April 1987

Science Policy Committee Recommendations

The Committee on Science Policy has formulated four recommendations for presentation to the Council of 25 April 1987.

1. That the Council instruct the Managing Editor of the *Notices* and the Chairman of the *Notices* Editorial Committee to open its pages for comment related to two motions considered at the business meeting of 22 January 1987. The motions can be found in the January 1987 *Notices*, page 76, or February 1987, pages 398–399.

2. That the Council declare its intent to hold a referendum after the 1988 Annual Meeting on the substance of the two motions or on broader issues of the federal funding of research in mathematics.

3. That the Council invite the sponsors of the two motions to support the referendum by moving to table the two motions in favor of the referendum.

4. That the Council charge the Committee on Science Policy to supervise the formulation of the motions on the referendum for presentation to the Council for its approval.

Committee on Science Policy

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Guido L. Weiss
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EDITOR'S NOTE: *The Managing Editor of the Notices and the Chairman of the Notices Editorial Committee will carry out the first recommendation without waiting for formal instruction. Items submitted for publication in this forum should not exceed 1,000 words.*

Washington Outlook

Kenneth M. Hoffman

Passages: Thoughts About Science and the Public

The relationship between science and the public is in a period of rapid change–full of bumps, bruises, misunderstandings, and rigidities; and simultaneously full of signs of growth, health, and renewed mutual commitment. The maze of seemingly contradictory facts, feelings, and perceptions is reminiscent of the changes that accompany one of life's "passages" or, perhaps more appropriately for this case, the sorting out process which accompanies the mid-course maturation process in a marriage. We in the mathematics community are having to do our share of sorting out in our relations with government and the public and may possibly gain some insight by looking at the issues we face from a phases-of-life perspective.

Few would dispute that the post-World War II relationship between science and the public began as a love affair. Science was awesome, having "won the war;" and pushing forward what Vannevar Bush called its "endless frontier" seemed a fitting national mission—surely science would somehow help protect us from the Soviet Union and keep the economy booming. The public was immensely attractive, in part because it worshipped science, but primarily because the scientific community had developed a profound love of country in the war effort; and because the public cared for science, it poured into that nurturing act both its tax dollars and the very best of its youth.

A traditional marriage began. Vows were sealed with the creation of the Office of Naval Research in 1946 and the National Science Foundation in 1950. There was thoughtful discussion during the engagement, but the ardor was intense enough to gloss over seeds of future trouble which lay in the facts that the public wasn't really able to understand what science was doing all day long, that there was much guilt in the scientific community over its final and decisive contribution to winning the war, and that science held too many truths about its importance to society to be self-evident, never clearly articulating, for example, how it would keep the economy booming.

The great United States university research-education system was built, further fueled in the late 1950s and early 1960s by the Sputnik-inspired space race, and highly-trained scientists and engineers were returned to the public in droves. Events moved quickly then: Science went to the moon; the Vietnam War came to tear at the fiber of the public, and by the late 1960s to early 1970s, Congress markedly *reduced federal fellowships to slow the production* of scientists and passed the one year Mansfield Amendment, which seriously questioned what the Department of Defense was doing in the basic research business. These actions, reactions, and overreactions generated turmoil in the science-public relationship, and each of the partners underwent changes. Neither got its newly formed attitudes or its complaints articulated very well—which is another way of saying that there was no effective federal science policy. The underlying sense of mutual commitment remained, but its emotional basis lay largely in wishing that things could be the way they used to be.

For some years now, it has been evident that things cannot be the way they used to be. This has to be faced. Science and the public each need to stand back and take a long, hard look at the person they married, then describe their mutual commitment in terms that make sense today. Judging by this winter's events in Washington, we have a ways to go, but we're getting there if we will but see the progress and not lose our nerve.

Two of the current symptoms of trouble on the science side are the intense reactions to emphasis on engineering and interdisciplinary research centers in the FY 1988 budget of the National Science Foundation and expressed fears that the six billion dollar Superconducting Super Collider, to be funded at the Department of Energy, will significantly detract from resources available for the rest of basic science. These amplify serious concerns which have been and will be with us for some time: The issue of "small" versus "big" science; the apparent growth of goal-oriented research; inadequate federal investment in civilian-sector basic research, especially when compared with the huge amounts of money poured into the "D" side of military R&D; and, pervading all of the above, an inadequate flow of brainpower into science and engineering. As happens in rocky relationships, some of the verbalized concern is long on emotion and short on facts and perspective.

The current symptoms of trouble on the public side are best wrapped up in the word "deficit" and in two perceptions prevalent in many parts of Congress: Science has not done an effective job of educating the public (members of Congress) about what it does and how this directly benefits society, i.e., why science should continue to be adored; and science has failed to articulate clearly the plans that go with its unquenchable lust for life and learning, plans *against which to assess its dollar needs and its direct contributions to curing society's major ills.*

Into the midst of all this has come Erich Bloch, Director of the National Science Foundation, with a forcefully presented plan. He has persuaded the President and the Office of Management and Budget to recommend a doubling of the NSF budget in the period 1988–1992. He hopes that, with the active support and involvement of the scientific community, he can persuade Congress to go along by authorizing a four-year budget for the years 1989–1992. (They will still need to appropriate funds year-by-year.) The first year of his five-year plan, 1988, has more emphasis on interdisciplinary centers than many people in the science community find palatable, since it temporarily slows the growth of funding in their fields. (Mathematics funding remains a high priority, although its growth from FY 1987 to FY 1988 is targeted at about 13%, somewhat less than we have been experiencing in recent years.) The budget may also have more emphasis on education than some scientists will find comfortable, when they already feel squeezed.

What seems important to realize and react to here is not this or that detail about continued feelings of apprehension—X went up $N\%$ and Y only $(N-2)\%$—but the fact that there is, for the first time in many years, a plan. In the metaphor of this column—may Erich Bloch forgive me—the NSF Director is playing the role of marriage counselor. He is describing to science and the public a basic plan for putting their relationship on a new footing, one appropriate for the stage of life they have reached together. It asks science to bend a little, to drop some of its near-arrogance, to begin to describe what it does in ways which are more understandable to the public, and to encourage the development of NSF programs which show more clearly how science-technology transfer comes about and how scientists are going to work directly on the major educational problems the country faces. The development of these programs is to take place side by side with the growth of fundamental science programs of more traditional sorts, not instead of them. But, of course there will be skewing in the direction of the "new" efforts during the first year. Who would believe the plan was serious otherwise?

The plan also asks the public to bend a little, to recommit itself to science as redescribed, and to support a congressional ramping up of the NSF budget to a level roughly two billion dollars more per year than it is now. In these tight budgetary times, this will test the public's commitment.

The plan is not primarily monetary. It is conceptual, based on identification and description of the two critical long-term problems which science and the public must work on together, and work on with greatly increased commitment: The competitive economic position of the United States internationally; and the scientific literacy of the public, i.e., the development of the human resources necessary not only to maintain the vitality of science and engineering, but to significantly raise the capability of the nation's broader workforce.

In mathematics, we must continue to debate how the evolving details of these and related plans affect the health of our enterprise. We are the quintessential "small" science; we are heavily dependent for research support on the Department of Defense as well as the NSF; we are only 30% of the way toward reaching the goals of the David Report; we still feel the pinch of the small number of researchers supported in our field; we have staggering problems to deal with at the collegiate teaching level; we must help reform the vast enterprise of school mathematics.

But we must not lose our nerve and begin to think narrowly after the progress we have made over the last five years. Assuming the President's budget is approved, we have increased NSF support for mathematics by 95% in those five years and have increased DOD support by the same percentage. We have educated many people about our problems and have made a good start at educating people about our potential and our role in society. We have set up several major new mechanisms to promote understanding of mathematics and to help lead efforts to strengthen research and education nationally: The Joint Policy Board for Mathematics; the Board on Mathematical Sciences; and the Mathematical Sciences Education Board.

We must help push forward the basic plan Mr. Bloch has devised and then work within its framework to see to it that the persistent and continuing issues which concern us are discussed and dealt with. We are almost perfectly positioned to benefit from the growth which the general plan will bring. More importantly, we are almost perfectly positioned to contribute to its development, implementation, and success:

> We have done as good a job as any scientific discipline at articulating our research needs;
>
> We have demonstrated that we can set priorities and stick by them, even when it hurts;
>
> We are the only scientific discipline to formulate and launch a complete review of its collegiate enterprise;
>
> We are the only scientific discipline to mount a full-scale assault on the problems of education at the school level in our broad area.

And if it is true, as Mr. Bloch says, that basic research is the key to economic competitiveness, then it is true that mathematics is the foundation of economic competitiveness.

That's powerful stuff, if we have the sophistication and the stamina to use it well.

computation, probability and statistics, applied analysis, and mathematical physics and optimization.

3. Army Research Office (ARO). The Army Research Office outlook is clouded by uncertainty over continued URI commitments and possible setasides for predetermined projects. In 1988, ARO will handle the bulk of SDI mathematics funding, which in 1987 amounted to just under $2 million. In 1986, ARO began funding for a Mathematical Sciences Institute at Cornell at an approximate level of $2.5 million per year. ARO programs include areas of applied mathematics, statistics, and computer science.

4. Office of Naval Research (ONR). The Navy's mathematical sciences program also faces uncertainty over eventual levels of funding. The Mathematical Sciences Division at ONR is currently organized into the following 8 program areas: applied analysis, numerical analysis, mathematical statistics and probability, statistical signal analysis, discrete mathematics, operations research, and decision sciences. The decision sciences program is currently under review. In addition, ONR handles R&D work at the Naval Research Laboratory, Naval Air Systems Command, Naval Sea Systems Command, and the Naval Electronic Systems Command. In the past, the order of magnitude of funds for each of these was about $1 million, except for NRL funds which have been somewhat larger.

5. Department of Energy (DOE). Activities supporting R&D in the mathematical sciences at the Department of Energy are lodged primarily in the Energy Sciences Computational Research Program. This program consists of 2 activities: applied mathematical sciences supercomputing research and energy science advanced computation. The applied mathematical sciences supercomputing research program funds basic research at national laboratories, universities, and private research institutions in 3 major categories: analytic and numerical methods, information analysis, techniques, and advanced computing concepts.

6. Defense Advanced Research Project Agency (DARPA). A substantial new mathematics program has emerged at DARPA. The thrust of this new program is in the areas of dynamical systems, harmonic analysis, data compression, neural connections, and computational algorithms. There continue to be changes of organization within DARPA affecting the administration and budget of this program.

7. National Security Agency (NSA). The NSA currently has a modest program ($1.2 million) for support in basic, unclassified external mathematical sciences. They have announced plans to enhance this effort significantly, increasing it to $5.0 million by 1990. Of considerable concern to NSA and others is the continuing decline of U.S. Ph.D. graduates in mathematical sciences.

8. Other agencies. Several collateral agencies such as the National Aeronautics and Space Administration (NASA) and the National Institutes of Health (NIH) have modest mathematics science programs. The National Bureau of Standards (NBS), as well as the numerous national laboratories attached to other agencies, provide considerable in-house mathematics, statistics, and computer research programs.

Letters to the Editor

Goals of Defense Funding

This letter is about the second of two motions introduced at the recent AMS meeting in San Antonio (*Notices* January 1987, p. 76). It concerns U.S. Federal Government funding for mathematics research through Department of Defense agencies generally, rather than funds from special sources such as SDI. The motion deplores trends perceived in research funding and requests that those representing the AMS "direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as increasing total research support."

There is a long history of DOD support for basic research in the mathematical sciences. This support has come for the most part through ongoing programs rather than special initiatives. Although the mechanisms for evaluating research proposals vary from agency to agency, the scientific standard for DOD funding in those areas with which I am most familiar has been as high as at NSF. DOD research funding has tended to focus on more applied areas of the mathematical sciences. The long-term DOD support, along with NSF and more recently the Department of Energy, has been an important factor in the development of applied mathematics in the U.S. since World War II. In particular, DOD support for graduate students and postdocs has provided real encouragement to several generations of younger researchers. During recent years, well over half the U.S. Government funding for research in applied mathematics, probability, and statistics has come from DOD agencies.

There is a continuing shortage of research support for highly qualified mathematicians, in "core" areas for which the only source of U.S. government funding has been NSF. It is my view that in addressing this problem one must continue to build the case for supporting mathematics as broadly as possible, emphasizing the unity of the mathematical sciences and pointing to the many ways (often unexpected) in which mathematics is applied. The case for U.S. government support of pure scientific research is made in the context of pressures to fund science directed toward such national goals as maintaining leadership in high technology and improving the competitive position of U.S. industry. In making the case for mathematics research funding one needs to continue to show how the national effort in the mathematical sciences ties in with these goals. During the early 1970s support for a number of mathematicians by DOD agencies was discontinued. It was expected that NSF support for mathematics would increase accordingly. In fact, most of the increases in NSF budgets during the period 1970–75 went to fields identified with industrial development rather than mathematics. (See the David Committee report "Renewing U.S. Mathematics: Critical Resource for the Future," *National Academy Press*, 1984, p. 112.)

Continuing discussions within the mathematical community and dialogues with the funding agencies are needed concerning policies and problems connected with research funding. The motion in question does not seem to me helpful in this regard. If passed at the next AMS business meeting, it is in fact likely to be counterproductive. I oppose it.

Wendell H. Fleming
Brown University
(Received February 24, 1987)

Policy on Letters to the Editor

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The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, and will be acknowledged on receipt.

A Request for Reconsideration of the Motions

The business meeting of the society at San Antonio on January 22 referred to the coming meeting at Salt Lake City two motions on SDI and on military research. The motion recommending that the coming meeting adopt these two motions was passed, but by a narrow majority. Thus it is clear that a number of our members are passionately in favor of the motions as stated; there are others who strongly oppose them in their present form. Some of the questions at issue could be formulated in ways that would command much wider agreement from the members of the Society; such wide agreement would be welcome, especially at this time when Mathematics is in dire need of better funding.

Jan 1987

Letters to the Editor

Military Funding in Mathematics

This letter is a shortened version of a paper

Military funding in mathematics

Bill Thurston

originally submitted as an article to the *Notices*. I hope that the AMS will decide to start publishing opinion articles *per se*, as do the APS (American Physical Society) in *Physics Today* and the ACM (Association for Computing Machinery) in *CACM*.

The article was commissioned by a group of mathematicians concerned about increasing military funding in mathematics. The original group was Lipman Bers, Lucy Garnett, Linda Keen, Lee Mosher, Barbara Simons, Mike Shub, Jean Taylor and Bill Thurston; we are in touch with many more. This letter does not necessarily reflect the opinions of anyone but me.

We plan a mailing list, and possibly a telephone tree. For more information, write to Bill Thurston, Mathematics Department, Washington Road, Princeton, NJ 08544.

Resolutions on this subject will be introduced at the Council and the General Meeting in San Antonio in January. There will be two related panel discussions during the January meeting: one on military funding in mathematics, and one on Star Wars software reliability.

What is the right question?

In many discussions of funding of science and of mathematics, ethical considerations having to do with the wider society or the longer term are dismissed as extraneous, unprofessional, or political. Such an atmosphere does not do us justice. Human society works only because people regard the welfare of the wider society as an important goal, often above their own narrow interests. People vary widely in their conclusions, but I believe we are nearly unanimous in the starting point.

For the topic at hand, the question is not "how can we maximize the resources and influence of ourselves and mathematics?" but "how can we most benefit society, mathematics and ourselves?"

We mathematicians are the only people who are in a good position to evaluate our impact on society. It is our civic duty to do so *especially* when we disagree.

Although most people desire to act in the best interests of society, many do not think through clearly what this means.

When a moral comparison between alternatives is unclear, people follow the gentle or not-so-gentle pressure of the here and now, the pocketbook.

Relevance

The issue is timely and urgent. We all are aware of deserving mathematicians who are denied NSF support for their research because money is scarce. We know mathematicians who have recently turned to the military, and others who are resisting acceptance of military funding.

I have personally had to come to grips with the issues because I am seeking financing for computation at Princeton, so I can quit spending a large part of my time on computer systems administration, maintenance and programming. Repeatedly, people approach me with opportunities for military funding.

I have chosen not to take that route. More than one person has criticized me, on ethical grounds, for *not* accepting military funding.

The military and support of science

World War II was a high point for the US military. The country had a united spirit in fighting against an evil regime in Germany and an imperialist regime in Japan — almost everyone was involved. Aspects of the war are controversial in some circles, but the patriotic unity and spirit of our nation is not disputed.

After World War II, the ONR (Office of Naval Research), followed by the AFOSR (Air Force Office of Scientific Research) and the ARO (Army Research Office) began supporting basic research in mathematics and other sciences. Many mathematicians whom I respect praise the management

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of funding during this period. I was too young to be involved, and I accept what people tell me.

The NSF was founded in the early 50s and began to replace the military agencies as a funding source. The military agencies gradually shifted toward applied rather than basic research.

When Sputnik was launched in 1957, science became a high national priority. More resources became available. The Advanced Research Project Agency, or ARPA (to which Defense was later prepended making it DARPA) was founded in 1958. In theory, DARPA is an agency which funds initiatives in areas of strategic interest to the US, rather than providing sustained or broad support for science. They have played a crucial role in the development of Computer Science as a discipline.

During the long and bitter war in Vietnam, the military presence on campus was curtailed, after much controversy. Finally, the Mansfield amendment was passed in 1969, ordering the military only to fund projects directly related to their mission; other scientific funding was supposed to go through the NSF. The trend has persisted until the present.

During the years of the Carter and Reagan administrations, the military budget has grown tremendously. The military is not the same organization it was after World War II. Our large military establishment has no definite mission against which performance is tested. Projects such as the MX missile have some kind of bureaucratic logic, but are hard to justify by any external criterion.

The effect of this huge influx of military money on science and engineering is documented in the pamphlet *Basic research: the key to economic competitiveness* by NSF director Erich Bloch: federal money for research and development has shifted from about 50 percent civilian and 50 percent military in 1980, to 28 percent civilian and 72 percent military in 1985. When the comparison is limited to research (excluding development), the percentages for military funding are smaller but the increase is similar. The thrust of this change has been away from basic research, and toward applied research.

Within the last two or three years, a new program in mathematics has arisen through DARPA. Its budget is now $10,000,000, quite a large chunk of the total Federal mathematics support. This program has evoked controversy, partly because it touches areas of mathematics which have not previously had military funding and partly because of criticisms of its management and narrow stated goals. It is defended and supported by our mathematical leadership on the grounds that if we cooperate with the program, we will eventually be able to straighten out its problems.

The SDI (Strategic Defense Initiative or "Star Wars") is another major potential source of military funds for mathematics. There is currently about a million dollars of SDI money in mathematics, but next year there may be much more. The Board on Mathematical Sciences recently organized a meeting between mathematicians and representatives from ISTO (Innovative Science and Technology Office), the arm of SDI funding research in universities, to investigate how mathematicians could help with SDI.

I won't take space to explain the dangerous and fraudulent nature of SDI, for in my experience mathematicians and scientists largely agree on this. SDI might not be politically viable after the end of the Reagan administration. Some scientists argue that although they regard SDI as stupid, they need not work against it, since it is unimportant and will die of its own weight.

But SDI has already had a large influence on the arms race. The Reagan administration has rejected the concept of a mutual verifiable ban on nuclear testing on the grounds that it would interfere with SDI research. In Iceland it has rejected a near-agreement for major mutual disarmament on the same grounds. *Newsweek* reports that Richard Perle (an influential DoD hawk) uses SDI as a monkey wrench in the arms control process. Whatever the ultimate outcome of the arms-control talks, and whatever opinion we have on the desirability of arms-control or of SDI, we cannot dismiss SDI as insignificant.

Generations

Those of us who came of age during the Vietnam war experienced a culture very different from that of people just a few years older. The generation gap was strong; it was "us" against "them." "They" were living in the past, sending "us" to fight in an immoral war. Many of us were involved in student demonstrations and student strikes. We were sprayed with tear gas, whether or not we protested. We had friends who were killed, others who refused induction and were convicted as felons, and others who served in Vietnam and survived with psychological scars that still dominate their lives.

But it is important for us of the Vietnam generation not to live in the past. Mathematics is a multigenerational and international enterprise. We need to recognize that others have been shaped by very different and sometimes very terrible experiences.

Many mathematicians who came of age during or after World War II but before the Vietnam war decry the current nature of the military, the SDI program, and perhaps the current DARPA program, and would like to see a return to the seemingly benign relationship between science and the military, as it was after World War II.

This is no longer the post World War II era and it is no longer the Vietnam era. We should re-examine the issue of military funding in light of the present and of what we hope for the future.

Military society and academic society

There is a basic contradiction between the principles which govern a military force and the principles of the academic environment. Military action is coercive. It is an extreme recourse, which should only be used under great duress. A military force is governed by authority, for it must act in concert.

In contrast, an academic institution is a place for reflective thought, diverse views, and considered discussions, not for the exercise of authority or coercion. It protects people from political fashions. It serves a society as a source of new ideas and a source of criticism for old beliefs.

For the health of society, military institutions and academic institutions should be *separated.* If, as many say, military institutions are not healthy enough to meet their internal research needs, let's cure the sickness rather than spread the disease.

For purposes of discussion, we can divide military funding of science into two loose categories: true military research, and general research.

True military research is by its very nature secretive. Information which is freely exchanged in the international academic community does not give a competitive military advantage to a particular nation. True military research certainly does not belong in a university. Nevertheless, it is present. For example, senior faculty in some of the best computer science departments are working on a big project to design "intelligent" military vehicles.

Much of the research funded by the military on university campuses is not truly military research, but general research. Scientists on military grants often maintain that they are doing the same basic research they would be doing if their grant was from NSF. On the collective level this is clearly false: military funding priorities are very special.

It is a dangerous reversal of the proper relationship between military and civilian life when control of civilian enterprises is funneled through the military. This reversal has taken place in fields not far from mathematics. It is difficult for students in many fields to *avoid* working on military projects. In places like MIT, graduate students in physics routinely shuttle between summer jobs doing true military research at the affiliated military laboratories, and general research funded by the military on the campus. The reversed relationship has funneled too much of our scientific and engineering effort into military matters.

In computer science, the major departments are now the ones which have a good relation with DARPA. According to an ACM report *Imbalance between growth and funding in academic computing science* by Gries, Miller, Ritchie and Young, a survey showed that in the top four departments the NSF support per faculty member in 1985 averaged $31,000, while that from the Department of Defense averaged $279,000. Such a department is in effect owned by the military. During quiet periods, the military is usually wise enough not to pull as much as they might on the strings, but the strings are well in place, to be pulled at need and at will. The military funding has emphasized applied research at the expense of theoretical research. In important areas of research such as VLSI (very large scale integration, the technology used for today's most important computer chips), the influence is so strong that information exchange is primarily at military conferences, not in journals. The information is available only to insiders.

The setting of research priorities should be a civilian process. The reversal of roles in which the military took responsibility for scientific research may have been appropriate during and shortly after World War II, but it is inappropriate, inefficient and dangerous today.

Mathematics Departments

Mathematicians are reluctant to concern themselves with grants of their colleagues.

Such an attitude makes sense only as long as grants are small in scale, and do not impinge on others. With the new funding, this is no longer the case. There are community issues within mathematics departments of immediate concern to mathematicians.

The typical military grant is large in comparison to other sources of funding within most departments, especially in this time of funding scarcity. The money has an impact on graduate students. A department has two choices: student support is either distributed among students in a wide pool, or it goes to students of the participants in the grant.

With the first approach, students are essentially forced to take military money in order to remain in the department. Students are in a position of disadvantage in presenting their case, and it is not right to trample over their scruples.

The second approach leads to inequity: students of those who accept military grants likely receive better funding than those who do not accept military grants.

An additional difficulty is that foreign students are not eligible for support on many military grants.

There is a similar problem regarding computer equipment, which is increasingly important to mathematicians. If equipment is pooled within a department, members of the department are forced to accept military money to use the equipment. If equipment is not pooled, mini-empires are created within departments, a commonplace and divisive phenomenon in some disciplines.

Should people who have scruples against military grants or who do not have research

interests in fields favored by military agencies be handicapped in attracting graduate students, in this time of a shortage of students? *Do we want this process to determine the direction of mathematics?*

Management

Military funding is frequently not managed for the good health of science. There are two reasons for this.

First, although the decision process varies among military agencies, it often involves much less expert and disinterested outside input than the process in the NSF. Thus, decisions are much more dependent on the integrity and quality of the program directors — which is variable. Personal relationships, rather than quality of research, may determine research grants. Researchers are tempted to say what the program administrator wants to hear. It is easy to invent proposals which are persuasive to people who don't quite know what is going on.

Second, the research funded by the military must be justified by military needs, not just scientific interest. At the 1986 mathematics chairman's day, Arthur Wouk of the ARO (Army Research Office), described the mission of the ARO program in mathematics: shock, blast, and penetration. His frankness is to be commended; it is not the ARO that sets these goals, but the army research labs and the generals. Some mathematical methods useful for understanding shock, blast, and penetration are of general interest, but this is a byproduct. Similar public statements can be found for the other military agencies.

The narrowing of goals stemming from mission-directed research saps the health of mathematics. The strength of mathematics comes from its diversity and its unity. Mathematicians study a tremendous range of interesting phenomena. As we go from one mathematical theory to another, we find connections which give us glimpses of one magnificent edifice which encompasses them all. Mission-directed research prevents us wandering where our interests lead. If one compares the tremendous intellectual breadth of research supported by the NSF mathematics division to that supported, with a comparable total budget, by the military agencies, it is clear that the ratio of ideas per dollar is far larger for the NSF.

We live in a democratic country

One rationalization for military research starts from the fact that we live in a democratic country. The train of thought continues: Democracy means individuals following the will of the majority. Since the general public and elected officials seek increased military power, it is our duty to go along; moreover we must explain our own research in military terms so they will listen to us.

In fact, the few bits of preference we communicate on election day are but a small part of democracy. The real workings of democracy are the discussions and actions of many people; elections are the guarantee and catalyst for this process.

For instance, military contractors often say their work is chosen through a democratic process for the good of the country. But the defense contractors all have strong lobbying efforts in Washington. Military projects are in fact born and nurtured in a coalition of lobbyists from industry, lobbyists from the Pentagon, and politicians. The military contractors have a large input to and a large responsibility for the choice of their work.

The combined mathematical societies, through the Joint Policy Board on Mathematics (JPBM) and its representative Ken Hoffman, have been sponsoring a strong effort in the Pentagon and in Congress to persuade them to increase Federal support, and in particular, military support, for research in mathematics. Their effort has been effective. The JPBM has solicited grants from DARPA for funding of mathematics awareness week. Ken Hoffman has defended DARPA against criticisms within the mathematical community. The JPBM and the Board on Mathematical Sciences selects and solicits mathematicians to testify before Congress and speak to the press: they explain that we need to present a simple message, spoken with one voice.

It is disingenuous to say our actions are merely in obedience to a democratic decision; these actions *are* the democratic process. Let us use this process to express our actual knowledge and our real beliefs.

Theorems and bombs: the effects of military funding

Many say that the act of accepting military funding is irrelevant to society at large: its only practical effect is to channel money away from bombs into better uses.

Money is one aspect of the research which is rather negligible to the military. The entire Federal mathematics research budget is about 1/5000 the size of the military budget, comparable in cost to a single fighter plane.

What difference, then, does military funding make? Strong effects are clearly visible: effects in technology, in politics, in the international order, and in culture. I will discuss these in turn.

Technology. In dismissing the relevance of their work to the real world, pure mathematicians forget that the development of mathematical knowledge is an informal process not measured merely by theorems. Progress in mathematics is mainly the clarification and compression of thinking and the sharpening of concepts and analytical tools. The accompanying logical lattice of

formally stated and established theorems is significant, but as new and sharper concepts replace old, mathematicians can often quickly reconstruct proofs for theorems which were once difficult.

Mathematics is a universal subject precisely *because* it is abstract. The fields of mathematics are intellectually closely related. Although human limitations lead individuals to specialize, still, mathematicians have in common a powerful and general-purpose way of thinking.

Recently, through circumstance, I have spent time with computer scientists. I find myself talking and thinking about computer science problems, and analyzing them with modes of thought sometimes foreign to the culture of computer science. I enjoy this. My experience would be similar if I were to spend time with physicists, biologists, economists, chemists, engineers ... — or with weapons makers. My theorems are not the commodity which I have to offer them, but rather expertise in mathematical modes of thinking.

When the military funds academic research, the most important *technological* commodity they buy is access to the intellect and intellectual environment of the researchers.

Politics. Military funding of scientific research by respected scientists and in respected academic institutions has a political effect, independent of its technological effect.

First, the funding undercuts potentially strong opposition by scientists to military projects. Some people argue that mathematicians should oppose the DARPA program in mathematics on an institutional level, but not on an individual level; people should take grants from them, but register their opposition to the program as a whole. How many of the mathematicians currently receiving DARPA support are likely to publicly register such opposition? At the 1986 DARPA mathematics meeting at Boston University, the director of the DARPA mathematics program, Dr. Helena Wisniewski stressed the need for people with grants in the program to go out and support the program. This is natural; people with grants from the NSF go out and defend their program. It puts those who accept support in an awkward position if they believe the program itself is dubious.

Donald Hicks, recently resigned as undersecretary of defense for research and engineering, made an infamous public statement in which he said that he would like to see funds cut off from scientists receiving support from the DoD who speak out and "bite the hand that feeds them."

A second political effect of military funding arises from the high prestige of university research in the eyes of the public and Congress. This acts as a political lever. Ionson, the director of SDI's Office for Innovative Science and Technology, said, "It's probably something that's never been done, but this office is trying to sell something to Congress. If we can say that this fellow at MIT will get money to do such and such research, it's really something to sell." Scientists will never receive a large proportion of the defense budget, but they can make a large impression in the minds of Congress. Their research greases the way for far bigger expenditures on far more noxious projects. On a smaller scale, program directors in the military agencies cite distinguished participants, who are given freedom to ignore the program mission, in order to justify their entire programs.

Military funding of mathematics is like a portion of the military advertising budget. It is small in proportion to the total budget, but highly visible. Computer-generated pictures by mathematicians appear on their glossy brochures and postcards. Many people who would not even consider accepting direct payments to advertise in favor of higher military funding or SDI accept "advertising" money indirectly for their research. When you accept support, you should consider whether the product you advertise is a product you wish to promote.

The international order. Mathematics is a particularly international field. The military encroachment on US mathematics will drain this international spirit. Many foreign mathematicians already are inhibited from discussing international relations with Americans because of different understandings of the world; this effect will grow.

In every country, people like Edward Teller warn about the enemy's ominous military research. All military-funded research adds to the atmosphere of threat, because politicians can't tell true military research from military-funded general research. The atmosphere of threat is more important than military capability. France has enough military warheads to destroy the United States, yet this does not disturb us, because our relations are generally good.

Culture. There are marked cultural differences between academic disciplines. The cultural differences play a large part in the careers and political outlooks of members of the disciplines. I don't think I need to give examples since we have all seen them. Militarily-funded general research paves the way to a culture which accepts true military research, classified research, and weapons research.

People model behavior on the behavior and expectations of those with whom they associate. This is a very powerful force.

NEEDS

The needs of mathematics and of mathematicians for more resources are clear and not in dispute. We are facing a shortage of mathematicians in the very near future — we need better support for students and for postdocs. Also, we have large needs for wider summer support, along with new

needs for computer equipment and technical staff to support and maintain the equipment.

Being poor does not mean we should sell out.

WE ARE NOT POWERLESS

Some people say it is a political fact that people in our country are much more ready to vote for something if it is justified in military terms. It is much easier to get what we want if we pose it thus. We are not the ones to decide how money will be spent; we have to take what comes along, or be left behind. Ken Hoffman compares the situation to Dunkirk: the boats may look rather leaky, but if we are going to sit on the beach and wait for a troop carrier we will be left behind.

We are not under attack from a hostile force. We are also not powerless. We have a strong case, and an important product: we do not have to sell it for potential military applications. Mathematicians have traditionally been detached from politics and lobbying, but that does not mean we never can or will take action.

There is great power in truth and sincerity. The mathematics community has tremendous reserves of human potential energy. If we are lean and hungry, we are likely to use our energy. If we are honest, it is likely to be effective, for whether justified or not, the public and Congress hold scientists (including mathematicians) in a certain awe. Let us tell the NSF, tell Congress, and tell the public what mathematics is really about.

CONCLUSIONS

1. There has been opposition within the AMS to discussion of the wider issues associated with military funding, with the explanation that they are political issues. Democracy is political; the issues are professionally and ethically of great moment, and we need to have a general discussion in which all responsible points of view are considered.

2. Funding of basic research is an important societal need, and it should be met through civilian agencies. Academia should be separated from the military. Military funding of research in universities, and of mathematics in particular, is bad for our society, bad for the universities, and bad for mathematics.

The military pattern of funding has a large negative impact, since it attaches strong strings from the military to academia. Even in normal times, this channels the short supply of mathematicians into an intellectually limited range of topics, and distorts the debates on societal issues. In troubled times, the strings can be exercised to disastrous effect.

Individual funding by military grants has a negative impact on the rest of the community — an impact on dangerous technology, on politics and public relations, on international relations, and on the culture of mathematics itself.

3. We should resist the increasing role of the military in academia and in mathematics, and work to replace military funding by civilian funding.

3a. Those of us who believe military funding is wrong should reconcile our actions to our beliefs.

We should also discuss the issues, without rancor, with people who believe military funding is right, and with those who believe military funding is wrong but that acceptance of military funding is right. Many sincere and well-intentioned mathematicians have military grants; some of them work in fields or subcultures where they have little choice but to accept them. During the era of the Vietnam war, there was much name-calling concerning the question of the military on campus. We need to recognize the honesty and good will of those who accept military grants, while opposing their actions. It is up to the conscience of the individual what grants to accept.

3b. The AMS should take a position in the JPBM and instruct its agents not to promote military funding, and it should make a policy decision not to participate in military grants.

3c. The Board on Mathematical Sciences, an arm of the NRC and NAS, should stop acting as a marketing agent for military funding programs.

3d. When a consensus can be reached, the AMS should take the further step of advocating decreased military funding, taking particular care to find appropriate alternate funding for fields which have traditionally depended on military support.

Bill Thurston
Princeton University
(Received October 25, 1986)

The Goal of Communicating

When trying to glean from papers the authors' motivations for doing the work, we often get an impression that the authors might be saying "so and so worked on this problem and I can generalize those results," in other words, the goal is one-upmanship. There is very little discussion of goals in the literature. Graduate students form their views of research in large part from the literature so this lack of guidance encourages the beginner to do motivationless research.

I would like to propose to those who might feel a lack of direction that they try to adopt as their primary research goal the discovery and communication of ideas that people need to know. Ideas that surprise. Ideas that are useful. Ideas that need to be communicated. Why they need to be communicated and to whom is up to the researcher to decide. This type of research requires a different approach. At least half the effort should be put into finding the right problem. Technical power in the proofs may turn out to be useful, but it is a secondary by-product, no more important than the results. There are

Motions at the Business Meeting

A group consisting of William P. Thurston, Michael Shub, Irwin Kra, Lipman Bers, Lee D. Mosher, Lucy J. Garnett, Linda Keen, and Jean E. Taylor has stated its intention of introducing the following two motions at the Business Meeting.

Motion 1. Many scientists consider SDI (commonly referred to as Star Wars) incapable of achieving its stated goals and dangerously destabilizing. Participation by universities and professional organizations lends a spurious scientific legitimacy to it. Therefore the AMS will lend no support to the Star Wars program. In particular, no one acting as a representative of the AMS shall participate in efforts to obtain funding for Star Wars research or to mediate between agencies granting Star Wars research and those seeking to apply for it.

Motion 2. The AMS is concerned about the increasing militarization of support for mathematics research. There is a tendency to distribute this support through narrowly focussed (mission oriented) programs which circumvent normal peer review procedures. This tendency, unless checked, may skew and ultimately injure mathematics in the United States. Therefore those representing the AMS are requested to direct their efforts towards increasing the fraction of non-military funding for mathematics research, as well as towards increasing total research support.

The handling of motions at a Business Meeting is described in Article X, Section 1 of the bylaws, here quoted in entirety.

Section 1. The annual meeting of the Society shall be held between the fifteenth of December and the tenth of February next following. Notice of the time and place of this meeting shall be mailed by the secretary or an associate secretary to the last known post office address of each member of the Society. The times and places of the annual and other meetings of the Society shall be designated by the Council. There shall be a business meeting of the Society at the annual meeting and at the summer meeting. A business meeting of the Society shall take final action only on business accepted by unanimous consent, or business notified to the full membership of the Society in the call for the meeting, except that the business meetings held at either the annual meeting or the summer meeting may take final action on business which has been recommended for consideration by the Council and has been accepted by the vote of four-fifths of the Society present and voting at such a meeting. Such notification shall be made only when so directed by a previous business meeting of the Society or by the Council.

It is the interpretation of the Secretary that each motion, if passed, would constitute "final action," so that the Business Meeting may not vote on the substance. The Business Meeting has at least the following options. It may amend the motions, refer them to a committee with or without instructions, vote not to consider the motions further, or vote to put them on the agenda of a future Business Meeting for definitive action. The next two Business Meetings are in Salt Lake City in August 1987 and in Atlanta in January 1988.

The Committee on the Agenda will consider these motions in the manner described in the box on page 52 and may have a recommendation. Other information and advice may also be available.

Everett Pitcher
Secretary

The first sentence of Motion 1 reads, "Many scientists consider SDI ... incapable of achieving its stated goals and dangerously destabilizing." Now SDI may (or may not) be destabilizing, but this is a judgement about international politics in which scientists (and in particular mathematicians) have no special expertise. As a citizen, I share this negative judgement but I do not think it is the business of our Society nor do I think that political leaders will pay the slightest attention to the views of the AMS on this question.

While many scientists do consider "SDI ... incapable ... of reaching its stated goals" (Motion 1) it is not clear which goals are meant: They have been stated quite differently by different authorities at different times. For some of the goals, there may be "proof" that they are unattainable; however, experts with classified knowledge may have classified experimental evidence that other goals can perhaps be attained. Among those many scientists who voted in various opinion polls on this issue, we do not know how many had real (or even classified) knowledge. I suggest that what we need is not such a sweeping statement about the goals, but perhaps a call for a careful, objective, and informal study, by scientists and others, of the merits and demerits of SDI.

Such a study is what has been tragically lacking and is *still* lacking. Pending such a study, the last sentences of Motion 1 (non-participation of the AMS in SDI) is an appropriate position for our Society.

To give a specific reference as to different goals: The Jan. 6, 1987 issue of *Science* (vol. 235) carries an article (p. 277) "Debate over SDI enters new phase" which begins "A clash over goals... ." Thus the motion presented to the business meeting did not take account of the actual political debate about the goals—and the Society is hardly in a position to take note of these rapidly changing arguments.

Motion 2 speaks of the "increasing militarization of mathematical research," although the statistical evidence (% of such funding by military agencies) does not strongly bear this out. There is perhaps more evidence for the growth of "narrowly funded (mission-oriented) programs." This issue has several subtle aspects. We are not experts on some of these missions; whatever we say, the government is likely to have mission-oriented agencies, some of which may need highly specialized mathematical help and may pay well for this help. We are (or can be) experts on the distortion of mathematics, but the motion does not say why this should matter to the country. A strong and balanced mathematical activity is important to the prosperity and especially to the long run security of the United States. A suitable motion should say so.

The long continued government support of mathematical research, complete with summer salaries, came about in large part because mathematics and mathematicians served to good effect in military research during World War II. I was personally glad to take part in that (classified) research at that time, as Director of the Applied Mathematics Group, Columbia. After the war the military agencies, led by the ONR, generously supported all sorts of mathematical research, because of a clear recognition that mathematics could matter in an emergency. We can earnestly hope that another such emergency will not arise, and that the country can work through to wiser policies to avoid another such emergency. But an appropriate motion for the AMS should convey the idea that balanced support of mathematical research is not just for our own benefit.

Saunders Mac Lane
The University of Chicago
(Received February 3, 1987)

P.S. For completeness I state I have personally done no classified research since 1945. I have held research grants (in homological algebra, but not currently) from both AFOSR and ONR. I currently have a security clearance, because I was chairman of the Report Review Committee of the National Academy of Sciences, and because this committee was charged (by vote of the Academy) to review carefully all classified reports issued by that Academy. In this work my experience with mathematics was an important background—even for reports not overtly mathematical. I mention this as a minor instance of the observation that mathematics matters to the security of the country. It would be unfortunate if motions by the society should appear to ignore the possibility of real issues of national security.

Comments on the Points Raised in Thurston's Letter

Having served on several Washington committees concerned with the support of basic research in the sciences, I would like to comment on Bill Thurston's letter to the Editor in the January 1987, issue of *Notices*.

I would sumarize Bill's argument as follows:

I. Mathematical thinking is powerful and therefore useful to society, particularly to the Department of Defense.

II. Mathematicians should not seek resources from DOD because:

(1) He who pays the piper calls the tune. Since military institutions and academic institutions are inimicable in style and substance, the tune DOD would like us to play would be discordant—inharmonious to our discipline.

(2) If large DOD resources were made available to mathematics, an imbalance would result.

(3) The DOD does not use peer review in the selection of proposals for support; frequently advisory committees are not used for the selection of programs.

(4) Accepting DOD funding lends support to the military establishment.

I. I agree. The Federal government supports mathematics above and beyond its support for the arts largely because of its usefulness to society. Washington responded positively to the David Report because it is beginning to understand the importance of mathematics.

II (1). The argument that federal support of basic research would bring with it unwanted restrictions and corrupting influences is an old one. Many of us taught summer school when we were young. We were pleased that our older colleagues, who believed government support would be beneficial, prevailed. I think there is common agreement that government support has greatly enhanced mathematics in the United States with much benefit to society.

But those who warned of government interference had a point. For example, Government auditors and university administrators hit upon time and effort reporting as a method of accountability for grants. Led by Serge Lang, we have been trying to eliminate that method of accountability so inimicable to university life. For the moment, it appears we have won.

See the Corson report ("Scientific Communication and National Security," National Academy of Sciences, 1982) for another example. It attempts to resolve the apparent conflict between free flow of scientific information and national security needs.

It seems to me that we have benefited by seeking and accepting Federal support for basic research while at the same time fighting explicitly against specific restrictions destructive to our discipline.

Those who commissioned Bill Thurston's article probably feel that while my argument may be valid for support from civilian agencies, it is not valid for DOD. I believe differently.

Many in the Defense Department recognize how important basic research is to the welfare of the nation and to the broad aims of their agency. They therefore feel basic research is worth supporting on a broad front. DOD has a tradition of supporting research in mathematics without strings attached, a tradition which we should encourage.

I would suggest then we follow an established and successful precedent: seek and accept DOD support but be on the alert and argue against specific restrictions detrimental to us.

II (2). The large resources made available to the scientific community by the Federal government has already created a considerable imbalance in universities. Check your local English department. Better still, contrast the resources for research mathematicians, with say, those for composers. By and large the humanities are poorly supported compared to the sciences. On the other side of the coin, graduate student support in mathematics is much smaller than other sciences (see the David Report). So where Thurston states he is concerned about imbalance, I would say he is concerned about change—the present imbalances are manifest.

I too am concerned about change, but in a different way. I think that greater support for mathematical research would benefit the country enormously. And it would allow us to capitalize on the exciting developments happening this very moment in mathematics.

I don't think the percentage of support from DOD will increase much, if at all. Moreover, I don't see it affecting our way of working, if we are careful about guarding against harmful restrictions.

II (3). When I was chairman of the Committee of Science and Public Policy (National Academy of Sciences) I oversaw two studies of Peer Review (see Peer Review in the National Science Foundation, Phases I, II, National Academy of Sciences, 1978 and 1981). Peer Review (which needs to be defined; it means different things at NSF than at NIH, for example) is the best system I know for determining which proposals to support. But I learned that it is very conservative. Very few gambles can be taken and it is almost impossible to begin new activities. Therefore, I believe it is unwise to rely on peer review as the only way to determine which areas of science to support and which scientists to support.

My experiences in Washington suggest a different and perhaps more constructive approach. The mathematical community should attempt to be more involved in the recruitment of mathematics program officers and their superiors in all agencies that support basic research. We should continue to strengthen our contacts with all agencies and be ready to offer our advice about research opportunities in mathematics, when it is sought.

II (4). Yes it does. The added statement that that's bad is a political or moral judgment. One that I don't agree with. And I don't particularly care to have someone else's political position dictate where I and other scientists should seek support.

I. M. Singer
Massachusetts Institute of Technology
(Received March 3, 1987)

In Support of the Motion Against SDI

I have been encouraged to reiterate in print, presumably for a wider audience, the comments that I made in San Antonio at the business meeting of the society.

There are clear and persuasive reasons for strong opposition to the so-called Strategic Defense Initiative (SDI). First, it amounts to a major escalation of the arms race. The word "defense" and the rhetoric of "umbrellas" are transparent fig leaves. Even a superficial reading of the proposals associated with SDI makes clear

that the envisioned systems could either directly and immediately be used offensively or could be used in that way with very minor modifications. Already the initiation of this idea has aggravated world tensions. Each step of building, testing, and putting in place will be that much more dangerous.

Second, the idea of SDI makes the current president and possibly his successor(s) intransigent in negotiating for arms reductions. This is no idle or marginal concern. Many observers feel that a perhaps unprecedented opportunity for arms reduction was missed in Iceland due to President Reagan's fixation on SDI.

Third, SDI is unrealistic. The fantasy is lifted whole from the "Death Star" of the Star Wars movies; such movies are not a plausible source for developing United States policy. That the envisioned systems are unrealistic has been the judgement of the overwhelming majority in every poll I've seen of people with relevant expertise. One might indulge oneself in what is unrealistic but harmless for the sake of the inevitable spin-off gains in knowledge. SDI is not, however, harmless. In addition to the above grave dangers, commitment of societal resources to SDI must inevitably drain those resources away from pressing needs, which will be reflected not only in the dollar figures of the U.S. budget but also in the allocation of intellectual and institutional resources. Also, one can realistically expect of SDI research an increased variety of weapons, which will hardly be harmless.

If it be given that SDI is a grave mistake, and therefore something which reasonable citizens should oppose, one should ask: what action should the membership of the AMS take *qua* members of the society, as distinct from actions we may choose to take as individuals or as members of other groups, e.g., political parties or religious organizations or whatever.

In response to that it should be first made clear that the current proposal, Motion 1, as it appears on page 76 of the January 1987 issue of *Notices*, is only a neutral stand. It says that the AMS "will lend no support," NOT "will oppose." Further, the representatives of the AMS, when acting *qua* representatives of the AMS will not seek funding for SDI related research, NOT that they shall attempt to hinder or interfere with such.

Even if Motion 1 be interpreted as in effect putting the AMS on record as opposed to SDI, that would not be improper *per se*. If the majority of the members of the AMS are persuaded by arguments similar to the above to oppose SDI, then it is fully appropriate for us to say so as mathematicians, expressing ourselves through a mathematical body. Our fellow citizens and elected officials correctly recognize that mathematicians have training that in fact helps us judge the reasonableness of SDI. Let us not underestimate the significance of our own training and perspective.

Healthy and wise action on the part of a free, open, and democratic society depends on citizens who publicly debate and publicly speak their minds. Within reasonable limits professional organizations such as the AMS provide an appropriate avenue for such speech, exactly when the expertise we share has relevance to the issue at hand. (Some may mutter: "Exactly! In this case we have no relevant expertise!" But if that were so, then why would we be potentially involved in the research? We have expertise; the mathematical community is and will be involved, acting as mathematicians.)

No one will deny the importance of the issues at hand. That which may increase the likelihood of nuclear war between the major powers literally threatens the survival of humankind, perhaps of all life, on the planet. In such a case being overly circumspect about the forum in which one speaks is neither wise nor responsible. I urge the membership of the AMS to support Motion 1, which would put the AMS in a neutral position with regard to SDI. I urge them further to oppose SDI in those contexts where expressing such opposition is appropriate.

Samuel B. Johnson
Guilford College
(Received March 9, 1987)

The Quest for National Security

Sponsored by hundreds of AMS members, two motions on military funding were put on the agenda for the next Business Meeting. The paper by Hyman Bass for the AMS panel at San Antonio takes up the questions raised by these two motions. His mention of SDI is brief and appears to support the group's Motion 1 completely. The bulk of his article is a treatment of exactly the question raised by Motion 2 of the group on military funding: the consequences for mathematics, in the present context, of military funding in general. He comes to a conclusion much more welcoming of military support than the group does.

Professor Bass speaks from years of awareness and a store of detailed knowledge. His remarks deserve to be taken seriously. Exactly for this reason it is important to be alert to a danger of confusion in his assumptions.

His premise 1 reads, "National security, like economic strength and social well-being, is a legitimate national goal, to which scientists can significantly contribute. As such, it deserves appropriate public and scientific support." Now who could possibly object to *that*? All the same, it opens the door to a possible confusion which (as I trust Professor Bass would agree) must be avoided. Namely, it leaves unexamined the question of what agencies support national security.

But this question is not self-answering. One surely ought not to take for granted that the goal of national security can be identified with the goals of government agencies that purport to defend it—like the National Security Agency and the Department of Defense. They have those good words in their names, but we must look at their actual policies. One of the reasons there is concern about DARPA money, CIA money, and SDIO money is precisely that it does *not* increase security, but in many people's view decreases it; that U.S. weapons, while they threaten the whole world (including ourselves), and have been used against countries powerless to attack us, can not be seen in many people's view to be defending us from anything.

The copiously flowing money is directed to designing and building more numerous and more destructive weapons which can be fired more quickly in response to alarms. But the greatest problem we face, the greatest problem the world has ever faced, is exactly that the weapons are now too numerous, too destructive, and too quick on the trigger. The main objectives of the Department of Defense, therefore, work to destroy security, what little of it we have left. This is true not only of their weapons production, but also of their research.

I am not saying that research per se undermines security, even mission-oriented research—not at all. Let us have mission-oriented research in the interest of national security, if we can get it. Research on satellites which would detect and publish to all parties evidence of warlike moves by anyone. Research on how to dismantle nuclear weapons and nuclear installations safely. Research on converting military industry to useful production without causing economic dislocation. Let us (individually and through AMS and JPBM) encourage mathematicians to do such research. But it is silly to expect support for it from organizations going in the opposite direction—such as the so-called Department of Defense. Military funding is anti-security.

Chandler Davis
University of Toronto
(Received February 27, 1987)

Urging Rejection of the SDI Motion

In the *Notices*, January 1987 on page 76, there appear two motions seeking to bind the AMS in opposition to mathematical projects funded by the U.S. Department of Defense, particularly by military sources such as SDI. I urge the members of the AMS to reject these motions, which I consider to be outside the authority and interest of the AMS.

The DOD, with various programs such as SDI, has a legitimate and important role in the American republic. The SDI represents an established policy of the U.S. government and has been formally endorsed by Congress. It is not a frivolous or foolish concept, as attested by the many serious supporting discussions and writings by authorities on international relations and military strategy—for example, by the current Democratic Senate Majority Leader, R. Byrd, as well as by experts in prior administrations such as H. Kissinger and Z. Brzezinski.

Honest opinions may differ on the long-term value of SDI to the people of the U.S.; therefore the AMS membership should not be casually assigned to any particular position. It is not appropriate for the Society to make an official statement on any such political policy except, perhaps, after a special vote of the entire membership.

Recent polls show that a substantial majority of the American people support SDI and I believe that similar support would occur among the membership of the AMS. Moreover, my experience indicates that most of these mathematicians would support SDI, and other policies of DOD, not because they anticipate personal gains through military funding, nor because they are intrigued by scientific curiosity and excitement, but because they sincerely believe that these policies constitute a valid program contributing to the defense of the security and freedom of the American people—as well as of other peoples of the world.

It would be undemocratic, even dictatorial, for a few dozen partisan advocates at a Business Meeting to pretend to commit the entire membership of the AMS on these matters.

Lawrence Markus
University of Minnesota,
Minneapolis
(Received January 14, 1987)

Research Funding

Last June, I learned that Sheldon Kamienny's NSF grant was not renewed. I wish to take this occasion to make some general comments on current NSF funding in light of this special case.

1. Financial support by the NSF today is insufficient to insure proper funding at the level of activity which both scientists and many people in the government seem to find appropriate. One result is that the cut off point for NSF grants is so high that reviewers for the NSF are placed in a position where they cannot function intelligently, and are playing dice. The lack of funds thus induces a malfunctioning of the peer review system. Who am I to be playing God and determine who is to get one month, or two months summer salary support, with many candidates equally worthy?

A few years ago, the NSF was cutting back on the support of a mathematician, basing its judgement in part on comments like: "This is a carefully written proposal. It would have been quite fashionable ten years ago." Some people contacted the NSF to complain about any

attempts to cut down the support of this mathematician on the grounds that his research was very substantial and very promising. Although he received only one month summer salary support for one year, he got back to two months a year later. I also know of another case when peer reviewers stated that the research proposal was not "in the main stream." It is NSF policy today to forward such reports to principal investigators automatically. Investigators should be able to see the reviews on request. But to be exposed to this kind of peer review inhibits originality, encourages researchers to follow fashions, and demoralizes the researchers. Original research can change "the" stream, whatever it is. Less productive periods can be followed by more productive ones. We never know when an idea will come, nor how good an idea it will be. Support should be long range. The current combination of a shortage of funds and peer reviews like the above is not supportive.

In the case of Kamienny, the peer reviewers rated his proposal: two good, two very good, and one between good and very good. It is true that Barry Mazur gave the original ideas and technical impetus for Kamienny's direction of research, namely modular forms, Eisenstein ideals, rational points. But in this school, there are very few people able to pursue this direction and keep it alive, and Kamienny is one of them—perhaps the only one today keeping it alive. And what he does, he does very well. During the last year, he also has had some quite good ideas with new insights which make it a real possibility that he may cause a breakthrough at some point. The subject is of such depth that several years must be invested in it before peer reviewers should expect such a breakthrough. It is demoralizing both for Kamienny and for others, me in particular, to see one more example of the NSF's support of mathematics not functioning properly.

2. It is quite unhealthy to support mathematics—science—by taking someone like Mazur as the cut-off point for guaranteed support, with the rest subject to arbitrary decisions depending on tastes and whims of reviewers because of lack of funds. The NSF is now in a position where if it gives summer salary support to one person below this point, then it has to withold it from another of comparable quality. Thus the NSF cannot fulfill its mission properly. The infrastructure must be supported. For instance, Kamienny is outside the big time centers like Princeton, Harvard, Berkeley, and thus deserves all the more encouragement. What's the point of giving big time grants to the super people and their graduate students at those places if most of these students are going to be dumped a few years after their Ph.D.? Are those students told that when they attend graduate school? To some extent there is a certain amount of lack of truth in packaging if they are not warned of the way they are going to be treated later. People like me would be irresponsible to advise students to go into mathematics—pure mathematics at least—knowing what can happen to them. Is it the Government's intention to drive people like Kamienny out of mathematics?

In fact this may very well happen. Kamienny has written me that lack of financial support means that he had to cut short his visit to MSRI during the special year on arithmetic; also that the absence of travel money makes it difficult for him to consult with colleagues in order to continue doing research.

3. Even more importantly, NSF decisions affect tenure positions. Kamienny wrote me that rejection of his grant by the NSF affects his prospects for tenure at Ohio State. Joseph Ferrar, Chairman of his Department, told me (authorized quote): "It is clear in our department that in recent years the existence or non-existence of an NSF grant has played an important role in tenure deliberations." Speaking for himself personally, Joseph Ferrar also told me: "If there is to be less money available for support of mathematics research than is necessary to support qualified applicants, then I feel that it would be wise to cut back across the board on summer salary support and devote the money available to other categories such as travel, consulting, equipment, and so on, so that more people are supported."

4. Of course, the distinction between "pure" and "applied" mathematics is not absolute, but in "applied" directions, money seems to be much more easily available. Historically, some pure mathematicians have gone from one to the other, and it is never possible to tell when such transfers of persons or subjects will happen (*vide* the Goppa codes in connection with Shimura curves, for instance).

5. The shortage of funds available to the NSF is parallel to the expansion of funds available for support via the Defense Department or things like SDI (Star Wars). As a result, some scientists—mathematicians—who find insufficient money to do research in the universities via NSF are now directing their fund raising efforts toward the Defense Department. We have seen during the Vietnam war where this leads.

I oppose this trend for at least two reasons:

one, it transforms research whose origins lie with the researcher and the universities into directed research, with specific goals set a priori, and even military goals at that;

two, the universities get hooked on military funding, with all the political implications that go along with this, and the substantial erosion of whatever independence the universities have.

Serge Lang
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(Received October 4, 1986)

Referendum

The AMS referendum on issues in federal support of mathematics has been a resounding success. All motions passed, most by very large margins. After considerable discussion last year over the wording of the motions, the final formulation was recognized as permitting a sounding of members' preference in this area. The unprecedented extent of debate in the *Notices* and at meetings led to an unprecedented volume of voting (more than twice as large as in an election of officers) and the outcome can be accepted without reservation as Society policy.

In our view, there is no doubt about a few immediate consequences. In particular, the Society representatives should now reorder their approach to the seeking of funding for mathematics. Mathematics has many actual and potential areas of application. Correspondingly, there are many agencies where we can seek funding while avoiding SDI and deemphasizing military work. Following the members' wishes in this regard will benefit both the profession and society.

Chandler Davis
University of Toronto

Lucy Garnett
Baruch College

Linda Keen
Lehman College

Lee Mosher
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Michael Shub
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Jean Taylor
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William Thurston
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(Received March 26, 1988)

Letters to the Editor

Mathematics and the AMS

Based on my recent impressions I doubt whether the American Mathematical Society is still a mathematical society.

I attended the Atlanta meeting and expected to meet many mathematicians there. Someone in your journal wrote the meeting was very enjoyable—perhaps he meant the Peachtree center. I was eager to talk mathematics with anyone (my own research is on mathematical crossroads) and was rebuffed with expressions like "I don't know," "I never heard of this before," "Send a preprint to me"—as if I was talking to clerks. Instead, those "mathematical" people around were busy with numerous conversations concerning Star Wars, Women's troubles in mathematics, appointments and promotions. None would like to try posing or solving a mathematical problem—with one exception. A nonsense man from Naval Research caught me after my talk and said ≈ "If you proved that, then maybe you can do the following problem..."; and we found a quieter room, sat and proved together a nice statement on algebraic relations between some analytic functions. It looks as if I met only 1 (one) mathematician at that crowded Atlanta meeting.

Another reason for my doubts is the contents of the *Notices*. When I was entering the AMS, the *Notices* were thoroughly mathematical: even the topics related to general politics were discussed in exact manner and within the competence of mathematicians. Recently I read in your journal that one does not need to know physics to judge a very large engineering project (the author suggests that it's enough to be literate) and that somebody is "right wing." If a mathematical journal prints "right wing" then no doubt the editor is on *the wrong wing*. This change was gradual and now I am fed up. Perhaps you cannot withstand the bullying of the "mathematical" politicians. So, I have a suggestion. I remember a discussion on whether one should receive the *Bulletin* as a part of the AMS membership (I always enjoyed the *Bulletin*)—now it's the time to discuss whether one should receive the *Notices* as a part of the AMS membership. I am tired of paying for garbage.

R. Gurevič
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at Urbana-Champaign
(Received March 21, 1988)

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.