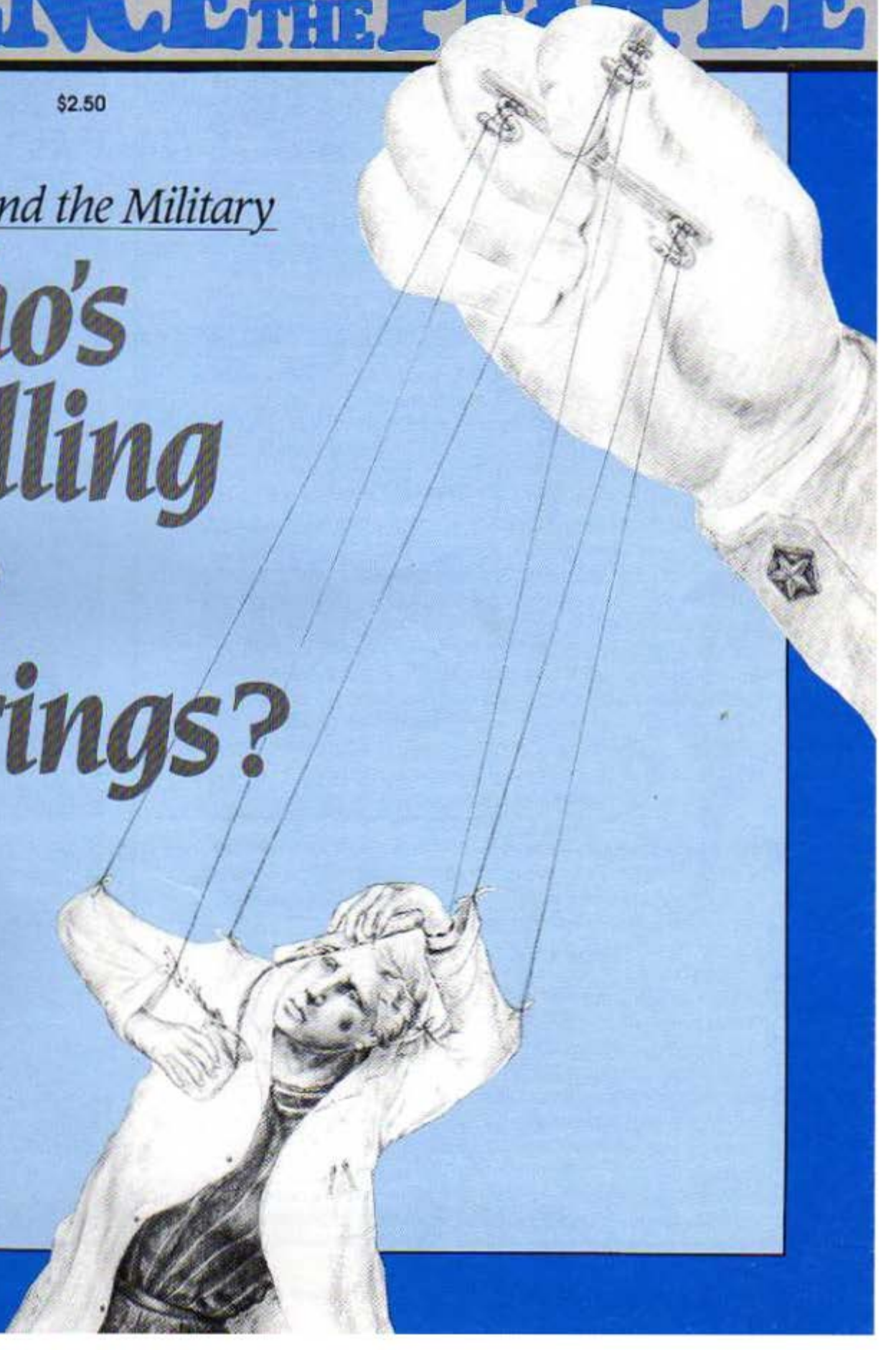
SPECIAL ISSUE: Military Funding of Scientific Research

SCIENCE FOR THE PEOPLE

Vol. 20 No. 1 $2.50

Science and the Military

Who's Pulling the Strings?



Preview

THE MILITARIZATION OF RESEARCH

After nineteen years, we tend to take the long view. Science for the People has been a vehicle for antiwar analysis and activity since its inception. Conceived in the struggle against U.S. involvement in the Vietnam War by an organization then called SESPA—Scientists and Engineers for Social and Political Action—SftP continues to challenge military applications of science and technology.

During the years of U.S. involvement in the war in Southeast Asia, we protested Pentagon-funded research on campuses and the use of napalm, Agent Orange, and other chemical warfare agents against the Indochinese. SftP also helped organize chapters of Science for Vietnam. We collected books, journals, and lab materials for Vietnamese libraries and schools, and worked with Vietnamese scientists on research such as the carcinogenic properties of defoliants.

In 1985, as a response to the U.S.-funded contra war in Central America, we organized Science for Nicaragua. SftP has been sending technical materials as well as North American teachers to the science departments of Nicaraguan universities for the past two years.

So publishing a special issue on the impact of military funding on research and science education is an appropriate way to begin our twentieth year. For this issue, we contacted old and new acquaintances of SftP. Physicist Charles Schwartz was a founding member of SESPA in Berkeley. He teamed up with graduate student Paul Selvin to write an overview of the Pentagon's presence in academia today. Robert Krinsky, a more recent friend of SftP, provided a historical and categorical look at trends in military funding of research science and education since World War II.

Greg LeRoy investigated the new research centers that have proliferated in the Reagan era—consortiums of university, industry, military and federal intelligence agency cooperation. Jonathan King and Steve Nadis explored two areas of military research—biological warfare and the Strategic Defense Initiative—and the broader military influence over scientific fields involved in that research. Gary Marchant interviewed several scientists whose work has been funded by the military to report on infringements of academic freedom, political censorship, professional punishment, and constraints on the public release of even basic research results.

There are also reports from scientists whose laboratories, research, or university departments have been supported by Pentagon funds. The experiences of these women and men—some of which are documented in the section titled Working Around the Military—cover a spectrum of political and professional differences. Through their involvement with Pentagon contracts and research, each has developed an analysis and rationale for accepting or rejecting military funding of their work. The accounts of their personal journeys illustrate the power of professional and economic dependence on military support to influence an individual's own scientific work—and more broadly, the direction of science itself.

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SCIENCE FOR THE PEOPLE is available to bookstores on consignment from the publisher or through Carrier Pigeon Distributors, Box 2783, Boston, MA 02208. The magazine is available in microform from University Microfilms, 300 N. Zeeb Rd., Ann Arbor, MI 48106. Science for the People is indexed in Alternative Press Index, Box 7229, Baltimore, MD 21218.

SCIENCE FOR THE PEOPLE (ISSN 0048-9662) is published bimonthly by the Science Resource Center, Inc., a nonprofit corporation at 897 Main St., Cambridge, MA 02139, telephone 617/547-0370. Edited and produced by the national organization of Science for the People. We offer a progressive view of science and technology. Articles, letters, reviews, newsnotes, photos, and art work are welcome. Please send double-spaced, typed manuscripts, on Wordstar IBM-compatible disks if possible. Unless otherwise noted, all material copyright 1988 by Science for the People.

SCIENCE FOR THE PEOPLE

January/February 1988
Volume 20, Number 1

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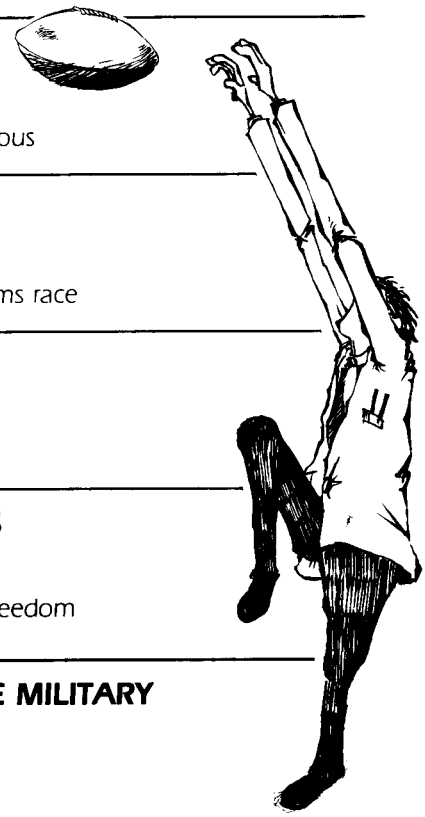

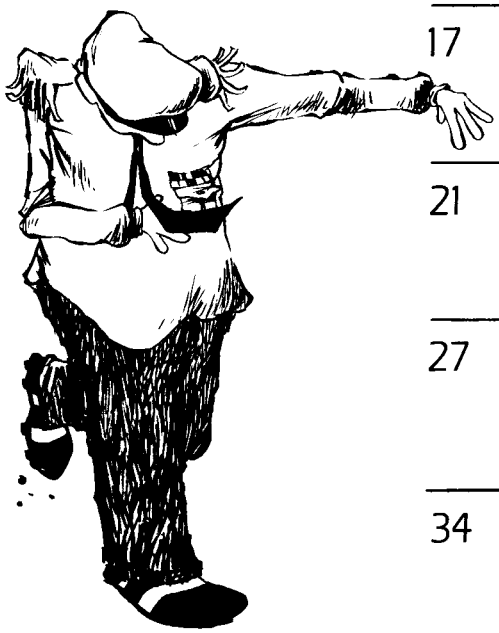

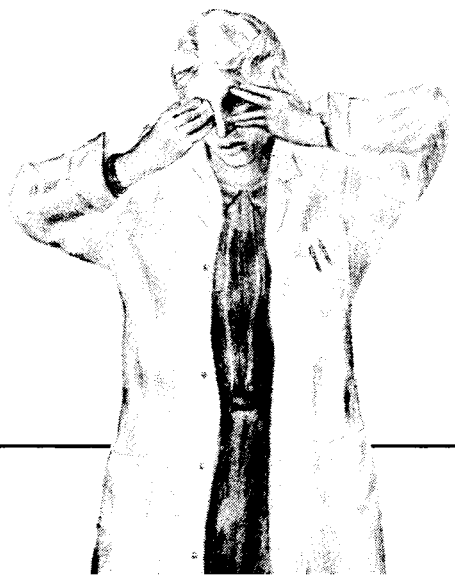

A SPECIAL THANKS TO MARK OSTOW AND XANADU GRAPHICS FOR THEIR GENEROUS SUPPORT.

SWORDS INTO

BY ROBERT KRINSKY

The emergence of sustained close relations between the military and academia occurred concomitantly with the rise of the United States as the dominant economic, political, and military power in the aftermath of World War II. In 1946, General Dwight Eisenhower, Army Chief of Staff, sent a memorandum to senior officials of the War Department on the subject of "Scientific and Technical Resources as Military Assets," in which he stated:

"The lessons of the last war are clear. The military efforts required for victory threw upon the Army an unprecedented range of responsibilities, many of which were effectively discharged only through the invaluable assistance supplied by our cumulative resources in the natural and social sciences." Eisenhower asserted, "Their understanding of the Army's needs made possible the highest degree of cooperation. This pattern of integration must be translated into a peacetime counterpart."[1]

In that same year, the Office of Naval Research (ONR) was established by the U.S. Congress as the first federal agency to contract for basic research. The ONR immediately received $40 million in unspent wartime project money.[2] Shortly thereafter came the establishment of the Army Research Office in 1951, the Air Force Office of Scientific Research in 1952, and the Defense Advanced Projects Agency in 1958.[3] The Pentagon had quickly emplaced a research and development infrastructure devoted exclusively to military pursuits. Each of these military research and development institutions was empowered to contract work from universities and other research institutions.

INCREASING ACADEMIC RESEARCH FOR THE DEFENSE DEPARTMENT

Over the twenty-six year period from 1960 to 1986, Department of Defense (DOD) obligations to academic institutions

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for research, development, testing, and evaluation (RDT&E) totalled $20 billion in constant 1987 dollars. In 1986, funding levels reached their zenith at the $1.1 billion level.

All Pentagon research is targeted for a military objective. The Defense Department research, development, testing, and evaluation budget category is comprised of six sequenced components: 6.1 activity supports investigations in the nature of basic processes and phenomena, 6.2 funds exploratory development, 6.3 concerns advanced development, and 6.5 includes management and support of research and development activities. The balance of research and development programs are allocated to operational systems development.[4]

Categories 6.1 and 6.2, taken together, are regarded by the Pentagon as the "technology base."[5] Historically, they have been the predominant areas of academia's involvement in military research and development. Though 6.1 funding is regarded as basic research, Dr. James Suttle, formerly the DOD assistant director for research and advanced technology in the first Reagan administration, notes that such projects are selected in view of their "potential relationship to the DOD mission."[6] Suttle explains, "When a 6.1 program is successfully completed the results often lead to a 6.2 program to explore the use of the proven concept in a device for military use."[7]

The Defense Department nearly doubled, in real terms, its funding obligations for technology base research to academia between 1976 and 1986. Academia's share of total Defense Department obligations for basic research (6.1) began a steep increase from 39.8 percent in 1980 to 54 percent in 1986 (see graph).[8] Fluctuations of the percentage of total exploratory development obligations (6.2) to academic institutions have been less dramatic over this period, but the amount of money as measured in constant dollars has increased 40 percent above the 1980 level to $198 million in 1986.[9]

In order to fully appreciate the pattern of increasing academic involvement with Pentagon research, and the extent to which this dramatically influences the character of the research and development agenda at colleges and universities, it is essential to consider the changing composition of the Pentagon's research obligations.

Academia is increasingly involved with a greater degree of applied research for the Pentagon. During the period from 1976 to 1986, the technology base funding category comprised more than 60 percent of the annual research and development funds to academia. This is a sharp decline from the levels of technology base funding which ranged between 78 percent and 88 percent annually over the period from 1978 to 1987.[10]

Emphasis on advanced applied research is likely to persist, buoyed by such programs as the strategic defense initiative (SDI). All funding to academia from the SDI Innovatove Science and Technology Office is categorized as advanced development funding (6.3).[11] SDI funding to academic institutions grew more than five fold in constant dollars, from $24 million in 1985 to $133.4 million in 1986, and maintained a high level in 1987 at $101.3 million. (SDI figures are in constant 1982 dollars.)[12]

FEDERAL FUNDING OF MILITARY RESEARCH FROM NON-DOD SOURCES

The Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF) have become important sources of military research and development funding to academia. Aggregate DOE appropriations for weapons procurement more than doubled, from $3.6 billion when President Reagan assumed office in 1981 to $7.6 billion in 1987. Over this period, weapons programs accelerated from 38 percent of the DOE budget to 65 percent, with the 1988 budget request for $8.1 billion.

Meanwhile, requested appropriations for energy conservation (including weatherization for low-income households, schools, and hospitals) in 1988 are 89 percent lower than in 1981. Appropriations requests for solar energy and other renewable fuels are 88 percent lower than appropriations granted in 1981.[13]

Estimates of the level of militarization at NASA during the Reagan administration range from 50 percent to 90 percent.[14] According to the *Wall Street Journal*, "Military men...are increasingly calling the shots in the U.S. space program."[15] President Reagan's national space policy gives the DOD priority access to the shuttle—the design of which was heavily influenced by military requirements.

Militarization of Higher Education Since World War II

SHEEPSKINS

Prior to the space shuttle accident, 34 percent of shuttle payloads through 1994 were scheduled for military commitments.[16] (See "The Military History of the Space Shuttle" by Jack Manno, in the September/October 1983 issue of SftP.) The consequent backlog due to the shuttle crash is likely to cause a dramatic increase in this commitment if and when the shuttle ascends again.

The National Science Foundation is increasingly being leveraged for military purposes through such joint efforts as the NSF-DARPA-ONR support for advanced computer architecture at Princeton University. In an apparent bid to ensure significant NSF funding, Eric Bloch, director of the NSF, is promoting linkages with the Pentagon. Bloch recently asserted to Congress, "We should have joint support of some of the new science and technology centers in the president's competitiveness initiative. NSF has taken the lead, but other agencies, especially in Defense, should be involved."[17]

GOVERNMENT & UNIVERSITY SUPPORT FOR MILITARY RESEARCH

The pattern of Pentagon research and development funding to academic institutions traces significant political initiatives by both U.S. presidents and academic executives. Funding obligations rose and were sustained at relatively high levels through President John Kennedy's missile buildup and the escalation of the U.S. government's aggression against Viet Nam throughout the administrations of Presidents Kennedy and Lyndon Johnson.

During President Richard Nixon's escalation of the U.S. war on Vietnam, a crescendo of opposition on college campuses across the nation caused the contraction of military funding to the academy. Academic senates adopted policies prohibiting secret research.

In 1970, the U.S. Congress enacted the Mansfield Amendment (section 203 of the 1970 DOD Authorization Act) which restricted research and development to "a specific military function or operation."[18] Defense Department obligations to academic institutions dropped 22 percent (in constant 1987 dollars) from 1969 to 1970, and by 1975 obligations had plummeted 48 percent below the 1969 level.[19]

Relations between the Pentagon and academia began to improve in 1978. President Carter accelerated a wide variety of military programs, and a special working group known as the Galt Committee was directed by Carter to review DOD research practices. The committee's findings stressed the importance of Pentagon access to university resources:

"The DOD has supported basic research for decades, and it must continue to do so if it is to pursue its overall national defense objectives at the highest possible level of effectiveness and insight. There are three fundamental reasons. Many of the known technological problems stem from gaps in knowledge which only basic research can fill. Basic research is a source of new concepts which introduce major changes in technological and operational capability. And finally, it is a source of insight for DOD policymakers and others in evaluating and reacting to the possibilities inherent in technical proposals and in technological developments anywhere in the world."[20]

Acting on this concern, in 1978 Carter increased research and development allocations to colleges and universities by 30 percent above 1977 obligations. A broad interpretation of the Mansfield Amendment was rendered by Carter, so that virtually no Pentagon research funding would be excluded from academia.[21] Additionally, a new position of Director of Research was formed, and the DOD reconstituted its office of university affairs in 1980.[22]

THE DOD-UNIVERSITY FORUM

By 1986, the Carter-Reagan military buildup in academia had brought research and development obligations to a level 126 percent greater in real terms than 1977.[23] New institutional structures emerged during the Reagan administration to cement closer ties between the military and academia. Formation of the DOD-University Forum (hereafter called the Forum) is the centerpiece.

The Forum is a policy advisory group consisting of senior-level DOD and university administrators. It is jointly sponsored by the DOD and three of the most influential higher education associations: the Association of American Universities (AAU), the National Association of State Universities and Land Grant Colleges, and the American Council on Education. The official function of the Forum is to "advise the Department of Defense on the full range of research-related needs and issues that affect the Department's ties with universities."[24]

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University administrators have not been passive agents in the resurgent militarization of academia. It is notewothy that the idea for the Forum was initiated by the AAU and adopted as part of *The Defense Science Board Task Force Report on University Responsiveness to National Security Requirements* issued in 1982.[25] The AAU, representing more than fifty-four of the largest public and private research universities, has been extremely effective in securing institutional access to public coffers. The organization is also responsible for spearheading political action that resulted in legislation establishing the Office of Energy Research in the Department of Energy.[26]

Though the Forum is co-sponsored by academia and the Pentagon, an indication that the Pentagon has the upper hand is the fact that nominations to the Forum by the sponsoring associations must meet with the approval of the Secretary of Defense.[27]

The Forum has significantly influenced the magnitude, direction, and character of DOD research at universities through its working groups on science and engineering, foreign language and area studies, and export controls. Examination of these activities reveals the many ways in which militarization of higher education is limiting the range of free thought and diverting scarce resources from civilian requirements.

THE UNIVERSITY RESEARCH INITIATIVE

The Forum's Engineering and Science Education Working Group advised the DOD to implement the University Research Initiative (URI). The URI was funded by the Congress at $90 million in 1986 and an additional $35 million in 1987.[28] It is a multidisciplinary research program focusing on ten priority military technologies involving the natural and physical sciences.

These priorities include: technologies for automation; biotechnology; electro-optical systems and signal analysis; high performance materials for a broad spectrum of defense applications; fluid dynamics systems; human performance factors for guiding design of machines; sub-micron structures in order to meet the military's need to increase electronic information processing five orders of magnitude by the 1990s; environmental science and technology in order to understand the conditions in which the weapons systems will have to operate; and propulsion technology, including plasma propulsion systems for use on future space missions.

The formulation of the URI is indicative of the increased emphasis upon advanced applied research in universities. Ronald Kerber, formerly Deputy Undersecretary of Defense for Research and Advanced Technology, stated that the purpose of the

URI is to "accelerate the process by which scientific discoveries are translated into practical applications for advanced defense systems."[29] The URI effort is slated for a three-to-five-year duration. It is intended to facilitate contacts among university, industry, and DOD labs, as well as increase the number of science and engineering students working in areas of concern to the military.

Approximately 85 percent of URI funds are allocated to multidisciplinary research programs. The balance finances graduate fellowships, young investigator awards to new faculty, and scientific personnel exchanges between DOD labs and universities.[30] These arrangements are financially lucrative to the researcher and university alike. For example, the Air Force's Laboratory Graduate Fellowship Program provided forty-five three-year fellowships to doctoral students in 1986. All tuition and fees are paid and the fellow's department receives $2,000 per year. Fellows accrue an escalating annual stipend of $13,000, $14,000, and $15,000 over the fellowship period.[31]

The ONR's Young Investigator Program provides a base funding of $50,000 annually for three years to academic faculty who received a Ph.D. or equivalent within five years of the award date. Further incentive is provided by the ONR's offer to match, on a two-for-one basis, support gained by the investigator from Navy labs and/or the Navy Systems Commands. Though ONR has an $80,000 cap on this lucrative deal, there is no limit on the amount of funds obtainable from these other Navy sources. The ONR's goal is to "establish strong long-term ties between DOD and outstanding academics."[32]

THE MILITARY'S ECONOMIC & BRAIN DRAIN

The damage done by diverting precious human and capital resources from the civilian economy exacts a social and economic cost toll far greater than the nominal price tag for the Pentagon research activities fulfilled by academia. The "spinoff" argument which peppers nearly every public Pentagon document on research and development is an oversold stratagem used to perpetuate the flow of large amounts of research funds to the military. A retrospective study conducted by the National Academy of Engineering in 1977 concluded:

"With few exceptions, the vast technology developed by Federally funded programs since World War II has not resulted in widespread 'spinoffs' of secondary or additional applications of practical products, processes and services that have made an impact on the nation's economic growth, industrial productivity, employment gains, and foreign trade."[33]

The intensified shift toward "mission-oriented" advanced applied research following this evaluation assures that the opportunities for spinoffs will fall off to zero. Seymour Melman, professor of industrial engineering at Columbia University, and others have documented in numerous instances that the characteristics of the design criteria and production practices in the military are inimical to competence in the civilian sector.[34]

The military practices the art of "anti-

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engineering," according to James Melcher, professor of electrical engineering at the Massachusettss Institute of Technology (MIT) and director of the MIT Laboratory for the Electromagnetic and Electronic Systems.[35] Regarding DOD's civilian spinoff claim, Melcher asserts, "If you're going to run business in this country that way, we know that it is not competitive."[36]

The drain on the civilian economy is further exacerbated as a consequence of the Independent Research and Development (IR&D) program. This was established during the Reagan administration for the purpose of providing incentives to industrial military contractors for subcontracting their research and development work to universities. It is a program highly regarded by the Pentagon, which recently observed that "while it is difficult to quantify the additional support for university R&D due to these incentives because the support includes exchanges of engineers, the IR&D incentives are considered effective."[37]

Engineering and physical sciences have historically been the recipients of the greatest share of DOD largesse and currently these academic departments remain heavily reliant on DOD funds.

An ability to leverage the thoughts of a great many more capable minds than it funds is a dividend to the Defense Department's role as a significant funding source in the engineering and science disciplines. Diversion of scarce scientific talent from civilian projects exceeds the number of university researchers on the Pentagon payroll.

More than 170 academic institutions submitted a total of 965 proposals requesting more than $6 billion in the URI competition. The DOD judged 165 to be "of greatest scientific merit and importance to national defense."[38] A recent Pentagon evaluation estimated that between one-third and one-tenth of the proposals submitted by university researchers are funded, but twice as many are worth funding.[39]

When evaluating proposals from university researchers, the Defense Department substitutes its own evaluative criteria for the traditional peer review process of the academic community. Peer review is designed to ensure scientific merit. The act of an external institution imposing its criteria on the university research process does not comport well with academic freedom, nor with broad social accountability by the universities which accept these terms as a condition for conducting Pentagon research.

The Pentagon's rationale for substituting its "merit review" procedure provides further evidence that research agendas are informed in significant part by political and economic power:

"While external peer reviewers can help to judge the merit of the science, they are often not aware of the many facets of projects already supported by a particular agency, or how a proposed research project might fulfill a specific mission requirement. As a result, the Services and the Defense Agencies rely heavily on the recommendations of their scientific program managers who are credentialed experts themselves in scientific or technical disciplines, and who also must be knowledgeable of relevant areas of military systems and operations."[40]

The pursuit of knowledge as defined by the military and for the military is the consequence of the Pentagon's merit review process.

NOTES

1. Full text in Seymour Melman, *Pentagon Capitalism.* New York: McGraw-Hill, 1970, pp. 231-234.
2. "Office of Naval Research Marks 40th Anniversary," *Science,* November 21, 1986, p. 932.
3. U.S. Department of Defense, *The Department of Defense Report on the University Role in Defense Research and Development for the Committees on Appropriations, United States Congress.* Washington, D.C.: The Pentagon, April 1987. p. 5. Note: these and subsequent data in this article do not include money dispensed by the Defense Department through university-operated, federally funded research and development centers (FFRDCs).
4. James R. Suttle, "Basic Research from Lewis & Clark to Laser Physics." *Defense 82,* Washington, D.C.: The Pentagon, p. 23.
5. Ibid.

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PUBLISH & PERISH

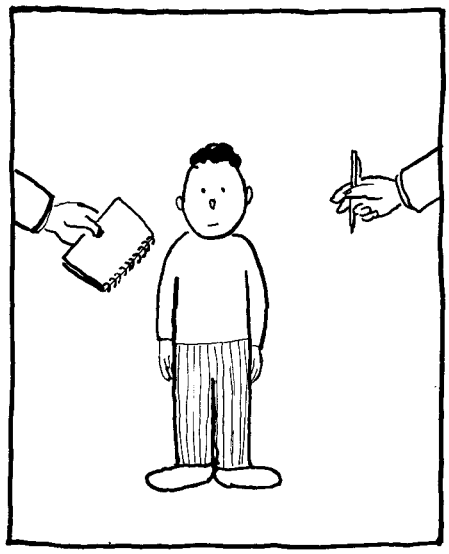
Integration of University Science with the Pentagon

BY PAUL SELVIN AND CHARLES SCHWARTZ

At 2 A.M. on April 15, 1986, the deafening roar over Tripoli arose from American F-111 jet bombers engaged in a "surgical strike" to destroy the Libyan head of state, Muamar el-Qaddafi. Guided by night-seeing infrared detectors linked to onboard computers, equipped with laser-guided "smart" bombs, and hidden by electronic jamming devices, the F-111s represent a new high-tech warfare pursued by Pentagon planners.

The new soldiers in this technological battlefield do not reside in the Pentagon and have no military rank or military garb. Instead, they work in industrial labs and on college campuses, hold the degrees of B.S., M.S., and Ph.D., and often dress in raggedy jeans. They are researchers, teachers, and students of science and engineering.

On campus, there is talk about the militarization of science; in the Pentagon, there is active effort to scientize the military. The Department of Defense (DOD) is building bridges to the brain centers of science and technology: the universities. "During the past decade, DOD has made a major effort to reverse the effects of the relative neglect of university research that occurred during the Vietnam war."[1]



Students, upon leaving the ivory tower, are finding that most roads lead to the Pentagon. MIT president Paul Gray laments that the brain drain to the Pentagon "may draw talented people, including students and faculty, away from other promising lines of inquiry"[2] with nonmilitary applications.

But stunted civilian operations that lack fertile workers and technological nourishment are only a domestic problem, harsher critics argue. An overfed military monster, armed with more powerful and effective

Paul Selvin is a graduate student in the Department of Physics at the University of California, Berkeley who has been active in issues surrounding the militarization of science. Charles Schwartz is a longtime member of SftP who teaches physics at the University of California, Berkeley and is trying to educate physics professors and students about the military applications of their work.

technological thunderbolts, is stalking the globe under U.S. foreign policy direction.

TRAINING & CHANNELING TECHNICAL PERSONNEL

Most discussion concerning the contribution of academia to the military-industrial complex has focused on campus research, such as classified vs. unclassified research and military vs. civilian funding. This discussion, while important, misses an equally—if not more important—contribution: the training of students. The future "front-line soldiers" of science—those with bachelor degrees—as well as the future "captains" of science—the Ph.D.s—are all trained at universities.

But recruits and trainers are in short supply. In congressional testimony concerning the Department of Defense appropriations for 1986, Dr. Robert Rosenzweig, former vice president of Stanford University and current president of the Association of American Universities, testified that "an insufficient number of talented U.S. students are being attracted into Ph.D. programs in the sciences and engineering." He also claimed that "there is a shortage of engineering faculty...that is hampering undergraduate engineering." The faculty shortage is so acute that when asked how a young Ph.D. engineer could best contribute to the Department of Defense, Dr. Rosenzweig responded: "If he is...good enough, we would like him to go back on university faculty."[3]

The Defense Department is interested in training a large number of technically oriented people to "build a cadre of scientists and engineers who will be participants in its programs in the future," according to Dr. Rosenzweig. Graduate student support, through fellowships and research grants, increases the likelihood that a graduate student will choose a research area of interest to the DOD. "If they are engaged early in work that is intellectually stimulating to them and that has some promise for the future and is supported by the DOD, it seems to me you are well on the way to having them hooked into that enterprise for a long time."[4]

In business this technique is called a loss leader. Sell cheap initially to reap the benefits later: fund scholarships or research grants to create a new crop of students familiar with DOD "products." With effective advertising and sufficient support, research fields become exciting, active, and full of users (colleagues). The Pentagon, like a company with loyal customers, is content to hear the familiar professorial "excuse:" "My research, although paid for by the DOD, is completely unclassified; it is the work I want to do, not what they tell me to do."

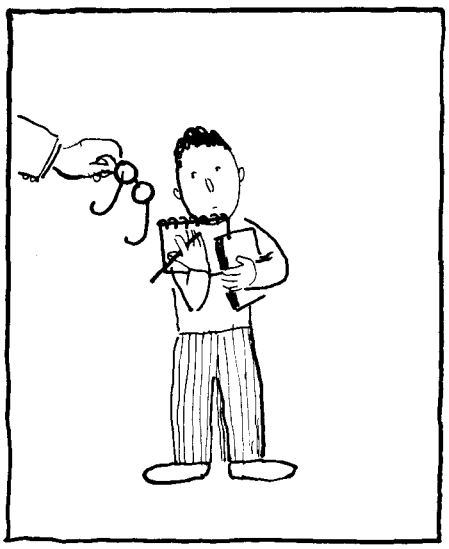
While many academics who wish to distance themselves from the military refuse to accept DOD money for research or, in more extreme circumstances, stop research altogether, it is almost unheard of to reject the responsibilities of teaching. One of the authors of this article, Professor Charles Schwartz of the University of California, Berkeley, has taken the unusual step of refusing to teach graduate and undergraduate classes to physics and engineering majors. Fifteen years earlier, Professor Schwartz resigned as a principal investigator from a DOD research grant after the funding agency, the Air Force Office of Scientific Research, refused to reveal the military's interest in his work.

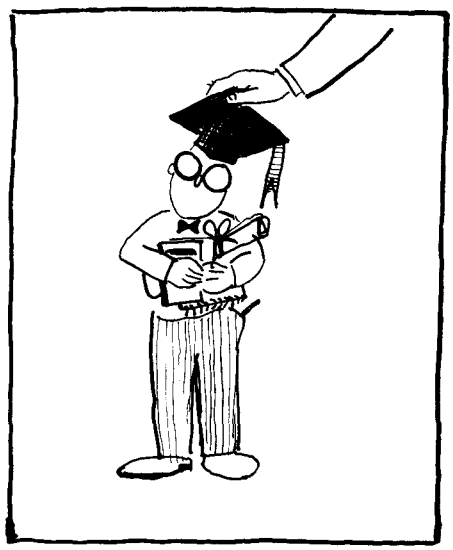
Students, the center of attention in this battle, often find that the only job niche available after leaving the university is in the trenches of the military-industrial complex. John Rigden of the University of Missouri and editor of the *American Journal of Physics* comments: "In my experience, students go to academe or else they work for Caspar Weinberger, either directly or indirectly."[5]

Physics Today, citing Susanne Ellis, an educational studies analyst involved with the American Institute of Physics' annual survey of physics bachelor-degree recipients, says, "It used to be the case...that graduating bachelors hardly ever wrote anything in the part of the questionnaire reserved for comments. But in the last two years," she continues, "respondents mention increasingly frequently that they are unhappy with the job prospects outside the defense sector: A typical comment is, 'The reason I have had such trouble finding a job is that I do not want to do defense-related work.'"[6]

The channeling of scientists and engineers into military-related work, while particularly acute for baccalaureates, also exists for Ph.D.s. "If you are in physics," says R.K. Weatherall, Director of MIT's Office of Career Services, "you may have started out dreaming only of contributing your bit to the stock of human knowledge. Later, with the Ph.D. under your belt, you may decide to leave the academic life for industry and then you discover that many of the most exciting places to apply your background in lasers, or cryogenics, or computer modeling are in the defense sector."[7]

The military web can also ensnare established physicists presently in the civilian sector. Recent cutbacks in civilian projects, combined with large increases in military programs, are forcing former or present civilian-oriented researchers to find military-related jobs. At the Lawrence Livermore Laboratories, the Tandom Mirror-Magnetic Confinement Fusion Project was mothballed at the same time that Livermore landed a multimillion





Data on Jobs and Budgets

What percentage of scientists and engineers in the U.S. are employed in military-related jobs? Estimates vary widely: 14 percent (National Science Foundation); 20 percent (National Academy of Engineering & Office of Technology Assessment); 30 percent (Dumas); 40 percent (Thurow). As for the fraction of jobs taken by new science and engineering graduates that are in the military sector, the estimates vary even more: 14 percent (NSF); 28 percent (Davis); 70 percent (Tsurumi). (Sources: NSF; Daniel S. Greenberg; Warren. F. Davis, unpublished manuscript, January 26, 1985.)

The military market for scientists and engineers depends strongly on the field and also on the type of job. The following table on scientists working for the military presents the only disaggregated data available. The entries show the percentage of scientists and engineers, within each category, who were employed primarily in work for "national defense" at the time of the 1980 census.

For students considering science and engineering jobs outside of academic institutions, the last column, "applied R&D," is the most relevant. The large percentage shown for aero/astro engineers is what one might have expected; but the near 50 percent figures for physicists and mathematicians are surprisingly high.

These figures, however, should not be taken at face value for today's situation; instead, they provide *lower bounds*. The true numbers today must be considerably higher than these, due to the large changes in federal priorities for R&D funding that have occurred since 1980. The graph, reproduced from *Science* magazine, shows the dramatic shift toward military funding in research and development—boosted from 50 percent to 73 percent—under Reagan. This graph shows only federal funding for R&D, which is about one-half of the entire national R&D expenditure.

Of "basic" research funds which the federal government supplies, only about 12 percent comes from the Department of Defense (NSF, Science Indicators 1985). The Pentagon, however, puts its basic research money into strategically chosen fields: in fiscal year 1986, the DOD portion of all federal support for university basic research amounted to 14 percent in physics, 35 percent in mathematics, 48 percent in materials science, 48 percent in mechanical engineering, 54 percent in computer science, 56 percent in aeronautics/astronautics, and 60 percent in electrical engineering, according to Federation of American Scientists statistics.

Scientists and Engineers Working for National Defense in 1980

FIELD	PRIMARY WORK ACTIVITY		
	all jobs	all R&D	applied R&D
all Fields of Science & Engineering	13%	19%	21%
all physical sciences	10%	14%	15%
Physics/Astronomy	22%	31%	46%
Chemistry	5%	5%	6%
all Mathematical Sciences	13%	32%	42%
Mathematics	15%	36%	49%
all Computer Specialists	11%	14%	15%
all Engineering	18%	24%	24%
Electrical Engineering	27%	32%	32%
Aero/Astro Engineering	58%	66%	66%

Source: *National Science Foundation 1982 Postcensal Survey. A 1981 survey restricted to PhDs shows figures about ⅔ of the above.*

dollar Strategic Defense Initiative project, forcing fusion workers to move to a new job or join the SDI project.

Similar cutbacks at MIT's Plasma Fusion Center have led Barton Lane, a theoretical physicist, to note: "People in fusion energy research are getting out of the field. They're going into the Strategic Defense Initiative. That's where the jobs are today for these kinds of skills."[8]

Surprisingly, there are no uniform statistical data available showing the breakdown of military vs. civilian jobs for scientists and engineers; numbers range from 14 to 70 percent. (See the accompanying sidebar.)

DEVELOPING THE SCIENCE AND TECHNOLOGY BASE

For years, the Department of Defense has recognized the importance of science and technology in maintaining U.S. military strength and "the essential role that the academic community plays in the maintenance of U.S. technological leadership." Consequently, "U.S. universities are a major factor in current DOD activites affecting the U.S. technology base," a Pentagon report to Congress maintained. In fact, DOD spending for basic research at universities has grown at a rate "far higher than the national growth of DOD (basic) research funds as a whole."[9]

However, the Pentagon does not need to rigidly control academic basic research. With $44 billion dedicated to *applied* research and development—73 percent of all federally-sponsored research and development in the U.S.—the DOD is able to transform advances in basic research into practical weapons systems. The ideology of a "pure" search for the truth in universities, coupled with an extensive defense-oriented applied research program in industrial and military labs, serves the Pentagon well.

The Pentagon's interest in basic research is two-fold: they're seeking new scientific knowledge and technological spin-offs. The study of the cosmic background, a subfield of astrophysics, yields technological spin-offs of interest to the military (for example, infrared detectors), but the scientific result—whether the cosmic background radiation follows a black-body spectrum at 2.78 or 2.75 degrees—is of little military interest. For instance, in yet another U.S.-Libyan confrontation, an air duel over the Gulf of Sidra in 1986, infrared detectors were used by an American F-15 fighter plane to home in on the enemy plane's exhaust fumes and destroy it with a heat-seeking air-to-air missile.

Other times, the goals of a basic research program are of direct interest to the Pentagon. Mathematical research into turbulent flow and nonlinear systems is

fundamental to wing and rotor design of airplanes and helicopters, as well as all kinds of projectiles, from bullets to rail guns and nuclear warheads. The study of shock waves in supernovas has the down-to-earth application of nuclear explosions.

Although the Defense Department does not control basic research on campuses, the Pentagon, nevertheless, stimulates certain areas of basic research, particularly in the physical sciences, through research grants, sponsorship of conferences, and support of graduate students and postdoctoral fellowships. Even within the physical sciences, the areas of basic research sponsored by the Pentagon are not random.

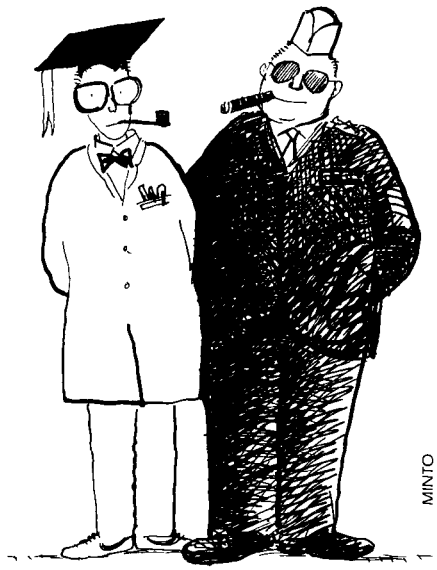
Despite the commonly heard rationales—"My research, although paid for by the DOD, is completely unclassified and is not weapons-related," or "I am fooling the DOD by taking their money which they would otherwise spend on weapons"—the Pentagon has an extensive and sophisticated organizational structure to determine what areas of science are of most benefit to the military and which particular research projects will further specific military goals.

PENTAGON ORGANIZATION: BASIC RESEARCH FOR THE MILITARY

The Pentagon receives top-level scientific advice from its science advisory committees: the Defense Science Board and other committees for each branch of the armed forces. They are responsible for identifying the particular research areas that the military will encourage. (See the accompanying sidebar.)

Once overall priorities are established, the Pentagon must then review specific research proposals for funding. An exhaustive study by Stanton Glantz and Norm Albers, published in *Science*, analyzes the process in detail.[10] A four-step process determines military research objectives based on the military requirements of each armed service. The military requirement is identified in step one: for example, it is found that a foot soldier cannot communicate with his or her commander. Step two: analysis shows that a new piece of equipment will solve the problem. Step three: the equipment will require micropower integrated circuitry. Step four: present micropower techniques are found inadequate, and funding for this field is prioritized, thus defining the military research objective.

Any proposal submitted to the DOD is compared by military scientists to the armed services' research objectives. Other scientists from the National Academy of Sciences/National Research Council judge the proposal on scientific quality. "Both the National Research Council's determination of scientific merit and the military



laboratory experts' judgment of relevance must be affirmative or DOD will not fund the proposal."[11]

SO WHAT?

Although the Pentagon has built an elaborate planning and review process to utilize and stimulate science and technology for military objectives, is it really getting much bang for its bucks? Or is the review process just another B1-B bomber—expensive, useless, and serving no real military purpose?

Opinions differ on how "smart" DOD funding agencies are. Not surprisingly, a Pentagon official claims, "The Department of Defense makes a very thorough effort to insure funding only research projects directly relevant to the military's technological needs...there is a sufficiently large number of research proposals received so that the funding agencies can afford to choose only those most nearly matching their goals."[12]

One computer science professor at the University of California, Berkeley, where about 80 percent of that field's funding is from the Defense Department, says that DOD project officers are "sharp" and "helpful."[13] However, because the military budget is so bloated, there is bound to be excess fat that strains the budget belt and needs to be spent, even if it has little or no military application. John Holdren and Bailey Green, of the Federation of American Scientists, report, "In some cases, perfectly sensible research with little relation to strategic defense—other than having been strategically re-labeled—is being carried out with the excess funds."[14]

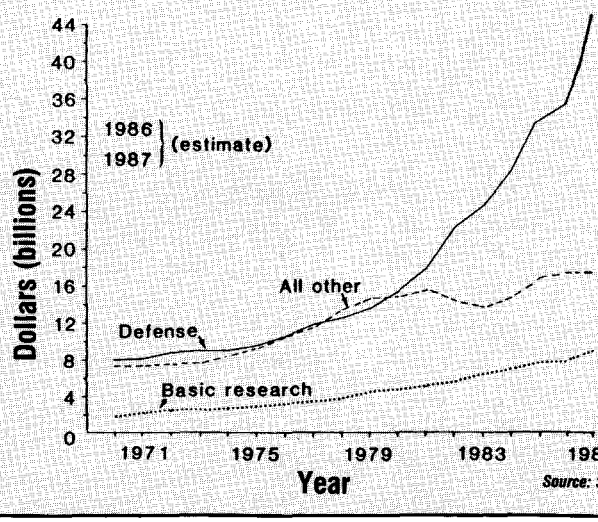
Other professors are skeptical of DOD's ability to pinpoint basic research that's of military interest. "They don't have the brains," said an MIT professor who has taken DOD money.[15]

Many concerned professors—perhaps afraid of what they might find—superficially investigate the military significance of their work. A Pentagon position paper took note of the different emphasis of the civilian researcher and the military funding agency: "Great differences were found in statements of military objectives; in many cases the DDC (Defense Documentation Center) statement contained a highly relevant objective for each project written by the DOD project monitor, while the university proposals, written by faculty researchers, largely ignored this point."[16]

It is often difficult to know the reasons why the military is interested in a particular research project, because the information is classified and, therefore, unavailable to the civilian researcher.

Opinions clearly vary about how well the DOD targets funding for basic research of military importance. Nevertheless, there is little question that modern-day warfare

The Militarization of R&D—Scientists and Engineers Working for National Defense in 1980



The Administration's budget would put 73 percent of federal R&D dollars into military programs. In 1980, military and nonmilitary R&D spending were about equal. [Basic research funds are included in the totals for defense and other programs.]

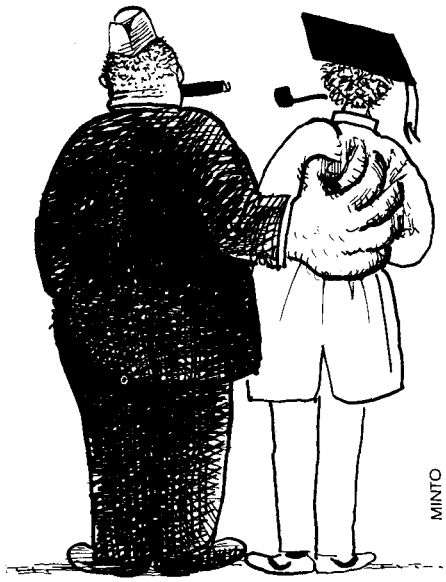
Source: *Science*, vol. 231, Feb 21, 1986, page 787.

has gone "high tech" and that without the basic research and training done on campuses, the military machine would have trouble operating.

A ROSE BY ANY OTHER NAME MAY BE DEFENSE RESEARCH

Differences between DOD and non-DOD funded research, while present, should not be overemphasized. In Washington, the National Science Foundation, Department of Energy, NASA, and DOD regularly consult, coordinate, and even trade and share project funding.[17] According to a 1982 report by the Defense Science Board, "Research and development in universities is supported by many sponsors, each relying on complementary funding from the other sponsors to leverage its own expenditures."[18]

The X-ray laser program, for example, was initially funded for several years by the Pentagon. In 1977, the director of DOD's Advanced Research Projects Agency reported to Congress that he was terminating the program because it did not seem to have any near-term military applicability, and recommended that NSF take over funding.[19] In the early 1980s, the first successful nuclear-pumped X-ray laser test was announced at the DOE's Lawrence Livermore Lab. (Subsequently, it was learned that many of the lab's claims were scientifically dubious.)



Normally, a number of military agencies simultaneously fund particular projects and entire fields which have both civilian and military applications. Lasers, computers, and thin-film technology are just a few of the many specific projects funded by DOD, NSF, and DOE.

The symbiotic relationships between the DOD and other funding agencies is even more subtle: funding by one agency supports projects associated with others. For example, Synchrotron radiation sources, like the one at Stanford, are funded by NSF and DOE, "with only minor support from DOD," according to a 1985 DOD report.[20] However, the report continues, "Any decrease in support of these facilities by the other agencies would severely affect the DOD materials research program." Thus "a rose by any other name may be defense research."[21]

LENDING LEGITIMACY

The Pentagon has sought to enlist the prestige and credibility of the academic community. The most striking example occurred when Commander-in-Chief Reagan attempted to disarm SDI critics by claiming that a majority of scientists believe that SDI is feasible. Reagan's statement backfired: some 3,700 science and engineering faculty members—including a majority of the top 59 physics departments—and 2800 graduate students signed a pledge not to accept SDI funding.[22] (See the article about scientific resistance to SDI, "After the Boycott," in this issue.)

Attempts to harness the prestigious ivory tower image also occur on Capitol Hill. "This office is trying to sell something to Congress," said James Ionson, who heads the Innovative Science and Technology Office of the Strategic Defense Initiative Office, in a 1986 *Science* interview. "If we can say that this fellow at MIT will get money to do such and such research, it's something real to sell."[23]

The DOE's Lawrence Livermore and Los Alamos National Labs, officially run by the University of California, also exert influence in Washington. Designers of U.S. nuclear weapons, yet having the independent and unbiased reputation associated with a university, these labs have fought most vigorously against a comprehensive test ban treaty. In 1978, President Carter was on the verge of signing a test ban treaty but was dissuaded after a meeting with then Livermore Director Roger Batzel and Los Alamos Director Harold Agnew. Said Agnew, "There's no question in my mind that we turned Carter around because we incurred so many enemies from the other side! It was obvious we had an impact."[24]

Back at the university's campuses, the Livermore and Los Alamos labs use their association with the University of California to recruit and retain students and graduates—a benefit that lab directors frequently note.[25] All recruiting advertisements display the University of California name. At UCAL-Davis, an exchange program for doctoral students—sometimes called "Teller Tech"—allows physics and engineering students to conduct their Ph.D. work at the Livermore facility.

Collaborative efforts, such as the Institute for Geophysics and Planetary

CONTINUED ON PAGE 48

Science Advisory Committees to the Department of Defense

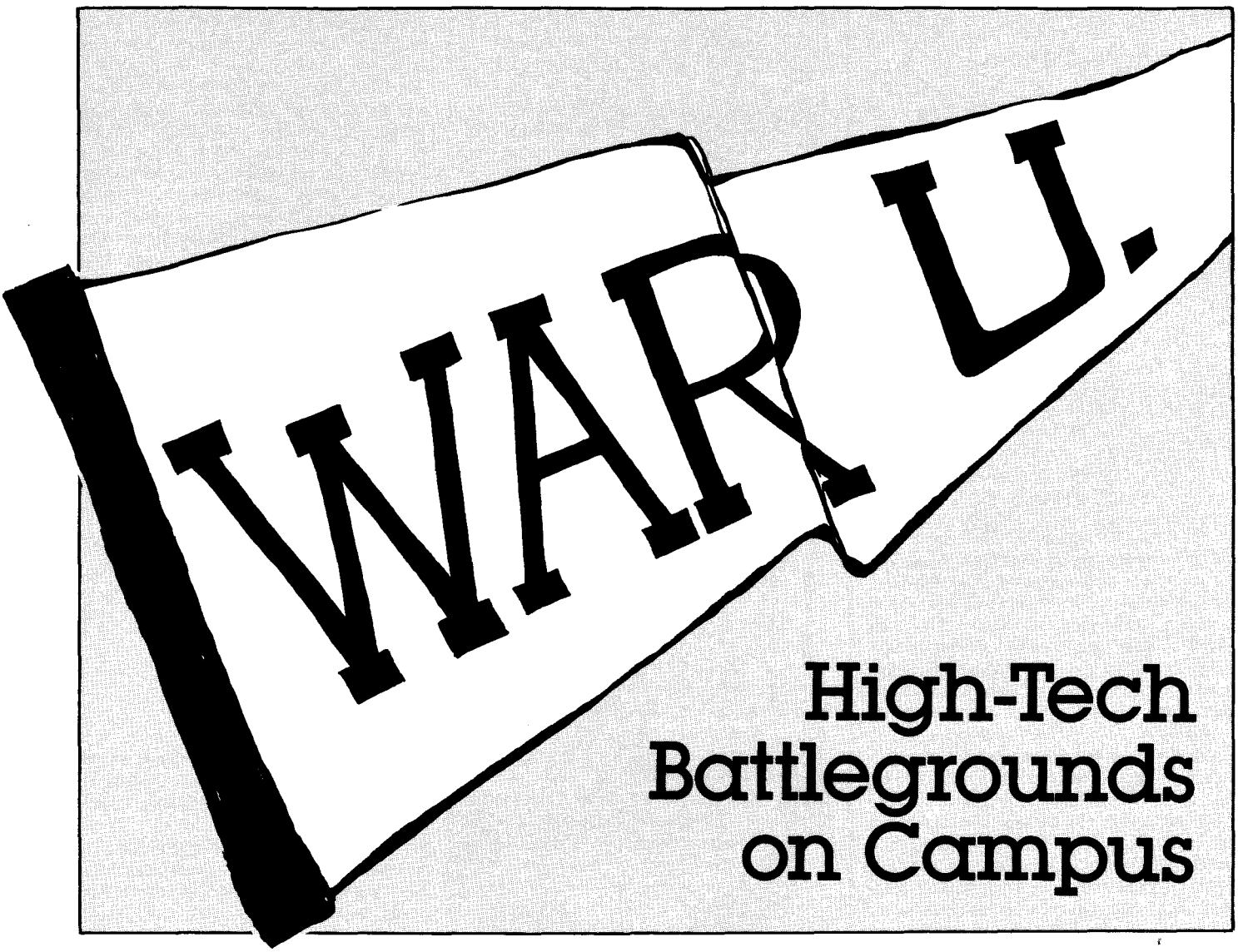
The following statistics reflect the number of academics on military science advisory committees—Defense Science Board: 23 academics out of 125 members in fiscal year 1986; Air Force Scientific Advisory Board: 22 out of 81 in FY 86; Army Science Board: 18 out of 98 in FY 86; Naval Research Advisory Committee: 23 out of 125 in FY 86; SDI Advisory Committee: 6 out of 12 in 1987.

The charter of the U.S. Air Force Scientific Advisory Board describes its objectives in charting the course for science: "The Board reviews and evaluates long-range plans for research and development...recommends unusually promising scientific developments for selective Air Force emphasis and new scientific discoveries or techniques for practical application to weapon or support systems...and serves as a pool of expert advisers to various Air Force activities."

The DOD-University Forum is a defense advisory committee recently created to deal with general policy issues rather than scientific questions. As of 1984, its members included the presidents of Stanford, Rutgers, Cal Tech, Minnesota, Georgia Tech, Columbia, and Rochester. (For more information about this forum, see the article "Swords Into Sheepskins" in this issue.)

A different group of Pentagon consultants, almost all from academia, is the Jason group. Composed of some four dozen of the country's most elite physicists, they work on specific technical problems of importance to the DOD. In addition, Jasons often invent and promote wholly new approaches to the use of science for the military.

Complete membership lists for all of these groups have recently been obtained via the Freedom of Information Act. For a four-page listing of all the academic members, send a stamped, self-addressed envelope to: Charles Schwartz, Physics Department, University of California, Berkeley, CA 94720.



High-Tech Battlegrounds on Campus

BY GREG LeROY

For the last six years, the Pentagon has been sneaking billions of dollars in military contracts right into the laboratories of almost every major university in the United States—often in violation of university policies, and sometimes without the knowledge of the professors and graduate students who are working on these programs.

This is being done at dozens of private research centers that have been created through the cooperative efforts of government, industry, and academia for priority research and development of a new breed of "smart weapons." Investigations are being conducted on materials that will allow fighter planes, such as the ATB Stealth Bomber, to hide from radar, and kinetic energy devices that will destroy moving targets from space for the Star Wars program. Research is being conducted on supercomputers that can parallel process vital information at blinding speeds (which would allow a better-coordinated nuclear strike) as well as numerous other high-tech goodies, many of which the general public isn't even aware of.

Some of these research centers are practically owned outright by the Defense Department. Others have their own buildings and scientists. The majority, however, are something entirely new: consortiums of the nation's largest defense contractors, who simply redistribute portions of their military programs to select colleges and universities across the U.S.

Almost every one of these campus-situated organizations share one thing in common. Their top-level positions are filled by people from the government's military and intelligence agencies.

MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION

One of the largest of these organizations is a cooperative research venture formed as a for-profit corporation at the University of Texas at Austin. Called the Microelectronics and Computer Technology Corporation (MCC), it was organized by retired intelligence officer Admiral Bobby Ray Inman, who gathered together 20 major corporations and $600 million in start-up capital.

Inman asked the university to build a 200,000-square-foot building for $20 million at their Balcones Research Center, about seven miles north of the central campus. The university not only obliged, they agreed to charge just two dollars a year rent for the building (with fitness rooms and jogging track included) and the 20-acre grounds.

Then an "anonymous Texan" donated

Greg LeRoy is the director of a nonprofit public interest group in Houston. A copy of the book from which this article was adapted, including references and a bibliography, is available for $4 from Public Search, P.O. Box 6767, Houston, Texas 77265.

$32 million (which five Texas foundations matched) for new faculty posts in science and engineering. Within four years, MCC had five different buildings, 440 people, and a $75-million-a-year budget.

All of this money is being used "to developed generic technology and development tools," says Mary Kragie, an analyst for the Public Affairs Office of MCC. Corporations pay hundreds of thousands of dollars to become a shareholder in the center, plus part of the costs for whatever research programs they take part in, usually adding up to millions of dollars a year.

In theory, if and when MCC produces a marketable product, those shareholders who participated in the program that produced the technology may be allowed to license it. Yet after four years and almost a billion dollars in financing, only two items (both software programs of debatable value) have ever been released on the open market.

Why hasn't anything else been produced? MCC representatives insist that the center is involved in long-range research that won't show short-term dividends. But there is another reason. The majority of MCC research and development is cutting-edge military technology—which the center will keep secret no matter what happens.

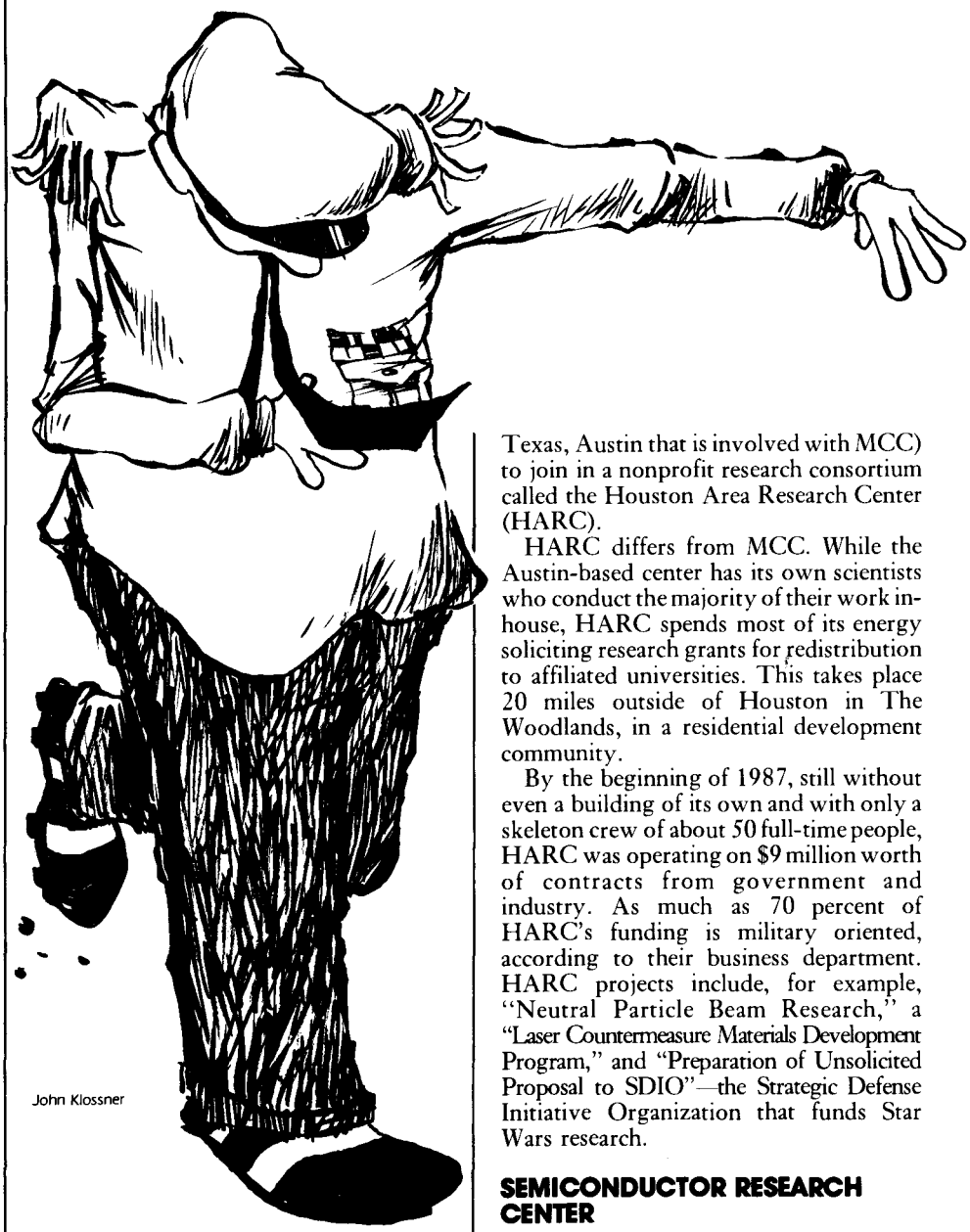
Look at their research agenda: software technology, very large scale integrated circuits and computer-aided design (VLSI/CAD), advanced computer architectures, semiconductor packaging/interconnect, as well as a recently initiated program into the new field of superconductivity. On the surface, these programs sound innocuous, but they are the new developments in microelectronics that are providing a foundation for the Pentagon's new high-technology weapons.

Large and complex software programs, for example, are needed to get Star Wars off the ground. Innovations in VLSI/CAD technology will help design better military aircraft and ballistic missiles. Pilots will be able to "talk" to their on-board computers if the computer architecture program comes up with a workable "human interface." New semiconductors (or a process to build them) could make computers a thousand times more powerful, while an advance in superconductivity would make it possible for all electronic systems to work faster, more powerfully, and in one-fourth the space.

So scientists at MCC are doing the necessary groundwork in all of these fields. Just how much of their research is financed by the Pentagon, they won't tell. That type of information is considered "proprietary," and being a private corporation, MCC isn't obligated to talk to anyone except their stockholders.

However, the source of the funding is obvious. "The lion's share of direct federal support for microelectronics R&D comes from the Department of Defense, and therefore is driven by military requirements," says a congressional report issued in March 1986. Nearly 80 percent of all R&D in some of these fields, according to this Office of Technology Assessment report, comes from the Pentagon.

This is substantiated by a review of the participants in the research center. Half of the top ten U.S. defense contractors are represented at MCC, and the majority of the other firms involved are the largest players in captive microelectronics operations that serve the military markets.



John Klossner

HOUSTON AREA RESEARCH CENTER

At exactly the same time that MCC was being organized, only 200 miles to the south, a man named George Mitchell was, as *Fortune* magazine put it, "laboring to become the Bobby Inman of Houston." Mitchell donated 100 acres from one of his real estate holdings, put up millions of dollars in start-up capital, and convinced twelve corporations and four local universities (Rice, University of Houston, Texas A&M, and the same University of Texas, Austin that is involved with MCC) to join in a nonprofit research consortium called the Houston Area Research Center (HARC).

HARC differs from MCC. While the Austin-based center has its own scientists who conduct the majority of their work in-house, HARC spends most of its energy soliciting research grants for redistribution to affiliated universities. This takes place 20 miles outside of Houston in The Woodlands, in a residential development community.

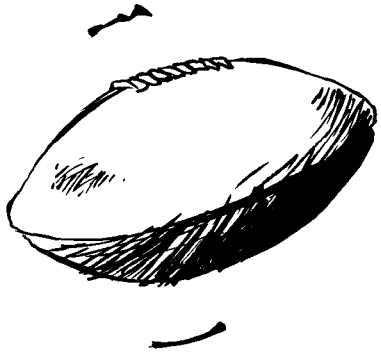
By the beginning of 1987, still without even a building of its own and with only a skeleton crew of about 50 full-time people, HARC was operating on $9 million worth of contracts from government and industry. As much as 70 percent of HARC's funding is military oriented, according to their business department. HARC projects include, for example, "Neutral Particle Beam Research," a "Laser Countermeasure Materials Development Program," and "Preparation of Unsolicited Proposal to SDIO"—the Strategic Defense Initiative Organization that funds Star Wars research.

SEMICONDUCTOR RESEARCH CENTER

The director of public relations at HARC says that George Mitchell met with people in North Carolina in order to learn how to set up a consortium. The people Mitchell was talking with were

opening their own venture at the same time. SRC, or the Semiconductor Research Center, was founded by industrial heavyweights—including Intel, Motorola, Burroughs, Honeywell, and IBM—but takes contracts directly from the Department of Defense as well.

SRC is part of the Microelectronics Center of North Carolina, an $80 million complex built at Research Triangle Park. Duke University, North Carolina A&T State University, North Carolina State University, University of North Carolina at Chapel Hill, and the University of



North Carolina at Charlotte are all involved.

Like Houston's HARC, the North Carolina center serves as a conduit for military monies to irrigate university campuses. "Core programs" at Stanford, Cornell, the University of Michigan, and the University of California at Berkeley have been established, and SRC is sponsoring additional research at 35 other universities.

Larry Sumney, the center's director, told *Electronics* magazine two years ago that SRC is planning to add even more Defense Department financing in the future. Expected to join are four new members: the Defense Advanced Research Projects Agency, the National Security Agency, NASA, and the Department of Energy. These federal agencies will put in even more money than the corporate sponsors.

SOFTWARE ENGINEERING INSTITUTE

In Pittsburgh, Pennsylvania, Carnegie-Mellon University beat out numerous other contestants in 1985 for an initial five-year $103 million contract directly with the Department of Defense to build what will be the largest government-financed software research center in the U.S. An additional $18 million is to be spent on a secure building near the CMU campus.

Carnegie-Mellon's Software Engineering Institute, or SEI, is expected to enter into "formal relationships" with 24 major universities and "research and technology arrangements" with 64 corporations. SEI's purpose, according to its own literature, is "finding ways to move state-of-the-art technology out of the laboratory and into military systems more quickly."

BASIC INDUSTRY RESEARCH LABORATORY

In the same year that SEI was formed, construction was beginning on the $26 million federally funded Basic Industry Research Laboratory (BIRL) at Northwestern University. This will be part of a $400 million research park on a 26-acre site next door to Northwestern's Evanston, Illinois campus.

The BIRL labs will represent, says a Northwestern press release, "a unique industry-university-government partnership." BIRL—like the other research centers—is "predicated on the concept" of the "transfer of university research to industrial laboratories."

SUBVERTING UNIVERSITY POLICIES

BIRL, HARC, SEI, SRC, and MCC are just a few examples of the fifty to sixty new research centers that have been created in the Reagan era. Other large, well-funded institutions are now operating at MIT, Stanford, and the University of Minnesota, to name a few. But you won't come across these centers as you stroll down the quadrangle of a university's main campus. All are located in secure buildings from a few blocks to twenty miles down the road.

There is a reason for this. These newly formed research centers are churning out military R&D in cooperation with universities that have written policies which prohibit military work from being done on campus or a general understanding that classified work is prohibited.

Dr. John Margrave, who held two positions simultaneously—vice president for Advanced Studies and Research at Rice University as well as director of the Material Science Research Center at HARC, the Houston Area Research Center—explained this violation of university policies in a 1986 interview. University scientists can accept defense contracts without violating Rice's written policies, he said, because "military programs are first sent to HARC." There they are restructured into two parts—one classified, the other unclassified. "You then subcontract the unclassified research back to the member university," Margrave said.

THE PENTAGON CLEARINGHOUSE

Dr. Jane Armstrong, HARC Director of External Relations, explains it another way: "HARC will act as a clearinghouse" for classified research. "It will provide a good arms-length relationship for people who want to work with these (programs)," she said.

It can happen like this. The Defense Department awards a contract to a company like Boeing or Rockwell. This private company then subcontracts out parts of the program to a "private" research center such as SEI, BIRL, SRC, or HARC. The research centers, however, do exactly the same thing—they subcontract parts of the program they've just received out to their member universities.

So by the time a contract is tossed out of the Pentagon and picked up in the office of a university professor, it usually does not look as though it is part of a military program. The contract has been rewritten so often, and the topic so minutely focused, that many university professors and graduate students are unaware that they are working on Pentagon-financed programs.

Just two of the centers already mentioned, SEI and SRC, sponsor research at over fifty major American universities.

EISENHOWER'S WARNING

Dwight D. Eisenhower, upon leaving presidential office in January 1961, gave an often quoted farewell address on the dangers of what he called the "military-industrial complex." He asserted that the "free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research.

"For every old blackboard there are now hundreds of new electronic computers. The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present—and is gravely to be regarded," he warned.

Could Eisenhower have conceived of the day in August 1982 when Pentagon representatives, acting under the International Traffic in Arms Regulations, would march into an international symposium of the Society of Photo-Optical Instrumental Engineers being held in San Diego, California and demand the withdrawal of over 100 technical papers just before they were about to be delivered?

Would it have seemed likely twenty years ago that mathematicians be required to "voluntarily" submit their papers for review to the National Security Administration under the assumption that innovative algorithms might be a threat to national security? Over ten mathematician's papers have been challenged by the agency in the last four years.

DEFENSE DEPARTMENT INFORMATION MONOPOLY

The military's use for high technology was not fully apparent in the 1960s. Then it seemed limited to real secrets, like nuclear weapons, that had no civilian value. But now the Pentagon has identified every new area of computer technology as vital to the

defense effort—even personal computers. In an action little reported by the press in September 1984, President Reagan signed National Security Decision Directive 145, which has empowered the military to set standards for the entire U.S. data processing industry.

Who's behind this information control? It's the National Security Agency, who will provide U.S. manufacturers with all the ciphers they will use for their semiconductor chips. Ostensibly, their reason is to safeguard computers against unauthorized access by providing secure, tamper-proof codes.

But there will be economic and civil rights repercussions. According to a report in the *New York Times*, NSA interventions will add about $1,000 to the base price of a personal computer. More importantly, as expressed by the Computer and Communications Industry Association, this will give "the DOD and the intelligence community vast and largely undefined power to shape national information policy."

Interestingly, there are now eleven companies which the NSA will allow to manufacture "Communications Security" devices under NSDD-145, known as the National Data Encryption Standard. Those companies are AT&T, GTE, Harris, Honeywell, Hughes, IBM, Intel, Motorola, RCA, Rockwell, and Xerox. All are investors (and are often cofounders) in the research centers. All but Xerox are top defense contractors.

EXPOSURE & EXPULSION IN THE 1960s

Only a few years after Eisenhower left office, newspapers and magazines began to expose military and CIA connections at American universities. Nuclear bomb work, bacteriological weapons design, germ warfare experiments, as well as the more mundane military R&D, were being done in collaborative efforts at major educational institutions throughout the country.

However, student protests against this collaboration, and the backlash of the Vietnam War, scared the military off campus. At many universities (including Columbia, Stanford, Princeton, Michigan, and MIT) entire Pentagon-financed laboratories were closed down.

In order to regulate military ties to the universities, Congress stepped in with the Mansfield Amendment of 1970. As amended a year later, the act allowed military research on campus only if it had "a potential relationship to a military function or operation"—which would have ruled out the majority of present DOD campus funding which is used for pure research into new technologies.

The times, of course, have changed. The Mansfield Amendment was reinterpreted. Public laws were passed, allowing federally funded laboratories to sell the technology that they develop. Other laws gave industry incentives to form cooperative research ventures.

After seven years and billions of dollars spent, the obvious questions are finally being raised. Is military money a help or a hindrance to universities? Are military research centers actually producing the remarkable technological breakthroughs they have promised? Will military technology be transfered to the civilian sector? Are the centers essential for our national defense?

UNIVERSITIES: WHAT ARE THEY GETTING?

Why are universities working with defense contractors and the Pentagon to create institutions that are being used to circumvent faculty and student opposition to military programs? Here are three reasons: money, precedent, and pressure.

First the Big M, money: there's been less and less of it for civilian research and development. As a result of foundering markets and the loss of capital, industry has cut back. Even the National Science Foundation (the federal agency which awards the majority of R&D funds to academia) has, in real terms, reduced their spending. According to the U.S. Office of Management and Budget (OMB), the Pentagon now finances twice as much research and development as the civilian sector. Eight years ago, funding had been equivalent.

The OMB's Bureau of Economic Analysis reported that in 1980 civilian expenditures in research and development amounted to $17.5 billion, while military R&D expenditures were $17.3 billion. By 1987, civilian R&D funds had dropped to $14.3 billion, and military research and development expenditures had skyrocketed to $31.4 billion. University administrators didn't need to be geniuses to understand the situation. They either grabbed some of the available military money, or they watched as their science departments atrophied.

Precedent was provided by the handful of other research labs that had been formed at major universities by the Pentagon over the last 40 years. Among the best known are the University of California's Livermore and Los Alamos National Laboratories (where nuclear weapons are designed), the Applied Physics Labs of Johns Hopkins (which does Air Force and Navy missile research), and MIT's Lincoln Labs (a mainstay of theoretical physics research for the military). Johns Hopkins and MIT together receive over half a billion dollars in DOD contracts annually.

Economic necessity alone, however, may not have been the only inducement used by the Reagan administration to gain access to "the intellectual infrastructure," as one center representative described university faculty. The nation's top intelligence agencies—the NSA and CIA—threw their weight behind the plan.

THE NSA'S MUSCLE

The National Security Agency, says James Bamford, whose book *The Puzzle Palace* is the most authoritative unclassified work on the subject, is the most well-funded and secretive intelligence agency in the U.S., and is said to have the largest collection of computers in the world. "We use literally acres of computers, including hardware from every major manufacturer," a NSA advertisement in a student newspaper boasts, trying to entice graduating mathematicians, computer scientists, and engineers to apply for NSA jobs so that they can make use of "a diverse range of leading technology."

Computers are used to make and break codes, to intercept telecommunications, and to search and digest enormous quantities of information. So advanced is the NSA's leading technology that satellites are able to read car license plates. Listening posts are said to have captured the conversation of Soviet military officers talking in their limousine. And the acres of NSA computers are thought to be capable of sifting through almost every telecommunications transmission issued.

This was Admiral Bobby Inman's specialty when he ran the NSA, according to Bramford: "technical" collection. Inman felt that the U.S. computer industries were not willing to take the necessary "risks"—that is, putting enough money into R&D to insure that they would be the first to develop new and innovative computer technology necessary to keep the NSA in the forefront of the world's intelligence agencies. So he took action.

The admiral lobbied behind the scenes to make it possible for collaborations of industry, government, and universities to form. As Washington's *National Journal* put it, Inman was "instrumental in talking Congress into approving a Reagan administration backed bill to relax antitrust constraints on joint research and development by U.S. firms." This was the Cooperative Research Act of 1984.

SPIES RUNNING THE CENTERS

Inman, when he founded MCC, took with him three men to Austin, Texas: Ted Ralston, another retired NSA officer; Dan Schwartz, former NSA legal counsel; and John Pinkston, deputy chief of research at the NSA who was appointed chief scientist at MCC.

When Inman retired earlier this year, Joseph Boyd, of the Harris Corporation, took over in the interim. Boyd spent many years in military and intelligence work, including a five-year stint, according to *Who's Who*, with the NSA. Later, Grant A. Dove became the new MCC director. A former Texas Instruments executive,

Dove remains chairman of the board of trustees of the National Security Individuals Association.

Inman was also the deputy director of the CIA for a few years under Reagan. The man who assumed his position four years after he had vacated this post was Robert M. Gates. Speaking to a *New York Times* reporter in 1986, Gates explained that the CIA was trying to accelerate a trend of soliciting help from the "best minds in the country." From 1982 to 1986, Gates said that the CIA had held over 150 conferences with "professors and experts" outside of government. This was one of Gates's responsibilities.

In a nomination hearing for his advancement within the CIA, Gates acknowledged on his conflict of interest form that in 1984 he had "asked to be a candidate for Director, Houston Area Research Center."

A similar situation exists at the Semiconductor Research Corporation. The president of SRC is Larry Sumney, the first director of the Defense Department's Very High Speed Integrated Circuits Program. Vice president for research is Robert M. Burger, who served in the National Security Agency for four years.

The first director of the Software Engineering Institute, John Manley, was a 21-year veteran from the Air Force. Larry Druffel, who took his place in 1986, had been the director of computer systems and software in the office of the Deputy Undersecretary of Defense for Research and Advanced Technology.

Why would the nation's top Pentagon and spy personnel want to run private research centers whose goals include providing a "secure environment" for classified and military work?

It is not simply because the NSA and the CIA have singular expertise with leading technology—there are many people in the civilian sector who are even more qualified. The only plausible reason must be that these research centers were specifically designed to develop technology useful to U.S. military and intelligence agencies. If that's the case, national security personnel would best be able to meet such objectives.

SEMICONDUCTORS

The Defense Science Board, a private group of scientists and business leaders that advise the Pentagon, describes the loss of American preeminence in semiconductor technology as allowing other nations "to dominate the world information market."

John Klossner

Semiconductors are the chips that give computers information on how to operate. It is "safe to say," concluded a report prepared for the U.S. Army Research Office two years ago, "that there is not a single western military system that is not critically dependent for its operation on semiconductor integrated circuits."

In 1975, the United States controlled 100 percent of the worldwide semiconductor market. By 1986, U.S. control had dropped to five percent. That means, said Harvard's Robert B. Reich, that Hitachi and Fujitsu now provide the "bubble" memories used primarily in fighter planes and communications satellites, while the National Security Agency is forced to "buy almost all its ceramic packages (used to house and protect the chip circuits) from one Japanese company, Kyocera."

This has led the Defense Science Board to recommend that a $250 million consortium be formed immediately by private companies with the Pentagon to foot an additional $200 million in annual contracts. Their object of research, if you hadn't guessed, is semiconductors.

Not to be outdone, the Semiconductor Industry Association, a private association of U.S. semiconductor manufacturers, has proposed a $500 million semiconductor research program to be called SEMATECH. Half or more of the funding for this program is expected to be shouldered by the Defense Department.

But it is not just semiconductors that are a matter of national security interest. All microelectronics are worthy of Pentagon concern. The "development of increasingly sophisticated weapons systems," a federal report explains, "means that virtually every aspect of current military technology depends on microelectronics."

SUPERCOMPUTERS

Another high priority area for the military involves supercomputers, which are incredibly powerful machines that can do more than 100 million floating point operations per second.

About a third of all supercomputers in the United States are used by the NSA or an agency in the Department of Defense. Seventy or so other units have been placed in major corporations, consortiums, or universities. These machines are perceived to be so critical to U.S. defense that Stephen D. Bryen, of the Pentagon's newly formed Defense Technology Security Administration, has called them "targets of opportunities for our adversaries, who include scientists from the Warsaw Pact countries."

Bryen is afraid that communist countries will sneak access to the supercomputers and work on codes and weapons problems, or that by simply using the machines they will learn how to make one. In fact, it has been suggested that one reason for the federal emphasis upon research centers is to

maintain government control over who is permitted to use a supercomputer.

Military interest in computers is nothing new. The Army and the University of Pennsylvania worked together in the early 1940s to develop ENIAC, the grandfather of computers, for use in ballistics calculations. But the extent of the Pentagon's emphasis on computers and software over the last seven years is unprecedented.

The Defense Advanced Research Projects Agency, for example, has initiated the Strategic Computing Initiative, which will spend a billion dollars over the next ten years on new supercomputing technology. (See Jonathan Tucker's article, "The Strategic Computer Initiative," in *Computing the Future,* the March/April 1985 special issue of SftP.)

The National Security Agency has recently opened its own "agency-run institute to perform basic research into parallel processing," according to the *New York Times.* Located in Lanham, Maryland, the Supercomputer Research Center is said to have a $20 million-a-year budget.

And in July 1987, President Reagan announced that he would request an additional $150 million for a three-year funding of research into supercomputers. This is in addition to the $50 million spent annually by the Office of Naval Research, the Air Force Office of Scientific Research, and the Army Research Office. It does not include $10 million financed under a Joint Services Electronics Program, or the tens of millions of dollars spent for supercomputer research in other smaller programs.

SUPERCONDUCTIVITY

In 1987, a Nobel prize was won by two scientists in Zurich who had shown that new materials could reach a superconducting state at temperatures much higher than previously believed possible.

As much as 40 percent of electrical power is now lost through the resistance encountered in wires and equipment used to transmit electricity. So superconducting materials would allow electric currents to flow virtually without resistance. A physicist with the National Security Agency told a conference of researchers that, among other things, further advances in superconductivity could allow the most powerful computers to be packaged in a space as small as one cubic foot.

Already, the Pentagon's Defense Advanced Research Projects Agency and the Office of Naval Research have plans to spend $10 million over the next two to three years on "proposals to develop materials processing and fabrication approaches to produce high-temperature superconductivity." In fact, overall military financing for superconductor research will jump from $5 million in 1987 to about $50 million in 1988.

According to the aerospace journal *Aviation Week and Space Technology,* a consortium has recently been created at the University of Alabama at Huntsville to be ready to receive Pentagon research money. Called the Consortium for Superconducting Materials and Instrumentation (CSMI), eight other universities and thirteen of the largest defense contractors (as well as the U.S. Army) have already signed on. About $5 million in annual funding is scheduled for CSMI, with almost half of the money coming from the Star Wars program. In fact, the Pentagon's Strategic Defense Initiative Organization is called the "catalyst" behind the formation of this consortium.

COVERT ACTION

Some analysts call research centers the academic version of the Iran-Contra affair. In this case, the diversion of funds is from the Pentagon to university laboratories. Thomond O'Brien, of the Institute for Space and Security Studies, a think tank founded by the general in charge of the Air Force's predecessor program to Star Wars, speculated on the Pentagon and intelligence agency's motives: "They can't get away with classified research at universities," O'Brien said, "and they don't believe they have the support and trust they need from Congress, so they get (private individuals and industry) to fund and promote their programs."

The issue has escaped public scrutiny because the research centers give everyone a piece of the Pentagon pie. Corporations are awarded immense contracts and can tap into university expertise. Meanwhile, academics take in lucrative money as consultants, researchers, or directors. Universities absorb military funds into their science departments, and newly formed research centers fatten themselves on their own administrative overhead.

POTENTIAL COSTS

In 1985, the U.S. Congress issued a report entitled *Information Technology and R&D: Critical Trends and Issues.* Authored by the Office of Technology Assessment and then reviewed by 34 leaders in all of the fields involved, the report concluded that "increased interaction among academia-industry-government" may have "potential costs" which could affect the competitiveness of industry and the freedom of open universities. These effects include:

- "subtle changes in the setting of research goals"
- "industries' traditional emphasis on secrecy is in direct conflict with academic practices"
- "distorting the university's traditional role as a developer of fundamental knowledge"
- "competition between research and education, draining faculty away from teaching, and recruiting students from other areas"
- skewing "the balance among programs" and capturing "unequal attention and support from university administrators"
- increasing "differences between the Nation's top-tier and second-tier universities" as "competition for industrial resources and partnerships increases."

Such concerns are valid. Employees at many research centers are required to obtain a security clearance in order to gain access to classified information. Even those who do not need a security clearance must sign documents promising not to reveal any "proprietary information."

Of greater concern, as identified in a recent Harvard University study as a major "threat to academic freedom," is that the Pentagon is granted permission to read "for review and comment" any material before it is actually published—even after an individual has left their classified duties.

Even corporate partners in the consortium maintain rights over their university researchers. At Stanford's Center for Integrated Systems, for example, a company can request a 90-day delay in a scientist's publication so that a patent application can be filed.

AUTONOMY LOST

Speaking about the Pentagon's plans for restricted access to supercomputers at American universities, the council of the American Physical Society issued a statement in November of 1985. "We believe," they said, "that restraints on the use of unclassified facilities would be harmful to the quality of academic scientific research and would in the long term threaten the nation's technological leadership."

The physicists argued that American preeminence in the sciences is a result of the open and free exchange of ideas between scholars, and that a campus is no place for security clearances and classified information. But at many schools today, military funded research towers over civilian R&D. "There is a danger," writes Stanford history professor R. Reinhold, "that researchers will create relationships that are likely to influence what they study and what they do not study. It's a threat to the autonomy of the university."

Since each university is nothing more than one of the dozens of shareholders in the research center's corporation, how will they put forth their own unique agendas? It will be virtually impossible, and university administrators may find themselves unable to choose between the needs of their own faculty and students and the separate and conflicting needs of the Pentagon and the intelligence agencies.

Personnel are already being siphoned from the universities into the military structure. At BIRL, professors can teach part time and also work at the laboratories. SEI raided Carnegie-Mellon's computer science department for four of its executive posts. And HARC has a program called

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Glenn Wolff

BIOLOGY GOES TO WAR

BY JONATHAN KING

Should an academic biology department accept money from the Navy? Recently, this question confronted me and my colleagues at the Massachusetts Institute of Technology. The development of a new biotechnology program was made to appear dependent on our agreement to support a request for such funding. The resolution of this question highlights the current relationship and increasing dependence of biological research on military funding and its connections to biological warfare research.

At the initiative of the MIT administration, an interdepartmental committee was formed to develop an undergraduate program in biotechnology. After many meetings to hammer out a jointly agreed upon program, the plan was presented to the administration. The committee was then told to look outside of MIT for the necessary funds to run the program. This request was somewhat unusual, since financial support for new educational programs is normally provided by the university, especially at the undergraduate level. In this case, the committee's efforts to find outside funding were unsuccessful.

MIT's provost, John Deutch, a former member of the Defense Science Board and the Scowcroft Commission, has had close ties to the Pentagon. So it was not surprising when the administration suggested that the program committee submit a Request for Proposals to the Office of Naval Research (ONR), which was seeking proposals for support of research and training in biotechnology. No details or constraints were laid out, although a sentence in small print mentioned research interest in "biofouling."

However, military support for teaching and training in MIT's biology department was such a departure from previous practice that the chairman of the department called a faculty meeting to consider the proposition. After an intense debate lasting several hours, a majority of the faculty present voted against seeking such funds.

Advocates of naval research funding asked that the issue be reconsidered at a second meeting, so that faculty who had missed the first meeting could attend. The chairman opened the second meeting by informing us that the administration would not look favorably upon the department's rejection of ONR funds, and that such a rejection would affect the department's budget for the following year. We would lose support for our students on the grounds that we had declined to accept a natural source of support. This prospect of a financial cutback was important in turning the tide, and the proposal to request ONR funds was approved.

BREAKING THE BIOLOGICAL WEAPONS BAN

There is a direct connection between the quandry that the MIT biology faculty found itself in and recent changes in U.S. government policy on biological weapons.

Jonathan King is a professor of molecular biology and director of the Biology Electron Microscope Facility at the Massachusetts Institute of Technology. Through the Committee for Responsible Genetics, he helped organize the Pledge Against the Military Use of Biological Research. Copies of this pledge, along with a special issue of the newsletter GeneWATCH *covering biological weapons research, are available from the Committee for Responsible Genetics, 186A South St., Boston, MA 02111-2701.*

MARCHING TOWARD A BIOLOGICAL ARMS RACE

The advent of the Reagan administration led to a distinct reversal in policy with respect to disarmament of biological weapons. The U.S., USSR, and over 100 other nations are signatories to the Biological Weapons Convention of 1972, which bans the development, production, stockpiling, and use of biological agents for military purposes. Outlawing an entire class of weapons, this is the strongest multilateral weapons treaty in the modern political world.

The emergence of a biological weapons (BW) program in this country was initially signaled by attacks on the treaty. The State Department launched a public relations offensive, charging the Soviet Union with the manufacture or use of toxin and

RESISTING BIOLOGICAL WARFARE

BY SETH SHULMAN

This winter, biological and biomedical researchers across the U.S. are joining together to oppose the startling increase of military-sponsored research in their fields. Biologists and chemists on university campuses and in private firms are vowing to refuse funds for military research. This is their Pledge Against the Military Use of Biological Research:

"We, the undersigned biologists and chemists, oppose the use of our research for military purposes. Rapid advances in biotechnology have catalyzed a growing interest by the military in many countries in chemical and biological weapons and in the possible development of new and novel chemical and biological warfare agents. We are concerned that this may lead to another arms race. We believe that biomedical research should support rather than threaten life. Therefore, WE PLEDGE not to engage knowingly in research and teaching that will further the development of chemical and biological warfare agents."

The nationwide pledge, sponsored by the Committee for Responsible Genetics (CRG) and the Coalition for Universities in the Public Interest, hopes to highlight the dangers of the Reagan administration's biological arms buildup. "The pledge campaign can help to reverse these trends that threaten to unleash a biological arms race," says CRG's director, Nachama Wilker. "Our goal is to bring the pledge to every biological and biomedical researcher in the country." Over 200 scientists have signed and returned the pledge since the campaign began in November.

"Out of this process will come press conferences, letters to Congress, and actions by professional societies," says MIT biologist Jonathan King, who helped initiate the pledge campaign. "If we scientists, educators, health professionals and environmentalists fail to make our voices heard on this gravest of misuses of our profession, the greater public will not be prepared and will be unable to ensure the development of policies in all our interests—policies to enhance, rather than hinder, life," King wrote in the July-October 1987 issue of CRG's *GeneWATCH*.

WE PLEDGE not to engage knowingly in research and teaching that will further the development of chemical and biological warfare agents.

The Boston-based CRG has also been involved in a legislative effort to make the provisions of the Biological Weapons Convention of 1972 applicable to private individuals and firms. Currently, it applies only to the U.S. government, which can contract its military research out to universities and civilian labs.

Biological weapons legislation aimed at civilian research gained bipartisan congressional backing in 1986, but never made it to the floor. The legislation, H.R. 901, "provides Congress with an opportunity to reaffirm U.S. commitment to the treaty," says Barbara Rosenberg, a research scientist at the Sloan-Kettering Institute, who is leading the effort.

The U.S. courts have proven an effective venue for challenging the biological arms buildup. Jeremy Rifkin's Foundation on Economic Trends successfully brought suit against the Defense Department, temporarily halting the construction of the proposed Dugway laboratory in 1985. The Army had planned to build a multimillion-dollar lab for aerosol testing and research on toxic biological agents at the Dugway Proving Ground in Utah. The court ruled that, in accordance with the Environmental Protection Act, the Army must conduct an extensive review of the environmental impact of the Dugway facility before proceeding.

The environmental impact statement was due January 19, 1988, with a hearing scheduled for 45 days after its release. But even if the impact statement is favorable to biological warfare research, there may be other ways to stop Dugway from opening. Time has run out for the Defense Department's allotted funding for the facility. The money appropriated in 1985 will have to be reallocated by Congress this year if the environmental impact statement for Dugway is approved. Many members of Congress oppose biological weapons research, and they are ready to fight the Pentagon's funding renewal request for Dugway.

But Dugway was just the first battle. The Foundation on Economic Trends won an even larger legal victory last spring when the Defense Department agreed to a court settlement requiring it to conduct a 20-month environmental impact study of the entire biological weapons research program. The settlement, says Rifkin, "makes the Department of Defense accountable for the first time for its expanded biological warfare research."

When the Pentagon publishes its evaluation, the American people will have a chance to challenge the safety and goals of this massive project to rearm the U.S. for biological war. "The public will be allowed to look at the DOD's environmental impact statement and challenge its inadequacies," says Andrew Kimbrell, policy director and legal counsel for the Foundation on Economic Trends. "And I can tell you, from our point of view, it will have to be pretty convincing to assuage some of our concerns."

Seth Shulman is a freelance science writer and former editor of SftP. Information in this article comes from his story "Poisons from the Pentagon," published in the November 1987 issue of The Progressive.

biological weapons, including the production of anthrax bacteria in Sverdlovsk and the dropping of yellow rain in Cambodia.

The yellow rain accusations were effectively refuted (see Robinson, Guillemin and Meselson, *Foreign Policy* 68, pp. 100-117, 1977), and serious questions exist about the U.S. government's version of the Sverdlovsk incident. These charges were most likely initiated as part of a general strategy of opposing negotiated disarmament treaties and to justify renewed support for BW research.

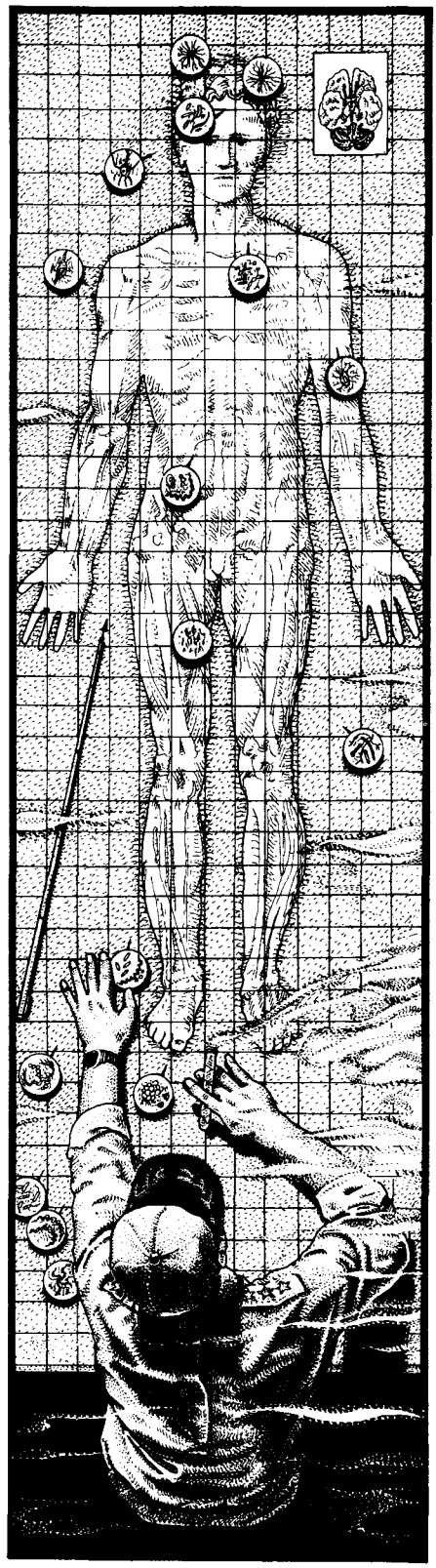
Subsequent to the treaty violation charges made against the Soviet Union, expenditures for U.S. biological weapons programs began to increase, more than quadrupling from 1981 to the present. The hiring of senior biotechnology researchers by the Department of Defense and the issuing of requests for research grant proposals in areas of biotechnology relevant to biological weapons clearly signaled a developing BW research program. These programs threaten to launch a biological arms race, with the attendant dangers to human and animal populations in many nations.

Any doubts about Reagan's plans for biological weapons development were put to rest when the Defense Department obtained long-term authorization for over $300 million to reopen the Army's Dugway Proving Ground as a BW testing facility. Furthermore, the Undersecretary of Defense testified before Congress that the United States must immediately build up its BW capacity. According to him, this was necessary since genetic engineering and other forms of technology were rapidly being developed for military purposes in the USSR.

Of course, since the U.S. is party to the biological weapons treaty, members of the administration cannot call for an offensive BW program. Biological weapons research is always presented as "defensive," just as first-strike nuclear weapons are always described as defensive in nature. However, biological agents are fundamentally different from all other weapons.

Organisms reproduce themselves; chemicals, radioactive compounds, and explosives do not. Because of the reproducing character of BW agents, plans to develop an offensive capacity first require the ability to defend one's own population, crops, and domestic animals. The spread of disease is so unpredictable and the range of biological agents that could be used is so large that the very concept of defending against biological warfare is misleading.

As a result, offensive and defensive BW programs have the same components. The data gained from "defensive" BW testing is the same information needed to develop offensive capability. (See Strauss and King, "The Fallacy of Defensive Biological Weapons Research," in *Biological and Toxin Weapons Today*, edited by E. Geissler, Oxford University Press, 1986.)



Glenn Wolff

THE MILITARIZATION OF BIOLOGY

The go-ahead for increased funding of BW research has led to a more general interest in biological research by the military. Slowly but surely, the military is insinuating itself into this area, just as it has done in the past in such fields as physics. Taking advantage of an expanding pool of biological researchers and the relative decrease in other federal sources of funding for biology, the military is providing support for universities, biotechnology companies, and individual scientists receptive to their proposals. The response of the MIT administration and some MIT faculty illustrates the attractiveness of military funds for biology research.

Some of the funding goes directly to research related to biological weapons programs. However, much of it goes to projects either apparently or truly unrelated to BW research. Military support for biotechnology programs at Cornell, Caltech, and other universities, along with funding of numerous individual research programs, have created a significant military presence in academic biological research.

Funding of biological research by the military serves several purposes. It contributes to the increasing incorporation of the university into the military-industrial complex. It provides a veneer of respectability to cover the support of the military for its more destructive projects. It increasingly focuses academic research on problems of concern to the military. And it provides direct and indirect support for the resurgence of BW research.

In discussing this serious and disturbing development, I have frequently been asked, "Who would consciously work on the development of biological weapons?" The answer is, of course, hardly anyone. That is not how recruitment proceeds. Scientific personnel are inducted into these programs indirectly.

For instance, if the biotechnology program at MIT agrees to do naval research, a substantial number of students and faculty will be financially supported by military funds. It is unlikely that they will become militarists or actively support BW. They will honestly feel that it is better that they, who are only interested in basic research, use the military funds, than to let it go to some real militarists.

However, as they continue in their careers and quest to find further support, some of them will find a convenient source of ongoing funding through their Defense Department conduits. No doubt, a number of these scientists will establish laboratories using military funding. Although the process may be quite subtle, the choice of research will be influenced explicitly or implicitly by the source of funding.

This process establishes a pool of scientists who can become dependent on the military for realizing their professional ambitions and for making a living. Out of this pool, the military will be able to draw

upon groups of scientific workers who actually organize and carry out research relevant to military programs.

The argument that military funds for biomedical research, such as vaccines, are beneficial is fallacious. Increased vaccine research is desperately needed and should be funded by the National Institutes of Health. Military-funded vaccine research has military goals, whether the individual investigators can perceive them or not. Furthermore, a vaccine for truly defensive use would have to be developed secretly, since it would be useless if the adversary knew of its existence. Vaccine development is, in fact, most important for vaccinating troops in advance of an offensive BW attack.

That the science whose origin was the prevention of disease and the alleviation of human suffering should be transformed into a new technology of human destruction is a tragedy of historic import. It needs to be resisted at every step of the way—at scientific meetings, on bulletin boards, in classrooms and journals. However, this battle cannot be fought under the banners of narrow morality. It must be coupled with a fight to redirect public resources to support needed civilian programs. If we want vaccine development, and if only the military is funding it, then we have to fight for tax dollars to be shifted into civilian vaccine research. Clearly, such research will have a different character than that funded by military programs.

THE RENEWED THREAT OF BIOLOGICAL WARFARE

BY SUSAN WRIGHT

The threat of biological warfare should have been eliminated as a result of the 1972 Biological Weapons Convention, which prohibits development, production, and stockpiling of biological and toxin weapons. However, since 1980, there have been renewed grounds for concern.

Biotechnology provides the means not only for enhanced control over the behavior of living things, but also the ability to construct novel organisms and substances. Like virtually all technological advances, it could provide temptations for military application. A Pentagon report released in 1986, pointing to these characteristics, claimed that exotic new bioweapons are now within reach of industrialized nations and even of those that are less developed. While informed scientists dismiss the Pentagon's scary vision, concerted efforts over many years might eventually produce some innovation at the margin of the field that would be attractive to military establishments.

Since 1980, there have been steep increases in spending on the Pentagon's chemical warfare and biological defense programs. The request for funds in these programs rose to $1.44 billion in 1987—an increase in real terms of 554 percent of the federal budget for these chemical and biological weapons programs in fiscal year 1980. Support for research and development for these programs is now projected at $220.4 million—400 percent higher than in fiscal year 1980. Spending on research and development is now exceeding the highest levels of the 1960s, when an active chemical and biological warfare program was being pursued. In addition, funding for basic research in these areas, much of which is carried out in universities and private labs, increased 60 fold between 1981 and 1986.

Many of these new military research dollars are being used to support a rapidly expanding program of biological research, with a heavy emphasis on biotechnology. Eighteen government laboratories and over 100 university and corporate labs are involved in this work. In 1984, there were over 100 projects in biotechnology sponsored by the chemical warfare and biological defense program.

The Department of Defense plans to construct a new high-containment facility at its chemical and biological warfare test site at Dugway Proving Grounds, Utah, for the purpose of testing aerosols of lethal pathogens and toxins. For the immediate future, the DOD intends to use this facility to test "conventional" biological warfare agents such as anthrax, but the overall rationale for this facility suggests that the Pentagon anticipates testing genetically altered engineered pathogens as well.

There is a serious danger that if this facility is built and used, the United States will proceed by incremental steps into research, development, and finally production of novel biological agents. The line between defensive and offensive activity would be crossed.

The biological warfare program proposed for Dugway Proving Ground is unnecessary, provocative, and destabilizing. If pursued, this program will almost certainly stimulate neutralizing measures on the part of adversary nations, and a spiraling interaction of research and counter-research is likely to follow, eroding the Biological Weapons Convention to the point where it is no longer effective.

Congress should initiate a detailed investigation of the Biological Defense Program. Why is it expanding when there is a comprehensive treaty banning biological warfare? Why pursue a program that will certainly raise questions for other nations about American intentions? Why risk damage to civilian populations or to domestic agriculture through a program of inquiry into the properties of novel pathogens?

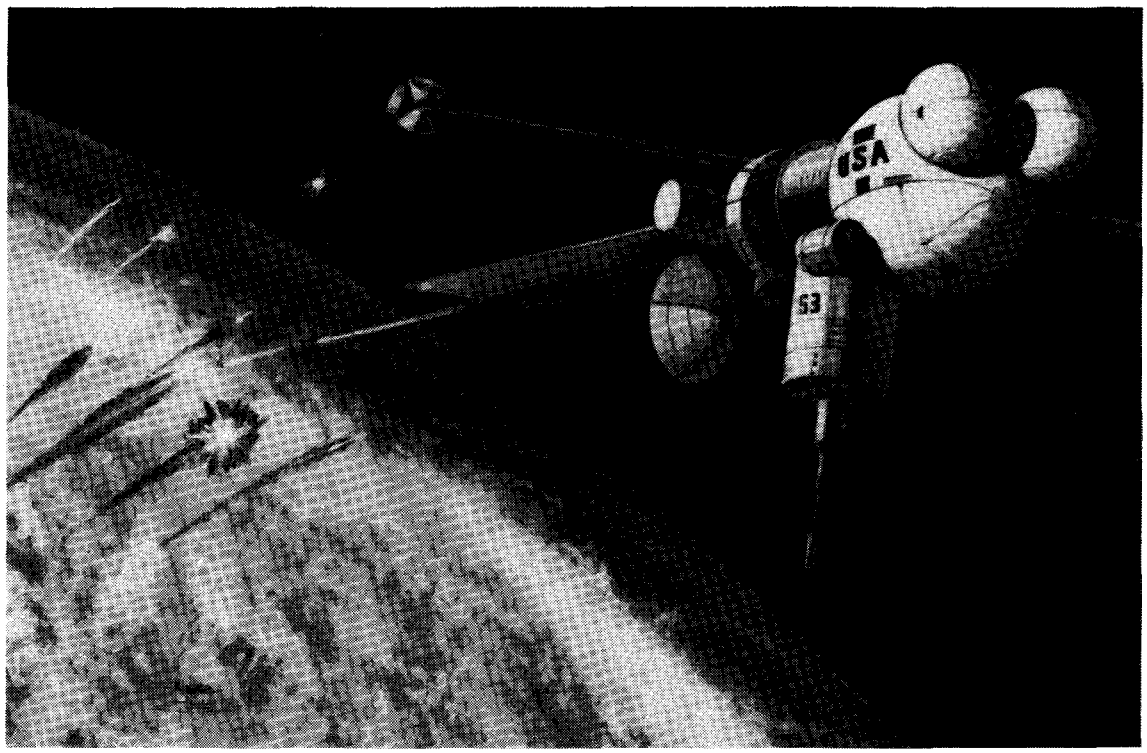
There is at present no formal policy requiring all biological warfare research to be unclassified, and it is known that some parts of the Biological Defense Program are classified. This too is a destabilizing policy. Secrecy in military research (even if these activities are entirely legitimate) tends to exacerbate fears on the part of other nations and plays into the scenarios of worst-case planners in military establishments. Openness, on the other hand, defuses suspicion and reduces military interest in gaining advantage through technological surprise.

The presidential administration needs to be much more careful with respect to allegations of noncompliance with the Biological Weapons Convention. Charges of violations, such as the "yellow rain" allegations, that ignore a whole body of scientific evidence supporting an alternative explanation in terms of natural causes can only serve to lower the credibility of the United States government.

The Reagan administration claimed that the Soviet Union was producing toxin weapons for use by the Vietnamese in Southeast Asia. But this "yellow rain" turned out to be nothing other than the feces of Southeast Asian honeybees. Yet the U.S. government has used these false charges to cast doubt on the effectiveness of the Biological Weapons Convention and to persuade members of Congress to vote increasing appropriations for chemical and biological warfare programs. Instead, serious concerns of treaty violations should be pursued through the formal mechanisms provided by the terms of the Biological Weapons Convention.

Susan Wright is a lecturer in the history of science at the University of Michigan and co-chair of the Committee on the Military Use of Biological Research of the Committee for Responsible Genetics.

AFTER THE BOYCOTT



Department of Defense photo/artist's rendition

BY STEVE NADIS

On March 23, 1983, President Reagan called on the nation's scientists and engineers to devise a defensive shield that would "give us the means of rendering these (nuclear) weapons impotent and obsolete." The "Star Wars" program, officially known as the Strategic Defense Initiative, or SDI, was to be the centerpiece of the Reagan military buildup—the largest peacetime effort in the nation's history. SDI, in turn, would be the most expensive military project in U.S. history, with a $26-billion, five-year budget and an overall price tag estimated between 100 billion and a trillion dollars.

Star Wars research, of course, was not new. It had been going on quietly for decades. What was new, however, was the crash effort to deploy such a system. To this end, research and development grew from 50 to 72 percent of total U.S. scientific research. The Star Wars budget correspondingly grew from $980 million in 1983 to a proposed $5.7 billion in 1988, making it the largest federal research program—exceeding the proposed research budgets of NASA ($4.7 billion), the National Science Foundation ($1.7

Writer Steve Nadis specializes in astrophysics and nuclear war. His report on astronomy's anti-star warriors appeared in the September/October 1987 issue of SftP.

HOW SCIENTISTS ARE STOPPING SDI

billion), or federal energy research ($2.9 billion).

"People go where the bucks are. There is a lot of money involved here," said James Ionson, director of SDI's Office of Innovative Science and Technology (IST), set up in the fall of 1984 to lure universities and small businesses with Star Wars research grants.

"The response from the academic, business, and government laboratory communities was immediate and overwhelming as everyone tried to find out...how they could become involved in the research programs of this new office," IST boasted in a briefing document distributed in 1985 to potential SDI researchers.

The response from scientists was indeed "immediate and overwhelming," but not exactly what IST had hoped for. In the summer of 1985, physicists John Kogut and Michael Weissman from the University of Illinois and Lisbeth Gronlund and David Wright from Cornell University began circulating a petition against soliciting or accepting money for Star Wars research. Since then, more than 7,000 U.S. scientists and engineers have signed the "pledge." Over 12,000 scientists have signed it worldwide, including more than 3,000 from Japan, 1,300 from Canada, and 750 from England.

U.S. signers include 57 percent of the faculties at the 20 highest-rated physics departments in the country, 50 percent or more of the faculty in each of 112 physical science and engineering departments at 71 schools, and 19 Nobel laureates in physics and chemistry (23 internationally). The pledge has been endorsed throughout the U.S. by scientists and engineers at more than 110 research institutions in 41 states.

TEARING AWAY THE VEIL OF HYPE

Many signed the petition because they doubted the technical feasibility of the kind of leakproof defense advertised by President Reagan. These scientists did not want to be used by the administration to enhance the credibility of the new system. They also believed the Star Wars program would accelerate the arms race, jeopardize arms treaties, and lead to a less stable nuclear balance. Some, such as MIT physicist Vera Kistiakowsky (who circulated the pledge in her department), feared the Star Wars program would distort national R&D priorities away from basic research. Another concern, expressed in the pledge, was "the likelihood that SDI funding will restrict academic freedom and blur the distinction between classified and unclassified research."

For whatever reasons, scientists signed up in record numbers, making the Star Wars boycott one of the largest mass movements by scientists in history. "I know of no recent program that evoked such a massive outpouring of concern from the nation's scientists and engineers at all levels as did SDI," commented Senator J. Bennett Johnston of Louisiana. These scientists, he added, "tore the veil of hype" from the program. "Washington must periodically be reminded that political rhetoric, even if employed by the most skillful of communicators, has no dominion over the laws of physics."

One feature that distinguished the boycott from other protests, says Ann Krumboltz of the Union of Concerned Scientists, was that it developed as a "totally spontaneous grassroots movement, not sponsored or organized by arms control groups. That was part of its strength. It was started by a handful of scientists at a few universities, and it spread like wildfire."

"What we are witnessing is the third major uprising of the nation's scientists against an element of U.S. weapons policy," said California Representative George Brown. The other precedents he cited were scientists' opposition to atmospheric nuclear tests in the late 1950s, which led to the Limited Test Ban Treaty, and opposition to antiballistic missiles ten years later, which led to the ABM treaty of 1972.

Perhaps an even closer parallel occurred in postwar West Germany in 1957, when 18 of that nation's most prominent scientists signed a public declaration refusing to participate in the government-proposed atomic bomb project. The protest completely killed the program.

DID THE BOYCOTT WORK?

What happened to the Star Wars boycott? More than two years after its inception, what effect, if any, has it had on the SDI program? Has it impeded SDI research? Has it mobilized protest against space-based warfare?

"There has been absolutely no impact," a spokesman from the SDI office claimed on October 29, 1987. "We have a large and capable group of people working on SDI, so we just haven't felt any impact." When asked whether the fact that so many of the nation's top scientists refuse to participate in the program has forced the SDI Organization to rely on other, perhaps less capable researchers, he said, "Now we're getting into the realm of hypothetics. The bottom line is that there's been absolutely no impact."

Available evidence, however, contradicts this assertion. "Support for SDI in Congress is now very thin, and there is no support for Reagan's Star Wars budget," claimed a congressional aide involved in SDI issues on Capitol Hill. To what degree the boycott alone was responsible for this shift, he could not determine, "but it all adds up," he said. "One after the other, there has been an unrelenting stream of scientific groups raising serious questions about the Star Wars program. That influences both Congress and the public."

"SDI is in real trouble," said former Undersecretary of Defense Richard Perle. Not only did Congress try to cut $2 billion from Reagan's 1988 Star Wars budget, it is also pushing for restrictions on Star Wars testing. If this continues, Perle added, "they will have effectively killed the program."

Even IST director Ionson would have to concede that the boycott has interfered with his original "marching order" to "get

John Klossner

the most brilliant minds in our country involved in this program." However, when many of the best and brightest refused to cooperate, Ionson adopted a convenient fall-back position, stating that "two second-rate scientists are as good as one first-rate one."

Air Force Lieutenant General James Abrahamson, who directs SDIO, has also felt the effects of the boycott. In the fall of 1985, Abrahamson claimed there were "only a few diehards left, sincere diehards, but only a very few" who opposed the SDI program. Interviewed a year later, he said, "Well, I'm disappointed.... We're losing a little bit." He continued, "What we're seeing is an intensive campaign on the part of the opponent. They're going out there and they're signing up people. The U.S. government doesn't do that. We don't go out there and sign people up. So that's having a lot of impact. A lot of these people are people that I would like very much to have in favor of what we're doing."

Clearly there has been an impact, but spelling out its precise nature or magnitude is a difficult, perhaps impossible, task. Some congressional aides have said, for example, that the boycott has been the biggest thing so far in the anti-Star Wars debate. "But it's hard to measure these things exactly," commented Union of Concerned Scientists lobbyist Robert Herman. "At the very least, it means there's that much more ammunition opponents can bring to the debate."

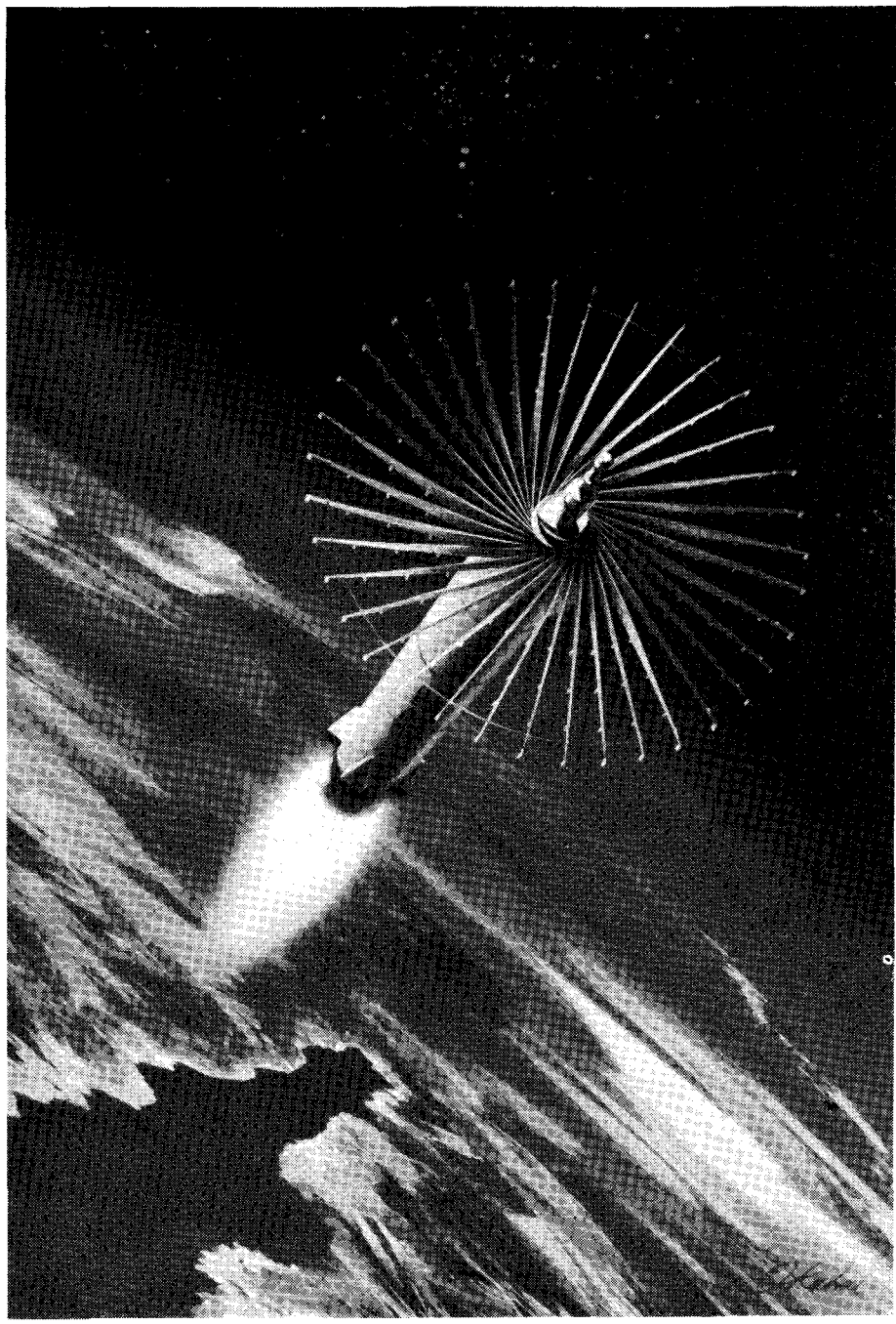
MIT professor James Melcher, who distributed the pledge in the university's engineering departments, claimed that "there definitely was some influence, at least in academia. But if there is an impact," he added, "you don't go crowing about it, because you might kill it."

BLOWS AGAINST THE EMPIRE

The boycott was but one of a series of crippling blows to the credibility of the Star Wars program. In March of 1986, for example, a letter expressing concern about SDI was sent to Congress by present and former research heads of government and industry labs (see the accompanying sidebar, "Since the Pledge"). The letter was signed by over 2,100 scientists and engineers from more than 130 labs.

In October of 1986, a poll found that 98 percent of the members of the National Academy of Sciences in fields most relevant to SDI research believed that SDI could not provide an effective defense of the U.S. civilian population.

In March of 1987, former Secretary of Defense Harold Brown and the associate director of defense programs at Livermore National Laboratory, George Miller, testified before Congress that the Soviets could easily defeat any strategic defense that the U.S. could deploy by the end of the century. Also in March, a report by



Department of Defense photo/artist's rendition

Artist's concept of the Army Homing Overlay Experiment homing-and-kill vehicle on track to intercept an inert ICBM reentry vehicle.

senators J. Bennett Johnston (D-LA) and William Proxmire (D-WI), based on interviews with over 60 SDI research scientists, found that any near-term defense would be leaky, destroying only 16 percent of incoming Soviet warheads, at best. Reports a few months later by SDI researchers at Livermore Lab and the Defense Science Board—the nation's own scientific advisory group—reached similar conclusions.

Finally, an April 1987 study by the American Physical Society concluded that it would take at least a decade of intensive research just to determine whether directed-energy weapons such as lasers could ever provide an effective defense.

"You have to look at the sum total of scientific statements," said a senate aide involved in the Star Wars debate. "Some said, 'We won't work on it.' Others said, 'We work on it, but we're very concerned.' That leads to a sense in Congress that all is not well, that the program has been oversold, overhyped."

According to Lisbeth Gronlund, "All this negative publicity combined with the boycott made it easier for critics in Congress to make their case." Moreover, "The boycott helped raise the consciousness of people who don't ordinarily think about this kind of thing," Gronlund said. "It got

people talking about Star Wars and discussing some of the implications of their work."

"One thing we found at Cornell," said David Wright, "was that you'd go into the computer room, and for weeks and weeks people would be talking about Star Wars. The pledge forced people to look not only at technical issues, but also political issues."

Some Cornell graduate students recently formed a group to talk about the role of science in society and to see whether it is possible to work in science without working for the military. The boycott also spawned another group called FREE—Forum for Responsible Ethics in Engineering—which provides information to graduating seniors on companies with which they plan to interview.

In MIT's engineering departments, Star Wars became a sticky subject. "This is a place where ideas and applications are being discussed all the time," said James Melcher. "That's what we do. The exchange goes on all the time—in classrooms, hallways, and parking lots. But with Star Wars, you sense that people don't want to talk about it—in the same way you don't want to talk about things that disgust you.

"Ten years ago," Melcher continued, "when people were looking for alternative energy sources, it was very different. There were all kinds of animated discussions. Trying to find clever solutions to real human problems—that's what makes engineering exciting. But I don't see people talking about Star Wars in the same way, like 'Gee, here's how we're going to fix up SDI!' It's not going to motivate anyone. All you get is a sick feeling in the bottom of your stomach."

MAINTAINING MOMENTUM

One challenge for the boycott organizers is finding a way to keep interest alive after their initial success. "Most scientists, while they're concerned about these issues, tend to fall back into equilibrium and focus mainly on their research," said Cornell's David Wright. "The SDI boycott came along and pulled them out. But after the immediacy is gone, they tend to go back to their classes or research. It's difficult to sustain a high level of activism."

Michael Weissman of the University of Illinois agrees. "People tend to get burned out," he said. "Then it's hard to get others to take over, especially when you seem to have accomplished your goal."

Barring a crisis, MIT professor Vera Kistiakowsky doesn't see much value in continuing to push the pledge. "You don't want to harass people who didn't sign the first time. Besides, the number of new people is rather small, making it not a terribly useful thing to do."

Michael Weissman and John Kogut continue to speak out against SDI at

SCIENTISTS WHO

HARRISON BARRETT: a University of Arizona physicist who specializes in the fields of optical computing and medical imaging. The areas of optical computing, he found, had become "very politicized," receiving lots of interest from the military. "I don't feel comfortable continuing there, even though I've been doing it for 20 years," Barrett said. Instead, he is concentrating his efforts on medical imaging. "My research had been supported by the Air Force, not SDIO. I suppose I could have drawn a fine line by saying, 'I'll take Air Force money, but not Star Wars money.' I chose not to."

ROBERT BOWMAN: head of ballistic missile defense research for the Air Force in the Ford and Carter administrations, who is now a leading Star Wars critic. What caused his change of heart? "I didn't change," Bowman said. "The government changed. Before Reagan came in, it had been a research program—run in accordance with the ABM treaty—to prevent the possibility of technical surprise. We never recommended that the U.S. deploy a system. The policy, in fact, was to seek a ban on space weapons. All that totally reversed with Reagan. The aim of the new program was to regain military superiority with offensive weapons disguised as defense."

After leaving the Air Force, Bowman took a job in the aerospace industry. "I had to leave industry as well," he said. "I found I had less freedom of speech in industry than in the military." In 1982, Bowman started the Institute for Space and Security Studies, which lobbies against Star Wars. He lectured on behalf of the Star Wars boycott and continues to speak out on the subject.

TOM EISNER: a Cornell biology professor who, along with graduate student Ian Baldwin, refused a grant from the university's Biotech Center because the money had come from the Army. "The research itself had no military applications, but it was an issue of principle here," Eisner said. "I feel that military money has no place in the university. The fact that it had 'no strings attached' doesn't change anything."

DAVID PARNAS: a professor of computer science at the University of Victoria in British Columbia, who resigned from a $1,000-a-day SDIO advisory panel in 1985. Since then he has become an active opponent of the Star Wars program. "Like President Reagan, I consider the use of nuclear weapons as a deterrent to be dangerous and immoral. If there is a way to make nuclear weapons impotent and obsolete, there's nothing I would rather work on."

Parnas's experience with computer-controlled weapons systems, however, made him question "whether any such system could meet the requirements set forth by President Reagan." He quickly concluded that "SDI endangers the security of the U.S. and the safety of the world. By working on SDI these scientists allow themselves to be counted among those who believe that the program can succeed. If they are truly professional, they must make it very clear that an effective shield is unlikely and a trustworthy one impossible.

"My decision not to participate in SDI will not stop this misguided program," Parnas wrote in "Why I Quit Star Wars," in the May/June 1986 issue of *Common Cause* magazine. "However, if everyone who knows that the program will not lead to a trustworthy shield against nuclear weapons refuses to participate, there will be no program. Every individual's decision makes a difference."

ANDY RUINA: a professor of theoretical and applied mechanics at Cornell. "The value of the Star Wars boycott was in advertising the idea that scientists can refuse to work on things, that scientists can be conscientious objectors," Ruina said. "I hope consciousness has been raised by the boycott so that scientists will look at other kinds of research critically. One of the objections to Star Wars is that it won't work; therefore it's stupid. But lots of weapons will work, which is all the more reason not to work on them.

"I don't take money from the Department of Defense, because I don't want to be in the killing business," Ruina continued. "But, of course, you're in it. You can't be a scientist at a major university and not be mixed up in it, somehow. I teach ROTC students and students who someday will take jobs at GE, General Dynamics, and Boeing.

"I have chosen to take this one step—to not accept defense money and try not to talk to people about military research—and I hope others will too. My little challenge, however, has showed the possibility of having severe career consequences. I'm not a real radical. A little step off the path and you really rub the grain."

RICHARD RUQUIST: a physicist who, in 1987, left a lucrative position with Sparta, Inc., a defense contractor heavily

HAVE SAID NO

involved in SDI research. Ruquist resigned because of his belief that SDI will be ineffective, dangerous, and expensive. "We could spend money on it until we were bankrupt, and it still wouldn't protect us," he said.

Prior to his resignation, Ruquist had done defense-related research for 27 years. "For more than two decades of my professional life, I saw Star Wars as a way to get rid of nuclear weapons. I was afraid of nuclear weapons, so I was a big promoter of this."

However, in the summer of 1986, Ruquist performed calculations which showed that a defensive system would be inherently vulnerable. "At that point, Star Wars was a research project that would be going on for decades. It represented no immediate danger, so I continued working on it, even though it was somewhat dishonest.

"The thing that really did it to me was when Weinberger announced an early-deployment system in five to ten years. It was a first-strike system—there could be no other purpose—and very risky. Now it was not only a matter of honesty, but one of real danger. So I got out. I'm still doing Star Wars research, but now I'm doing research against Star Wars," said Ruquist, a visiting scientist at MIT.

SARAH TASKER: In the spring of 1985, at the time an MIT undergraduate physics major, Tasker quit her research project at the plasma physics lab when she realized the military applications of her research on free-electron lasers. "People in the lab were starting to talk about making really high-powered devices to attract military interest," she said. "The only reason for making very high-powered lasers is to blow holes in something."

JOHN TRUMP: an MIT professor of electrical engineering and developer of the high-voltage laboratory. "John, over a period of three decades, would be approached by people of all sorts because he could make megavolt beams of ions and electrons—death rays," said James Melcher, who directed the lab where Trump worked. "What did he do with it? Cancer research, sterilizing sludge out in Deer Island,"—a waste disposal facility—"all sorts of wondrous things. He didn't touch the weapons stuff." Trump died in 1985.

ZELLMAN WARHAFT: a Cornell engineering professor who has refused to take military research money throughout his professional career. "I feel there is too much defense work going on at universities that is taking away from the civilian side of science R&D," Warhaft said. "Instead of allowing scientists to suggest interesting projects to work on, the federal government is saying, 'You won't get funding unless you do this.' That's unfortunate because it limits the possibility of new discoveries.

"I'm particularly against Star Wars, which is a folly as well as a danger. Not only is money being wasted, it's being wasted at the expense of other more important work. I won't take defense money because I choose to work on things which will lead to the betterment of society."

ROY WOODRUFF: former associate director for defense systems at the Lawrence Livermore National Laboratory, who had managed the X-ray laser research program. In October 1985, Woodruff left his post because of "overly optimistic, technically incorrect statements regarding this research" made by physicist Edward Teller and his associate Lowell Wood to top policy makers, including President Reagan and members of the Joint Chiefs of Staff. Reported breakthroughs in X-ray laser research have been used to win more federal funding for the Livermore Lab.

"For us to be potentially basing national policy on the speculations of Dr. Wood, advanced through Dr. Teller, is totally inappropriate," Woodruff said. "The representations by Dr. Teller were not in keeping with the laboratory's position. They were much more optimistic, and I don't believe they were founded on actual results.

"I resigned my post out of principle. I liked the job, and it was a very difficult decision." However, Woodruff added, "I was placed in an untenable position where continuing as associate director lent my personal technical credibility to Dr. Teller and Dr. Wood's statements. In essence I was...demoted since I was left with no other ethical choice."

Woodruff maintains that he was "unilaterally downgraded" to an entry-level "analyst" position, where he was to receive no assignments which would give him visibility. He still supports X-ray research, but believes "it has to be responsibly portrayed to the nation's senior policy makers."

Despite his commitment to an "appropriate research program," Woodruff says "we don't know at this date whether we can make a weapon and, if we can, how effective it would be. At this juncture, we can't even say it's possible."

lectures and on television stations around the country. Weissman recently spoke at Eureka College, President Reagan's alma mater. In a poll taken afterwards, two-thirds of the students in the senior class came out against Star Wars.

Kogut is generally pleased with the impact they've had so far. The pledge was read into the *Congressional Record*, and organizers of the drive regularly brief senators and representatives on the subject. "I think we made a lot of progress last year," Kogut commented. "Ordinary magazines like *Time* and *Newsweek* began to catch on. Journalists began to see that Star Wars could be used for offensive purposes, and that would be a bad thing."

Both Kogut and Weissman believe that a long-term impact on opinion makers—like columnists and editorial board members—may gradually sway public opinion. "We've raised the consciousness of our colleagues, and also the media," Kogut said, "and eventually the public, although that's where I'm a bit frustrated. It's hard to reach the average fellow. Most people tend to believe President Reagan. We come along with our sober, sensible arguments and that doesn't compete so well."

Kogut claims, "The Administration can do tricks on a regular basis, touting successes where there are none. They'll get the front page, of course. When we debunk them, we'll get page 27D."

"It's hard to know what the public thinks," said Lisbeth Gronlund. Speaking at a conference in Austin, Texas attended by almost 300 peace activists, she found that less than half of them had heard about the Star Wars boycott. "Unlike the Freeze or comprehensive test ban, public opinion, so far, hasn't played a big role," she said. "Maybe it will in the future."

David Wright gave a talk in Philadelphia, and afterward a man came up and said, "When I heard about the pledge, and the scientists who refused to take money, that really convinced me." "I don't know how many people feel that way," Wright said, "but at least for this one man, it made the difference."

THE BIGGER PICTURE

Recently, organizers have begun to move the debate to a broader examination of military research. "How many times can you say Star Wars is bad?" asks Rich Cowan of MIT's Science Action Coordinating Committee (SACC), which distributed the SDI pledge among MIT students. "Once you've distributed 3,000 leaflets on how bad Star Wars is, you face the law of diminishing returns."

At MIT, two committees are now investigating the question of military research on campus. SACC wants MIT to give students the freedom to reject projects that are not ethically acceptable to them. "We want MIT to guarantee that no

student will be denied funding because he or she refuses to work on military-related research," said Cowan.

United Campuses to Prevent Nuclear War shares these goals. In addition to its arms control efforts, this national organization helps establish student internship programs with peace groups. "We want students to know there are alternatives to working in the military," said their executive director, April Moore. In terms of weapons research on campus, Moore said, "we feel students have a right to know where the money is coming from, and we encourage them to find out."

A student group at Cornell is doing just that—preparing a report on university research funding. "That's something I'd like to see a lot of universities do," says Chris Moore, one of the group's founders. They're sponsoring a panel discussion by Cornell faculty who refuse to take military funding. Another symposium will look at military and industrial collaboration on campus to see whether it poses a threat to academic freedom.

"We're trying to widen the debate that started with the Star Wars boycott and move on up to more basic issues, questioning the partnership between scientists and the military," Chris Moore explained. "The boycott set a precedent, but it was a boycott of very specific kinds of research. Regardless of what you do with Star Wars money, even if your research is harmless, by taking the money you're endorsing Star Wars. That argument extends to DOD money in general. It shouldn't surprise scientists that the defense budget is skyrocketing under Reagan. By taking money, they're endorsing it."

As a follow-up to the Star Wars boycott, Chris Moore suggests circulating a less specific pledge about military funding in general. "Who knows," he said, "you might get a surprising number of people to sign."

University of California-Berkeley physicist Charles Schwartz thinks boycotts and petitions are a fine place to start, "but signing a petition is relatively easy. For most people, it doesn't cause too much discomfort, and it doesn't solve the basic problem." To avoid training potential weapons makers, Schwartz has decided not to teach physics to engineering or physics majors. He has called on other physicists to do the same, generating a worldwide strike that would involve a "collective and gradual withdrawal of our services in all ways that contribute to the arms race."

Herbert Bernstein, a theoretical physicist teaching at Hampshire College, is taking a different tack. Rather than merely challenging the applications of science—whether for Star Wars or other military projects—he is examining the nature of science itself. "Instead of refusing to apply your science, I'm asking if you can change what science is so that it is possible to be both smart and good," said Bernstein. "In other words, can you reconstruct science so that it combines disciplinary excellence with social good?"

MIT mechanical engineering professor Donald Probstein would rather use science and engineering to advance social well-being. Probstein, a missile expert, was reluctant to turn down Star Wars funding, because of the scarcity of other funding sources. But he did refuse the SDI money. "There are many important problems I can contribute to, especially in areas of environment and energy," he said, "problems I think require solving for the benefit of mankind. I'd like to spend my lifetime working on those problems."

SINCE THE PLEDGE

OPEN LETTER TO CONGRESS: 2,100 scientists from more than 130 government and industry labs signed a letter expressing their concerns about SDI. The letter claimed that the stated goal of rendering nuclear weapons obsolete is not realizable and urged Congress instead to "limit the SDI program to a scale appropriate to exploratory research." Among the signers were five Nobel laureates and present or former directors of Argonne, Brookhaven, Fermi, Lawrence Berkeley, and Los Alamos laboratories.

The letter began circulating in the spring of 1986, one year after the Star Wars pledge made the rounds at universities. "We felt the pledge would not be meaningful for people who work in government and industry labs," explained Pierre Hohenberg of AT&T's Bell Laboratories, one of the original signers. "A pledge not to solicit funds is meaningless, because most people in these labs don't have to solicit funds. A pledge not to work on it is the same as saying you want to quit your job."

An accompanying letter sent to all senators from Senators Daniel Evans (D-WA) and J. Bennett Johnston (D-LA) stated, "Such a spontaneous outpouring of concern directed to the Congress from scientists within our most respected government and industrial laboratories is rare indeed. It would have been far easier for them to sign nothing, to say nothing."

BIOLOGICAL & CHEMICAL WEAPONS BOYCOTT: A pledge not to participate in biological and chemical weapons research began circulating in September 1987 and received several hundred signatures in the first two months.

"We were inspired by the success of the Star Wars boycott," said Leonard Minsky, executive director of the National Coalition for Universities in the Public Interest, which is distributing the petition along with the Committee for Responsible Genetics. At a meeting with the Star Wars pledge sponsors last year, Minsky mentioned the idea of a similar pledge on biological and chemical warfare. "We agreed it would help raise the issue of the appropriations of military research on campus," he said. (See the article about biological warfare in this issue.)

AAAS REPORT: An internal report by the AAAS Committee on Scientific Freedom and Responsibility, scheduled for completion in 1988, is examining the SDI funding and decision-making process to see whether it might circumvent the normal peer-review system. The report, which may or may not be released to the public, will also determine what kind of restrictions, if any, are placed on SDI grant recipients. "This is an initial effort to find out whether we should be concerned," said Mark Frankel, head of the AAAS Office of Scientific Freedom and Responsibility.

UNIVERSITY RESOLUTIONS AGAINST SDI RESEARCH: In October 1985, a large majority of the Tufts University faculty passed a nonbinding resolution that Star Wars research should not be conducted on the campus. The University of New Mexico passed a similar measure in 1986.

Despite reservations about SDI, the administration at Tufts chose not to abide by the resolution, stating that it wasn't university policy to prohibit faculty research of any kind. A year later, the faculty decided to have all research projects listed in the Tufts monthly journal, indicating which proposals involve SDI funding. The listing has appeared in one issue. "We're asking the administration to make that information available on a regular basis," said physics professor Gary Goldstein, who sponsored the SDI research ban resolution, along with professor Sheldon Krimsky of the Department of Urban and Environmental Policy.

POLITICAL CONSTRAINTS

Military Funding & Academic Freedom

BY GARY MARCHANT

It is by the goodness of God that in our country we have those three unspeakably precious things: freedom of speech, freedom of conscience, and the prudence never to practice either of them." Mark Twain wasn't addressing scientists when he wrote those words, but the sentiment suits them.

In recent years, growing concern and attention has focused on encroachments of the academic freedom of scientists doing research funded by, or of interest to, the military. Recent incidents have helped spark these concerns. The forced withdrawal of papers that were to be presented at scientific conferences, increasing classification of basic research (including some "retroactive" classification), and prepublication review clauses in research contracts are examples of scientific censorship. Other restraints include the use of export control legislation to restrict

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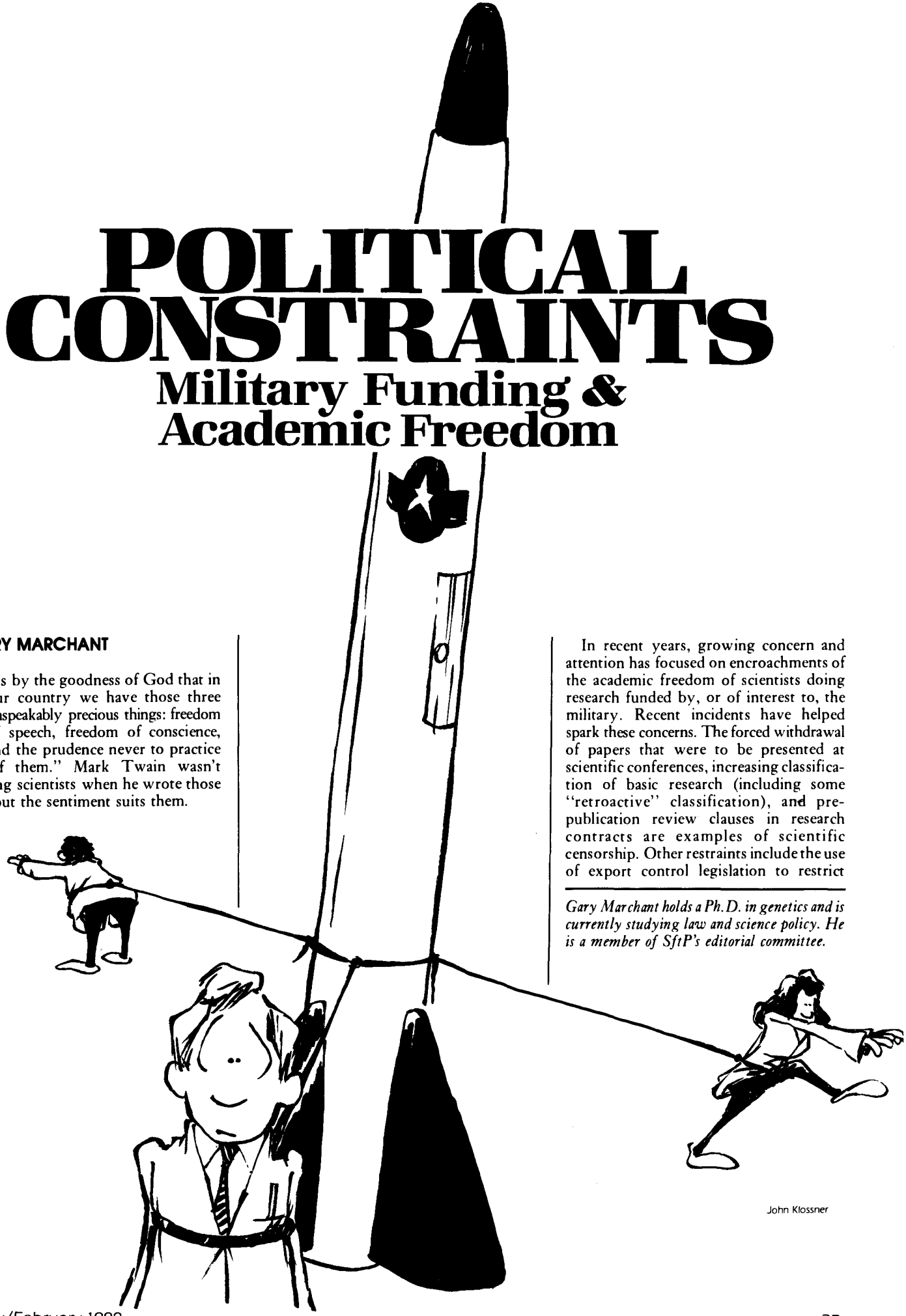

John Klossner

basic scientific information and restrictions on foreign scholars.

While these infringements on scientific freedom have generally received the serious attention they deserve, there has by comparison been relatively little attention given to restrictions on the political freedom of scientists working for or funded by the military.

There is mounting evidence to support the common-sense assumption that accepting military funding seriously impairs the freedom or willingness of scientists to speak out politically on controversial issues such as arms control and Star Wars. This restriction on the political freedom of scientists is especially prevalent and pronounced in periods where the military dominates research funding.

For example, in 1968, several mathematics professors who had contracts with the military for support of basic research signed an advertisement in a professional newsletter urging their colleagues not to do research that contributed to the Vietnam War. Soon after, the professors received letters from the military branch that sponsored their research notifying them that the termination of their contracts was being considered.

A letter from the Army to one of the professors stated: "While you as individuals have every right to your own opinions and convictions, your present position vis-a-vis that of the Department of Defense must place you in a most uncomfortable, and perhaps untenable, situation; continuance of this relationship could well serve as a source of embarrassment to you. In view of this unfortunate circumstance, a mutually acceptable decision to terminate our present association when your present support expires appears to be consistent with both of our positions." After considerable outcry and pressure from other scientists, the military relented and agreed to renew the professors' contracts.[1]

Also in the 1960s, a physicist named Kenneth S. Cook, working as a weapons analyst for the Air Force, sent a confidential letter to a top Pentagon official claiming that the Air Force was manipulating information and exaggerating the effectiveness of ballistic missile defenses. Three weeks later, Cook was called into the office of his commanding officer, who had somehow received a copy of the "confidential" letter.

Cook's top-secret security clearance was summarily removed without explanation, and he was ordered to submit to a physical and psychiatric exam by military medical personnel. Cook was dismissed after being found physically and mentally incapable of performing further service with the Air Force, and was not permitted to produce evidence from his own doctor that contradicted the military's medical evaluation. Cook later sued the Air Force and the Civil Service Commission for wrongful dismissal.[2]

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In 1985, the director of the Army Corps of Engineers' Construction Engineering Research Laboratory (CERL) at the University of Illinois sent out a memo ordering an end to all collaboration with scientists who had publicly opposed the Star Wars program. The action was prompted by the publicity and success of the anti-Star Wars research pledge at the university.

The memo, by director Colonel Paul Theuer, stated: "I want the word put out 'loud and clear' that NO USA-CERL projects or official relationships will be continued or conducted with those aspiring to separate themselves with the 'star wars' program—an Administration program. As part of the Executive Branch, we have to support the President." After heavy criticism, Theuer withdrew his order, claiming that the memo was based on "incomplete" newspaper reports about the opposition to Star Wars.[3]

For the past decade, physicist Hugh DeWitt of the Lawrence Livermore Laboratory has been speaking out against the lab's role in promoting the arms race. After an attempt to remove DeWitt for his political activities failed several years ago because of strong support from scientists and congressmen who came to DeWitt's defense, Livermore Lab is once again trying to force him out. This time, the lab is citing dissatisfaction with DeWitt's scientific progress, despite his outstanding reputation in the physics community, as its justification for trying to remove its most prominent internal critic. (See the article about Hugh DeWitt on page 39 in this issue.)

In the spring of 1986, Undersecretary of Defense for Research and Engineering Donald Hicks attempted to politically censor and intimidate scientists supported by military funding. Hicks, who is in charge of all Pentagon research contracts, said in an interview that if scientists "want to get out and use their roles as professors to make statements, that's fine, it's a free country." But, he continued, "freedom works both ways. They're free to keep their mouths shut...I'm also free not to give the money." When asked if he really meant that only those who agreed with the policies of the Pentagon should receive its funds, Hicks replied, "Absolutely."[4]

Although the Department of Defense, facing sharp criticism, issued a statement claiming that Hicks was speaking "hypothetically" and was not representing official departmental policy,[5] Hicks struck a sympathetic chord with some—both inside and outside the Pentagon. *Physics Today* reported that Hicks's immediate boss, Deputy Secretary William Taft IV, agreed with Hicks. Secretary of Defense Weinberger sent a letter to Senator Proxmire about the incident in which he

expressed a personal view "that there are some significant ethical considerations involved" for grantholders who bite the hand that feeds them.[6]

The *Wall Street Journal* printed an editorial strongly supporting Hicks. Referring to scientists who "stick their heads in the sand" by signing the anti-SDI pledge: "Perhaps they really are holier than the rest of us. But we don't think the rest of the country should have to subsidize their virtue."[7]

These examples are certainly just the tip of the iceberg. The threat of sanctions against a scientist who speaks out on political issues will, if successful, probably never become public. Scientists who are deterred from speaking out on political issues will also be deterred from revealing the mechanisms used to enforce their silence.

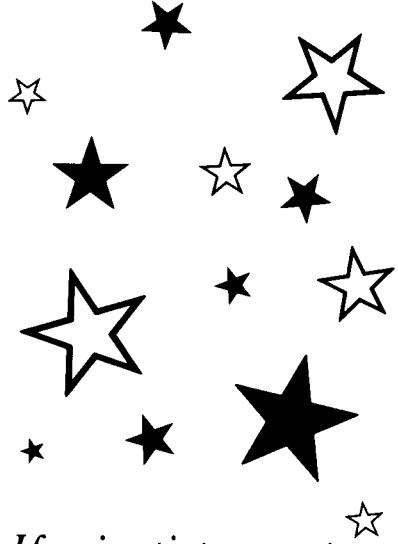
As most of the examples cited demonstrate, those attempts at intimidation or coercion that are publicized are often withdrawn or rescinded in the face of heavy criticism. The threats that are most effective are those that never become public knowledge, and therefore it is very difficult to get an accurate measure of the extent of political censorship that exists among military-supported scientists.

According to Allan Adler of the American Civil Liberties Union, the possibility of sanctions is real enough that "any scientist trying to get, for example, an SDI grant is likely to cease any activities they were previously involved in that were critical of the administration's military policy. Any scientist that accepts such a grant knows that they will have less discretion—both scientifically and politically."

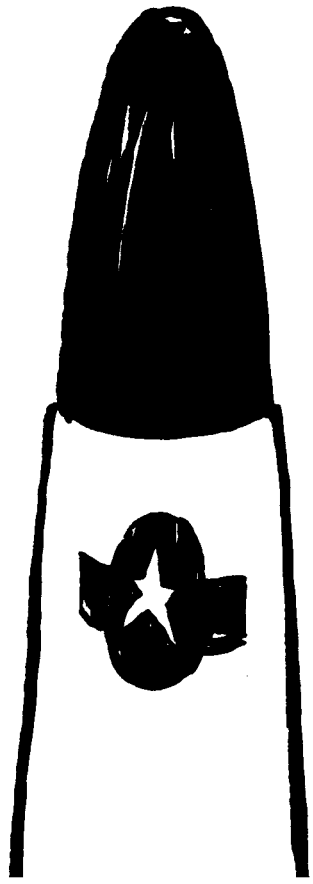
MECHANISMS FOR PUNISHING DISSENT

There are a variety of mechanisms that are available to Pentagon grant officers, nuclear weapons laboratories, and military contractors to control the political activities of the scientists that rely on them for funding. In his case studies of scientists working for military contractors during the Vietnam War, Jeffrey Schevitz found that the responses military research establishments took towards dissident scientists "ran the gamut from cooption into advisory committees, to drawing the limits of tolerated activity, to verbal threats, to the scare tactics of security checks, to termination."

For example, one researcher at the Stanford Research Institute (SRI) who spoke at a management-sponsored staff meeting in support of student antiwar demonstrations was later grilled by security officers from the Office of Naval Intelligence and then terminated. Another scientist whose name appeared on a student leaflet was called onto the carpet in the president's office and told that being involved with antiwar organizations "was not consistent with being a researcher at SRI."[8]



If scientists want to use their roles as professors to make statements, that's fine. It's a free country. But freedom works both ways. They're free to keep their mouths shut. I'm also free not to give them money.



Since much of the research funded by the military requires a security clearance, the awarding and revoking of such clearances is a powerful mechanism for political control. The application process for a security clearance screens out applicants with undesirable political backgrounds. For example, a scientist applying for a security clearance must give details of all organizational memberships ever held, and a separate, more detailed account must be provided if he or she has ever been a member of any of over 300 organizations on a list compiled by the U.S. Attorney General in the 1950s.[9]

Once a scientist has succeeded in obtaining a security clearance, he or she faces the constant threat of having the clearance revoked in response to any disapproved political activity. Robert Oppenheimer's career ended when his security clearance was withdrawn as a result of his opposition to the hydrogen bomb. Similar actions against lesser-known scientists are not an infrequent occurence today.

For example, a senior engineer with a leading defense contractor was recently informed that his security clearance was being "reinvestigated" after he publicly questioned the ethics of military work. He was told, "You've made certain statements in public and we want to know if you are someone who will safeguard secrets."[10]

The use of more devious and sinister means to intimidate and discredit dissident scientists is not without precedent. Such tactics were used in the early 1980s against Hugh Kaufman, an Environmental Protection Agency scientist who opposed the Reagan administration's cutbacks in hazardous waste enforcement projects. Kaufman was followed, photographed, and had his phone tapped by EPA investigators when he started making speeches about hazardous waste to citizens' groups. In one incident, the investigators fed information to the media that Kaufman was seen entering a motel with a "brunette." The woman turned out to be Kaufman's wife.

Documents released under the Freedom of Information Act revealed that the director of the Superfund program, Rita Lavelle, had ordered the investigation, in the words of a department report, in "an apparent attempt to discredit" Kaufman and "silence the communication of his ideas."[11] Given the past practices of the national security apparatus in this country, it is certainly not unthinkable that similar tactics are used against scientists who speak out on military issues.

These more blatant methods of intimidating and coercing dissident scientists run the risk of public exposure and triggering a public outcry. Also, the First Amendment protects free speech from government

interference, even though private employers are usually not bound by it. Therefore, more subtle means of punishing outspoken scientists are common.

Richard Ruquist, who worked for military contractors for over twenty years before quitting in protest over the Strategic Defense Initiative, says that "people who aren't willing to keep their mouths shut get put in a corner somewhere where they are harmless." Career stagnation is the usual reward for "troublemakers," who are denied promotions and usually assigned to the least interesting projects. Hugh DeWitt of Livermore Lab has not received the normal pay raises that other less-outspoken scientists of his calibre and seniority regularly receive.

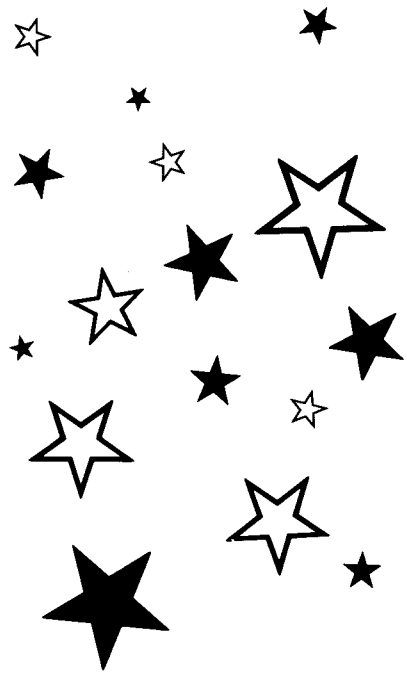
Tom Grissom is a physicist who worked for fifteen years at Sandia Labs, a nuclear weapons design facility. In 1986, he quit his job at Sandia in opposition to nuclear weapons. According to Grissom, "no meaningful or effective dissent is tolerated at the Sandia Labs. No one would be fired, you would just find yourself in a hostile and alienated environment." The managers of any military contractor have the power to make a dissident scientist's work environment so difficult and miserable that the scientist would be forced to leave "voluntarily," as did Grissom.

If a direct attempt is made to terminate a scientist's job or grant for political reasons, it is usually done under the guise of some other excuse. Thus, Livermore Lab is currently trying to remove Hugh DeWitt from his position by citing unsatisfactory scientific progress, even though DeWitt is one of the best in his field.

The control of scientists' political activities can extend beyond the period that they are actually funded or employed. It was reported at a conference on whistleblowing organized by Ralph Nader that Dupont's pension plan allows the company to cancel a retired employee's right to receive benefits if he or she becomes involved in "any activity harmful to the interest of the company."[12]

The federal government has recently required 3.6 million employees with access to classified information to sign Standard Form 189. These forms bind the signatories never to divulge in a "direct or indirect" fashion "classified or classifiable" information. The forms will remain on file for 50 years, and failure to sign will result in automatic loss of security clearance and hence employment. Because the form applies to information that can be classified by the government after it is divulged by a former employee, it gives the government much broader power to punish the disclosure of politically embarassing information.

Congress members also have the power to punish scientists who take politically controversial positions. In 1967, mathematician Stephen Smale was attacked for his opposition to U.S. policy in Vietnam by conservative Representative Roudebush from Indiana. An aide to Roudebush was reported to have said that "the Congressman looked into Smale's background and he's about as pink as they come.... We have already been in touch with Senator Gordon Allott and he has agreed to veto the grant." Shortly thereafter, the National Science Foundation tried to cut his funding, accusing Smale of mismanaging his grant. Smale's funding was restored after publicity and controversy about the situation revealed that there was no substance to the NSF's allegations.[13]



Indiana Congressman Dan Burton's bill will cut funding to universities where professors refuse to do SDI research. "If they're not willing to do their part to defend America, I don't see why they should receive our tax money," says Burton.

A more recent proposal by ultra-conservative Indiana Congressman Dan Burton would defund entire universities, not just individual researchers and professors. An article in the June 1987 newsletter of the right-wing organization Accuracy in Academia reported that Burton will soon be introducing a bill to cut funding to universities where professors refuse to do SDI research. Burton was quoted as saying, "if they're not willing to do their part to help defend America, I don't see why they should receive our tax money."

Steve Baldwin, executive director of Young Americans for Freedom, who is helping to draft the bill, said that "the bill is in the same vein as the Solomon Amendment that cut off federal aid to students that refused to register for the draft.... If given more support and a bigger lobbying effort, it could have a good chance of passing."[14] The bill would cut off all federal aid to public universities which have banned SDI research.

When contacted, an aide to Representative Burton expressed regret that there was no legal mechanism for attacking individual scientists. "We don't want to seem anti-education and punish whole schools, but just the troublemakers," said aide Kevin Frankovich. In a telephone interview, Baldwin said that no university department has yet formally banned SDI research, but he hoped "that word leaking out about the impending bill would deter any schools from doing so."

SELF-CENSORSHIP

Although the mechanisms outlined above are effective for punishing dissident scientists who do speak out, the mere hint of sanctions is enough to deter many scientists from ever criticizing military policy in the first place. Threats such as those from Under Secretary of Defense Hicks, even if they never become official policy, send a clear signal to scientists and have a chilling effect on political activity.

In a speech to the Senate in December 1967, Senator William Fulbright called attention to this danger of self-censorship when he warned, "The corrupting process is a subtle one: no one needs to censor, threaten or give orders to contract scholars;

without a word of warning or advice being uttered, it is simply understood that lucrative contracts are awarded not to those who question their government's policies, but to those who provide the government with the tools and techniques it desires."[15]

Once a scientist has become established and comfortable working for a government laboratory or private company, or has grown dependent on research grants from the Pentagon, there is a strong incentive not to take any risks that might jeopardize one's situation. Dorothy Nelkin, a professor of science, technology and society at Cornell, believes that it is almost impossible to document concretely the extent of self-censorship among scientists who receive military funding.

"It is very hard to know what people would have done if they were in different circumstances—would they have been politically active if they weren't so constrained?," Nelkin asks. "What we can do is infer from common sense and sociological knowledge about how people respond to incentives and penalties that people just don't jeopardize their source of funding. Since military funding sets up the structural conditions for reducing dissent, activism isn't going to be a factor with these people."

Tom Grissom, the scientist who left Sandia Labs for political reasons after fifteen years, recalls that many scientists at the lab were very troubled by President Reagan's announcement of the Star Wars program in 1983. "Although they talked quietly to others in the corridors about their concerns, they did not want to be too open or identified about it," said Grissom. "There was an underlying fear that the lab management had ways of punishing them—in ways that may not be overt, but nevertheless effective."

Physicist Michio Kaku of City University of New York, and author of *To Win A Nuclear War*, tells of a colleague at another university whose contract was not renewed. The friend had been very politically active during the Vietnam War, and continued to hold strong political views. However, after his university contract ended, the only job he was offered was at Lawrence Livermore Laboratory. He phoned Kaku after deciding to accept the Livermore position and, in Kaku's words, "he was very honest about it. He said he felt sheepish, but that he would have to keep his mouth shut and end any political involvement. The bottom line, he said, was his wife and two kids."

A 1974 study of the participation of scientists in the antiballistic missile controversy of the late 1960s and early 1970s concluded that the source of a scientist's funding played a key role in determining their political activity. "Many industrial and government scientists do not feel that they possess the same freedom and security to become publicly identified in a controversial issue," the study found. "Whether, in fact, that is illusion or reality is immaterial. It is the scientists' *perceptions* of constraints upon their outside-work activities which serve as inhibitors upon their participation in issues like ABM."[16]

A good example of self-censorship was the reluctance of many scientists to sign the anti-SDI pledge. Two of the originators of the pledge campaign—Lisbeth Gronlund of Cornell and Michael Weissman of the University of Illinois—knew of scientists who opposed SDI, but refused to sign the pledge because either they were receiving military funding then, or hoped to in the future. Weissman talked to several people who explicitly said that they feared offending their military grant officers and so would not sign.

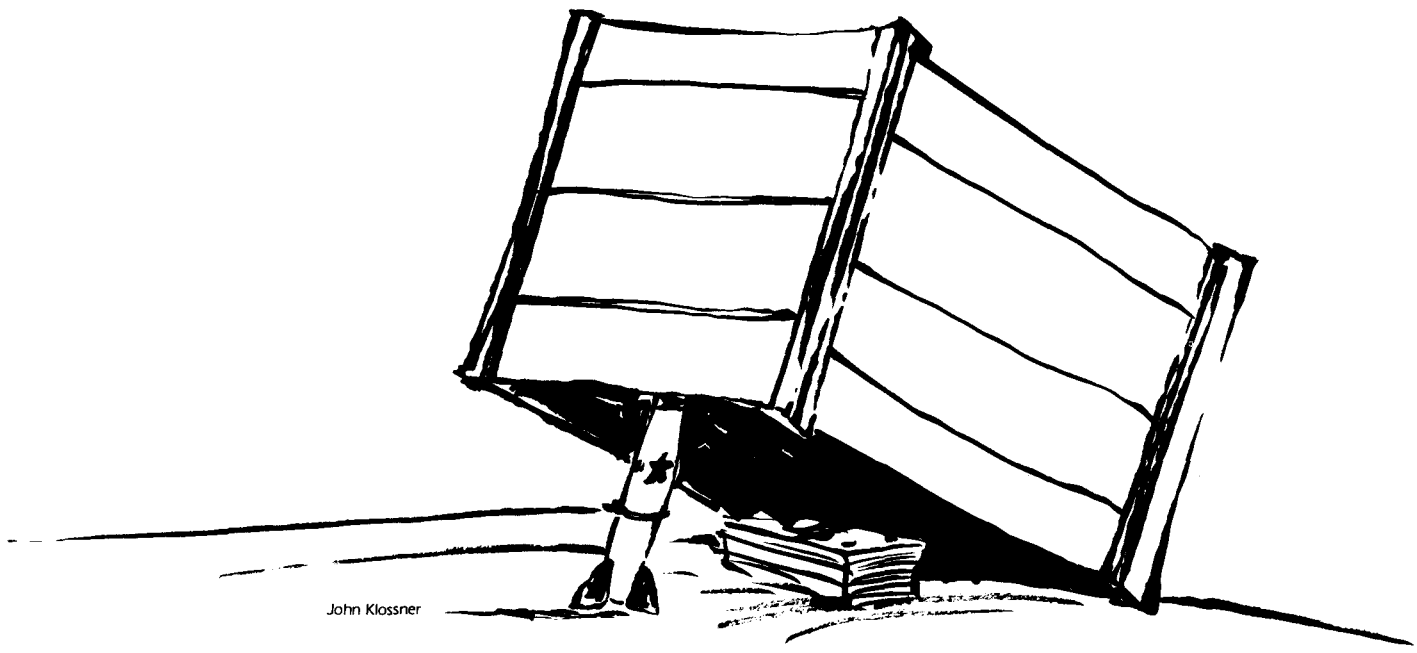
Gronlund noted that some scientists "were also hesitant about jeopardizing their standing with university administrators, as lots of pressure was being applied by administrators at some universities for scientists to apply for SDI funding." She also found that reluctance to sign the pledge because of fear of political repercussions was most prevalent "at universities which were not in the top 10 or 20." Well-known professors at prestigious universities are more immune from political pressure because they would have fewer problems finding alternative sources of funding than would scientists at second-rung universities.

Likewise, Weissman's experiences with the pledge suggested that the chilling effect was largest "in fields such as electrical engineering, where military funding saturates the field." Weissman said he "really saw fear in people's eyes."

CARROTS AS WELL AS STICKS

As well as using threats and sanctions to punish scientists who engage in uncondoned activities, the military also uses rewards and incentives to induce political acquiescence. One obvious inducement is the generous salaries and grants available from the military, which usually exceed the funding available from nonmilitary sources for comparable work. An article in *New Scientist* entitled "Star Wars—An Astronomical Bribe for Scientists" concluded, "One thing is clear: money is a powerful lure for grant-hungry scientists. Some of those who initially sneered at the (SDI) programme have begun to change their tune, publicly at least."[17]

David Parnas, a computer scientist who was appointed to Reagan's SDI advisory panel dealing with computer aspects of space-based ballistic missile defenses and who later resigned because he believed the program was unfeasible and ill-advised, observed that many of his colleagues were



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prepared to set aside their scientific doubts in order to feed at the pork barrel trough. Parnas observes that for these scientists, "the project offers a source of funding, funding that will enrich some personally.... During the first sittings of our panel, I could see the dollar figures dazzling everyone involved. Almost everyone that I know within the military industrial complex sees in the SDI a new 'pot of gold' just waiting to be tapped."[18]

The same type of bribery occurs at the international level, where most NATO allies have suddenly muted their once-vocal criticisms of SDI now that they are receiving SDI contracts.

A similar type of enticement occurs with graduate students through funding programs such as the Hertz Foundation Fellowships. The Hertz Fellowships, which offer one of the highest stipends available to some 120 graduate students every year, are administered through an office in Livermore, California and are closely associated with the Livermore Lab. Two of the directors of the fellowships include H-bomb developer Edward Teller and Lowell Wood, head of the Livermore Lab's O-Group working on SDI.

The fellowship rule for eligibility "requires all Fellows to morally commit themselves to make their skills and abilities available for the common defense, in the event of national emergency." According to Michio Kaku, who was one of the first recipients of a Hertz Undergraduate Fellowship, the purpose of the fellowships is "to create a cadre core of anticommunist scientists." The fellowships, also known informally as "Star Wars scholarships" because of the large number of recipients who end up at the Livermore Lab, were endowed by Hertz Rent-A-Car founder John Hertz, following World War II, to attract young scientists into military research.[19]

Another effective means for limiting political opposition by scientists is co-optation—either through appointments to advisory committees or lucrative consulting arrangements. Scientists who are given an opportunity to offer their opinions and views within the system are less likely to publicly air their concerns and risk the access, prestige, and benefits they receive from their participation on committees or as consultants.

For example, one academic who is a former member of the Defense Science Board was approached by *Chemical & Engineering News* as a test case. The scientist refused to discuss his experiences or feelings about his work, because any direct or indirect attribution of anything he said would preclude further work for him as a consultant.[20]

Michio Kaku says he knows scientists who double their salaries by consulting for the Pentagon. In Kaku's view, these scientists are "like prostitutes who sell themselves to the highest bidder—only they are selling their brain instead of their body."

Finally, political opposition by scientists funded by the military is curtailed by the inevitable socialization pressures and processes that often produce more pro-military views. Perhaps the most powerful of these influences is the scientist's own internal rationalizations for accepting military funds. Other more subtle influences might come from pro-military assumptions and biases embedded in specialized information sources that many military researchers are likely to read, such as aerospace publications.

Hugh DeWitt has described how many of the scientists working on Star Wars at Livermore Lab have grown more and more isolated from the outside world. "They don't bother to read newspapers," said DeWitt. "They get teletype messages from the CIA off the computer. They have a skewed view of the world, very skewed."[21]

Also, the acceptance of military funding by a scientist is liable to cause tension in relationships with friends and colleagues who politically oppose such work. The military-funded scientist is thus more likely to seek out friends who will be more accepting of Pentagon funding, and who are likely to be more conservative.

In government or industry labs doing military research, the socialization pressures are most pronounced. Tom Grissom says that military research labs such as Sandia are "awash in a sea of constant reinforcement" of the lab's official ideology. "Since there is no dissent, employees only get exposed to one side of the issue—that of the lab's management. There is no discussion of the other side, except in a disparaging way. Any scientist surrounded by 8,000 other employees, all apparently holding the same pro-military views, must ask, how could all these people be wrong?"

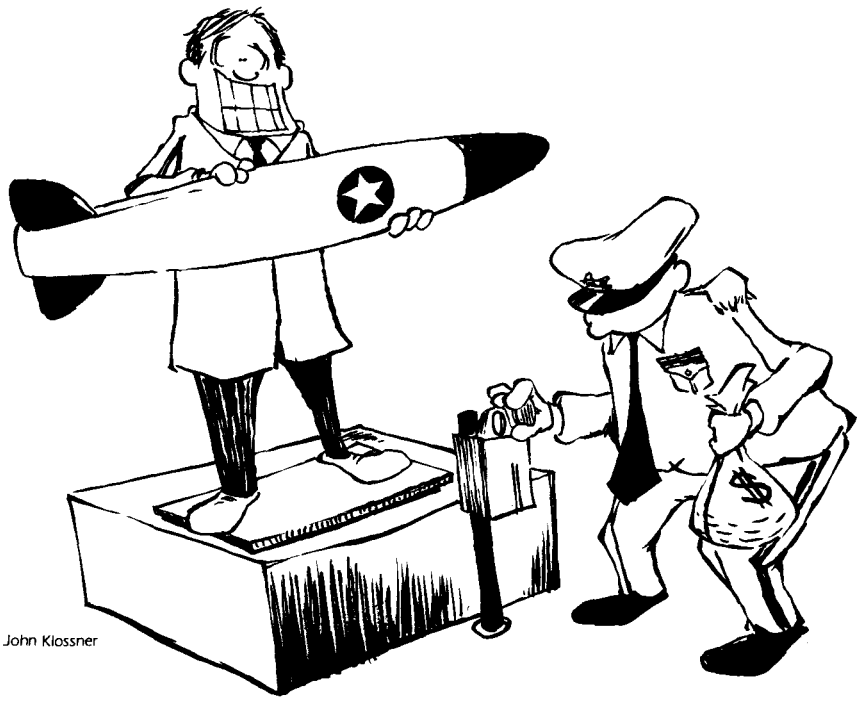
Many young scientists who get involved in military research often become fascinated with the technical aspects of their research and gradually forget about moral qualms. A good example is Peter Hagelstein, the young scientist who developed the concept of the X-Ray Laser for Star Wars. For his book *Star Warriors,* William Broad went to Livermore Lab in 1984 and was told by Hagelstein, "My view of weapons has changed. Until 1980 or so I didn't want to have anything to do with nuclear anything. Back in those days I thought there was something fundamentally evil about weapons. Now I see it as an interesting physics problem."[22]

One longtime participant in military research has succinctly described the lure of such research to many scientists:

> "They are inspired by ingenious and clever ideas, challenged by bold statements of real and imaginary military requirements, stimulated to match or exceed technological progress by the other side or even by a rival military service here at home... They derive either their incomes, their profits, or their consultant fees from it. But much more important than money as a motivating force are the individuals' own psychic and spiritual needs; the majority of the key individual promoters of the arms race derive a very large part of their self-esteem from their participation in what they believe to be an essential—even a holy—cause."[23]

THE IMPORTANCE OF POLITICAL CONTROL OVER MILITARY SCIENTISTS

We have seen how the military establishment, through the use of both sticks such as threats and sanctions, and carrots such as bribes, cooptation, and



John Klossner

socialization influences, is able to control the political activities and dissent of most scientists funded by the military. Of course, there are some individual scientists who have the courage to resist this control; and there are many others who need no threats or encouragement to become avid supporters of the military.

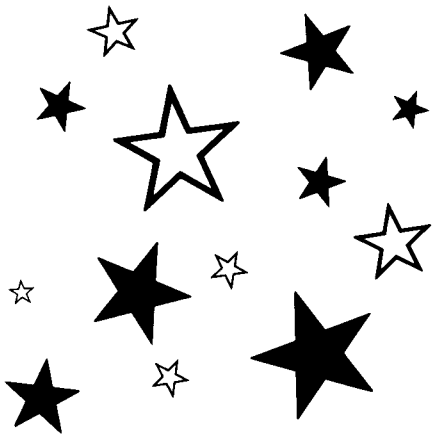
There is no doubt, however, that these control mechanisms constrain the activities of many scientists who would otherwise be politically active, and slowly convert other scientists who are at best ambivalent about military programs into enthusiasts.

While almost any source of research funding has the potential to be used as an instrument of political control, the problem is much more common and severe for military funding sources. According to Tom Grissom, it is more acceptable to speak out at federal labs that do a lot of nonmilitary research, such as Oak Ridge, than at a lab like Sandia which does almost exclusively military work. Similarly, within the Oak Ridge lab, there is much greater tolerance in sections that do only nonmilitary work than those sections doing weapons research. From Grissom's experience at different federal labs, "the proportion of work funded by the military or related to nuclear weapons directly determines whether dissenting views are tolerated."

The Pentagon recognizes that military research is critical for the development of new weapons. Military research has often been called the oxygen which fuels the arms race. Therefore the "political purity" of the military research establishment must be protected at all costs, even if it means squashing the political rights and freedoms of individual scientists. A participant at a recent conference on scientists and the arms race summed up the situation this way:

> "Military R&D is well shielded, sustained and bolstered by this (military-industrial) complex as one of its most sensitive links. This also has organizational consequences. The scientific staff is subjected to stringent discipline and control. Purely organizational measures are reinforced by economic attractions and political arguments. As a result, scientists and engineers employed by military R&D have shown astounding resistance to appeals calling their attention to social and moral responsibility. The challenge is all the greater to try to bring military R&D under some social and political control, and to halt its devastating impact on the arms race and society."[24]

Scientists have enormous credibility to the public and politicians on techno-political issues such as Star Wars and the arms race—setting aside the question of whether such influence is deserved and desired or not. As both the quantity and relative proportion of military-funded research grows, more and more scientists who might object to at least some of the Pentagon's goals and objectives fall victim to the sticks and carrots of political control waged by military managers. Thus the enormous investments in military research not only contribute to the arms race materially, by providing a never-ending series of new weapons, but also politically, by silencing many of the most effective potential critics of the arms race.



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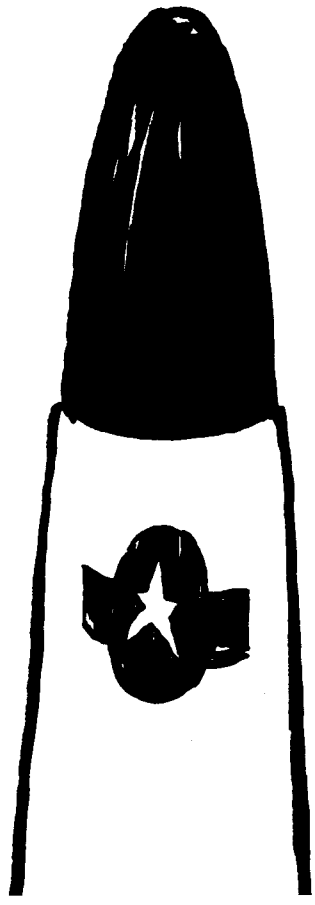

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WORKING AROUND THE MILITARY

BUYER BEWARE SCIENCE

BY RICHARD RUQUIST

Scientific information flowing from theoretical analysis and experiment is essential to the U.S. weapons industry. But this information is not always free-flowing. If it is critical of an ongoing weapons research program, it may not flow at all. In the interests of preserving jobs, profits, and even of saving reputations, negative results derived from military research are often covered up by the organizations operating the programs.

It then becomes the responsibility of the "buyer," usually the Pentagon, to uncover the flaws. As such, much of the U.S. military-industrial complex operates on a "buyer beware" basis. The operation is further complicated by the fact that some government officials, in order to benefit their own projects, are willing to suppress negative results, broadcast positive results, and sometimes "leak" sensitive material.

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What follows is a perception of the military-industrial complex derived from all of the stories I've heard, along with reporting in newspaper and magazine articles. In 25 years of work on Pentagon research programs for industry and university laboratories, I must honestly say from my own experience that such unethical behavior is rather infrequent. Moreover, the most serious incidents in my personal experience, which I discuss below, are all borderline cases that an idealist might consider to be dishonest, but that I suspect a pragmatic businessman would regard as fair game.

Still, these are clear examples of a buyer beware ethic in science, and if my experience were multiplied throughout the entire industry, the perception of dishonesty and resistance to criticism in military research would be warranted. In my last example, derived from my experience working on the Star Wars program, I discuss how suppression of the complete flow of information may become a dangerous game.

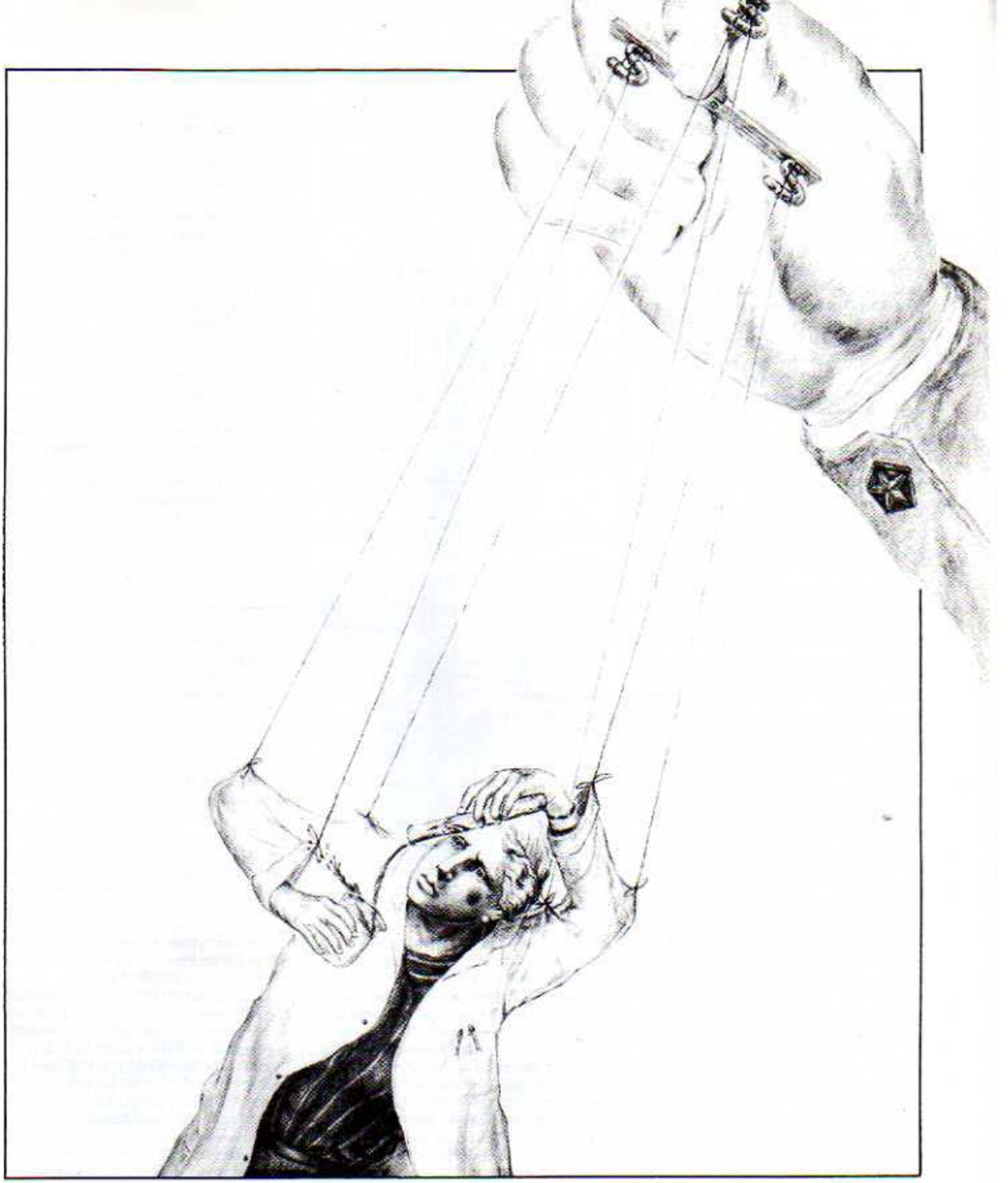
In the summer of 1965, I was working for a large East Coast weapons contractor on ballistic missile defense. The marketing office of this company asked me to analyze the propagation of electromagnetic radar waves in the very long plasma wake that forms behind intercontinental ballistic missile (ICBM) nuclear warheads when they re-enter the atmosphere just before impact. The company was writing a proposal to build small radars that would irradiate the plasma wake with microwaves—which are quite similar to those used in a microwave range for cooking.

After joining the proposal team, I first calculated the path of the radar waves in that plasma. To the surprise of everybody on the proposal team, the theory predicted that these radar waves would rapidly diverge out of the plasma within a few meters behind the warhead. Therefore, the radar experiment proposed by my company looked like a complete waste of time. To my dismay, I was told by my company's marketing people to keep these results quiet, and my memo describing the analyses was suppressed.

If the information had been released, I am sure that it would have caused some consternation in the government and industrial organizations that conceived and designed these experiments. At the very least, other theorists and outside consultants would have been brought in to determine whether or not the theory was correct. Perhaps some inexpensive laboratory experiment would have been performed to confirm it. But this was a multimillion dollar project already in the procurement stage. In short, to introduce critical information at this stage would have rocked the boat.

Still, I thought it was dishonest to suppress such critical information, and soon thereafter I left to join a university

TESTIMONIAL



Illustrations by Catherine Berney

laboratory. Subsequently, my former company won the contract and my calculations were later confirmed, albeit after several years of experiments and many dollars had been unnecessarily expended.

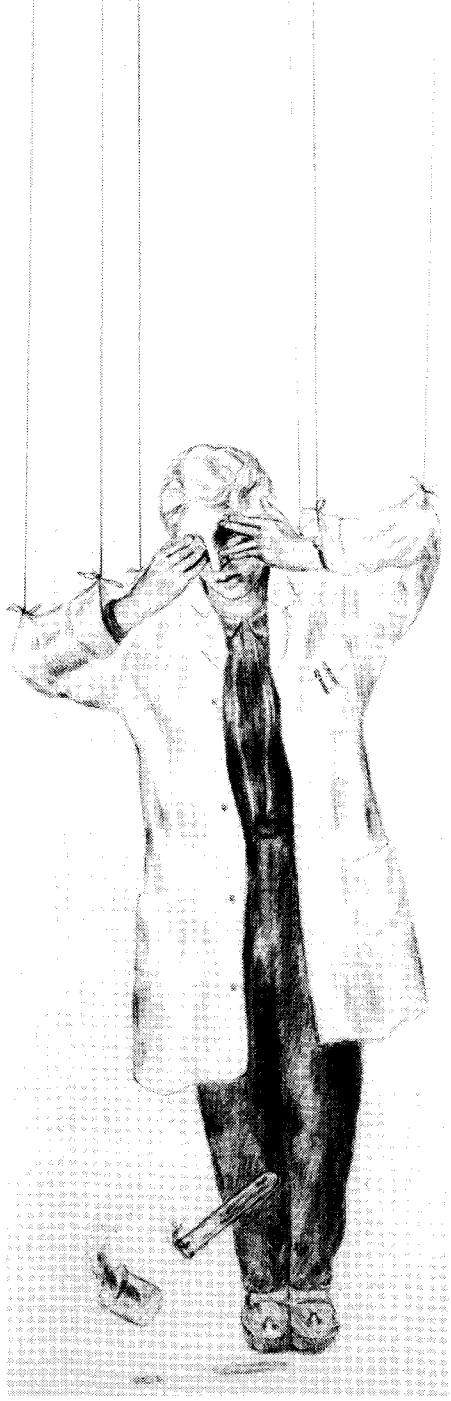
The university laboratory where I next worked was a so-called national laboratory. It derived most of its funding from Congress. Perhaps as a result, it did not have the "always please the customer" attitude that I found in corporations. As such, national labs are more likely to deliver an honest assessment of a weapons system. However, even these laboratories may have some difficulty releasing critical or pejorative information once they have put their reputations behind a concept and are involved in its development.

The closest I came to personally experiencing such difficulty was one time when I was given responsibility for collecting and correlating the ground-based radar data from test-warhead plasma wakes. The laboratory had already endorsed a particular solution to the BMD discrimination problem which was in the form of a particular mathematical correlation. When I first came into this project, data was just becoming available from a variety of new warheads. As a result, when I plotted all the data on a single piece of graph paper, the correlation disappeared.

At the in-house presentation of this result, the top management of the laboratory was very unhappy. To the credit of my immediate supervisor, he allowed me to present the new data at the following Pentagon briefing. But I perceived that the incident jeopardized my opportunity for advancement and I left. More than 10 years after this incident, I was denied employment on a contract with this laboratory because their top management considered me to be "unreliable." Apparently my earlier perception was accurate.

Recently, both leaks and the classification of pejorative information have been popular news items. Two incidents in my personal experience are interesting, because essentially the same information was at first leaked, and then later on suppressed, dependent on the perception of different Pentagon officials as to whether the information helped or hurt their project.

In the late 1970s, I was working for an industrial laboratory that invented and sold very high-powered lasers. On a classified project, I calculated the amount of power that these lasers could propagate from the ground to space, and found that



an unlimited amount of power could be transmitted. I expected that this result probably was classified, but my top management suggested that I check with the official in Washington who had the final authority to decide if it was classified. Since release of such information at that time was beneficial to his project, I was allowed to publish it at an unclassified international meeting of a professional society. As a result, I received national acclaim for this work, including a report about it in *Aviation Week*, a well-read aerospace magazine.

In contrast, in the 1980s, while working on a Star Wars project for the Army, I decided to publish some of the theory underlying those results in an unclassified journal. A group of civilian Army officials then apparently decided that the sensitivity of the analysis made the whole laser defense system seem fragile. They agreed that the analysis was unclassified, but would not release it because in their opinion it was "critical military technology." This new category now allows the government to suppress information, including scientific theory, without even having to classify it.

The above examples of the tendencies of corporations and the government to suppress undesired scientific information (or to leak beneficial information) are by themselves relatively harmless. The total cost to the nation would only be significant if my experiences were multiplied throughout the entire U.S. weapons industry. I cannot judge if this is so, but recent revelations in the media, supported by a few outright catastrophes, suggest that it may be true. In contrast to these so-called harmless cases, the last example I wish to discuss involves the most expensive, and I believe dangerous, defense project ever proposed.

Early in the Strategic Defense Initiative (SDI) program, more popularly known as Star Wars, the last company I had worked for used a computer code to do an engagement analysis of the entire space-based strategic defense system, including exotic laser and particle beam weapons, and very sophisticated sensors. The success of this computer analysis made us the leading SDI systems analysis company in the nation.

The program used reasonable, albeit optimistic, approximations and assumptions about how all these space-based devices would eventually work, and it included all likely USSR countermeasures (CM) to the defense system. The difficulties came when the CM involved a Soviet attack on the defense system just before launching a full attack on the U.S. As programmed in the analysis, the USSR hypothetically first launched a great number of antisatellite (ASAT) missiles against the space defense system, just before it hypothetically launched its ICBMs against the U.S. The results were that all of the U.S. defense satellites over the USSR were shot down by the ASATs, creating a large hole in the system's satellite constellation.

However, with the passage of (computer) time, when the ICBMs were launched, the hole had partially closed as other satellites

orbited into position, thus providing some defense capability over the USSR during ICBM boost-phase. In addition, the defense system outside the USSR was sufficiently effective in the midcourse and terminal phases that by the time the warheads reached the U.S., only one in 1,000 survived to impact. Thus, the system successfully met the SDI criterion for acceptable warhead leakage in spite of the very significant initial loss of defense satellites.

However, the success of the full Star Wars system in this computer analysis was based on the assumption of a simultaneous launch of all ASAT missiles. It was argued that this was the most stressing case because battle management for the engagement would be saturated. I, for one, was suspicious of this result, because if the Soviets could create a hole in the system before launching their ICBMs, why could they not also shoot down the remaining satellites as they filled in the hole? Furthermore, battle management was not even modelled in the code at that time. I smelled a snooker.

This is a case where, instead of suppressing critical information, the data was just never calculated because the outcome was known in advance. It is left up to the customer to recognize that the system's success was conditioned by assumptions in the attack scenario: a clear case of buyer beware science.

At first I reasoned that the concept of a formidable Star Wars system could bring the superpowers to the arms control table, where the system could be used as a bargaining chip by the U.S. And subsequently the threat to develop it could be used to ensure treaty compliance. But President Reagan seemingly destroyed this rationale in the November 1986 superpower meeting in Iceland when he refused to even discuss bargaining over SDI.

Thereafter my work became much more difficult, and I began to think of the possibility of retiring. On the other hand, I stood to make a great deal of money in the next few years. And after all, Star Wars was just a very expensive research project that seemed to be decades away from deployment, so this time I stayed on. Over the years, my original idealism had waned, and I had grown accustomed to the buyer beware mentality of U.S. weapons programs.

What finally moved me to quit the system, and protest against it, was the perception that deployment of missiles in space, constituting a first-strike capability, was truly dangerous. In January of 1987, Secretary of Defense Caspar Weinberger endorsed deployment of a partial system of space-based missiles within a decade. Star Wars then became an immediate threat, rather than a long-term research program. In February 1987, I resigned in order to be free to criticize this Department of Defense policy.

MILITARY FUNDING OF PUBLIC RESEARCH

BY SHEILA RISE & YEWELL C. HOWE

When we first began to express our feelings about science in a political framework, we tended to oversimplify. Our early training taught us to reduce complexity, to discourage analysis. As children, we were presented with an idealized, organized, and simplified view of social relations: every cowboy and Indian movie made it quite evident who were the good guys and who were the bad.

But now we realize that life rarely operates that way. Like politics, life is inherently complex and full of contradictions. Even when an issue permits us to choose sides, putting our views into practice can be an excruciating struggle. Translating even the most thoroughly reasoned political position into action has never been easy.

In the case of military-funded research, what you see is rarely what you get, and what you get may be many other things as well. Military strategists, largely in response to criticisms from peace activists, have developed increasingly sophisticated methods for achieving their research goals. By changing the sites of laboratories, disguising project titles, renaming sources of funds, and obfuscating stated objectives, the military has concealed much of that part of its mission which had become politically controversial.

Sheila Rise and Yewell C. Howe are pseudonyms for the two authors, who are presently doing research in Minneapolis, Minnesota.

For politically progressive science workers who wish to avoid or oppose research directed against humanity, we can offer no clear-cut guidelines. Rather, we must all question our work and attempt to analyze what is acceptable within our own political and moral views.

In this article, we have attempted to outline some of the observations, ideas, conflicts, and questions that arose for us and our friends during work on projects funded in part by the military. With the increasing commoditization of science and the reduced availability of nonmilitary government or foundation support, these issues are being faced by more and more research workers at all levels. It is important that we continually ask ourselves if, when, how, and why we should participate in military-funded research.

TYPES OF MILITARY INVOLVEMENT IN SCIENCE

Fundamentally, we consider there to be three types of problems involving the financial support for the research and the application of the knowledge gained from that research. Stated simply, there are military-funded projects with obviously destructive applications, publicly or privately funded nonmilitary research with potential military uses, and projects that are funded by the Department of Defense, but which have no obvious use in achieving military objectives.

For most of us, the decision of whether or not to participate in research funded by and for the military is straightforward. We can rule out military-funded research that is unambiguously oriented toward destruction of either human life or the ability to sustain or reproduce it.

The second domain, involving projects which might be of interest to the military but which are funded by agencies other than the Department of Defense or Central Intelligence Agency, presents a somewhat more difficult dilemma. To begin with, the DOD may be involved in the research even when it does not appear to be. Private research establishments (whether for-profit or not) may not disclose their DOD research funds. And support from the DOD which may be earmarked for other projects nevertheless contributes to the overall functioning of the institution.

Furthermore, nonmilitary funding

agencies (whether governmental or private) often share fundamental ideological or practical objectives with the military. Federal agencies such as the National Science Foundation, Department of Energy, Health and Human Services, or National Institutes for Health are nominally charged with encouraging research designed to improve the "quality of life." However, this usually means the lives of certain groups of people in particular countries. The ideology of the administrators who decide where funds are sent and on what they are spent subtly permeates the funding process.

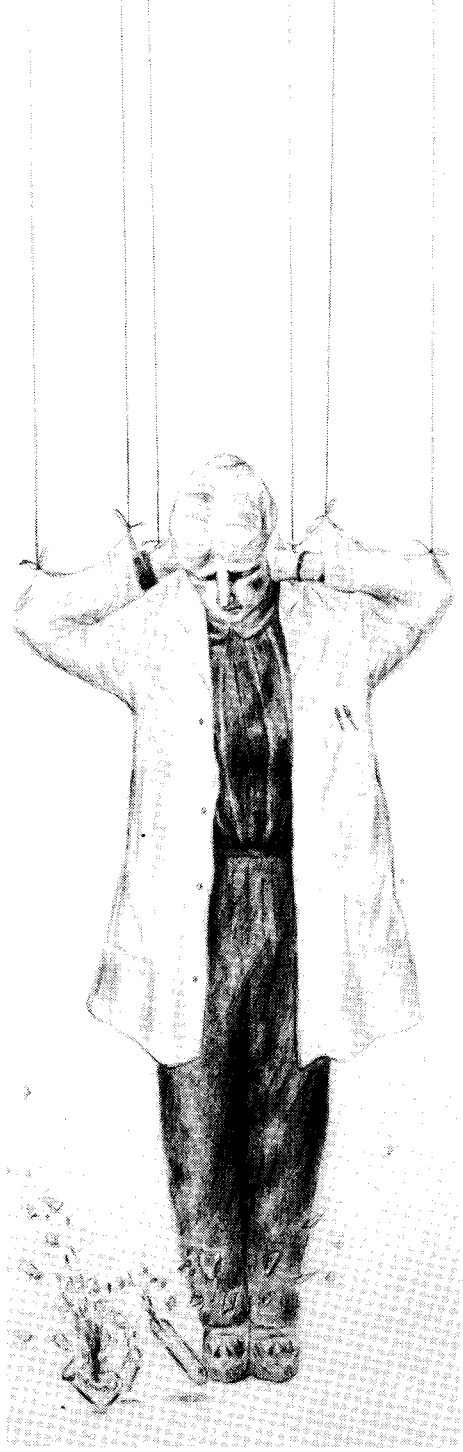
Scientific inquiry that is explicitly intended to address technical needs abroad usually serve the goals of U.S. policy makers, who typically hold views that are inconsistent with the desires of the working classes of these countries. Thus, the lack of obvious military support does not guarantee that one's research will not be consistent, ultimately, with military objectives.

We would like to focus on military-funded research that has no well-defined direct or indirect miltary application. We hope that our observations will be useful to those wondering what to do when faced with research projects that are funded by the DOD, yet seem to have no direct relevance, short- or long-term, to military objectives.

For example, suppose you are given the chance to work on an interesting problem in the population dynamics of marine crustacea off the coast of Argentina—you love the ocean and it also represents an important nutritional resource for the people of the region. What do you do when you learn that the project is funded by the Office of Naval Research?

Or you have acquired the technical skills and intellectual curiosity for studying the physiology of vision under low light—many automobile accidents occur at dusk and dawn, and chronic eye disorders may develop among children who frequently read without adequate illumination. How do you respond when, after accepting a new position at another university in this field, you discover that the research is supported by a contract for the U.S. Air Force?

Or perhaps you wish to apply your fascination with chemistry to improving the durability and energy efficiency of simple tools used in Third World agriculture. Should you accept a postdoc to study the physics of high-stress polymers, knowing that your stipend will be paid from a U.S. Army grant? Why might the



CIA be supporting research in the psychology of decision-making? What interest could the Army have in research on the mathematical properties of specific types of nonlinear differential equations? The list seems endless.

One characteristic of these projects is that each could just as easily be funded by other publicly supported agencies such as NIH, NSF, and the DOE, or by private foundations such as Ford, Mellon, or Kellogg. So why is the Pentagon interested in this type of research, and what are the risks in working on such military-funded projects? To understand the potential benefits and drawbacks, we must consider the objectives and operating mechanisms of scientific research agencies of the military.

MILITARY FUNDS AND PUBLIC RESEARCH

Beyond the superficial differences like dress or bureaucratic procedures, most scientists employed by the military are similar to those working for public or private agencies. Military researchers, like all other scientific workers, regularly study and apply published results, new techniques, and ideas that are publicly available in journals, laboratory reports, and books. Whether the work was funded by the Department of Defense or the National Science Foundation, the research results are the same. On the surface, there would seem to be little difference between DOD-supported and publicly financed "basic research" which seems to have no direct military application, as long as all the research is unclassified and the results are freely distributed.

However, the relationship between sponsor and investigator is much more complex, involving publicity, ideology, and influence over the direction of research. Slowly and subtly—through interactions over progress reports, contract meetings, and research planning sessions—the problems and goals that the funding agency has on its agenda become those of the "independent" researcher. Surely, this process by which investigators adopt the priorities and topics of the granting agency occurs with all funding agencies, military or otherwise.

At a time of intense competition for research funds, the piper listens carefully, if not always consciously, for the requested tune. For military-sponsored projects, there is the risk of drifting away from one's original intentions toward more applied results that the military is seeking. We may become accepting and complacent and thereby, perhaps, unintential cooperators.

But cooperators at what? Why would the military fund apparently benign projects unrelated to military missions? We see three reasons.

First, military research administrators have large budgets and considerable latitude in determining what research is appropriate to the needs of the armed forces. These administrators who make recommendations for funding of external

research projects are mostly people who were trained side-by-side their counterparts in academia or industry; they now attend the same meetings and conferences. For some, their incentives for military involvement stem from good salaries and benefits, greater assurance of logistical support for their studies, and job security. Despite the mandate of their employer, their personal biases seep into their views of what fundamental studies are likely to produce "interesting" results.

Second, while military research must be justifiable in terms of the missions of the DOD, the applications can be many steps removed. Fundamental research is needed to build up the "technology base" in academic areas of future interest to the armed forces. And finally, a certain amount of basic research that holds no promise for eventual military application may actually be useful in countering negative publicity that periodicallly arises over chemical or biological warfare research, for example.

The leap from research on beneficial antibiotics to its application in the production and distribution of antibiotic-resistant pathogens for biological warfare is just a small step. How do we know when such a step is likely to be taken, and how might we prevent or counteract it? Ironically, one of the best ways to do this may be to become a participant. Those scientists who are in contact with Pentagon research are in a better position to learn about the underlying premises of certain research interests. Some of this knowledge may be useful in analyzing what they are up to. Of course, as one's politically progressive views become known, that possibility is reduced.

While certain research topics are less likely than others to lead to materiel for war, there are no completely "safe" projects. That is true even for non-DOD projects. This neither means that we should abandon all research, nor that a grant funded by the Pentagon is equivalent to a similar grant funded by another source.

One must never forget that, as a whole, the principal mission of the U.S. armed forces is aggressive; they have served, and will continue to serve, as the strength behind the rise of the U.S. to its present position as the preeminent political and economic force in the world. Their *modus operandi* is war, the physical destruction of lives and property. It follows, therefore, that most of the research which they undertake or fund should ultimately serve these needs.

Science workers, both in and out of the military, who do not support these objectives are faced with difficult analyses and even more problematic choices. Because research funds and positions are increasingly difficult to find, saying no to military-funded research is hard to do when alternatives are few.

Yet in other ways, deciding to say yes is even more difficult. The simple solution of never working on any project that is supported by military funds is, in our view, politically naive and unrealistic for those of us who want to do serious science and pay the rent. Whether working on such projects ultimately contributes to the effectiveness of the armed forces or can be used to oppose military objectives will depend on how one works with the military.

SCAPE-GOATING THE SCIENTIST

FROM AN INTERVIEW WITH HUGH DeWITT BY GARY MARCHANT

The Lawrence Livermore National Laboratory is one of two federal labs responsible for designing all U.S. nuclear warheads, and one of the largest institutional recipients of Star Wars contracts. It is not the kind of place in which you would expect to find one of the nation's foremost critics of the arms race. Yet, for more than a decade, Livermore physicist Hugh DeWitt has been speaking out against new weapons technologies and the Livermore Lab's role in promoting new weapons.

Now, after being employed for thirty-one years at the Livermore Lab, Hugh DeWitt's job is in jeopardy. The lab is trying to force its main internal dissident out. According to DeWitt, "the way it is working is that the lab does not attack me for my political activities or writing and speaking. Rather, the lab claims that my scientific work is irrelevant, inadequate, and nonprogrammatic."

The Livermore Laboratory, which is managed by the University of California, cannot fire DeWitt outright unless he commits some act of gross misconduct. However, if a researcher gets unsatisfactory performance ratings in two successive periods, the lab can then initiate dismissal proceedings. A year ago DeWitt received a lower-than-expected performance rating, and this year's rating "from all indications, is going to be as bad as they can make it." DeWitt believes that the lab is trying to make things so unpleasant and difficult for him that he will leave "voluntarily."

This is not the first time the lab has tried to remove DeWitt from his position. In 1979, DeWitt wrote an affidavit and became an expert witness for the *Progressive* magazine and the American Civil Liberties Union when the government unsuccessfully tried to supress an article about the hydrogen bomb. DeWitt's affidavit demonstrated that the information in the article had come from open sources, much of it from an encyclopedia article written by Edward Teller.

After losing its case, the government singled out DeWitt as a scapegoat against which to retaliate. He received a letter of reprimand, which is the first step in being fired, and an effort was made to start proceedings to remove his security clearance. He was formally charged with mishandling classified information, and faced the possibility of not only losing his job but also being sent to prison. DeWitt believes that the only thing that saved him was the large number of individual scientists, scientific associations, and Congressmen who came to his defense. After about a year, all the charges against him were dropped and no further job action was taken against him.

This first attempt to remove DeWitt from his position at Livermore was very traumatic and harrowing. After some serious soul-searching, DeWitt resolved that he would not be intimidated from speaking out against dangerous new developments in the arms race. "I decided to be extremely active and go very public," says DeWitt. Only by keeping a visible public profile would DeWitt be protected from further efforts to remove him from his job. DeWitt began accepting invitations to speak, and started writing articles in a variety of publications.

Hugh DeWitt is a physicist at the Lawrence Livermore National Laboratory in Livermore, California. Gary Marchant is studying law and science policy at Harvard and is a member of SftP's editorial committee.

DeWitt became an avid proponent of a comprehensive test ban, and helped to reveal that the Livermore Lab designed nuclear weapons on the assumption that nuclear testing would always be possible. This policy was used by the lab as a powerful argument against a nuclear test ban, but it has recently been shown that U.S. nuclear weapons can be maintained reliably without further nuclear testing.

DeWitt attended the much-publicized demonstration at the Nevada Test Site against the first nuclear test of 1987, and recently visited the Soviet Union to discuss a test ban with Soviet officials and scientists. He returned to the U.S. impressed with the sincerity of the Soviets' understanding of the extreme danger posed by nuclear weapons and convinced of their genuine interest in a test ban. Lately, DeWitt has given some of his attention to Star Wars, and has emerged as an effective and leading critic of the program.

As DeWitt's political activities have broadened and received more attention, he has become a major embarrassment for the Livermore Lab management. The top managers of the lab frequently go to Washington to testify to Congress and sell new ideas to the Pentagon and administration officials. According to DeWitt, these officials "speak with great authority, and Congress listens with deference and respect. The arguments of the weapons-lab people are couched in very technical language that goes over the head of most politicians.

"Thus," DeWitt continues, "the lab officials have a great influence in deciding U.S. weapons and arms control policies, unless countered by scientifically trained experts holding other opinions." When Hugh DeWitt testifies in opposition to top lab officials from the same Lawrence Livermore Lab, the credibility and authority of those officials is greatly diminished.

DeWitt's activities not only challenge the policies promoted by the lab, but they also pose ethical and even legal questions about the lab's lobbying and advocacy activities. DeWitt has helped expose the role of the lab in direct lobbying against arms control measures such as a comprehensive test ban, possibly in violation of the lab's permitted activities.

Dewitt believes that the weapons labs are a major force in driving and perpetuating the arms race, through constantly producing an endless series of new and ever more dangerous nuclear weapons, while lobbying against arms control measures that could restrict the labs' activities. DeWitt

attributes part of the motivation behind the labs' efforts to an ideological fear of the Soviets and a desire to stay number one in weapons technology.

However, DeWitt thinks that weapons labs have more crass motives as well. The continuing arms race provides the contracts and jobs on which the labs thrive, and thus any attempt to restrict the arms race is seen by the labs' managers as a threat to the power and vitality of the labs. In this sense, DeWitt thinks the weapons labs "are the same as companies such as Boeing, TRW, and Martin Marietta that promote new weapons for self-serving reasons. The only difference is that the labs' motive is funding and jobs rather than profits."

Given DeWitt's high profile and reputation, it would be very difficult, if not impossible, for Livermore Lab to get rid of DeWitt for his political views and activities. Therefore, lab management has resorted to attacking DeWitt for his scientific work. They have a problem here as well, however, because DeWitt has consistently produced quality scientific work and publications that are highly regarded in the physics community. So lab management does not say that the quality of DeWitt's scientific work is substandard, but rather that it is inappropriate and irrelevant for the lab's program.

DeWitt is a theoretical physicist, and has been the leader of a group at the lab that does work on strongly coupled plasma physics. DeWitt's group is part of a shrinking minority of scientists at Livermore Lab who are doing basic research rather than classified weapons work. Although he has been doing such work at Livermore for many years, lab management is now saying that DeWitt is not doing enough "programmatic" work, in a thinly disguised attempt to remove him for his political beliefs. DeWitt believes that he may be forced out within a few months.

DeWitt suspects that the relatively small amount of basic research conducted at Livermore Lab performs a very useful function for the lab administrators. It serves to attract bright young scientists to the lab who can then be slowly edged into military work. Once young scientists start working in the lab, they become isolated from much of the outside world and conditioned to the lab's dominant ideology that "we can never have enough deterrence." For example, DeWitt points out that the program to bring in outside speakers to the lab only invites individuals who reinforce the dominant political ideology of the lab, often disguised under the cover of "technical" presentations.

DeWitt says there are a few scientists at the lab who share his concerns about the arms race, but most keep quiet. "They are afraid of getting crossed wires with the lab managers," he says. "They know the managers have subtle ways of affecting their careers if they want, through blocking promotions and pay raises, for example." DeWitt himself has been denied the usual salary increases that are normal for someone at the lab with his experience

and seniority, although DeWitt claims that this does not bother him much and just treats it as one price he has to pay for his outspokenness.

DeWitt is also critical of the relationship Livermore has with the University of California, which manages the lab for the federal government and provides "an academic cover of respectability for its weapons work." The university exerts very little control over the lab, essentially letting it do what it wants, while collecting the generous checks the government pays UCAL to manage the lab. As well as giving the lab academic respectibility that helps attract new scientists, the arrangement with the university frees the lab from direct government supervision and civil service regulations. DeWitt believes that this mutually convenient relationship between the lab and the university has greatly contributed to the continuing escalation of the arms race through the rapid and steady development of new types of warheads.

When asked if, taking into account only considerations about his scientific career, DeWitt ever wished he had spent his career at a university rather than the Livermore lab, he replied emphatically, "Yes, in fact I wish I had gone back years ago." However, he quickly added that "the work I do inside the lab as a critic and active proponent of arms control is immensely more important than any of my scientific work. Of course, this is why I'm in trouble. If I get fired tomorrow, frankly it's been worth it."

COMMITTING SCIENCE TO PEACE

FROM AN INTERVIEW WITH VERA KISTIAKOWSKY BY GARY MARCHANT

Vera Kistiakowsky is in many ways atypical of most of her colleagues in the physics department of the Massachusetts Institute of Technology. She is a woman and a feminist in a heavily male-dominated profession. Although a faculty member of one of the most militarized university departments in the country, she refuses to accept military funding for her research. Above all, Vera Kistiakowsky is an outspoken critic of the arms race, and devotes considerable time and energy to grassroots peace efforts.

In her twenty-five years at M.I.T. as a researcher in experimental nuclear physics, Kistiakowsky has never accepted support from the military. She did have a brief experience working with the military earlier in her career, when she accepted a job at the U.S. Naval Academy Radiological Defense Laboratory in San Fransisco. Although hired for a specific project involving basic research, she was soon called upon to do less interesting and more applied work for the Navy. When she protested that this wasn't what she was hired for, she was told, "You're in the Navy now." Kistiakowsky left soon after seeing first-hand how little independence a scientist can have when employed by the military.

Today, when asked if she would ever consider accepting military funding, even for basic research, Kistiakowsky replied, "I wouldn't, simply because I think the shift of support of research from the civilian sector to the military sector is very bad for the health of science in this country, and therefore I wouldn't do it."

Working in a university that has received over $300 million worth of SDI contracts alone, more than three times that of any other university,[1] Kistiakowsky is very aware of the pressures on scientists, especially younger researchers, to accept military funding. "I know that in connection with SDI that there are people who are taking SDI funds because they say they have no choice," said Kistiakowsky. "I believe in all of those cases it was a question of receiving money from some other branch of the military or the intelligence agencies, and then the contract was shifted to SDI when SDI came into existence. And even though the researcher involved was opposed to SDI, it was 'take it or don't get funded.' "

According to Kistiakowsky, most scientists who accept military funding do not justify it as necessary for national defense or security. Rather, most scientists offer one of a series of rationalizations to defend their decision to accept military support. Kistiakowsky cites an example where someone came to her and said, "Why does it matter? It's a lousy program and the thing will never work, but it's money that I could use for my research." In Kistiakowsky's view, such cynical excuses for accepting military funding "are rather remarkably immoral, but scientists do it."

Kistiakowsky has been active in the last few years trying to bring attention to the damaging and distorting effects military funding can have on science. Three years ago, she circulated a letter at M.I.T. requesting an investigation of the impact of the military at the university. This letter resulted in the formation of the Kaysen Committee, on which Kistiakowsky served.

One question that the committee examined was how military funding affects the direction of research. Kistiakowsky recalled that one materials scientist who was receiving SDI funding came to the committee and testified that his source of funding was indeed influencing decisions, both on what research he would do and how he should do it. His research became much more demonstration oriented, rather than exploring basic properties of materials as he wished.

Kistiakowsky has also called attention to other hazards of military research, including the danger of classification and other restrictions on research and scientific openness, the distortion of national research priorities, and the possibility that acceptance of military funding by universities could lend political legitimacy to defense programs such as the Strategic Defense Initiative. Kistiakowsky is also concerned that military funding will make many scientists reticent to criticize ill-considered military programs: "It may not be so much from a fear of retaliation, although that is a clear possibility, as it is a feeling that it isn't really gentlemanly to take money and then say bad things."

A number of important factors have helped shaped Kistiakowsky's strong views on military research and the arms race. One very important influence was her father, George Kistiakowsky, a former chief science advisor to the president and member of many key governmental advisory groups, who became very critical of the arms race later in his life. Through her father, Kistiakowsky had an early connection "with people who were very concerned about what the outcome of many of the new weapons would be. So, intellectually, I was always keyed into this kind of thing."

Another important influence in the

Vera Kistiakowsky is a physicist at the Massachusetts Institute of Technology. Gary Marchant is studying law and science policy at Harvard and is a member of SftP's editorial committee.

development of Kistiakowsky's concerns was her participation in the women's movement in the sixties and seventies. This involvement provided the transition from just thinking and talking about social issues to actually trying to do something about them through activism and organizing. In the women's movement, Kistiakowsky found a lot of shared interest and concern about military issues. "Women at large tend—and this is a terrible generalization to make because I know some very committed, self-sacrificing men who work on these issues—but I think that as a group women are much more responsive to social issues."

During this period, Kistiakowsky was elected president of the Association for Women in Science. There, she met some opposition to her views about the military and science. The board rejected Kistiakowsky's attempt to have the association consider military issues, and decided that the Association for Women in Science should be a single-issue organization and stick to increasing participation of women in science.

Kistiakowsky continued to give speeches on the issue of military funding of research, and encountered some women who were hostile to her views. "They said there were all kinds of good jobs in the military, and this was a place where women scientists could really advance, and one shouldn't oppose it." She didn't meet this opposition from many women, but was sympathetic to the lack of opportunities for women scientists. "That's where all the jobs are," she acknowledged. "People do get threatened if you imply that they should not be taking military funding."

The final factor that pushed Kistiakowsky into full-fledged peace activism was President Carter's 1979 decision to require draft registration. Kistiakowsky remembers how that decision brought the issue home to her own life. "Both my kids would have to register, and there is nothing like self-interest to bring you awake. In any case, I realized that the arms race was really heating up in no uncertain fashion, and I started concentrating on what I could do to help stop the arms race."

The most unique quality about Vera Kistiakowsky is not just that she speaks out against the arms race, but unlike many of her academic colleagues who share her concerns, she follows up her words with action. Kistiakowsky is a member of the board of directors of the Council for a Livable World and has worked on a number of projects with that group. She is also involved with a number of grassroots peace organizations, such as the United Campuses to Prevent Nuclear War. Through these national organizations and several local peace groups in the Boston area, Kistiakowsky keeps very busy organizing and participating in meetings, conferences, and campaigns.

Kistiakowsky is very aware of how the structure of science and university departments discourages political activity. "To be successful as a scientist, at least in my field, you have to be very aggressive, assertive, as well as intelligent, hard working, and of course lucky. People usually sum all these things up with the word committed. So, if you look as though you're not committed, it does tend to be held against you. Working on arms control, which has been something physicists have participated in over the years, is probably less of a handicap than a lot of other things that you can do. But any scientist who devotes large chunks of their time to something else is not optimizing their chances, especially earlier in their careers."

Despite the pressures and obstacles that make it very difficult for a working scientist to be active on social issues such as the arms race, Kistiakowsky has managed to strike a balance whereby she can succeed in her academic pursuits while at the same time acting upon her political beliefs and concerns. While winning widespread recognition and admiration in the peace community, Kistiakowsky has authored more than one hundred scientific papers and has received a number of professional awards and appointments.

Surprisingly, Kistiakowsky receives very little criticism from fellow scientists about her outside activities. "I would accept them giving me a hard time, but a lot of colleagues instead walk circles around me because I'm fairly outspoken. Others think it's a good idea." She did receive some flak when she was very involved with women's issues, and some people said that she was wasting her time. "However, working on arms control is a proper male endeavor and therefore I have never been criticized," says Kistiakowsky with an ironic smile. "I don't think they know quite all of the things I do, but certainly the reading, speaking, and writing is perfectly acceptable. Running local organizations probably isn't."

One of Kistiakowsky's most recent undertakings was circulating the scientists' pledge against accepting SDI funding in the Physics Department at MIT. About 40 percent of the scientists in the department signed the pledge, which Kistiakowsky considers impressive, given the amount and history of military funding in the department. Kistiakowsky said some scientists refused to sign because they said they might someday get SDI funding. "Others said no for a variety of reasons, including several who thought all funding could come from SDI in the future because that was the way to get rid of dissidents, and therefore they wouldn't sign it. A couple of people who said they were foreign nationals were afraid they would get into trouble if they signed it."

Kistiakowsky believes that efforts such as the SDI pledge are very important, "because it is clear that numbers count in Congress. Five eminent, very knowledgeable scientists testifying that something won't work is always offset by five eminent, maybe not very truthful, scientists on the other side saying it will work. But if you have nearly 7,000 scientists pledging not to take the money because they oppose the project, and you only have some eighty-odd scientists forming a group that supports it—that's a statement that Congress can understand."

"The thing that is very sad," says Kistiakowsky, "is that it doesn't seem to have convinced Congress that they shouldn't be spending any money on this. It has stopped the continuing increase of funding levels for SDI, but it hasn't decreased it." Kistiakowsky believes that people such as SDI director James Abrahamson probably feel that they have succeeded in getting SDI so entrenched that it will not disappear, even with a change in administrations. "I don't know if they are right in their assessment, but it certainly has gone from something that has not been viewed as very realistic into something that is absorbing an enormous amount of R&D funding."

When asked to summarize her feelings and thoughts about her own efforts to try to do something about military research and the arms race, Kistiakowsky said, "The dilemma I face now is how to do something that is effective. I do what I can, but it doesn't seem to be making a very big difference. I'm sure it's just hubris to want to make a big difference, but it would be nice to have an impact on these issues because I think they are very important. It isn't selfish. It's just that it would be important to help turn around what appears to me to be a very great stupidity on the part of our leaders. But one certainly can't have an impact unless one tries."

1. John Pike, "Corporate Interest in the SDI," *F.A.S. Public Interest Report*, April 1987, page 9.

ECONOMIC CONVERSION

Carol Ryan

An Alternative to Academic Dependency on the Military

BY JONATHAN FELDMAN

Professors teach what they know," says Carl Barus, professor emeritus of engineering at Swarthmore College. "They write textbooks about what they teach. What they know that is new comes mainly from their own research. It is hardly surprising, then, that military research in the university leads to military-centered undergraduate curricula."

If professors teach what they know, and what they know becomes more and more a reflection of military-sponsored university research, then this is bound to affect the career choices of students after they leave the university: "they will find themselves drawn into careers in military work, not just dissertations, because the narrow and highly applied character of their graduate work leaves them few other choices," warn John Holdren and F. Bailey Green.[1] The narrowing of the scope of scientific inquiry inherent in the militarization of science can be seen in the decreasing applicability of Pentagon-funded science to civilian needs.

The economic dependency of scientists on the Pentagon weakens the resistance of the academic community to the military, and channels labor towards service of the warfare state. By providing students and faculty with economic alternatives to the military, scientists will be freer to address pressing social problems through their work as researchers and as actors in the public realm.

Economic conversion planning can provide students and faculty with such alternatives. Economic conversion is a planning process for the orderly transfer of capital, labor, and other resources from military to civilian uses. Successful conversion planning in universities and at the national level would protect researchers from the dislocation that comes when defense funding is cut.

The demilitarization of universities following the Vietnam War was clearly a victory, because scientists were freer to express their political views and apply their knowledge to peaceful purposes. But the regional military labs and high-tech companies with defense contracts which now surround technical universities across the country are a serious reminder that a broader strategy is needed to confront the Pentagon, involving not only students, but faculty, community supporters, and perhaps administrators on campus as well.

This article was excerpted from a forthcoming book on U.S. university links to the warfare state and intervention in Central America, to be published by South End Press later this year. Jonathan Feldman is co-director of the National Commission for Economic Conversion and Disarmament in Washington, D.C., telephone (202) 462-1261.

Such broad coalitions are increasingly possible, with large defense budget cuts on the horizon. The December 1987 summit bringing together U.S. President Reagan and USSR General Secretary Gorbachev for the signing of the INF treaty symbolized the growing commitment of politicians in the United States and Soviet Union to cut national defense spending as a way to cope with domestic economic problems. A further warning that more cuts could be in the making was U.S. Secretary of Defense Frank C. Carlucci's announcement at the close of 1987 that the military services were instructed to cut $33 billion from the coming year's budget, representing real cuts of five percent.[2]

Such defense cuts, together with growing budget deficits, threaten the Strategic Defense Initiative (SDI) and other large-scale programs which have pumped millions of dollars into science departments across the U.S.[3] The articulation of alternatives to such defense research programs through conversion plans would provide universities with options other than scrambling over a shrinking pool of Pentagon funding.

The successful conversion of university defense-dependent laboratories and the provision of civilian alternatives for scientists depends on a three-tiered strategy, with political participation at the university, regional, and national levels. At the university level, past efforts have included the documentation of work opportunities in alternative energy production.

In 1978, the University of California Nuclear Weapons Labs Conversion Project studied the possibility of converting the Lawrence Livermore National Lab to alternative research in the energy field. The project requested and received a detailed computer print-out of every employee's job category and salary at the laboratory. After drawing up an inventory of skills and research expertise among university scientists, conversion planners matched them with an alternative agenda for peaceful research. In future projects, the criteria for such research could be developed in consultation with progressive science groups, peace organizations, and professional groups.[4]

The formal organization of such conversion planning requires the creation of alternative use committees in defense-dependent universities throughout the U.S. Such committees could draw on the technical knowledge of scientific laborers and the managerial skills and political connections of administrators. These committees would be divided evenly between administrators and researchers. These two groups would negotiate and plan the development of alternative research programs in science departments throughout the nation.

An alternative to scientific and engineering resources devoted to military production can be found in the expansion of research in renewable energy resources such as solar power, hydroelectricity, co-generation, and alcohol fuels from biomass sources. Such energy research, together with alternative research in other fields such as medicine and agriculture, can then be shared with third world nations seeking solutions to their own scientific problems.

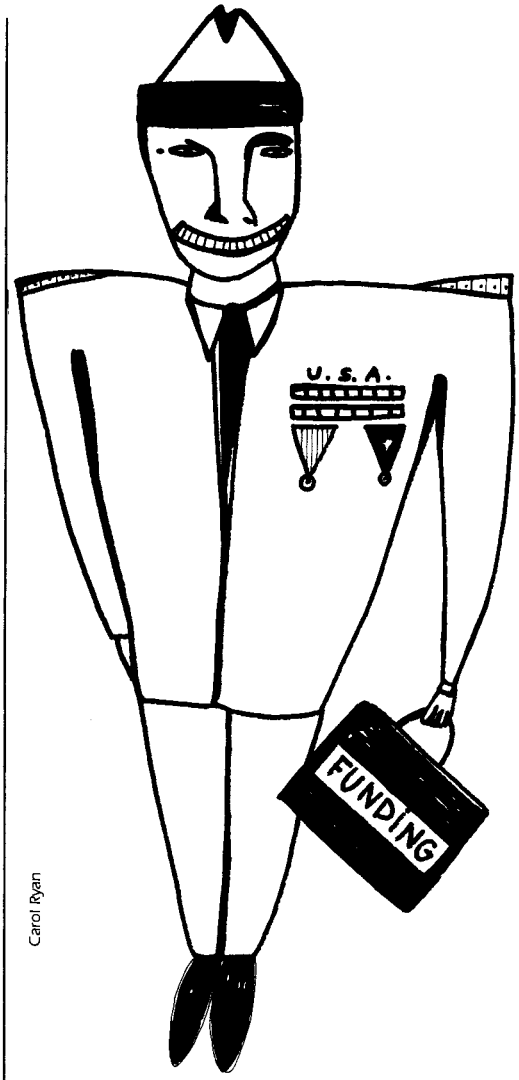
For example, Japan is developing a comprehensive alternative to SDI, America's major high-technology program, through the Human Frontiers Science Program. While the program relies on "big science," it plans to study "energy conversion from light (photosynthesis) and other sources, to electrical, chemical and kinetic energy."[5]

The conversion of universities depends on the growth of broad-based coalitions of constituencies who would benefit from a stronger civilian-based economy. The decline of nonmilitary sectors in the U.S. economy, as witnessed by a decaying infrastructure and productive base, has made whole classes of professions and social groups potential beneficiaries of a national economic program to rebuild decaying civilian industries and convert military facilities to nonmilitary uses.

The lack of competence or "competitiveness" of U.S. industry is partially rooted in the diversion of scientific and engineering talents to the military. University scientists and engineers can play a pivotal role in rebuilding the U.S. economy in projects as diverse as pre-manufactured housing for the homeless and high-speed, energy-efficient mass transit. They can also help retrain their counterparts in the defense sector whose socialization to the patterns of military-serving research impedes their own conversion to alternative civilian work.[6]

People who are excluded from academic resources or marginalized by university programs would also benefit from a program of economic revitalization and conversion. Peace, environmental, labor, and women's groups, the working class, poor, and people of color all have a stake in what universities do and the organization of U.S. research and development programs. These groups can apply pressure (and have often done so) on universities to expand such programs as women's studies and Afro-American studies and research which makes disarmament a central concern. Coalitions can begin to push universities to develop an alternative budget which gives less support for military research and more funding for such peaceful programs.[7]

The conversion of universities also depends on the participation of such campus-based and progressive coalitions in local and national efforts to convert the economy. If industries make more civilian products and less for the military, there will be a greater demand for civilian research



Carol Ryan

The articulation of alternatives to military research programs through conversion plans would provide universities with options other than scrambling over a shrinking pool of Pentagon funding.

and development. Markets will emerge to support civilian R&D and professional associations, and some business interests tied to an alternative R&D policy could be part of university, local, or national conversion movements.[8]

Basic research, even science designed for peaceful uses, can also be exploited by the military. (See "Not Without Us," by Joseph Weizenbaum, and "Ethical Dilemmas: Between a Rock and a Hard Place," by Aristov, Regen & Smith, in the November/December 1986 issue of SftP.) However, the conversion of the local and national economy will create barriers for such technology transfer. The demand for military applications will decrease as the economy contracts through conversion. But statewide and national conversion legislation will also make it more difficult for faculty researchers to close down their military research labs and reopen them off campus.

Many universities, like prime military contractors, will resist conversion unless they are forced by legal and political means.[9] Steps toward a legal mechanism to prohibit certain military research has been developed in the city of Berkeley, California. In November 1986, Berkeley voters overwhelmingly passed the Nuclear Free Berkeley Act. A specific clause in the act mentions legal constraints on universities: "No person, corporation, university, laboratory, institution or other entity shall, within the City of Berkeley, knowingly engage in work for nuclear weapons." The act requires the cessation of nuclear weapons work within city limits, the divestment of city funds from businesses that engage in nuclear weapons work, and involvement of the city in the promotion of "educational activities...to advance public awareness and understanding" about the dangers of nuclear weapons.[10]

The necessary planning for economic conversion is defined by a 1987 bill now before Congress, introduced into the House of Representatives by Ted Weiss (D-NY) and supported by 50 more House sponsors. The Economic Adjustment Act would establish "alternative use" or planning committees at every military base and military industrial facility in the U.S., including university research laboratories and "think tanks" which receive defense contracts. Such committees would be comprised of management and labor representatives and act as the primary agency for developing plans to convert military facilities to civilian-oriented activity.

The Weiss Bill would require universities and other contractors (as a condition for receiving defense funds) to pay an amount into an economic adjustment fund equal to one and one-fourth percent per year of the value of the contractor's gross revenue on defense sales.[11] Thus, in response to university claims that they cannot afford conversion planning, the Weiss Bill permits a process whereby university conversion would be self-financing through defense contracts.

NOTES

1. John P. Holdren and F. Bailey Green, "Military Spending, the SDI, and Government Support of Research and Development: Effects on the Economy and the Health of American Science," Federation of American Scientists *F.A.S. Public Interest Report*, Vol. 39, No. 7, September 1986, p. 14.

2. On defense cuts, see Richard Halloran, "Carlucci Orders $33 Billion Cuts for Armed Forces," *New York Times*, Dec. 5, 1987; Greg Bischak, "Pentagon Legerdemain," letter to the *New York Times*, Dec. 22, 1987; and Collen Cordes, "Many Scientists Welcome the Reluctance of Congress to Back Large Increases for 'Star Wars' Research," *The Chronicle of Higher Education*, Dec. 16, 1987, p. A17-A18. Bischak reports that the $33 billion "is largely the difference between former Defense Secretary Caspar W. Weinberger's bloated request and the more modest proposal of Frank C. Carlucci." However, fiscal restraints and a Democratic presidential victory in 1988 may bring substantial defense decreases.

3. On SDI's impact on the universities, see Chapter 6 in *Star Wars: The Economic Fall Out*. Rosy Nimroody, Sr. Project Director. Cambridge, MA: Ballinger Publishing Co., 1988.

4. A description of the University of California conversion project and an outline on conversion planning basics is found in Randy Schutt, "Economic Conversion Planning," Chapter 9 in *The Military in Your Backyard*. Palo Alto, CA: Center for Economic Conversion, May 1984. Greg Bischak, an economist with Employment Research Associates in Lansing, Michigan has proposed the development of a "portfolio" of alternative research and development work, with an emphasis on basic research. The ideas presented here build on this suggestion.

5. Mario Pianta, "High Technology Programmes: For the Military or for the Economy?," *Bulletin of Peace Proposals*, No. 1, 1988, forthcoming.

6. For an elaboration of the argument that the military coopts needed scientific talent, see Lloyd Jeffry Dumas, *The Overburdened Economy*. Berkeley, CA: University of California Press, 1986. On the problems of engineers in military-serving firms, see Seymour Melman, *Profits Without Production*. Philadelphia, PA: University of Pennsylvania Press, 1987.

7. An article by Robert Krinsky in the *Bulletin of Peace Proposals*, op. cit., describes the work of the National Coalition for Universities in the Public Interest, which is attempting to make university resources available to a larger public.

8. Pianta, op. cit.

9. For an explanation of why economic incentives will not lead to conversion among prime contractors, see Seymour Melman, *The Permanent War Economy*. New York: Simon & Schuster, 1974; Jacques Gansler, *The Defense Industry*. Cambridge, MA: MIT Press, 1980; Fred Kaplan, "Defense Profits Are Double Commercial Profits, Study Says," *Boston Globe*, May 13, 1987.

10. On the Berkeley law, see Nancy Skinner, City Councilor, memo on "Implementation of Measure K, the Nuclear Free Berkeley Act," Jan. 12, 1987; Ordinance No. 5784-N.S., "The Nuclear Free Berkeley Act," City of Berkeley. For a discussion of the prospects for economic conversion on the regional level, see Jonathan Feldman, "Converting the Military Economy through the Local State: Prospects for Economic Conversion in Massachusetts," *Bulletin of Peace Proposals*, op. cit.

11. The bill also requires a one-year prenotification of plans to cut back or terminate a defense contract or military base. Planning assistance is provided, together with income support and retraining programs for communities and workers, while a conversion is underway. See Defense Economic Adjustment Act: H.R. 813, 100th Congress, 1st Session, January 28, 1987.

SHEEPSKINS

CONTINUED FROM PAGE 5

6. Suttle, op. cit., p. 24.
7. Ibid.
8. Suttle, op. cit., p. 14.
9. Computed from data in DOD, op. cit. ¶3, pp. 10, 14.
10. Computed from data in DOD, op. cit. ¶3, pp. 7, 10.
11. DOD, op. cit. ¶3, p. 17.
12. Computed from data provided by the Strategic Defense Initiative Office of Innovative Science and Technology, the Pentagon, Washington, D.C.; and the Federation of American Scientists, *Public Interest Report*, September 1986, V. 39, N. 7. Deflators from: U.S. Department of Commerce, *Survey of Current Business*, May 1987, Vol. 67, No. 5.
13. Edward Markey, "Markey Releases Analysis of Reagan Energy Budget: The Militarization of Energy Department Budget Marches On." Press release from the office of U.S. Congressman Edward Markey, January 12, 1987.
14. See for instance: Federation of American Scientists, *Public Interest Report*, Sept. 1986, V.39, N. 7; communication by author with Jonathan Reichert, Department of Physics, State University of New York-Buffalo, July 1987.
15. Mark Zieman, "Growing Militarization of the Space Program Worries U.S. Scientists," *The Wall Street Journal*, Jan. 15, 1986, p. 1.
16. Ibid.
17. Eric Bloch, testimony before the U.S. Senate Armed Service Committee, Subcommittee on Defense Industry and Technology, March 9, 1987.
18. Federation of American Scientists, *Public Interest Report*, Sept. 1986, V. 39, N. 7, p. 14.
19. Computed from data in DOD, op. cit. ¶3, p. 7.
20. Suttle, op. cit., p. 25.
21. Howard Ehrlich, "The University-Military Research Connection," *Thought & Action*, Fall 1984, V. 1, N. 1, p. 118.
22. Suttle, op. cit., p. 25.
23. DOD, op. cit. ¶3, p. 7.
24. U.S. Department of Defense, Office of the Under Secretary of Defense for Research and Engineering. *Report of the Defense Science Board Task Force on University Responsiveness to National Security Requirements*. Washington, D.C.: The Pentagon, January 1982.
25. Ibid.
26. Communication by author with John C. Crowley, July 1987.
27. U.S. Department of Defense, Office of the Under Secretary of Defense for Research and Engineering, *Report of the DOD-University Forum: Calendar Year 1984*. Washington, D.C.: The Pentagon, p. 2.
28. DOD, op. cit. ¶3, p. 7; and U.S. Department of Defense, *The Department of Defense University Research Initiative Research Program Summaries*. June 1987, Washington, D.C.: The Pentagon, p. 2.
29. U.S. Department of Defense, *The Department of Defense Statement on the Science and Technology Program by the Deputy Under Secretary of Defense for Research and Advanced Technology to the 100th Congress, 1st Session*, March 1987, p. 8.
30. DOD, op. cit. ¶28, URI Summaries, p. 3.
31. DOD, op. cit. ¶29, p. 48.
32. DOD, op. cit. ¶29, pp. 49-50.
33. Quoted in op. cit. ¶18, p. 16.
34. See especially Seymour Melman, *Profits Without Production*. New York: Knopf, 1984.
35. Communication by the author with James Melcher, June 1987.
36. Ibid.
37. DOD, op. cit. ¶3, p. 9.
38. DOD, op. cit. ¶3, p. 27.
39. Ibid.
40. U.S. Department of Defense, *The Department of Defense Report on the Merit Review Process for Competitive Selection of University Research Projects and an Analysis of the Potential for Expanding the Geographic Distribution of Research*, April 1987, p. 3.

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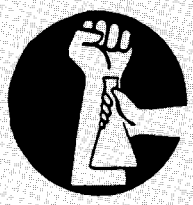

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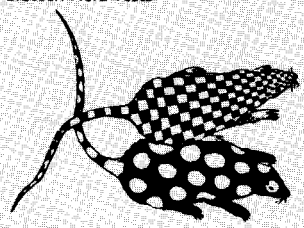

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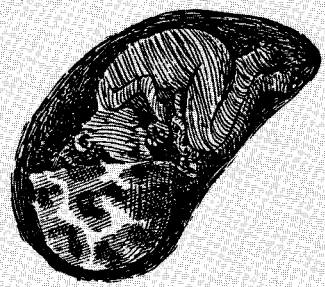

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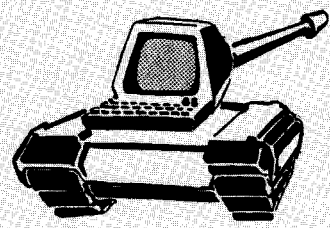

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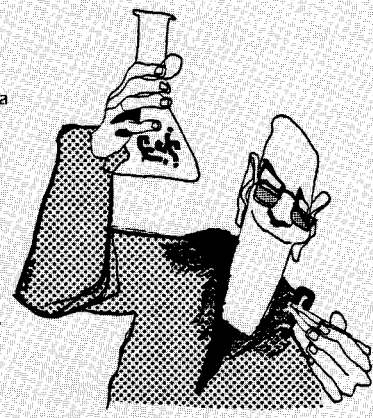

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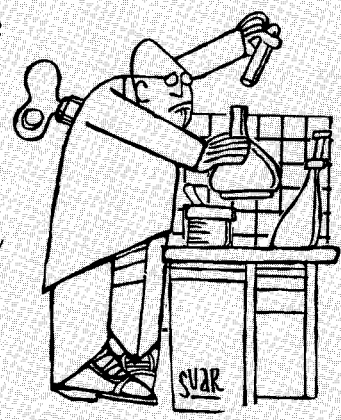

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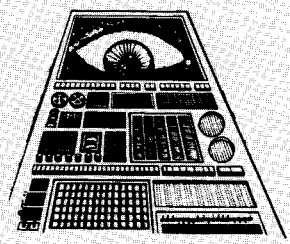

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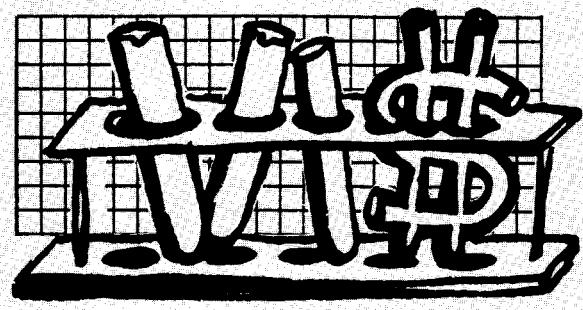

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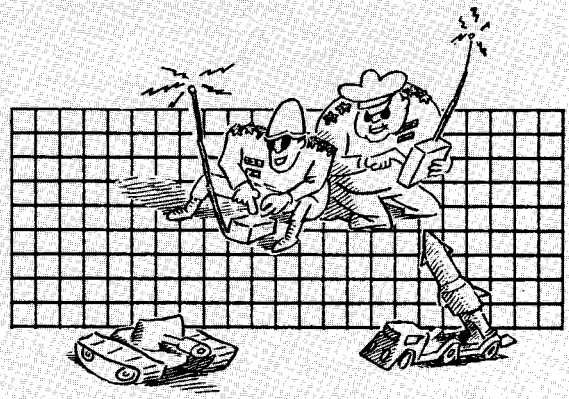

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Physics and the Center for Non-Linear Studies, establish lab contacts with campus researchers and students. The University of California's association with weapons labs is not unique. Six other universities have similar relationships with major weapons labs.[26]

A 1985 DOD report for Congress, entitled "The Technology Base and Support of University Research," sums up the rationale for a military-university partnership: "DOD reaps several benefits from its supplemental support of science and engineering education. First, the programs attract highly qualified students and support their training in areas of interest to DOD. Second, fellowship support increases the number of doctoral students who then have the potential to train other students. Third, training programs provide a pool of recruits for the various DOD RDT&E (Research, Development, Testing and Evaluation) programs. Finally, the programs provide a variety of intangible benefits, ranging from the expansion of professional contacts and rapport with the various DOD laboratories to the generation of interest and excitement in science and mathematics at the elementary and secondary school levels."[27]

NOTES

1. DOD Report to Congress, "Selected University Laboratory Needs in Support of National Security," April 29, 1985. Published with hearings before the U.S. House of Representatives, 99th Congress, Subcommittee on the Department of Defense, Part 8. Washington, D.C.: U.S. Government Printing Office, 1985, pp. 771-966.
2. Paul Gray, quoted in article by Daniel S. Greenberg, *Discover*, January 1987.
3. Robert Rosenzweig, "Department of Defense Appropriations for 1986." From testimony in hearings before a subcommittee of the Committee on Appropriations, U.S. House of Representatives, 99th Congress, first session, Subcommittee on the Department of Defense, Part 8. Washington, D.C.: U.S. Government Printing Office, 1985, pp. 771-966.
4. Ibid.
5. John Rigden, quoted in *Physics Today*, June 1986, page 62.
6. Susanne Ellis, *Physics Today*, June 1986, page 84.
7. R.K. Weatherall, director of MIT's Office of Career Services, 1986. Personal communication.
8. Barton Lane, quoted in Greenberg, op. cit., January 1987.
9. DOD Report to Congress, "Selected University Laboratory Needs...," op. cit.
10. Stanton A. Glantz and Norm V. Albers, *Science*, vol. 186, 1974, page 706.
11. Ibid.
12. Stanton A. Glantz and Norm V. Albers, op. cit., interview with Marshal Harrington, an Air Force contract monitor; Elliot Weinberg, Director of Scientific Research for the Office of Naval Research; and Edward Reilley, Assistant Director of Defense Research and Engineering.
13. Public forum, Computer Science Department, University of California, January 1985.
14. John P. Holdren and F. Bailey Green, *Journal of the Federation of American Scientists: Public Interest Report*, vol. 39, no. 7, September 1986. Holdren & Green's study concludes that the military buildup under Reagan has produced serious imbalances in the nation's research and development efforts, with particularly damaging consequences for the economy and the health of the universities. A rebuttal issued by University of California officials (see *NOTICE*, published by the Academic Senate, UCAL, April 1987) asserts that DOD accounts for only about 11 percent of all federal awards to the university, and that this figure has not grown significantly under Reagan.
15. Phone interview, October 2, 1987.
16. Department of Defense, "Analysis of the Origin of 'A Rose by Any Other Name May Be Defense Research.'" Position paper on "DOD-sponsored Research at Stanford," unpublished, September 7, 1971. See also Glantz and Albers, op. cit.
17. Glantz and Albers, op. cit.
18. Committee on Armed Services, "Hearings On Military Posture...." Report to U.S. House of Representatives, 97th Congress, second session, Part 5, March 2-30, 1982. Washington, D.C.: U.S. Government Printing Office, pp. 83-85. See also *Physics Today*, October 1984, page 9.
19. George H. Heilmeier, Defense Advanced Research Projects Agency (DARPA) FY 78 Research and Development Programs. Testimony before the Subcommittee on Research and Development of the House Armed Services Committees, February 1977, page III-19.
20. DOD Report to Congress, "Selected University Laboratory Needs...," op. cit.
21. Department of Defense, "Analysis of the Origin of 'A Rose by Any Other Name...," op. cit.
22. Holdren and Green, op. cit.
23. Ibid.
24. Harold Agnew, *Los Alamos Science*, Summer-Fall 1981, page 154.
25. Rita Arditti, Pat Brennan, Steve Cavrak, *Science and Liberation*. Boston: South End Press, 1980, page 99.
26. Other schools have similar relationships with DOD facilities: Lincoln Laboratory (affiliated with MIT), the Johns Hopkins University Applied Physics Laboratory, the Applied Physics Laboratory of the University of Washington, the Applied Physics Laboratories of the University of Texas, the Applied Research Laboratory of Pennsylvania State University, and the Marine Physical Laboratory, affiliated with Scripps Institute of Oceanography, University of Califorinia, San Diego.
27. DOD Report to Congress, "The Technology Base and Support of University Research...," contained in "Department of Defense Appropriations for 1986" hearings, op. cit.

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"Summer Internship for University Students," which plans to induct both undergraduates and graduate students into its structure.

The real irony is that these research centers (and "priority" R&D for defense technologies) may be unnecessary. The U.S. is already "superior" to the Soviets in 14 of the 20 "most important basic technological areas," as explained by the Pentagon in a 1986 report. In the remaining six technological areas, both countries are considered relatively equal.

There is also evidence that the centers accomplish exactly the opposite of what Congress was told they would do. The billions of dollars spent do not appear to be helping America remain technologically strong, or to successfully compete against Japanese imports. Rather, federal funding provides defense contractors with incentives to spend less in R&D, while the Pentagon subsidizes their research centers.

Heavy Pentagon financing of military research may also reduce American competitiveness in the international marketplace. One explanation for the emergence of Japan and Germany as technological leaders is that neither country is burdened with large defense budgets like that of the U.S. In 1981, America spent about 30 percent of its R&D expenditures on defense and space projects (as a percentage of Gross National Product). Germany spent only 5.6 percent, and Japan 2.5 percent—leaving them more money to allocate towards marketable civilian goods.

Giant U.S. defense and communications contractors are combining their research facilities and capital, homogenizing their research agendas, and getting ready to live off whatever technology comes from these large and uncompetitive federally funded centers. This puts smaller companies at a disadvantage—if not out of business. And military secrecy at the research institutions makes it very unlikely that whatever technology is developed will be rapidly transferred to the civilian sector.

The bottom line is that research centers, through disproportionate funding of military R&D, seem to be making private industry even less competitive, while simultaneously cloaking universities in secrecy. Maybe this was the design for these centers: to make higher profits with less investment and competition, to give the Pentagon more intellectual bang for its buck, and to keep the military's hand in the shadows. As for students and faculty—they were meant to be kept ignorant of the fact that as much as 70 to 80 percent of their programs are financed by the Pentagon.

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