WANT FORTY TO FIFTY FACULTY WORKING together who feel they can change the world,” Professor Tom Magnanti (Management Science) says when he introduces the new Leaders for Manufacturing program at MIT.

“The Engineering and Management faculty have been doing things under the rubric of manufacturing for years. The program builds on that base,” says Professor H. Kent Bowen (Materials Science and Engineering). Bowen spearheaded development of the program and co-directs it with Magnanti.

“The bottom line is that it is manufacturing that creates wealth,” Associate Professor David Hardt (Mechanical Engineering) says.

“We spend a lot of time figuring out how to manufacture products that weren’t any good to begin with. The real problem is doing better design, which includes better design of the manufacturing process. I hope by the end of the five years Leaders for Manufacturing will be called Leaders for Design,” Associate Professor Warren Seering (Mechanical Engineering) says.

Doubting Thomases who have been putting their money into Japanese yen, take

note. Leaders for Manufacturing is the new, experimental, five-year joint educational and research program that the MIT Schools of Engineering and Management and eleven of the nation’s leading manufacturing corporations have established to help the United States recapture world leadership in manufacturing.

The goals of the program are to develop a model curriculum for educating a new generation of leaders in manufacturing, and to draw some of the nation’s best students into careers in manufacturing industries.

The participating companies, whose commitment of funds, people, and plant



sites to the program underlines the seriousness of their intent, are Alcoa, The Boeing Co., Chrysler Corp., Digital Equipment Corp., General Motors Corp., Hewlett Packard Co., Johnson & Johnson, Eastman Kodak Co., Motorola, Inc., Polaroid Corp., and United Technologies Corp. Their partnership will help MIT attract the best and brightest students to the program as fellowship holders, and will permit the faculty to redirect their research and teaching.

The first twenty students (officially, "Fellows")—twelve of the top applicants to the Engineering graduate school and eight of the top applicants to the School of Management; fifteen men and five women—hit



Assistant Professor **Harry West** (Mechanical Engineering) demonstrating how a robot performs its task.

Cambridge and the books last June. Two years later, in June 1990, each will graduate with a Master's degree in Management, a Master's degree from an Engineering department, six months of on-site research experience with a sponsoring organization under close faculty and industrial supervision, and, if all goes according to plan, one or more of the best job offers this country can make to its newest university graduates.

The Institute's commitment is enormous. Eventually 10 to 15 percent of the faculty of both the Schools of Engineering and Management will be involved. Several hundred students (in addition to the Fellows) will participate in related research, including Ph.D.'s who will be tomorrow's educators.

"The program's purpose is to define that combination of educational experiences that will yield graduates who can be measurably more effective in the definition, design, manufacturing and delivery of high-quality products and systems," Dean Gerald L. Wilson of the School of Engineering says. "We want these students to emerge from the program as agents for change—as industrial revolutionaries, if you will."

"Today, most top managers in Europe and Japan have a technical education, while most U.S. managers don't," Dean Lester C. Thurow of the School of Management says. "As a result, foreign companies have been more willing to take risks on new technologies." Leaders faces this deficiency by dedicating itself to educating Fellows with

the technical as well as managerial skills required to plan and run sophisticated manufacturing operations, and to engineering research that takes advantage of the latest concepts and technologies.

"Together, MIT and industry will work to focus the energies of some of the nation's most talented young minds on the problems of a critical economic sector," MIT President Paul E. Gray says.

MIT has a rich tradition in manufacturing with countless contributions to industrial practice and technology, some of which have spawned whole new industries. Computer-aided design (CAD), for example, traces its origins to the doctoral thesis of Ivan Sutherland, whose Sketchpad is acknowledged as the spark that ignited this growing new industry. In 1952, researchers at MIT's Servomechanism Laboratory demonstrated the world's first numerically controlled machine—often hailed as the single greatest advance in manufacturing of the century. Later, the Lab developed APT, now the worldwide standard language for programming numerically controlled tools. In the 1930s, with the close cooperation of Standard Oil of New Jersey (now Exxon), Professors Gilliland and Lewis developed the fluid-bed reactor technique for catalytic cracking of petroleum products. The first commercial plant to use this method, which started production in early 1942, made a major contribution to the war effort.

Additional examples of MIT's involvement with industry and manufacturing abound. In 1948 Alfred P. Sloan, Jr. SB 1895 gave the Institute \$1 million for a Metals Processing Laboratory that would provide, he said, "an instrumentality of significant progress . . . injecting science into the basic processes of production—a wide-open field for exploitation." Sloan's laboratory manufactured space equipment, cast early guidance systems, built jet and automotive engines, employed six foremen in its welding shop, and housed machine tools and a ten-ton blasting furnace. Much of its technology was not available anywhere else.

In the mid-1970s, the Institute built a \$20 million microelectronic center to provide students and faculty with hands-on fabrication facilities. In 1971, Professor Nam Suh (Mechanical Engineering) established the Industrial Polymer Processing Program, a model for dozens of consortia of industries that pool their funds to work on common problems. Early efforts of Materials Science and Engineering, and Mechanical Engineering faculty and students to deal with manufacturing problems resulted in the Laboratory for Manufacturing and Productivity and the Materials Processing Center. Graduates of the Chemical Engineering Practice School have run the country's leading chemical companies for more than seventy years. Campus-wide Project Athena is a large-scale, industrially

IFM Operating Committee

This Operating Committee of key company personnel from the Leaders sponsoring companies works side-by-side with Management and Engineering faculty to develop specific research projects and new subjects.

Charles Fletcher

Vice President, Engineering
Aerospace & Industrial Products
Alcoa

Thomas J. Tobey

Technical Operations Manager,
Corporate Headquarters
The Boeing Company

Frank McCabe

Vice President, Corporate Quality and
Process Technology
Digital Equipment Corporation

Rohn Harmer

Director of Manufacturing Engineering
Eastman Kodak Company

Sara Beckman

Manager, Manufacturing Strategic
Planning
Hewlett-Packard Company

John M. Matson

Corporate Director of Operations
Technology
Johnson & Johnson

William M. Beckenbaugh

Manager, Manufacturing Research
Center
Communications Sector
Motorola Inc.

Herbert Ahrens

Director, Manufacturing Strategic
Planning
Polaroid Corporation

Harsh Manglik

Director, Business and Manufacturing
Development
United Technologies Corporation



BRAD FORD HENZGAS

The LFM Governing Board meeting at the School of Management last September. Seated, l to r: Joseph Oldfield (Polaroid), Fred Fetterolf (Alcoa), Robert Hermann (United Technologies), Rohn Harmer (alternate, Eastman Kodak), Thomas Tobey (alternate, Boeing), William Hanson (Digital Equipment Corp.), Mauro Walker (Motorola), Sara Beckman (alternate, Hewlett-Packard). Standing, l to r: MIT faculty representatives Donald Rosenfield, H. Kent Bowen, Merton Flemings, Lester Thurow, Glen Urban, Arnoldo Hax. Missing: Stuart Christie (Johnson & Johnson), Thomas Magnanti, Gerald Wilson, David Wormley.

LFM Governing Board

This Governing Board of senior executives from the sponsoring companies and senior MIT faculty meets regularly to guide the overall course of the program.

COMPANY REPRESENTATIVES

C. Fred Fetterolf

*President and Chief Operating Officer
Alcoa*

Deane Cruze

*Vice President, Operations
The Boeing Company*

Albert D. Welliver

*Vice President, Engineering and
Technology
The Boeing Company*

William C. Hanson

*Vice President of Manufacturing
Digital Equipment Corporation*

William F. Fowble

*Senior Vice President and
General Manager Manufacturing
Distribution and Field Support
Eastman Kodak Company*

Harold E. Edmondson

*Vice President, Corporate
Manufacturing
Hewlett-Packard Company*

Stuart A. Christie

*Corporate Vice President
Operations Technology and
Development
Johnson & Johnson*

Mauro Walker

*Vice President and
Corporate Director of Manufacturing
Motorola Inc.*

Joseph Oldfield

*Vice President and Director
of Worldwide Manufacturing
Polaroid Corporation*

Robert J. Hermann

*Vice President, Science and Technology
United Technologies Corporation*

*Plus Representatives
From Chrysler and General Motors
to-be-named*

MIT FACULTY

Professor H. Kent Bowen

*LFM co-director
Department of Materials Science &
Engineering*

Professor Thomas L. Magnanti

*LFM co-director
School of Management*

Donald B. Rosenfield

Program Manager

Dean Lester C. Thurow

School of Management

Dean Gerald L. Wilson

School of Engineering

Professor Merton C. Flemings

*Department head
Department of Materials Science &
Engineering*

Deputy Dean Arnoldo C. Hax

School of Management

Deputy Dean Glen L. Urban

School of Management

Professor David N. Wormley

*Department head
Department of Mechanical Engineering*

Faculty named Leaders professors

Six members of the Management faculty and five members of the faculty of the School of Engineering have been named Leaders for Manufacturing Professors. Leaders Professors are actively involved with partner firms, mentor students and junior faculty, and participate in Pro-Seminars, sponsored research projects, and in the development and/or teaching of the Leaders curriculum. The new Leaders professors are:



Gabriel R. Bitran
Management Science



Thomas W. Eagar
Materials Engineering



Paul Lagace
Aeronautics and Astronautics



David H. Staelin
Electrical Engineering



Stuart E. Madnick
Management Science

supported experiment in the use of computers in education. And the list goes on.

"MIT has always had a strong component of people doing science and engineering for the benefit of mankind," Professor Thomas Eagar (Materials Science and Engineering) says.

Nevertheless, there was a time not too long ago when Metallurgical Engineering became Materials Science and less applied, when Mechanical Engineering became more engineering sciences-oriented, and when Physics began to concentrate even more on pure science. To preserve his interest in welding ("about as industrial as you can get"), Eagar learned to live with "a certain snobbery among pure scientists because my work has applications," and Hardt grew accustomed to suggestions that the Laboratory for Manufacturing and Productivity (which he directs) seemed "too applied, too goal-oriented, too down-to-earth."

Now Leaders for Manufacturing hopes to help change all that. The Program has recruited senior manufacturing faculty from other engineering disciplines (Hardt's early interest was bioengineering, which at

the time, 1978, was more "in" than manufacturing). Members of the faculty at the Schools of Engineering and Management will gain substantial institutional support for their work.

For example:

Assistant Professor Charles Fine (Management Science), who works on product and process quality improvement and manufacturing technology evaluation, "will have more access to firms interested in being sites for research, and more opportunity to do that research with bright students," he says.

Professor Steven Graves (Management Science) will have the opportunity to do more empirical work to validate his manufacturing systems models. "I would like to understand better how product design impacts manufacturing, what type of decision support you can provide to the design process to make a product easier to manufacture and service," he says.

David Hardt will be able to bring long term large-scale funding to the Laboratory for Manufacturing and Productivity, historically funded by modest research agreements with more than forty compa-

nies, "We have a litany of successes and failures in factories that we don't understand," he says. "We have many new questions, and need a sponsor base to fund our research into the answers." (The Laboratory for Manufacturing and Productivity has a full complement of seventy graduate students—an attractive pool of future faculty—eleven faculty and staff, and a half dozen associates.)

Professor Thomas Kochan (Industrial Relations) will "work with the companies to examine how human resources are integrated into the manufacturing place. I see us building improvements in performance," he says. "The companies will be able to learn from each other with data we collect across a broad base. This concept is near and dear to my heart."

Warren Seering, whose two-part graduate design course functions like a consulting firm, with the students seeing through their projects with industrial clients from negotiation and contract to delivery of product, looks forward to getting to know a sponsoring company well. "It's a dimension that keeps the job alive," he says.



BRADFORD HERZOG

Stephen C. Graves
Management Science



David E. Hardt
Mechanical Engineering



BRADFORD HERZOG

Thomas A. Kochan
Industrial Relations



BRADFORD HERZOG

Warren P. Seering
Mechanical Engineering



Robert J. Thomas
Organization Studies



BRADFORD HERZOG

Roy E. Welsch
Statistics and Management Science

Assistant Professor Harry West (Mechanical Engineering), who teaches and conducts research in areas of design, kinematics, and robotics, hopes to be able to enrich his research by working with a Leaders company on a project such as building cheap robots with sophisticated computerized parts to perform process machining.

Associate Professor Robert Thomas (Organizational Studies) looks into how firms make decisions about production technology. "Leaders is a unique opportunity and a unique audience for this kind of research. I'd like to follow a project from cradle to grave, tap into the different perspectives of all the participants, find out which solutions work and which do not. Then I would like to use that as a base for curriculum within the Sloan School and within the Leaders program. Engineers and managers need to learn more about each other, begin to speak the same language. There's no place else in the country that's making this effort at the intersection of engineering and management."

That's what it's all about, isn't it?

Certainly Tom Black thinks so. Black is

one of the hand-picked young college graduates who received a letter out of the blue last April asking if he or she, already accepted into the School of Management or a graduate department in the School of Engineering, would rather enroll in Leaders for Manufacturing. "The program is," Black says, "the greatest thing since sliced bread." His classes integrate information across disciplines in ways he has never imagined. For Kevin Freund, who had been working as an associate consultant at Bain & Co. and was "ready to get into a lineup, I see myself in a management position in a technical company. If I'm going to make strategic decisions I need to understand the technology." Bernard Loyd, who is also working for the Ph.D. degree in Aeronautics and Astronautics, wanted a field in management that would combine his background in aeronautics and international (he grew up in Chicago, Munich, and Liberia), and his interest in manufacturing. "Everything is becoming international, and manufacturing is at the core of everything because it produces goods," he says. Peter Moran came to MIT from a first level management job with a high-tech firm. He has

been impressed with the level of commitment of major professors and senior managers in the Leaders companies, and the opportunities the Fellows have to meet these people. He has found that both his design process class and the Fellows themselves illustrate problems of differing cultures that the Leaders program has been designed to address.

The Fellows all take the Management core curriculum as well as selected electives. Within the School of Engineering, they design individual programs within an Engineering department. In addition, all students take a required weekly Professional Seminar, the Program's major mechanism for bringing together its disparate constituencies of Management and Engineering faculty and students, and company sponsors. Together, in the classroom and afterward over sandwiches, they think about important broad issues in manufacturing. (Edgar Schein, Sloan Fellows Professor of Management, spoke at the first session on the relationship of people to work. In another session, David Hardt and Rebecca Henderson, a recent addition to the School of Management faculty, discussed both

Department of Business and Engineering Administration 1931

The purpose of this Course is to educate young men in the fundamentals which underlie the administration of technical enterprises. Successful administration in industry demands technical aptitude, business acumen and natural ability for leadership. These attributes are enhanced by training which provides a background of science and engineering, and at the same time develops a facility in the analysis and solution of business problems. A definite technique of administration now in process of development is proving unusually effective in the hands of those who are fitted to apply the scientific method to business management.

From the beginning of the factory system, scientifically trained men have served industry in planning, building, equipping and operating physical plants. In recent years there has been a growing appreciation of the value of their services in purchasing, selling, accounting and financing. It has been found that careful analysis, rigid logic and painstaking adjustment of means to ends are almost indispensable in every phase of business management under modern conditions of large production, keen competition and narrow margins of profit.

Since both scientific training and instruction in economics and business technique are essential to the all-round development of the business executive, it seems the part of wisdom to combine them in one Course. With this end in view, the Institute has developed a course in Business and Engineering Administration.

The establishment of the Course

was due to an inquiry made in 1913 by a committee of Institute alumni at the request of the Alumni Council. It was recognized that a considerable number of students did not, after graduation, follow an engineering or technical profession, but were drafted into commercial or managerial positions in industry. This committee first made a thorough survey of instruction given at that time in American colleges in business administration, commerce, finance, accounting and kindred subjects, but found no curriculum in force which combined these studies with engineering and applied science. As a result of this investigation it was recommended that "a new course be established whose aim shall be to furnish a broad foundation for ultimate administrative positions in commerce and industry by combining with a general engineering training instruction in business methods, business economics, and business law." In accordance with this report, the Faculty, at the request of the Corporation, established the Course, then called Engineering Administration, which graduated its first class in 1917.

Within a few years this course developed into one of the largest at the Institute. Between 1917 and June, 1931, 1,076 men have been graduated, or about fifteen per cent of the total number of men graduated by the Institute in all courses in the same period. That the curriculum is meeting a need is evidenced by the fact that over eighty-five per cent of the graduates of the first class undertaking Engineering Administration (1917) are now holding executive positions in industrial establishments.

—excerpted from a "circular issued to acquaint prospective students with the opportunities offered for both undergraduate and graduate study in this field."

technological and managerial aspects of computer integrated manufacturing.) During the seminar, students and faculty also look closely at each of the sponsoring companies, with student teams developing presentations and companies bringing in their own best in-house instructors. The Pro-Seminar can be a lot of work, not only preparing presentations but keeping up with the reading (e.g. *Kaisba—The Japanese Corporation: Relevance Lost: The Rise and Fall of Management Accounting: The Workplace Within*).

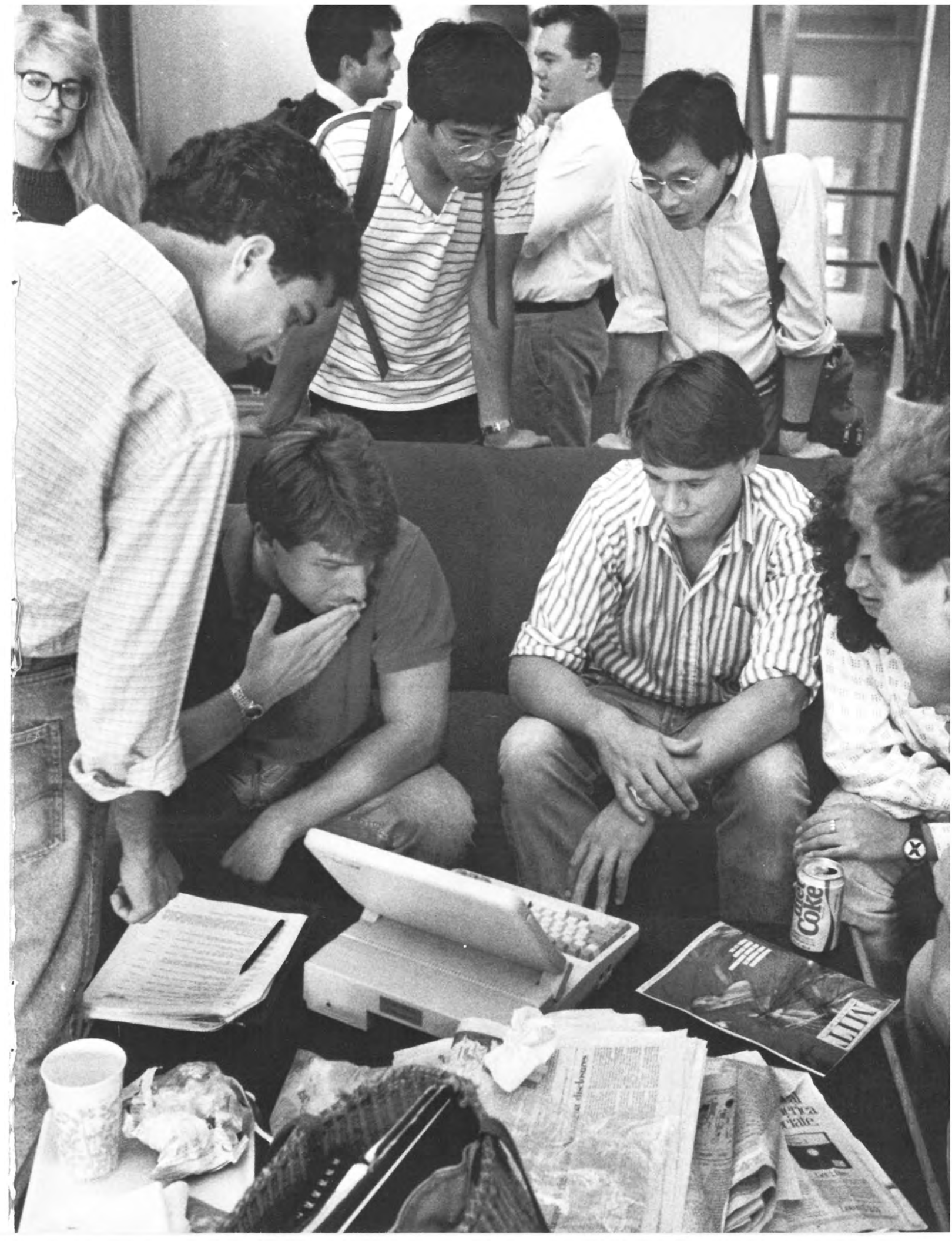
Leaders for Manufacturing is a partnership of two schools and a partnership with companies. It builds from a strong base of Engineering and Management faculty who conduct productive research in manufacturing arenas. Senior executives from the sponsoring companies comprise its Governing Board and Operating Committee, and meet regularly in Cambridge to chart the Program's course, identify its research interests, and evaluate its progress. They will be working actively with faculty to identify new opportunities for education and research, and to affect considerable change on campus. "Ten years ago it would have been heresy to talk about these things," Bowen says. "Four years ago we would have been shy to talk about them."

"We want a sense of teamwork and collegiality," Magnanti says. That community of feeling got off to a good start in August when eleven Management and Engineering faculty travelled together to Japan to get to know more about Japanese manufacturing methods, and not incidentally, to get to know each other. Already engineering terms are beginning to turn up in Management classrooms, and Management vocabulary is making its way into Engineering.

"Leaders is an opportunity to create a new model for research and manufacturing," says Professor Gabriel Bitran (Management Science), one of six Management faculty and five Engineering faculty appointed a Leaders for Manufacturing Professor. "It's very important for managers to understand the technology of engineering, and it's important for engineers to understand management points of view. It has always been important for engineers and managers to work together, but at this time it is more important than ever."

"The new model is for all universities. We want to see more university-manufacturer alliances. We want to be copied. And we want companies to count on the Program's graduates."

Leaders for Manufacturing begins as an experimental program. Much of its success rests on its ability to convince companies to give its graduates jobs that are consistent with their education and intelligence. The Program must make a difference. As it grows from concept to operating model, *MIT Management* will report. ■



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