

who worked in NSF and in the upper reaches of the federal science advisory apparatus before moving to the private sector, saw a place for a federal role, particularly where there was underinvestment in longer term R&D. The marketplace is effective in weeding out non-competitive players, he said, but it has some shortcomings. Management is not infallible. "People respond to the incentive system," said Drew. "They tend to respond to the short term, the bottom line, not the long term, the investment that results in new product areas."

Drew saw an argument in favor of Brown's National Technology Foundation if it focused on these "gray areas." It should not be given open-ended granting authority, however, since it would then be pushed into "shoring up weakening industries, a political game."

As the hearings wore on, attention centered on the decline in U.S. manufacturing both as international competitor and as employer of U.S. workers. Several witnesses warned that traditional manufacturing is a major producer of real wealth for the society which high-technology industry cannot fully replace.

The legislators were also told that technological change taking place in manufacturing would not only displace production workers but also cut deeply into the ranks of supervisory and clerical workers. Subcommittee chairman Representative Doug Walgren (D-Pa.) expressed a perception that became a theme of the hearings when he emphasized that it is "necessary to evaluate the social impact of these changes."

At the moment, the discussion of industrial policy seems effectively stalled. The chain effect of a huge budget deficit, high interest rates, and an overvalued dollar are making it more difficult for U.S. industry to compete in international markets. And the Reagan Administration's preference in its science and technology policy for restricting government to supporting basic research and removing obstacles to private sector initiatives appears clearly in the ascendant.

Congress seems disposed to move on a narrow front where bipartisan support exists to boost manufacturing technology, orphaned in the past by industry, universities, and government. This may, as Brown suggested, provide a "prototype or demonstration" of what the government can do for technological innovation. But the main message of the recent hearings as evidenced by the discussion of the social effects of economic change may be that Congress is now seriously concerned about the downside of high technology.—JOHN WALSH

NSF Studies Cooperative R&D

Fostering technologic innovation is something of a sideline for the National Science Foundation (NSF), whose main business is supporting basic research. But for several years, the foundation has been sponsoring industry-university cooperative research projects—now numbering more than 100—and also has helped set up nine larger university-industry cooperative research centers. Both programs are nurturing the transfer of innovative technology between universities and industry. Within NSF, a social science research group under the direction of Louis G. Tornatzky has begun systematically studying these cooperative programs to see what makes them tick.

The long-term goal of the NSF productivity improvement research group, Tornatzky says, is to develop "data-based management of research programs." Ideally, that means identifying what elements of research management are likely to succeed, regardless of setting, and developing ways to implement them. The group's analysis of NSF's various cooperative research ventures is still nowhere near that goal, but its early findings are providing some insights into why some cooperative programs are highly productive while others are not.

The analysts have noted, for example, that research centers set up internal communication "networks" very differently. This kind of network analysis soon may become a diagnostic tool, according to Tornatzky's colleague J. D. Eveland, useful for showing when an organization is falling into a style of communication that has proved disastrous at other centers. Eventually, some general administrative guidelines for how to set up centers to optimize internal communication ought to come out of these studies, he adds.

The NSF group also is completing an assessment of 118 industry-university cooperative research projects, most of which consist of one-on-one partnerships. The consensus is that such collaborations can be very fruitful for both parties, and that the partnership not only improves the research but changes its nature, Tornatzky says. One surprise is that, their own stereotyped views notwithstanding, university scientists often regard these collaborations as improving their work at a fundamental level. "This is counterintuitive—they're saying their efforts are not 'sullied' by industry but improved," he says.

Another finding with implications for university administrators trying to revise faculty consulting policies comes out of these studies. The success of cooperative relationships came closer to being assured if the participants knew each other well before formalizing a partnership. This often means that the university scientist who makes a good partner in a cooperative venture will have had prior experience consulting to industry—and ideally to the company where a partnership is to be forged. The cooperative programs usually have also been judged valuable by industry participants for meeting their respective companies' needs. Industry participants often credited their university partners with providing the impetus for projects that ultimately improved a company product or process.

It has not been altogether easy for Tornatzky and his immediate colleagues to convince others at NSF that this approach to evaluating the management of research is valid. For instance, Tornatzky says, "There are pressures to massage the data," arising from the "inevitable tension" managers feel when it is time to look at their own projects. Tornatzky's approach, if it is to work at all, must remain strictly empirical.

Viewing research as a "social process"—that is, as fundamentally dependent on how people communicate—is a "concept that many at NSF are not comfortable with," Eveland adds. "The prevailing attitude is [to support] university science, with the assumption that quality science finds its way into industrial applications." The NSF study group is "trying to put some structure on all of this data" in hopes that the typical, somewhat haphazard transfer of innovative technology between universities and industry can become more efficient, and at least more predictable, than it now is.

—JEFFREY L. FOX