## **Needed: Information on Technology's Impact**

Reprinted from THE SCIENTIST ® 1(13): 9, 18 May 1987.

The watchword in Washington and the rest of the United States is competitiveness. There have been more discussions by more people about America's ability (or inability) to compete internationally than perhaps about any other topic this year. And with each announcement of further erosion in the U.S. balance of payments, the intensity of that discussion escalates.

The problem has been at least two decades in the making. American industry did not modernize its manufacturing processes soon enough. It did not pay enough attention to quality. It looked for high short-term returns and neglected investments in R&D that ensure long-term prosperity. Moreover, the federal government has eschewed anything like a coordinated industrial policy.

But now there is consensus that the federal government can and should play a role in improving America's competitive position. In his last State of the Union address, President Reagan underscored competitiveness as a priority issue for the nation and for his administration. In Congress, 160 senators and representatives have joined a caucus to promote competitiveness. Outside government, some 25 institutions in

industry, education and labor have banded together as the Council on Competitiveness.

Out of all this, however, little of substance has yet emerged. In the past few years the government has deregulated some industries, offered modest tax credits for investment in R&D, and loosened antitrust restrictions to a degree. Still, the trade deficit expands.

One figure stepping forward with substantive, long-term remedies for what ails American industry is Erich Bloch, director of the National Science Foundation. Bloch has opened the eyes of the Reagan administration and many in Congress to the direct link between basic research and technological advantage. He has held out the concept of Science and Technology Centers as one means to enhance competitiveness. The NSF initiated its Centers Program with Engineering Research Centers. These work closely with industry to turn discoveries in basic research into economically viable applications.

Bloch has also drawn attention to the pressing need for improving science education. "Investing in basic research and education will not immediately reduce the trade deficit," the NSF director wrote recently, "but it will provide the new knowledge and technically educated people that are prerequisites for anything we do in commerce, industry, defense, or health." ("NSF's Budget and Economic Competitiveness," *Science*, February 6, 1987, p. 621.)

While I support Bloch's call for better science education and government-university-industry cooperation where relevant, and while I believe these measures will contribute to promoting U.S. competitiveness, there is more to do, especially in managing existing technologies and in being able to make informed decisions about which potential technologies to pursue.

William Norris, chairman emeritus of Control Data Corporation, spoke in Denver in April of the need to "increase the efficiency of creating and applying technology." (see The Scientist, May 4, 1987, p. 7.) But to do so requires information about the economic impact of specific technologies. More than simply discovering new technologies, we need to know how to use technology most effectively which technology to invest in and how this choice will affect and in turn will be affected by similar decisions in other parts of the economy. We must be as committed to the rational use of our technological assets as we are to pursuing technological innovations. In a world of limited resources, it is vital to make systematic use of the information that can tell us how to deploy those resources best.

An effort now underway aims to

provide the information for such decisions. In 1986, Ali A. Seireg, chairman of the American Society of Mechanical Engineers' Council on Engineering, and Wen Chow, group director of ASME's Technical Affairs—in an effort to bring together the expertise of engineers with that of economists—sought out Wassily W. Leontief, the pioneer of inputoutput analysis who won the 1973 Nobel Prize in economics. Leontief's input-output analysis demonstrates how different sectors of an economy, described in terms of existing technologies, perform and interact. Newly formulated dynamic input-output models, developed by Leontief and Faye Duchin, director of New York University's Institute for Economic Analysis, can reveal the relative cost of specific alternative technologies and the ways in which technological innovations in one or more sectors affect the rest of the economy.

Recognizing the potential of input-output analysis as an important tool for decision-making by engineers and managers, Seireg and Chow arranged to place the expertise of ASME members at the disposal of Leontief and Duchin. This union resulted in the ASME's Technical Economics Program which is guided by a coordinating committee chaired by Seireg that consists of prominent engineers, industrialists, educators and economists, including The program seeks "to Norris. develop and implement technical/economic models for quantitative assessment of the choice of technology and the return on investment from engineering innovations and technological developments." (Seireg, "Establishing the Market Value of Innovation," *Mechanical Engineering*, January 1987, p. 39.)

of Teams input-output economists and engineers are working with experts in different industries to compile technical data for the new input-output model. In close cooperation, the economists and engineers are jointly defining technology and design alternatives, pertinent data requirements, formats of database and model outputs, and the diverse ways in which the outputs can be utilized in practical applications. The resulting engineering database and input-output model will be operated and maintained, with updates year after year, at the ASME's New York headquarters. It will be available to governments, businesses and individuals. Although the program is initially focusing on computers, materials, energy and biotechnology, the intention is to extend the effort, as soon as possible, to all sectors of the U.S. economy.

It is no coincidence that Japan, the nation that has competed so well economically, has led the world in the use of input-output analysis and, more generally, in emphasizing the importance of comprehensive information in decision-making. While over 500 researchers at Japan's Ministry of International Trade and In-

dustry work out in meticulous detail input-output tables of the world economy, the U.S. government supports only a small staff at the Bureau of Economic Analysis to create limited input-output tables of the American economy, and those with great delay. Historically, the U.S. government has steered away from data gathering on the scale of the Japanese—and from input-output analysis specifically, which, Leontief has said, "is considered somewhat dangerous [because it] smells of planning and such things."

But collecting and making available better information—not for controlling but simply for understanding how an economy works and for making better decisions—is exactly what is now needed. The right information drawn on at the right time, highly leverages the success of any undertaking. Strategically, we need information about the economic impact of technology almost as much as we need the advanced technology itself.

Amid the clamor for competitiveness, the ASME's Technical Economics Program, with the guidance of Leontief and Duchin at the Institute for Economic Analysis, is quietly laying a foundation on which we can once again build a truly competitive industrial capacity. Both government and industry should give high priority to supporting such efforts.