tenauer, McDonnell Douglas' director of executive development. For the St. Louis-based corporation, the project already has paid dividends. At the recent NWPC convention in Los Angeles, its women lunched with Attorney General Janet Reno and Senator Dianne Feinstein (D-Calif.) and hobnobbed with powerful political insiders of both parties.

The training program is open to McDonnell's top 50 female managers. Twice this year, participants gathered to hear from officeholders, political consultants, and corporate officials and to attend seminars on public-policy issues that affect the company, such as soaring liability-insurance payments. State and local chapters of the Women's Political Caucus also work with the McDonnell executives, introducing them to a network of contacts at that level.

MALE SKEPTICS. The program represents quite a change for male-dominated McDonnell. Even though it has the company's official blessing, some insiders say that a few male employees are skeptical about a program designed to assist only women. "It's a little scary and intimidating for some of the men," says Bonnie W. Soodik of Huntington Beach, Calif., the only woman in the company's vice-presidential ranks. "But it's been intimidating for women forever."

And the intimidation doesn't end with victory at the polls. When Republican Patricia Secrest, co-founder of a small automotive-parts company, was elected to Missouri's House of Representatives in 1990, the GOP floor leader issued a warning about her male colleagues: "They aren't going to like pushy businesswomen asking questions." Undeterred, she helped shape a workers' compensation compromise to lighten the burdens on small companies—but not before a male lobbyist pinned her against a wall and "threatened to put his fist through my teeth," she recalls.

It was the 1991 clash between Supreme Court nominee Clarence Thomas and former aide Anita Hill that caused businesswomen to question the wisdom of their exile from politics. "A lot of women in the business community began to notice for the first time how few women are in the House and Senate," says Lynn Shapiro, executive director of WISH List, which raises money for pro-choice GOP women candidates.

Republican consultant Carol Whitney, who directed a recent Los Angeles training session for the McDonnell Douglas women, predicts that several of her star pupils will win public office. That could mean profound changes in women's politics, which has been dominated by community activists, teachers, and lawyers. That's a benefit to business that no public-relations campaign could buy.

By Richard S. Dunham in Los Angeles

Science & Technology

ENGINEERING

COMING OFF THE DRAWING BOARD: BETTER ENGINEERS?

Curriculums shift so industry gets the sort of graduates it needs

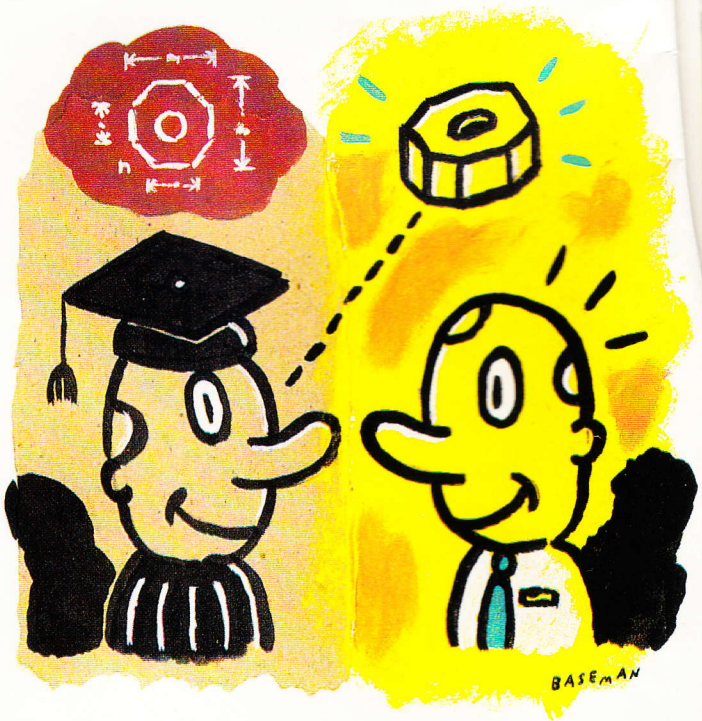
As an Apple Computer Inc. engineer in the 1980s, Joe Wujek recruited dozens of engineering students—and didn't like what he saw. Science-heavy studies and narrow specialization had left the new prospects without the skills to design products that mix mechanical and electronic components. And intense classroom competition between individual students was poor preparation for Apple's team approach to engineering.

Today, at 60, Wujek is trying to bring a real-world flavor to academia. At the University of California at Berkeley, where he now teaches, Wujek assigns students practical problems, such as building an easy-to-program VCR. His design class last spring broke with a hoary rule that barred freshmen lacking prerequisite studies from taking courses alongside seniors. Now, he has senior "managers" learning management skills by overseeing the design work of freshmen "engineers." And he has his students negotiate their grades with him—to prepare them for future salary wrangles.

MATH DIET. Groundbreaking moves such as Wujek's are leading the most dramatic change in engineering education since the late 1950s. Back then, U.S. schools responded to the Soviets' Sputnik launch by adopting a science-heavy curriculum. Ever since, engineering students typically have spent their first two years on a heavy diet of math, physics, and chemistry, then entered a specialty such as aerospace, chemical, mechanical, or electrical engineering. And the best students were often channeled into research careers. That alignment helped the U.S. build the rockets, solid fuels, and computers needed to land a man on the moon. And it helped propel the U.S. into the lead in new technologies—from computers to high-tech weaponry.

Now, however, the end of the cold war plus fierce global competition are redefining the nation's priorities. At the same time, the pervasive impact of electronics and other advances is blurring the differences between engineering specialties. To design electronics-laden cars and many other products, industry now wants engineers with both electrical and mechanical skills. Aware of such changes, one-third of the nation's 330 engineering schools are revamping their programs to make them more practical and responsive to industry. "This is a fundamental redesign of engineering education," says Robert Zemsky, co-director of the National Center on the Educational Quality of the Workforce.

Elite schools are leading the way. To stress practical skills, Stanford University, the University of Michigan, and



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others have begun master's degree programs requiring the completion of design projects rather than the traditional research thesis. In September, Berkeley will start a four-year "mechatronics" program that merges traditionally separate mechanical and electrical engineering studies. Responding to a 1990 survey of 90 technology experts in industry and government, Massachusetts Institute of Technology's aerospace department revised its curriculum to combine structural and propulsion engineering with new courses in statistics and computer science tailored for engineering managers.

TIMELY LESSONS. In another key change, some schools have begun teaching math and science within engineering courses, rather than in separate first- and second-year classes. Carnegie Mellon University now teaches differential calculus as part of a new sophomore electrical engineering course. Officials insists that such changes aren't meant to deemphasize math and science. Instead, this "just-in-time" approach means students learn calculus or chemistry in the context of engineering problems—rather than requiring them to recall the concepts from earlier courses. Administrators also hope it will help engineering schools—whose enrollments have dropped in the past decade by 13%, to 382,000—retain students who might switch majors out of frustration at having to take so many prerequisites before they can learn engineering.

Industry, meanwhile, is seizing what it views as an unusual chance to shape its future employees. "The people responsible for establishing curriculum are more open to working with industry than they have ever been," says Patrick J. Carroll, FMC Corp.'s director of corporate technology. He helped coax Stanford into developing programs that mix business school courses in management and budgeting with advanced engineering. And current and former executives from Boeing, Digital Equipment, Ford, and other companies are on campus, teaching such courses as spacecraft design at Stanford and manufacturing at MIT.

Four industry-academic consortiums, funded by the National Science Foundation, are pushing the curriculum changes. Some 34 schools are involved, including MIT, Stanford, California Polytechnic State University, and Howard University. One NSF coalition brought together workstation maker Sun Microsystems Inc. with Cornell University. Last October, Sun's manager of engineering education, G. Jeffrey Arnst, suggested developing courses based on standard computer programs that combine civil, architectural, and structural engineering. "This is the technology the real world is using. It's the experience I want to see when a student graduates," says Arnst. Cornell civil engineering professor Anthony R. Ingraffea agrees that academia needs to "reintegrate" its overspecialized disciplines to give students the mix of skills industry seeks.

The main impediment to that has been the inertia of decades-old university practices and cultures. For instance, in order to mix seniors and first-year students—which the school had ruled out to keep freshmen from getting in over their heads—Berkeley's Wujek had to create two separate courses that meet in the same room at the same time. Challenging MIT's do-it-yourself-or-die philosophy, department head Earll M. Murman lets his aerospace students work together on homework—as long as they acknowledge the collaboration. Stanley V. Jaskolski, chief technology officer at Eaton Corp. in Cleveland, thinks this makes sense: "The major issue facing academia today is the need to produce students who understand the technique for teaming to produce a product."

Even administrators are challengin longstanding rules of standardized er gineering education. Last year, mor than a dozen schools threatened to with draw from the Accreditation Board fc Engineering & Technology (ABET), whos rules require that eng neering students take specific number of mat science, and engineerir courses. The schools wan ed ABET to accept cours that blend these disc plines, says Carnegie Me lon engineering dean St phen W. Director. F example, CMU's new cour that teaches calculus wit in engineering wouldn count toward meetir math requirements und ABET's current rules. "We said this our program. If you don't want to a credit it, we'll do it anyway," says Dire tor. Now, an ABET committee is conside ing overhauling the rules to allow t more flexible curriculums.

OLD HANDS. The pressure for change likely to grow stronger. Cost-cutting a competition mean industry can no lon er afford to train freshly minted eng neers in practical skills they didn't get school. "Industry now expects the ur versities to provide someone capable doing design work and process technol gy," says Arden L. Bement Jr., forme TRW vice-president for science and tech nology, who now teaches engineering a Purdue University. Moreover, some ex ecutives say the proposed curriculum changes don't go far enough. "Univer sities may take a group of six engineers and call it a team," says Frederick J. Kovac, vice-president for technology business planning at Goodyear Tire & Rubber Co. "We think a team must be multifunctional," with marketing and finance students included, for instance.

The reform movement should gather force, too, as schools such as Berkeley, Cornell, Michigan, and others welcome a new group of students—practicing engineers from industry. Many schools are setting up programs designed to teach the latest advances to these pros, who typically take classes during work or after via videoconferencing systems. The engineers stay current, and their professors get feedback from the work world. That kind of contact with industry has also helped spark a curriculum revolution at business schools in recent years, notes Zemsky. "There's no going back to old patterns of how curricula are developed," he says. After all, the nation's competitiveness depends, in part, on the skill of tomorrow's engineers.

By Gary McWilliams in Boston

THE MAIN IMPEDIMENT TO CHANGE: DECADES-OLD UNIVERSITY PRACTICES

SOME CHANGES IN ENGINEERING EDUCATION

CARNEGIE MELLON UNIVERSITY Has merged electrical and computer engineering into a single degree program. Teaches students advanced math concepts as they need to apply them—rather than in separate math classes.

CORNELL UNIVERSITY Is developing a combined civil and geotechnical engineering program. Plans case-study learning for engineers.

UNIVERSITY OF CALIFORNIA AT BERKELEY Offers a new, four-year program in "mechatronics," merging mechanical and electrical engineering.

MIT Electrical Engineering & Computer Science Dept. has created a master's degree for professional engineers, as has the school's Aerospace Dept.

UNIVERSITY OF MICHIGAN Has a new master's of engineering degree program with its business school to teach management skills to engineers.