Industry: Worth Considering in the '90s?

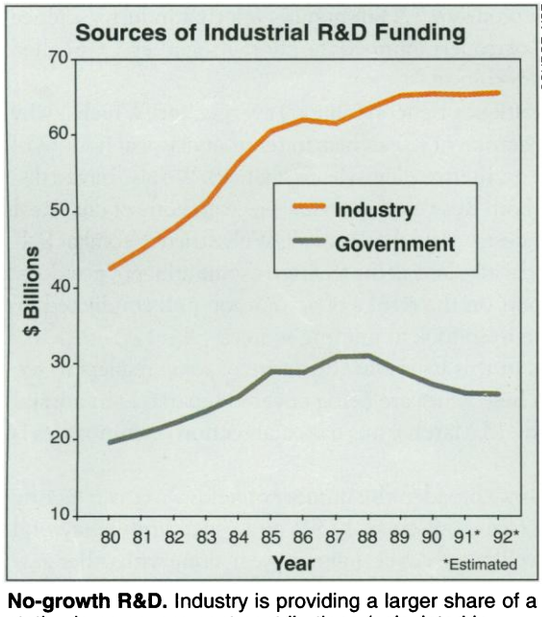
Last year we looked at science on campus. This year we examine trends affecting corporate research–and researchers.

The apparently unending funding drought...the aging of the scientific workforce...the crumbling of the Ivory Tower...tensions between big and little science...the move toward more applied research...the growing need for scientists who can work among disciplines. These were some of the trends we discussed last year in our article on the forces affecting much-beleaguered university-based research. And you may have been one of those who wondered: Is it better in industry?

Well, many of the same trends depressing academicians are also affecting industry R&D scientists. The job scene isn't exactly rosy there either—hiring, for example, has for the most part been flat. Yet, there are some obvious pluses in the corporate workplace, and as international competition becomes ever more intense, this may be an exciting time to get in on the rat race.

After a decade of hostile takeovers and wrenching staff dislocations as many industries, particularly old-line manufacturing concerns, laid off thousands of employees, experts tell us the corporate terrain is settling down in the 1990s. But that doesn't suggest that things are returning to what they were in the 1970s. As physicist David Snediker, vice president for quality at Battelle Memorial Institute, puts it, there's been a "sea change in the environment in which companies have to operate."

How to describe the change? The top scientist-managers with whom *Science* spoke come forth with a swarm of buzzwords: downsizing—or, to be more politically correctly—"rightsizing," "skinnying down" of the managerial ranks, "total quality management," changing the company "culture," "integration" of operations, "globalization," employee "diversity," shortening "time to cash." The terms may have an unpleasant business-school ring to them, but they describe trends that are having important impacts on the conduct of R&D.



SOURCE: NSF

No-growth R&D. Industry is providing a larger share of a static pie as government contributions (calculated in 1987 dollars) slack off.

These trends have, of course, made the ranks of industry much more competitive for researchers. But don't despair. Those with the right qualifications—and a willingness to adapt—are doing fine in today's corporate environment.

Industry Trend I: Thinning the herd

As the weeding-out process continues, only the leanest and meanest companies are going to live to see the dawn of the 21st century. And in some sectors, the landscape is being defoliated dramatically: "There will only be a handful of [U.S.] chemical companies in 2000 or 2010," says Dow Ph.D. recruiter Dennis Guthrie. Similarly, *Chemical & Engineering News* is reporting massive casualties among smaller drug companies, and carries a prediction that nearly half of the big international drug companies will go under or fall to acquisition—while giants such as Merck and Bristol-Myers Squibb will get bigger.

Meanwhile, managerial ranks are being thinned out and departments are being merged. Physicist Robert Hirsch, technology director for DuPont's Polyester Film Enterprise, provides an example: Only a few years ago at DuPont, the businesses for two types of film, "Mylar" and "Cronar," were "completely isolated" from each other. Today, there is common management of the technology, which, he says, not only gets rid of redundancy but provides for cross-fertilization. Intellectually and competitively, this may be good news, but the consequences for some aren't so rosy. DuPont materials scientist Gerry Lavin says the company has gotten rid of three of the five supervisory layers that used to exist between the vice president for research and the lab researcher. Industry, never at a loss for cumbersome neologisms, calls this "de-layering." Whatever you call it, researchers now have far fewer supervisors and have to be "more responsible for their own work," says Lavin. Sounds like good news for the survivors.

Industry Trend II: Globalization

Science has always been international but not until recently, with the emergence of intense global competition, have major U.S.-based companies come to see themselves unequivocally as part of the world marketplace. Joint ventures with foreign companies are proliferating—recently, for example, Advanced Micro Devices Inc. teamed up with Fujitsu in a $700 million Japan-based chip manufacturing scheme. A lot of U.S. companies are setting up R&D labs abroad—notably in Europe and Japan—as part of attempts to get closer to consumers. A recent survey by the Industrial Research Institute (IRI), for example, showed that more than half the 112 respondents have labs outside the United States. 3M Corp., for one, has 38 foreign labs, says Chuck Larson of IRI. But although this means more travel and international contacts for U.S. scientists, it doesn't portend a great increase in jobs since companies as a rule hire local talent.

On the other hand, U.S. scientists now constitute local talent for foreign companies setting up shop in the United States. England is still the number one foreign investor, says Deb Chatterjee, technology director at BOC Corp. But in recent years Japanese companies have set up hundreds of new corporate R&D labs to position themselves closer to U.S. customers and take advantage of the current surplus of highly trained U.S. technical people. Matsushita, for one, has set up eight new labs over the past decade. Japanese firms are "picking up people left and right" in areas where local scientists and engineers are getting laid off—in Washington state, California's Silicon Valley, Texas, the Boston area, and around Princeton, New Jersey, according to Evan Herbert, a New Jersey-based specialist in management/technology communication. The Japanese electronics giant Nippon Electric

(NEC) now has a basic research lab in Princeton with about 100 researchers—making it (some say) probably the only industrial lab now in the United States where scientists can do pure basic research.

Yet another wrinkle affecting once isolated corporate scientists is the move toward alliance formation. As companies attempt to make optimal use of their limited resources, managers are "more and more realizing that no one has the resources to go it alone," says Alan Chynoweth, vice president for applied research at Bellcore. Even as he spoke, Chynoweth was in St. Louis for a meeting on a "high-speed packet network" being developed collaboratively by the regional Bell companies, Hewlett-Packard, the University of Washington, and NEC.

Industry Trend III: Refocusing R&D

One of the worst pieces of news to the average scientist is that throughout the industrial research community R&D budgets are tightening up, and pure basic research, always a small fraction of those budgets, is being downsized as well in the fever to improve products and speed their way to the marketplace. Moreover, as research becomes more applied, "we are no longer thinking of R&D as a separate function," says Larry Linden, technology analyst at Goldman Sachs & Co. No more "ivory tower labs off in some pretty forest," he says—rather, R&D is becoming decentralized as labs devoted to particular applications are being located close to operational units. This, in turn, is having an enormous effect on conditions at the lab bench.

Applications-mindedness. Scientists trained to do basic research are having to change the way they think, says Bert Westwood, vice president for research and technology at Martin Marietta. How? "They now must think first and foremost about the application of their work." In other words, says IBM engineer Jim Comfort: "People have to understand they are in this to make money."

AT&T Bell Labs supplies a notable example of how R&D has become reoriented in recent years. Research director Arno Penzias describes it bluntly. Far from evincing embarrassment at the mourning some researchers express over the demise of the old Bell Labs, Penzias says: "The opposite of applied is unapplied."

When he first took the job 10 years ago, Penzias recalls, he thought the need was to do a better job selling R&D to management. But 3 years ago, he told *Science*: "I finally got to the point where I had to change." Now, he says, organization is much tighter: clear management responsibility has been assigned for every technology; there is much more interaction between research and the business units—and "the word customer is a word we all use."

A similar ethos is taking hold at Xerox Palo Alto Research Center (PARC) in California, says Bob Bauer, director of research and technology integration. To illustrate, Bauer relates that at Xerox's systems sciences lab the researchers used to be "very isolated." But after the company started shifting focus a few years ago, it occurred to the half-dozen scientists who were working on the creation of an "artificial engineer" that there were thousands of engineers working right there at Xerox. So they burst out of their lab and flew to Rochester, New York, to visit the headquarters of the service force. Ultimately they fed their work into an ongoing project by the service technology group—thus finding a real-world application for their research and providing the company with a new and expanded artificial intelligence program for trouble-shooting and preventing equipment failures.

Then again, even in today's climate, there are exceptions to the fixation on funding applications-oriented research only. Penzias cites a researcher who wanted to work on geometric optics, a nonpriority area as far as AT&T was concerned. "In the past we would have said, 'Take your chances,'" says Penzias. "Today he had to argue with us." As it happens, the researcher's perseverance paid off: He has produced "a revolutionary new way of storing information on laser discs," says Penzias.

Streamlining. Another aspect of the sea change in industry is the speeding up of "cycle time" (the time it takes a new idea to move from the lab into a finished product). Key to this is increased integration of the process of design, manufacture, and marketing in what is known as "concurrent engineering." To get a feel for how this can change the life of a corporate scientist, consider General Electric's effort to transform itself into what its top brass call a "boundaryless" company.

"In the past you'd have a team of Ph.D.s develop a new polymer, throw it over the fence [to the development people], then work on the next polymer," says Michael O'Mara, manager of GE's chemical research center. Now the lines between research and the rest of the company as well as various levels of hierarchy are being "worked out"—in current GE lingo.

Smoothing out kinks in the system contributes to speedup of cycle time, which, according to Pat Griffis, vice president for Matsushita's business engineering center in Secaucus, New Jersey, leads to moving research straight "from the incubator to the frying pan." Griffis relates the story of a Ph.D. scientist in optoelectronics at Matsushita who reached a point where his team was ready to develop the prototype for a new optical communications system. But since even the potential customers didn't understand "what a distributed feedback laser is," says Griffis, the scientist "went out and did marketing on foot"—explaining the system to users and finding out how it could better fit their needs. In the past, the marketing people didn't step in until a finished product was in hand, observes Griffis, adding that with

Learning to Love It in Industry

While the stigma attached to doing "applied" work is alive and well in some quarters of academia, Paul Horn of IBM offers a model that more scientists may be following in the future. He started out in the 1970s as a physics professor at the University of Chicago. "I came to IBM [in 1979] to do basic research," he says. "I thought applied work was uninteresting." But his attitude "gradually changed" after he became director of basic research. He completed the transition two and a half years ago when he became director of silicon technology. "What I have found is that the problems are very exciting and intellectually challenging," he says.

Physicist David Snediker of Battelle, who started his career doing hot-atom chemistry at the National Bureau of Standards, has also migrated to the applied world. He says that if he'd stayed in academia, "I would have looked down my nose" at applied research. But after later moving to GE, he discovered that "working on ball bearings was some of the most fun I ever had." Obviously that's not for everyone. It hurts to "have to pass a lot of interesting stuff by," says Snediker, so to be happy in industry "you need to derive a great amount of satisfaction from having to solve a problem and seeing the fruits of your research out there."

–C.H.

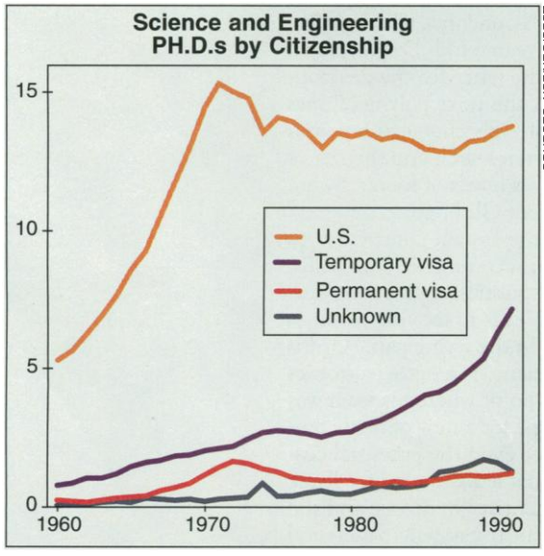
the changes occurring in modern corporations, people in different departments trust one another more. Researchers are now less inclined to see marketing as "Joe Isuzu on the loose," and the technical people, in turn, aren't stigmatized as "the revenge of the nerds."

Teamwork. Indeed, if there's one huge difference between industry and academia, it has always been the high value industry places on teamwork. Today more than ever, the basic manpower unit is the team. "Historically," says engineer Jim Comfort, who works on technology for advanced logic systems at IBM, "you had your individual project" and threw the results over the transom. Now, the team concept has been extended all the way back to the basic researcher, who no longer "throws" but "carries" his product to the next phase of development. "The research and development people are now all in one bucket," says Comfort.

To see just how far the team concept has been extended at one corporate giant, Lavin of DuPont says that in the "Kevlar" business, there are 12 subdivisions, each of which has a multifunctional team. One, for example, is a global "rope team." It comprises a half dozen people, including a researcher and people from manufacturing, finance, and marketing, who meet every month or so—either in Wilmington or at one of DuPont's overseas operations—to develop strategies on everything from tugboat rope to mountain-climbing rope.

Quality. All of the above trends are part of the hottest industrial fad of all these days: quality. Nowadays, says Snediker of Battelle, "everybody and their uncle" is getting a vice president for quality. (He himself became Battelle's first 5 years ago.) Quality is a rather protean concept covering everything from sophisticated statistical formulas for guiding manufacturing, to enlightened personnel management. At Battelle, says Snediker, his job is nothing less than "changing the whole social environment to do R&D in." Scientists tend to be "control-averse" and weak on teamwork, he explains. If you hold a workshop on "interpersonal skills," you'll only get their backs up. So instead you have workshops on things like "systematic problem-solving."

IBM has another approach—called "market-driven quality." The needs of users of research—including developers and manufacturers of a product as well as those who purchase it—are always kept paramount, says the program's director, physicist Bernard Vanderhoeven. The system includes giving researchers much more feedback, such as a "scorecard" in which management regularly assesses the research division on both products and teamwork.



R&D melting pot. Scientists from India and Pacific Rim countries are capturing ever larger shares of U.S. Ph.D.s—and many are staying for jobs in U.S. industry.

Industry Trend IV: Humanizing company culture

While companies are taking their cues from Japan in measures to speed products to the marketplace, raise quality, and enhance efficiency, there is a parallel thrust that is rooted in very American concerns about social equity.

Demographics. Despite all the alarm cries of recent years, industry is not particularly worried about a looming manpower shortage in its scientific ranks. For one thing, as in academia, it's still a buyer's market in the Ph.D. arena. But this hasn't relieved managers of their concern that white males are not entering these fields in appreciable numbers, and no great increase in female and minority scientists is expected in the foreseeable future. Which is why practically everyone has an active "diversity" program. Particularly in industries based on the physical sciences, there'd be trouble if foreigners were not there to fill the gap. "I'm constantly disappointed with how few females and minorities are in the pool to draw from," says John Armstrong, vice president for science and technology at IBM.

Xerox is putting on a big push to hire more women Ph.D.s in fields where they are rare: computer sciences, physics, and electrical engineering. This year, says Linda Thornton, manager of communications at Xerox PARC, the company launched a program to make Xerox "the employer of choice for women in 2000." That includes using the company's fellowship and summer intern programs to link women up with industry mentors and encourage them to hang in through their Ph.D. Xerox also will launch a pilot program next year that will include provisions such as child care to make life easier for people with dependents.

But for now and the foreseeable future, foreign-born scientists are becoming ever more in evidence, especially those from China, India, and Pacific Rim countries. At a conference held early this year by the Commission of Professionals in Science and Technology, speakers described how resistance to hiring foreigners has been strong in some quarters because of the hassles and paperwork. But that's been changing dramatically.

Procter & Gamble, for instance, changed their policy 2 years ago, says Ted Logan, the company's manager of technical recruiting. He says foreign students seeking U.S. jobs "tend to be among the best from their countries." Their presence leads to "a greater diversity of solutions" to problems, says Logan—and "they help spread the company's culture to overseas operations." About 20% of P&G's new Ph.D. hires are now foreign nationals.

DuPont is also high on diversity. It now boasts an Indian woman lab manager, Bombay-born materials scientist Uma Chowdhry, who recently took over the company's Jackson Laboratory. Chowdry says, "Times have really changed since I came to DuPont in 1977." Now, she says, "there are Asian networks, black networks, female networks all over DuPont." She estimates that 12% of the 336 professionals she supervises are of Asian or Hispanic origin. This year, 52% of new hires at Du Pont Chemicals were female, minority, or foreign-born, and the company is aiming to bring the percentage in the technical workforce to 50%.

Social skills. Chatterjee notes that with the increase in diversity, American scientists and engineers "must have a much higher degree of cultural sensitivity." And as teams become the predominant labor unit, loners and eccentrics, however fondly regarded, have little place in corporations seeking to get into fighting trim. So, the ability to interact well with other people has become a *sine qua non* for working in industry. Says Mark Naster of

Secrets From the Other Side

So you've got your shiny new diploma or have just completed your postdoc. Your university has done a great job at educating you, but chances are your advisers haven't spent much time telling you how to parlay that into a consistently remunerative set of activities—i.e., a job. And after hanging around academicians for the better part of a decade, you're not at all sure you want to spend your life hustling grants and are wondering if industry is the answer.

Be forewarned: The vast majority of new Ph.D.s "simply don't know how to prepare for an interview" in industry, says Dennis H. Guthrie, Ph.D. recruiting and placement manager for Dow U.S.A. in Midland, Michigan. What's more, they don't even know they need to prepare. "They just assume that they can answer questions as they come, thinking off the top of their head."

Dangerous assumption. So Guthrie is here to help you with some advice:

The on-campus interview. Dow, like many companies, has a two-tiered recruiting process, the first one (usually) on campus and the second at a company location. Guthrie's advice begins by suggesting you put yourself in the shoes of an on-campus recruiter: "WOULD YOU HIRE YOU?"

His recommendations: Allow the recruiter to lead the interview. Don't ramble. But don't be shy. "I don't want to have to pull data out of job applicants," says Guthrie. Specifically, recruiters are interested in the answers to four questions:

(1) What job does the candidate want? "'I'm willing to do anything' is the worst possible answer—and is interpreted as either desperation or a lack of thought and preparation," says Guthrie. The right answer is to list, in order of priority, the jobs that interest you. That means you have to know something about the company. All the better if you can mention specific locations or organizations.

(2) Can the person do the job? Here's where you give them a concise description of your research, advises Guthrie, following the format they are familiar with in industry: (a) why you did it; (b) how you did it, and (c) the results. This is your chance to blow your own horn, says Guthrie, keeping in mind the difference between confidence (knowing the facts) and arrogance (exaggeration and self-puffery). A recruiter will typically ask you to describe the point at which you took over the thrust of your research from your adviser, highlighting the new ideas you brought to the project.

(3) Will the person do the job?—Meaning: Will the person excel? That calls for letting the interviewer know that you not only know your stuff but also possess leadership and initiative. Here you talk about projects you've organized, groups you've chaired, and other activities that show you will go beyond the call of duty.

(4) Will the person be compatible with the existing team? Industry doesn't want hermits or troublemakers, so it will help if you've mentored students or been involved in other cooperative activities. Says Guthrie: "You may be Nobel material but if you can't work with other people, we are likely to pass on you."

The on-site interview. If you get to round two, what matters first is timing. Fall is okay for an interview, says Guthrie, but the best time is January and February. Later than that, your chances go down as it's getting late in the annual hiring cycle. Your on-site visit will last all day. But the heart of it will be the 40 to 45 minute "seminar" in which you present your work. "Based on your seminar, you will either be working uphill or downhill the rest of the day," says Guthrie.

Making a good impression is simple: just be exceedingly well-organized, concise, clear, confident, professional, and enthusiastic as you introduce yourself and explain your research. Other tips: Use only one form of media (overheads or slides) in your presentation, and don't put too much data on one slide.

Also important is the question and answer session after your talk, he explains. There you will be tested on your ability to answer questions on your feet. Guthrie recommends that applicants leave some minor but semi-obvious question unanswered during the presentation, which will provide a pump primer for later discussion. Remember, he cautions, never talk down to your audience.

Guthrie suggests that you be prepared with questions for your on-site interviews. If you aren't, you may seem insufficiently curious, and there might be an awkward gap as interviewers scramble for what to do next.

Dow recruiters conduct initial on-campus interviews with 700 to 1000 Ph.D. job-seekers a year (mainly chemists and chemical engineers but also some biochemists and materials scientists). From there the funnel tapers pretty abruptly: Of these about one-third are referred to the next stage, and one in five of these are hired.

By the way, while corporate technology officers often emphasize the desirability of business skills, Guthrie says Dow is "very rarely interested in a Ph.D. chemist with an MBA. You're better off with a second degree or postdoc in a field that expands on your first."

–C.H.

Marion Merrell Dow: "We're not just looking for scientists, we're looking for human beings...[social] behavior is as important as skills and knowledge combined."

Even the managers seem to some to be getting more "touchy-feely," with more active systems of rewards and feedback. "I probably send out one to two dozen personal handwritten acknowledgments a week" of work well done, says Bell's Penzias. Recently, he awarded chocolate bars and tee-shirts to the members of a team that developed a new way of coding speech for wire transmission. And at Xerox, the new company culture is strongly flavored by New Age jargon—management talks about things like "nurtured core competencies" and the need to "empower our people."

Industry Trend V: Versatility wanted

Another area of change reported by industry people is the increasing challenge to scientists to diversify their own talents or skills. "It used to be that R&D organizations were so large you hired every discipline and then brought some to the front burner," says J. P. O'Connor, director of human resources at Monsanto Corporate Research. But no longer is an R&D team like "like an orchestra where you hire someone to play a single note."

Despite the fact that university-industry ties are closer than ever, a scientist coming to industry from academia is in for a culture shock—which is why former Procter & Gamble recruiter Fred Schulz says if he were starting out, "I would do my best to try to have a link with industry while doing my Ph.D."

In academia, says Snediker, the hyperspecialization and the boundaries between disciplines are such that "electrical engineers can't even talk to the mechanical engineers." In industry, in contrast, says industrial engineer and former Bell & Howell CEO Don Frey, who is now at Northwestern University: "After 5 years it won't

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Industry in the '90s

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matter what your Ph.D. is if you're an engineer." Snediker adds that as academic scientists are trained, "we learn how to do research kind of in a vacuum. We don't know how to plan, how to manage a project, and we have no idea whatever of the concept of team." Scientists thinking about industry work should be sure they have some hands-on experience with their area of expertise, adds Isaac Dvoretsky, a recruiter for Shell Development Corp. in Houston. "Some people get their whole Ph.D. on nothing but a computer."

And there's more to the challege in industry. "Even at the very high tech end of things, people who stay in the lab without understanding the business side of things are just gone," says Paul Villella of Source EDP, a computer and communications recruiting firm in Washington, D.C. At Hewlett-Packard, for example, physicist Leonard Cutler says the company has set up a cooperative effort in high temperature superconductivity with DuPont and Los Alamos National Laboratory, which involves holding meetings between scientists, managers, and lawyers to discuss issues such as intellectual property rights.

New knowledge is flooding in at such a pace that, as Westwood puts it, "it's not 40-year careers any more. It's 7-year careers." Now, says IBM's John Armstrong, "we hire people as people rather than for specific jobs. No one does the job for which they were hired for very long." Industry wants Ph.D.s not as much for their specialized knowledge as for the fact that the degree means you have successfully done some creative high-level problem-solving, says IBM's Jim Comfort. Indeed, at IBM the question now asked about job applicants is: "Is this a person that one would hire independent of any known need?"

Working in industry is now more fast-paced, highly structured, and bottom-line-oriented than ever. Despite (or maybe because of) the increased pressure for results, virtually everyone *Science* talked to said that their jobs are a lot more exciting than they used to be. There are inevitably those researchers who feel constrained by having to follow company priorities or who resent not being able to work alone. But complainers are hard to find. In industry, being a happy camper is part of your job.

–Constance Holden

Plus Ça Change...

Engineer Donald Frey of Northwestern University says a young academic scientist considering jumping to industry might well harken to words uttered in 1966 by Nobel laureate chemist Peter Debye: "You should not ask for people who have already done in university what they're going to apply in industry—this is the most nonsensical way of doing it. You should ask for people who have a feel for how to handle a new problem. The specific nature of the problem is not important."

'Green Science'

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says Elizabeth L. Anderson, president of Clement International Corporation, an environmental consulting firm based in Fairfax, Virginia that employs 200 people, most of whom are scientists. "I don't see any shortage of jobs in this area, thanks to the momentum of all the environmental statutes and international agreements," says Anderson—not to mention the publicity over events such as the U.N.'s June "Earth Summit" in Rio.

Big companies redefine their roles

Big industry also has jumped on the green bandwagon. Firms such as DuPont, General Electric, and Monsanto employ several dozen environmental scientists. "We're not in the environmental business, so to speak," says Samuel A. Shulof, head of GE's new environmental research center in Schenectady, New York. Instead, he says, "we look to solve GE's problems" such as "reducing the cost of compliance" with environmental regulations and cleaning up PCBs that GE's transformer manufacturing plants released into New York's Hudson River over the years. What started as a handful of regulatory experts two years ago has mushroomed into a 60-scientist laboratory filled with experts in a variety of disciplines, from polymer chemists to microbiologists. Schulof says it's hard to predict who the center might hire in the future—"the whole field is moving, evolving."

Monsanto's environmental sciences center has a mission similar to GE's, says Allan Ford, the center's director. "We're looking at new technology for reducing our environmental costs and reducing our environmental impact." Although Monsanto has "Superfund sites like any other company," one of the chief goals of his center is to identify environmental problems before they happen, says Ford. So he has put together a team of 40 scientists, with backgrounds ranging from chemical engineering to agronomy, to investigate three basic areas of research: analytical chemistry, ecological risk assessment, and cleanup technologies. "We like to take people who do different kinds of science and put them together on the same problems," he says.

Government—slim pickings

One of the few environmental organizations in the country that reports bad news from the job front is the largest of them all—the Environmental Protection Agency. From January through July of 1992, the agency had hired 294 permanent and temporary scientists and engineers. This was well off the pace of 1991, when it hired 832 scientists, and 1990, when it hired 913. "And it isn't looking very good over the long term," says an agency spokeswoman. But some policy experts predict that the job market for environmental scientists at the EPA and elsewhere might get a boost with a Democratic victory in November, given that the vice-presidential candidate, Senator Al Gore (D–TN) is a strong advocate of environmental protection. Nevertheless, with legislation to establish a National Institutes for the Environment possibly heading for congressional action in 1993, and such issues as global warming, biodiversity, and the ozone hole firmly embedded in the public consciousness, it's likely that environmental science will remain a hot topic regardless of who inhabits the White House. "These problems aren't going to disappear overnight," Chamberlin says. Neither, hopes Weis, will the bridges that are beginning to form between the scientific disciplines.

–Richard Stone