

The US needs a coherent industrial policy

Over the last few years there has been widespread discussion in many national publications of the effects on our long-term economic health of international competition, which has led to a severe crisis in our balance of payments. I have little knowledge of international trade policies, and I am not going to discuss the many proposed solutions to this crisis. The present *Buyers' Guide* issue of *PHYSICS TODAY* is, however, an opportunity for US physicists to assess our international position not only in instrumentation but also in more general areas of physics that interface with technology and have a direct bearing on the nation's long-term economic health. I hope the ensuing commentary will stimulate further discussion in the pages of *PHYSICS TODAY* of this vitally important area.

Since World War II the US has been an unquestioned world leader both in basic physics research and in the application of physics for the common good. Well-known examples of our commercialization of the fruits of basic physics research include computers and consumer electronics, light-wave communications, electric power and a variety of instruments of great importance to medicine.

We cannot take for granted the continued excellence of our science and engineering, nor can we flourish economically, unless we are able to generate new and higher levels of technology. Recently we have begun to face strong international competition in a number of areas of physics, instrumentation and technology, and if we are to maintain our forefront position into the next century, we need more than ever to maintain a climate where the manufacturing engineer, the entrepreneur, the inventor and the basic scientist can prosper together. Our nation needs a coherent industrial policy that strongly encourages civilian R&D investment for the future.

The position of the US internationally has been broadly evaluated by the Committee on International Science of the National Science Board, the Physics Survey Committee of the National Research Council (whose findings were published as *Physics Through the 1990s*) and the Subcommittee on International Scientific Affairs of the Panel on Public Affairs of The American Physical Society. Among the key findings are:

- During the period 1970-84, "civilian" R&D expenditures as a percentage of GNP in West Germany and Japan (two of our strongest economic competitors) increased from about 1.7% to 2.6% while in the US they remained more or less static at about 1.8%. In the 1970s total expenditures for R&D (including civilian, defense and space research) as a percentage of GNP declined in the US from about 2.8% to 2.4% while those of the USSR rose from 2.7% to 3.7%.

- Major physics-related-instrument manufacturers in several critical fields are foreign. These include producers of instruments for research in low-temperature physics (Oxford Instruments, England), surface science (VG Semicon, England), molecular-beam epitaxy (VG, England; Riber, France), electron microscopes (JEOL and Hitachi, Japan; Philips, the Netherlands) and bit-error-rate test-set equipment (Anritsu, Japan). Major commercial manufacturers of high-quality semiconductor substrates are abroad—for example, Wacker Chemical of West Germany for silicon and Sumitomo of Japan for compound semiconductors. The few US manufacturers in these areas face stiff

competition. In precision optical components, for example, we imported \$731 million worth of equipment in 1985 while exporting only \$208 million, according to the Department of Commerce.

- The availability of specialized and unique equipment and facilities is usually a prerequisite for conceptual breakthroughs in science and technology, particularly for small-group research of the type championed by Daniel Kleppner (*PHYSICS TODAY*, March 1985, page 78). Such small-group research has often been the forerunner of advanced technology. Accessibility of such equipment and facilities is crucial for effective competition. Western Europe and Japan, for example, have taken the lead in several major areas. These include cold-neutron facilities in Grenoble, the heavy-ion accelerator at Darmstadt and pulsed high-magnetic-field facilities in Japan. A joint government-industry Optoelectronics Institute in Japan has major capabilities in a critical high-technology area; the US has comparable facilities only perhaps at AT&T Bell Laboratories.

- In some foreign countries considerable activity of a high quality is taking place in several fields of physics that don't attract the same level of talent in US labs. These include semiconductor science in Europe, opto- and microelectronics in Japan, nonlinear optics in France and heavy-ion atomic physics in West Germany. US industry often has to look for foreign-trained or foreign-born personnel in key areas of materials synthesis and optoelectronics.

I have purposely omitted many examples from areas of basic physics and instrumentation where we are at the forefront. I want to illustrate both the strong international character of science and the competitive world in which we live. Such competition in science is extremely healthy and I believe that we, as a nation, still serve as a magnet for many of the best scientists in the world. Even in many of the instrumentation examples I cited, we were not only the first in research but also the first in commercialization. What is worrisome, therefore, is our inability to stay at the leading edge of instrumentation technology in areas such as electron microscopes, surface-science equipment and optical components.

To regain our technological advantage, manufacturers must continuously invest in longer-range R&D. Industry needs to develop a willingness to adjust to the customer's needs for ever more advanced or specific functions, even when the company is a small, specialized instrument manufacturer. A company's foreign competitors are usually willing to do that. The further exploitation of our ideas by others is a natural evolutionary process and would be of little consequence in a stable and fair world. However, the international high-technology arena does not often have a level playing field. Direct government support of exploratory civilian R&D work similar to our support of US defense industries is common abroad. Often this research support is what provides the competitive advantage. Fortunately, there are still a few major US corporations (for example, AT&T and IBM) that strongly believe this.

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