

Tomorrow's instruments: US shortfall

It has been said that when an experimentalist obtains his equipment he is casting his vote for what will be important in his science for the next five years. For a nation to be in control of its own priorities in experimental science, it must therefore be heavily involved in the development of instrumentation for tomorrow's science. But in the US our strategy of research support in recent years has failed to give adequate attention to the support of R&D on instrumentation for its own sake without immediate application in mind. The money available just to purchase, much less develop, instruments has fallen sharply: The proportion of NIH and NSF research funds allocated to permanent laboratory equipment decreased from nearly 12% in 1966 to about 5% in 1974, a constant-dollar decrease of 40% for NSF grants despite substantial increases in the agency's budget.

In the wake of this decline in funding, we see all too clearly the consequences of our long-standing failure to support the development of instrumentation to the stage of availability. High-energy physics aside, a disturbingly large fraction of the instrumentation that will perforce determine the shape of tomorrow's physical science in the US is being developed outside the US. Consider, for example, the subject of this month's special issue—materials science (see page 23). In this field the major research instruments today are electron-optical and x-ray diffraction devices.

The scanning electron microscope (which has also had vast impact and become indispensable in many other fields in just one decade) was developed in England. Japan quickly followed England into the market; the US entered a few years later. The recently popular electron microprobe was developed in France. Although the US had a significant role in the development of transmission electron microscopy, there are no longer any US manufacturers of these instruments.

The exciting new lattice-imaging technique, for which Arizona State University physicists John Cowley and Sumio Iijima (themselves both "imports") received the B. E. Warren Diffraction Physics award this year, is expected to have great impact in materials science. It offers a "quantum jump" in the detail and certainty with which we can view material structures, alloys and defects in atom-by-atom detail. It requires very high-voltage, high-resolution electron microscopes. The technology to produce them is no longer available in this country. In Japan and Europe it is.

In x-ray diffraction, during the last ten years the US market in the standard line of equipment used for materials science has been dominated strongly by European and Japanese manufacturers. For the newer but increasingly important items that change and extend what can be accomplished (for example, micro-focus and high-intensity sources, topography apparatus) the experimenter must usually turn to European and Japanese suppliers. Energy-sensitive x-ray detectors are among the few new items in which the US leads or at least does not lag. In

gearing up for appropriate utilization of synchrotron x-ray sources, the US is perhaps not lagging, but neither is it ahead.

In neutron scattering, the facilities of the Institut Laue-Langevin in France are most highly acclaimed. One of the outstanding attributes of the ILL is the innovative instrumentation that has been developed there *before* it was uniquely required for a particular measurement needed for a particular budgetarily-justified application. Many of these ILL instruments have then made possible new kinds of experiments, leading to new insights. An outstanding example is the 80-m small-angle neutron-scattering apparatus with an area detector.

Although in major instruments for the study of the surfaces of materials the US has not lagged as badly [ESCA (Electron Spectroscopy for Chemical Analysis) was developed in Sweden, but Auger spectroscopy and LEED (Low Energy Electron Diffraction) were developed to their present effectiveness largely in the US], the general picture in materials science is one in which the US has relinquished the development and commercialization of instrumentation to other countries.

Talking with people in various fields strongly indicates that most experimental areas in the physical sciences are in the same situation. This necessarily is a concern for the life sciences, also, as the physical sciences, especially physics, are well-springs for much of the instrumentation on which the life sciences depend.

The vital question, then, is whether we as a nation are doing enough toward developing the instruments that will be the most important ones five and ten years from now, the ones that will determine the nature of our investigations and the pace of our scientific progress, the shape of US science tomorrow. Although some things are being done even in the areas singled out here as in shortfall, our track record is not encouraging.

Since action follows money and proposals for action follow the perceived availability of money, we must conclude that our funding agencies have not invested sufficiently in the development of instrumentation for tomorrow's science on its own merit. Perhaps they have been inhibited in part by a feeling among basic researchers who referee proposals that instrument development is not "real" science, in part by the human problems posed by having to choose between salaries and hardware, and in part by excessive concern with immediate application and quick payoffs. In any case we are suffering the penalty that in many areas US science is circumscribed far too much by the types of instruments that can be bought off the shelf. US science has therefore to wait for the instruments to be developed elsewhere and thus foregoes in an important way its opportunity to set its own goals and priorities for what kinds of things can be measured how well and, therefore, what the thrust of US experimental science will be.

R. A. YOUNG

Gorgia Institute of Technology