The State of Academic Science: Concern About the Vital Signs

It is generally acknowledged that curtailment in the growth rate of the federal R & D budget and the inroads of inflation have combined to dampen the scientific enterprise in the United States. But most assessments of the damage and of the implications for the future have lacked force because they were expressed in sterile statistical terms or were suspect because they carried the tinge of self-interest. Now a new report has appeared whose tone and substance are likely to earn it more serious attention.

Titled "The State of Academic Science: The Universities in the Nation's Research Effort," * the report is based on a study funded by the National Science Foundation (NSF). It complements the national survey on the subject published as the last annual report of the National Science Board (*Science*, 22 October 1976) as "Science at the Bicentennial." The authors of the new report are Bruce L. R. Smith of Columbia University and Joseph J. Karlesky of Franklin and Marshall College. Both are political scientists.

A parodox facing anyone analyzing the current state of American science is stated by the authors as follows:

"The basic findings are seemingly contradictory: while research of the highest quality continues to characterize academic science, with sometimes exceptional achievements, there are some signs of deterioration. A significant underlying problem that heightens the impact of adverse trends is the weakening financial condition of the universities."

This sets the theme of the study. While avoiding doomsday rhetoric, the authors portray science in the United States as a flourishing growth which, however, is beginning to show some serious signs of blight.

Incidentally, while the report does concentrate on academic science and, therefore, gives most attention to basic research and graduate education, it does, unlike some other studies on the subject, recognize that universities are part of a national research system. It takes into account that, from the federal standpoint, research in industry, government labs, nonprofit research institutions, and the so-called FFRDC's (federally funded research and development centers) are also important. And it gives attention to evolving relationships between these other entities and the universities.

In the universities, the report sees an overall pattern of declining federal support, a downtrend in graduate enrollment, an aging faculty entrenched by virtue of tenure, deteriorating instruments, a shortage of capital investment for facilities, tensions between scientists and university administrators who are themselves under strong financial pressures, and demands from federal and state authorities for extensive accounting and compliance with regulatory laws.

An important distinction the report makes is that the poorer institutions are getting poorer at a much faster rate than the richer ones. What is foreseen is that the gap between the prestigious research universities and other institutions may develop into a gulf. The report describes the beginning of a process of "stratification," which could lead to a drastic decline in the number of serious research institutions. A process of erosion occurs when cuts in research funds lead to a loss of graduate students and a sort of multiplier effect sets in, so that research winds down.

Interesting inferences can be drawn from the report about the nature of research productivity. It is obvious that the decline in the number of graduate students will be reflected in a smaller corps of researchers in the future. But the implications of the decline in their numbers for current research are also serious. The link between research and graduate education is amply recognized as important, but the way senior and junior faculty and graduate students interact and the specific mix desirable to encourage productivity in research are subjects that need more analysis.

The fortunes of the various disciplines vary. Physics is reported to be experiencing perhaps the deepest recession, despite current excitement on research fronts. Chemistry is somewhat more bouyant and seems to be reestablishing the ties with industry that lapsed during the golden age of federal funding. Life sciences research maintained the post-sputnik growth pattern longest. It is still reasonably bullish because of the applications of biology to medicine, environmental problems, and agriculture. Engineering is in the midst of one of its cyclical booms in undergraduate enrollment but finds the opposite effect in its doctoral programs, apparently as a result of industry's current coolness to engineering Ph.D.'s.

The authors have filled in the statistical portrait of the research effort by site visits and interviews which provide some interesting detail. A very common concern among researchers these days is with the problems of instrumentation. The useful life of many instruments is 3 to 5 years, and the funding squeeze has resulted in general reduction in funds for new scientific equipment. Funding agencies, apparently, are prone to cut instrument money out of research grants as they try to stretch the available funds. And because researchers want increasingly sophisticated equipment, even leaving aside the effects of inflation, this raises the costs sharply.

The matter of the availability of instruments does raise the question of whether researchers make the best use of those they have. Purchase of unnecessary instruments or refusal to share are not unknown and the report notes this as one of the problems of management, on which universities are seen to have serious weaknesses.

What the report strongly conveys is the emergence of a manpower problem quite unlike that of the post-sputnik era, which stimulated the growth phenomenon of the 1960's in science. Increases in funds for research and graduate education resulted in expansion of the universities and, in turn, created jobs there for the products of the graduate schools. It was a time when the interests of the federal government, of the universities, and of individual scientists closely coincided.

Circumstances have changed. The report's authors see no prospect of another surge in federal R & D funding. The universities must face up to continued constraints on graduate education and to the tight academic job market. Most universities currently live in "a state of manageable discomfort," say the authors, but more serious trouble appears to lie ahead.

Academic research is, so to speak, living on capital now. If the country waits until the brewing crisis becomes obvious, say the authors, it will be very difficult and expensive to rebuild the research system which has been allowed to decay.

No formal list of recommendations is put forward in the report. Rather, a few major constellations of problems are noted as needing special attention.

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"Federalization of research" is seen as creating burdens for universities which only the federal government can ameliorate. Expansion of formula-type grants, which have been used in varying forms by both the National Science Foundation and the National Institutes of Health, is suggested. The federal government is faulted for treating the universities as just another supplier of services and thus encouraging the stratification process among institutions. What the report proposes is that the government recognize that it has a more general responsibility for the well-being of the universities.

Although the authors offer no systematic plan, they argue that steps must be taken to mitigate the effects of retrenchment on graduate education and young faculty. They also point to the need to deal with what they call "changing authority relationships." Serious strains are viewed as developing between both federal and state governments and the universities, and also within the universities between administration and faculty, and it is suggested that the ground rules developed during the growth period need to be recast.

The new report should serve as a consciousness-raising document for legislators and policy-makers. As advice to the universities the report is practical if not very palatable. Nowhere is its message put more succinctly than in the final section in a kind of obiter dictum: "the era of rapid growth is over. Innovation now must be by substitution rather than by expansion."—JOHN WALSH

Missile Accuracies: Overlooked Program Could Undermine SALT

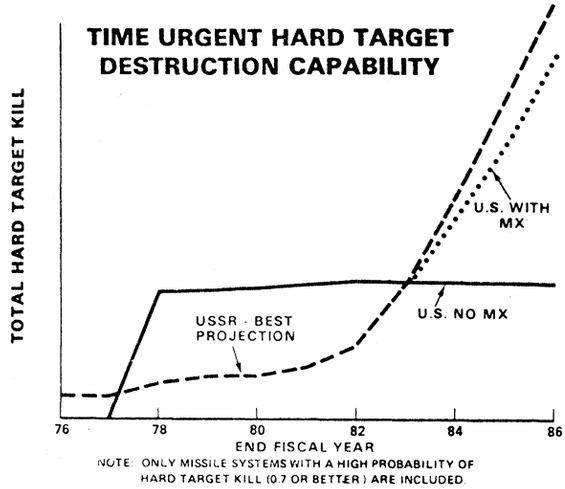
Last month, as the Carter Administration resumed the Strategic Arms Limitations Talks (SALT) in Geneva, Congress approved a pair of small, missile "improvement" programs which some people view as a first "big step" toward giving the United States a first strike capability against the Soviet Union's strategic forces. They are concerned that unless the program is delayed or halted by the President, or bargained away at SALT—and there is no sign that either of these things is likely—it will spur another escalation of the arms race.

The programs are small fish in the vast sea of the $36 billion military procurement budget which the House and Senate conferees are about to approve for fiscal year 1978. One is $29.9 million for software changes in the existing NS-20 guidance system now aboard the Minuteman III missiles—which, if nothing is done to delay the program, will be deployed during October through December of this year. The other is $67 million for the Mark 12A warhead, a more powerful version of the existing Mark 12 now aboard Minuteman III. Both programs were initiated as research items in 1974, as part of the Pentagon's attempt to move to a "counterforce" strategy. Although they were debated at the time, they have since slipped by with so little congressional ado that the Pentagon recently issued statements claiming confidently that each would have "no significant" arms control impact.

But a number of experts say otherwise. According to one set of unofficial calculations, the improvements will give Minuteman III warheads an 80 percent chance of destroying their targets in the Soviet Union, instead of the 20 percent probability now assigned to the present Minuteman III warheads.

The increase will be caused by two things. First, the NS-20 guidance improvements will halve the "circular error probability" of each warhead. The current version has a 50:50 chance of falling within 1200 feet of its target; the new model would have the same chance of landing within 600 feet. Second, the new warhead will be double the yield of the old one, according to a Senate Armed Services Committee report. The 80 percent figure has been used by many people, including Representative Thomas J. Downey (D–N.Y.), writing in a recent *Foreign Policy* article, and by Jeremy J. Stone, executive director of the Federation of American Scientists (FAS), in congressional testimony.

The Air Force, which operates the land-based missile force, claims that the improvements are "a measured and reasonable response to developments on the other side." It also denies that the improvements will result in the "dramatic" increases in force accuracy that Stone and others are claiming. (However, informed sources outside the Air Force say that this could be a reference to the Mark 12A's poor test performance, which may mean that it will not quite be



Relative strengths of U.S. and Soviet missile forces, in warheads, or pairs of warheads, having a 70 per cent or better chance of destroying very hard (2500 psi) targets. Because of these criteria, the entire U.S. Minuteman force is excluded and a Soviet lead shown for 1976. But following software changes in the Minuteman III guidance scheduled for 1977, and deployment of Mark 12A warhead in 1982, the United States gains a substantial lead until 1983. [Source: Annual Defense Department Report, January 1977, pp. 125.]