COMMENTARY ON DEFENSE FUNDING

At the Council Meeting in Salt Lake City, it was decided to place five motions on a mail referendum which would be sent to the AMS membership following the January 1988 Annual Meeting. (See the reports of the Council Meeting and the Business Meeting in the AMS Reports and Communications section, October 1987 *Notices*, page 1013.) On page 13 of this issue of *Notices* is a bibliography of material pertaining to this referendum. This is the last issue of *Notices* in which this section will appear. Any further commentary on the defense funding issue should be directed to the *Notices* as a letter to the editor and will be considered for publication by the Editorial Committee according to the policy stated in the Letters to the Editor section of this issue of *Notices*.

James Glimm
New York University
Courant Institute of Mathematical Sciences

The debate over the San Antonio motions 1 and 2 could be epitomized by the question "Why do we want to shoot ourselves in the foot?" asked by one writer to these *Notices*.

The motions 1′ and 2′ are political, divisive, negative, backward looking, and contain technical errors. They should be rejected. The motions contain some useful ideas, which should be reformulated in constructive terms and considered for action by appropriate AMS committees. Some of the useful ideas are captured in motions 3′, 4′, and 5′ and others will be alluded to below.

POLITICAL refers to the promulgation by the AMS of policy statements that are not based on mathematical expertise or on information known principally to mathematicians. The mathematical community has had at most a marginal participation in the SDI program. For example it would not be possible to assemble a blue ribbon AMS panel with the technical credentials to evaluate SDI.

DIVISIVE refers to AMS resolutions which displease a significant block of mathematicians. The letters published in these *Notices* demonstrate the divisive character of motions 1 and 2. The council of the AMS has just established a policy directive to emphasize the importance of applied mathematics. That this policy coincides with a vote which has irritated many applied mathematicians indicates that there is still some distance for the AMS to move on the applications learning curve.

There are four reasons which have been used successfully to advance governmental support of science over the past four decades. These are (a) the support of science for its own sake, (b) defense and national security, (c) productivity and economic well-being and (d) health. These arguments do not compete with each other. They cooperate, both politically and intellectually. A success in one area will re-enforce our performance in all of the others. We would all prefer the support of mathematics for its own sake. Washington understands this and also the fact that our sister disciplines feel the same way about their own subjects. Politically effective plans must be built around opportunities in areas (b), (c), and (d) and we can argue that (a) must keep pace as well.

Applied mathematical thinking, whether done by engineers, applied physicists, or mathematicians, has a potentially enormous impact on society. Society has a stake in the outcome and will certainly play a large role in selecting the broader goals of science and applied mathematics. The economy of several U.S. cities will prosper or falter according to the ability of engineers and mathematicians to devise, use, and understand computer design codes which model the flow of air around a wing or engine inlet. The health of at least our young urban minorities and possibly of all of us has been jeopardized in the AIDS epidemic by a failure to act on the first principle of mathematical

epidemiology: early is the best and easiest time to confine an epidemic.

Defense and national security are also legitimate governmental functions. Defense has been employed by all governments throughout history, by democracies and dictatorships, by socialist and communist governments, and even by neutralist governments. Defense has been supported by all presidents and congresses in our own history.

It is not reasonable for the mathematics community to ask for a larger and more responsible role in the scientific life of our nation while pulling back from the defense area. If the thrust of the motions 1′ and 2′ is rather to broaden the base of applied mathematics problems by seeking opportunities in areas (c) and (d): productivity and health, then the sponsors should state this clearly. Such a thrust is a good idea. To achieve success will require more than voting on resolutions. Some mathematicians will have to put their careers and their talent on the line.

NEGATIVE politics is the listing of dislikes, while a positive policy consists of a practical plan for achieving desired goals. To illustrate the difference, I list some topics in the health area where mathematical thinking is being used and where the future prospects appear bright. Models of heart valves have been successful. More generally methods of fluid and continuum science can be applied to computational models of body tissues and organs. Biology at the molecular level requires a three dimensional reconstruction of known protein or gene sequences. Prominent success was achieved recently with the cold virus. Knot theory is relevant to genetics and the effective comparison of genetic sequences was proposed and first solved by mathematicians. The epidemiology of AIDS was mentioned above. The brain, as well as models for neurons and groups of neurons have been investigated by mathematicians.

BACKWARD LOOKING contrasts to (my estimate of) current and future political trends. After a period of increasing defense budgets, and with a large trade deficit, budget imbalance, and a possible runaway health problem, the major focus of political thought will shift to new areas. Those areas for which technology is amenable will present to the scientific community, and to mathematicians in particular, their best and most constructive opportunities.

TECHNICAL ERRORS are contained in the SDI motion. If SDI is infeasible, some research should continue, both to evaluate the ongoing Russian program in this area and to assess changes in the relevant technologies. It is a technical error to argue from infeasibility to oppose all SDI research. SDI comes in many flavors. The version studied and criticized by the American Physical Society has received only limited funding for several years. The technical error in the motion consists in using arguments against this version of SDI and applying them out of context to other or all versions of SDI.

CONCLUSION. A vote against motions 1′ and 2′ is not a vote for SDI. It is a vote in favor of good judgement and common sense by the mathematical community.

Saunders Mac Lane
The University of Chicago

In these *Notices* for October, 1987, pp. 895-896, Mikhail Katz holds that the shallowness of the current debate on military funding in mathematics stems from the lack of a historical perspective. At the end of his article, he asked that older mathematicians "step up and tell us all" on the subject of pre-Vietnam funding. I venture to respond, though I can't possibly tell "all" and my response necessarily rests in part on personal recollections.

Before World War II there was no federal government funding of research in mathematics. One possible exception is the National Research Council postdoctoral fellowships in the sciences, chiefly funded, I believe, by the Rockefeller Foundation; they were a major help to a number of young mathematicians in the 1930s.

During WWII, very many American scientists were enthusiastically engaged in war research of various types.[1] J. von Neumann and S. Ulam were at Los Alamos, F. Burton Jones and others at the Radiation Laboratory (for radar, at MIT), many were at Aberdeen for ballistics research and others worked for the Applied Mathematics Panel (AMP), directed by Warren Weaver (at that time, Vice President of the Rockefeller Foundation and a trustee of the AMS). I was active in the group at Columbia University, 1943–1945. The Applied Statistics Group at Columbia made some notable contributions—for example, Abraham Wald's discovery of sequential analysis.

After WWII, there was a general agreement that science (including mathematics) could make major contributions not just to military matters, but also to the general welfare. This idea was formulated by Vannevar Bush in his influential book *Science: The Endless Frontier.* One result was a congressional

[1] See also J. B. Rosser, "Mathematics and Mathematicians in World War II," October 1982, *Notices*, **29**, 6, pp. 509–515.

proposal for a National Science Foundation—vetoed by President Truman, because the proposal gave too much independent authority to the Foundation; the director of the NSF was to be elected by the members of the National Science Board (NSB). Only much later did I understand President Truman's objection. In the NSF now, both the director and the members of the NSB are appointed by the president. When I was a Board member (1974–1980). I noted that the officials of the NSF and the Board members paid great attention to the views of the President and the Congress: They were spending the taxpayer's money.

But in 1946 there was no NSF. Into this "funding gap" stepped the Office of Naval Research (ONR) to set up a program of contracts for scientific research. In mathematics, this covered both pure and applied mathematics. The program did not have a full peer review mechanism; however, the awards in mathematics were based on extensive advice from the mathematical community. This worked because that community was then much smaller than it now is, so that it was possible for an individual to know "all" active mathematicians (I estimate that in 1945–1950, I knew personally over 80% of the active research mathematicians in the USA).

The ONR program set the pattern for the other defense agencies and for the subsequently established NSF. For example, Alan Waterman, the first director of the NSF, came to that agency from the ONR. Initially, the mathematics program of ONR was managed by Mina Rees (Ph.D., Chicago 1931, who had been a technical aide for Warren Weaver at the AMP during the war).

Until about 1949, mathematicians generally expected that mathematical research was to be supported by university funds. This funding was inevitably modest. Then gradually there came to be funding from the ONR, then the NSF (established 1950) and from other defense agencies—OOR (the Office of Ordinance Research) and AFOSR (the Air Force Office of Scientific Research). Peer review methods were later introduced at AFOSR and perhaps at other agencies.

My own first contact with such funding was in preparing an application in 1950 to one of the defense agencies for funds to support a visit by Marcel Riesz to the University of Chicago (he came; he lectured on topics unrelated to defense.) For several years, I thought that a safe policy would be to use federal funding only for those items (such as visitors) which the department could do without if troubles arose. After a while, such a conservative policy was forgotten by everyone.

In 1957, the U.S.S.R. lofted Sputnik. The general concern that the USA was falling behind soon led to a drastic increase in funding for science—for example, the funding for the "new math" under the School Mathematics Study Group. All the federal agencies mentioned above took part. In the mathematical community, it was the general opinion that funding by a variety of agencies was much better than having just one big agency; if a grant application was rejected by one agency, there would be alternative possibilities. With the more extensive support, it became possible in many sciences to use government funds to pay part of the academic year salaries (an idea evidently appealing to deans and university administrators). In this and other regards, practice in mathematics was modeled on that in the other sciences. (Physicists, having achievements and needing big apparatus, knew their way around Washington much better than we mathematicians.)

Government funding for summer salaries for scientists began at the ONR in 1947 and developed slowly—first usually for 1/3 of annual salary; later at the NSF, 2/9ths. In 1960, Arthur Grad came from the ONR to be Program Director for the Mathematical Sciences at the NSF. He travelled around the country to gather information, to encourage grant applications and to encourage summer salaries and support for graduate students on grants. He is reported (incorrectly!) to have said that he wanted a Cadillac in front of every mathematician's house, so that students could see that the subject prospered (I never counted the Cadillacs, but I did observe a general upgrading of mathematicians' houses and a rapid increase in the NSF budget for mathematics). The various defense agencies (ONR, AFOSR, OOR) supported much applied mathematics and also much mathematics with no relation to the agencies' "mission."

This liberal support of science began to slow down about 1965. Subsequently, the Congress adopted the so called Mansfield Amendment (in the Armed Forces Military Procurement Act for 1971). This amendment required that the various defense agencies support only that scientific research which was relevant to the agency's mission. There was then an attempt to transfer some defense agency money previously used for the support of pure sciences to the NSF, but substantial portions of the money were dissipated in the transfer. The subsequent development of the funding of mathematics is summarized in the David report (*Notices*, **3** (1984) p. 435).

After this (hopefully) objective summary, I will try to comment on the more subtle question: To what extent did this government and defense funding

help or distort mathematics? In this, it is not easy to separate the effects of NSF funding from that by defense agencies.

First: It certainly encouraged the vigorous growth of American mathematical research in the period 1950–1970. It improved the financial situation of scientists, and it encouraged them to devote more time to research activities. (In many universities there was a real reduction of teaching loads for mathematicians.) The fact that grants were made to individuals or to small groups of mathematicians tended to strengthen their positions vis-a-vis university administrators. The number of research mathematicians was substantially increased by a liberal program of postdoctoral fellowships and the provision to fund research assistants under grants. Travel funds and grants for visitors sharply increased the rapid exchange of ideas.

Second: The defense agency support was a major source for the renewal of applied mathematics in this country. In the early part of this century, there had been an effective "native" school of applied mathematics. However, at several major institutions (for example, Yale, Chicago, Harvard, Wisconsin) leading applied mathematicians retired or left for administrative positions without training or finding talented replacements. I have not succeeded in understanding why this happened (in the 1930s). However, R. G. D. Richardson (at Brown University), Richard Courant (at NYU), Solomon Lefschetz (at Princeton), and others set about to build centers of applied mathematics. It is my observation that the support of the various defense agencies played a vital role in their success, notably at the Courant Institute. This did not happen at the cost of grants in pure mathematics.

Third: Did the defense agencies support pure mathematics across the board in this period 1950–1970? For 1950–1965, I think the answer is "yes"; though I have only sketchy evidence. For example, during this period I had several grants from the AFOSR for research on algebraic topology and homological algebra; I was never under any pressure to produce practical applications; only once, in 1967, was I asked to attend an AFOSR scientific seminar—where I gave a lecture on the origins of category theory!

Fourth: Peer review was not then the method of choice for the defense agencies, since they depended more on professional staff and on advisory committees. Did this lead to misjudgements? I do not know, and I do not think it possible to find an objective answer. I.M. Singer, for the National Academy of Sciences, once directed an empirical study of peer review at the NSF: What would happen with different reviewers? The answer was: It would be somewhat different—but we don't know if it would be better or worse.

Fifth: Quality? Occasionally research funded by defense agencies was largely nonsense; I know a couple of dandy examples from WWII. I also think I know examples of such NSF-funded research.

Sixth: Does funding by a defense agency constrain research or the activities of the recipient? For the period 1950–1970 in question here, I did not hear of any such constraints, and I personally noticed no such constraints. I think there was an unspoken understanding that government support of scientists meant that the scientists would be willing to help the government in a time of clear national emergency. The understanding was real. I recall one occasion when the chairman of the AFOSR advisory board notified several grantees that an international crisis was brewing; would we please start out to get a security clearance so we could be ready to help? I and others did so start.

I hope that this summary of the earlier aspects of government funding may be a useful background in the present inevitably changed situation.

I would like to thank Arthur Grad, Walter Leighton, Everett Pitcher, Mina Rees, and Barkley Rosser for knowledgeable and helpful comments on a first draft of this article—but they bear no responsibility for its final form.

Thomas R. Love
Daemen College

I am writing to support all five of the motions at the Salt Lake Meeting.

I was not going to comment on the motions until I heard of Dr. James Glimm speak in opposition to them. I could not let his statements go unchallenged. Dr. Glimm said that the members of the AMS are not technically competent to judge the merits of the Star Wars program. The American Physical Society recently released a study of the program which showed it is not viable. We are competent enough to read that report and agree with it.

Dr. Glimm and others gave us the standard patriotic rhetoric, saying in effect that we are talking about the defense of the country. We are talking about the Department of Defense, which until the late thirties was known as the War Department. Changing the name of the agency did not change its mission, but it did make it harder to fight: no one wants war, but who can argue against defense? If the program were purely defensive and technically viable, it would be

hard to argue against. But this program is neither: particle ray-guns are not purely defensive, they can easily be turned into offensive weapons; the APS study concluded that at least ten years of study would be required to determine if the program is viable.

Dr. Glimm listed several areas where mathematics could be used to help improve life on this planet: models of the spread of disease, food distribution, etc. I agree with him, these are areas which need to be studied. But there are limited funds available for research and limited numbers of mathematicians to work on them. If the Star Wars program draws the funds and the mathematicians, these other programs will not receive the funds or attention they should.

There are no moral issues in pure mathematics research (other than justifying the time spent by some of the best minds in the country on such esoteric questions when there are important questions facing humanity). But there are tremendous moral questions one must face when working on weapons systems. Will the next century see a modern version of Nuremburg trials where, after the destruction of most of the civilized world by a new generation of weapons, the scientist's only defense for their creation of the weapons is "Those were the only research funds available?"

It is time we realized that the only defense against nuclear weapons is peace.

Michael Shub
IBM Research
T.J. Watson Research Center

After consultation with other makers and cosigners of Motions 1 and 2 at Salt Lake City, I moved to table these motions at the Business Meeting with the following statement.

"It was our intention in putting these motions before the business meeting to expand the debate within the AMS on two important public policy issues of professional concern, and to allow the broadest possible base of the society to set the framework for those policies. The council has responded to the initiative of the Business meeting in San Antonio and has decided to bring the motions, slightly amended in a friendly way, to a mail ballot of the membership, and to have an open debate in the *Notices*. Moreover, they have decided to seek the guidance of the membership on three additional questions which arose in connection with the discussion of the San Antonio motions. I applaud this tendency to involve the membership in active debate and to rely on its judgement in setting overall policy and I see it as a success of the process set in motion in San Antonio.

The council has deferred to the outcome of the mail ballot and I think it would be appropriate for the Business meeting to do the same. The President has assured me that even if we table these motions, he still will allow discussions on their substance here today. So I move that Motions 1 and 2 before us be tabled in deference to the results of the mail ballot to be conducted by the Council."

The recommendation of the Committee of the Whole at the Business Meeting in San Antonio that Motions 1 and 2 be passed, obviously extends to the mail ballot.

Daniel B. Szyld
Duke University

It appears that the discussion about the motions concerning military funding of mathematics has taken an unusual twist. Some people now believe that only pure mathematicians favor the approval of the motions while applied scientists are all adamantly opposed to it. Nothing can be further from the truth. First of all, as is becoming more evident every day, there is little distinction between pure and applied mathematics. More important, among those traditionally called applied mathematicians there are many of us opposed to having our names and our brains used in a seemingly uncontrollable military buildup. Some even signed a pledge circulated by physicists not to solicit nor accept funding for Strategic Defense Initiative (SDI or Star Wars) research.

The single event which most contributed to this misperception seems to have been the publication in *SIAM News* (March 1987, p. 6) of Ettore Infante's Commentary "Is DOD Research Support Good for the Math Sciences?" which was similar to his position paper at the AMS meeting in San Antonio in January, and published in the *Notices* (February 1987, pp. 239-240).

In the commentary he essentially says that we, as scientists, should do science and accept support from military-related projects and agencies the same way we do from, say, NSF, and if we are concerned about the policies carried out by the agencies or the implications of the projects we should address those concerns as citizens and not as mathematicians. This concept oversimplifies and misdirects attention from the concern of the many members who cosponsored the two motions being considered for adoption. These motions generated a necessary and important discus-

sion which Infante is apparently trying to redirect to nonprofessional arenas. In fact, part of the reason for the motions in the first place is that the Society has been using its resources to increase the level of military funding without a democratic and thorough discussion of such issues among its members.

One of the motions deals with SDI or Star Wars. It is President Reagan's fantasy of shielding us from incoming nuclear missiles. It has repeatedly been said that if the shield existed, the Soviet Union would be forced to a "launch on warning" strategy and thus we would have made the world much more unstable. Moreover, Star Wars can be thought of as another step towards a first strike capability, with similar destabilizing effects. But leaving these two important points aside, Star Wars does not appear technically feasible in the eyes of many scientists. In fact, a great number of them, particularly physicists, have pledged not to collaborate with Star Wars development in any way, and thus the Administration has been having a hard time selling the idea to taxpayers and to Congress, which has drastically cut all SDI requests. In this context the issue of credibility is a very political one. If scientists work for SDI, they are allowing their names or that of their institutions to be mentioned by the funding agencies as "proof" that Star Wars is workable. Such scientists are used in the political arena to justify a program of dubious technological feasibility and dubious security advantages.

In this context, the separation of our concerns as scientists and citizens or taxpayers becomes impossible. One does not have to be an expert in particle beam weapons, say, to understand that our professional goals are being distorted.

Another motion to be considered expresses concern about increased military funding of mathematics research. I strongly support this motion for several reasons.

First, the goals of military funding for science are very clearly military-oriented. If a project does not advance military capabilities in the long run, it will not be funded. Scientists who feel that "well, it is the same proposal I would send to NSF," miss the point that collectively the projects serve military interests and reorient the focus of science in this country. Moreover, as with Star Wars projects, scientists doing research for the military are used to add credibility to arguments presented for funding multi-billion-dollar projects, which politicians cannot fully understand due to lack of expertise. Actually, the military funding for mathematics research is about 2/100 of 1% of the military budget, and can be seen as a small budget to advertise military projects.

Second, scientists do become dependent on military funding for their research. John Kenneth Galbraith calls such researchers "subsidized scientists." In addition to reorienting their research they also may become politically and culturally dependent, reinforcing a militaristic and isolationist society. For example, I know of a U.S. professor who wanted to invite an Eastern European collaborator to come to his university for a short visit, but decided against the idea for fear of loosing some of his funding in the future. This brings to mind the statement by then Undersecretary of Defense Donald Hicks, who said he would like to see funds cut off from scientists receiving DOD support who speak out and "bite the hand that feeds them." So much for the separation between citizen and scientist.

Finally, I wish to express my concern regarding the level of rhetoric expressed in some positions, which has gotten to the point of members threatening to leave the Society if the original motions are adopted. It is an attitude which distracts from the real issues being discussed. It adds a flavor of divisiveness to what should be conducted as a fully democratic process. In contrast, the motions do not call for casting out our colleagues who solicit or accept military support, but rather calls for the AMS not to help them secure those funds. It also calls for the AMS to state unequivocally that science is much broader than "shock, blast and penetration," and that efforts should concentrate on funding a broader and more universal concept of scientific inquiry.

Linda Keen
Lehman College, CUNY

Mathematics is underfunded. Support for basic research in pure and applied mathematics is in the national interest and the government should support such research at universities. Very specific military research, for example for SDI (Starwars), does not belong on campuses. The motions before the Society address the fact that we must distinguish between what is and is not appropriate. Much of the discussion on these motions is about where the line should be drawn and it is healthy.

I urge you to join the over 400 supporters of the original motions and vote for all the motions on the ballot.

Mina Rees
CUNY Graduate School

This letter is written in partial response to the last sentence in the letter from Mikhail Katz of SUNY-Stony Brook, published in the October issue of the *Notices*: "Would these (older) mathematicians please step up and tell us all?"

As some readers of this letter will know, I was the first head of the Mathematics Branch of ONR and largely responsible, in consultation with my colleagues, for establishing the policies that would govern the operation of the mathematics program. In particular, I was very happy, early in the program, to secure approval from the Captain who headed the Research Division, for the support of research in pure mathematics.

Though I find it impossible "to tell all," I call attention to a paper I gave at the San Antonio mathematics meeting in 1976, "Mathematics and the Government: The Post-War Years as Augury of the Future." This was published in *The Bicentennial Tribute to American Mathematics, 1776–1976, Dalton Tarwater, Editor*, The Mathematical Association of America, 1977. I believe this paper will provide some, but by no means all of the answers to questions now under discussion.

Probably most important is the fact that the situation now is very different from the situation that determined our planning immediately after World War II. Then the total number of research mathematicians was small enough so that it was possible for us to know most of those who attended meetings of the Society by name. Moreover, we were extremely lucky that many of those mathematicians who came to Washington fairly often stopped to talk with me and other members of the ONR staff often enough so that we found it relatively easy to keep in touch with their work with a relatively small number of visits to their campuses. In particular, John von Neumann, who is specifically mentioned by Professor Katz in his letter, had frequent occasions to visit Washington, and I was able to discuss with him many questions that troubled me. Of course, his work with computers was seminal. Not only did he participate with a splendid staff in the construction of the Institute for Advanced Study computer, but, in collaboration with Arthur W. Burks and Herman Goldstine, he produced a series of papers dealing with aspects of the overall logical considerations arising in connection with the von Neumann machine which was basic in the development of computers.

But when I was on the National Science Board from 1964 to 1970, it was clear to me that the considerable increase in the number of research mathematicians and in the number of universities involved, as well as the growing size of the NSF budget, made the ONR experience largely irrelevant. ONR had no peer review except for advice from a National Research Council Committee that reviewed our competitive program which provided small one year contracts to selected new Ph.D.s. In all other instances proposals were discussed by members of our staff with qualified mathematicians. This would be an impossible task in NSF today. I find that I have considerably sympathy with the opinion expressed by Peter Lax and other mathematicians that DOD has provided much diversification, and that this can be their distinctive contribution.

On the other hand there are some distinct advantages to an association with one of the military services. In my paper in the Bicentennial Tribute volume to which I have referred, I quote A.W. Tucker of Princeton who commented on one occasion that, though most mathematicians supported by ONR continued to work on their own research, there were some mathematicians who "felt an obligation to reach out beyond customary courses, seminars and research, to make two-way contact with industrial labs and government undertakings." Partly as a result of such visits, Solomon Lefschetz set up at Princeton a broadly based program in differential analysis that provided a home for the work of a number of vigorous young mathematicians who, in their subsequent careers became leaders in new developments in such areas as stability theory of differential equations, mathematical theory of control processes, and dynamic programming. And the project in the ONR Logistics Project under Tucker produced several of the leading figures in fields related to the Project. As George Dantzig observed in a book published in 1963, "Tucker's interest in game theory and linear programming began in 1948. Since that time, Tucker and his former students (notably David Gale and Harold W. Kuhn) have been active in developing and systematizing the underlying mathematical theories of mathematical inequalities. Their main efforts ... have been in the field of Game Theory." Though none of the people I have mentioned was under pressure to work on problems of interest to the navy, their interest in these problems was most welcome.

I hope that my response to the plea for information has some usefulness but I doubt that it will solve any of our present problems.

Jean E. Taylor
Rutgers University

I was one of the authors of motions 1 and 2, which will shortly appear in your mailboxes (along with motions 3, 4, and 5 which I also, more reluctantly, helped draft as a member of the Executive Committee of the Council of the AMS). Although I agree with much of what those urging you to vote against motions 1 and 2 say, I do not agree with their conclusions. Rather, I find many of their arguments tangential to the actual motions. I urge you to read the motions to see what they in fact say, and then to vote FOR them.

Motion 1 says roughly (read it) that the AMS should not act as a marketing agent for SDI. One effect of the passage of this motion would be to prevent the AMS from running a show like that at the National Academy over a year ago. There the backers of SDI were given a forum to sell their wares to prominent mathematicians— without rebuttal by experts who believe that participation in such SDI research is unwise. The basic reason I support Motion 1 is that I think SDI, as sold to the American people, is a fraud. I do not think that the AMS should lend its support to something fraudulent. But you don't have to believe that SDI has been mathematically demonstrated to be a fraud to vote for Motion 1; you just have to agree that the AMS should adopt a neutral position and "lend no support" to SDI.

Motion 2 says roughly (again, read it yourself) that there are some inherent problems in military funding for research, and that the AMS should, in its efforts to increase funding for mathematics, work to have the proportion of non-military funding increase. If the motion called for a complete and immediate end to military funding for mathematics, I would not support it, since I appreciate the diversity-of-funding arguments. In fact, I really bought those arguments until I realized that a diversity of funding was turning out to mean a diversity of defense department agencies involved in funding! I'd like to see us go after a truly diverse set of funding sources. Meanwhile, we can and should say that we feel it would be better for mathematics if more of its funding came from non-military sources.

I was disappointed to see that two members of the AMS have threatened to resign if these motions are passed. The AMS exists to further mathematics research and the interests of mathematicians, and I personally believe that both are advanced by these two motions. The AMS is already actively involved in soliciting defense department support, and it might be the target of publicity efforts by SDI proponents. It is reasonable and right to find out how the membership views this. If the plurality of those who vote goes against my opinions, I certainly will not resign. My efforts to strengthen the AMS and the communication between its members and its leadership will continue.

William P. Thurston
Princeton University

Near the end of January, AMS members will have the chance to vote in a referendum on five questions. I urge you to vote.

Whether you work at a major university, a small college, in industry, or in government, whether you are a U.S., or a foreign citizen, this is your Society. The actions of the AMS on these questions affect the climate in which all of us work. I have been struck by the differences between prevailing opinions expressed by ordinary mathematicians, and opinions prevailing in the circles of power within the AMS. The growing breath of democracy in the AMS over the last year has been most refreshing. We have a rare chance to exercise democracy: please do.

I recommend a vote of YES on all five questions. In the January 1987 *Notices* I wrote a comprehensive letter explaining why the large presence of the military in academic departments is unhealthy. In a nutshell, a military force, by the very nature of its mission, needs to be and is organized in a hierarchical line of command so that it can act in concert. The function of a University is to nurture diverse ideas so that they have a chance to grow to maturity, and reach a stage where some of them can be transplanted and bear fruit in society at large. This calls for an entirely different, pluralistic organization. This letter evoked a large, mostly sympathetic private reaction as well as the public reaction in the *Notices* forum. I will not attempt to reiterate the points made in that letter. It still reads well, and I think it still answers many of the comments which have appeared since.

However, I would like to clear up a couple of misconceptions I have heard arising from the letter of a year ago. First and most important, I want to emphasize that I do not blame people who accept funding from the military, and I am not trying to stop them from receiving military funding. Motions 1 and 2 do not bar anyone from or blame anyone for accepting money from the military or SDI. There are many people, both students and faculty, who whether or not they like the idea of military funding, have no other recourse. I have heard more than once that "Thurston has the luxury of not having to take

military money, but I'm not in his position." I have heard of many mathematicians who are under pressure from their deans to bring in grants, at the pain of being fired, having their teaching loads raised, or not getting raises (let alone not having resources for research). *This is why we need to address the issues as a group:* alone we are powerless. Motion 2 of the referendum proposes that the AMS direct its efforts toward increasing the proportion of civilian funding for mathematics—this does not mean cutting people off from military funding, but giving them more of an option of civilian funding.

Second, there have been statements in the *Notices* that the motions are divisive and against applied mathematics. Some people have interpreted what I wrote, or things they have read about me, to mean that I don't care about applications or applied mathematics—or that I think mathematicians should be left to do what they please, with no accountability in terms of real-world applications. This is off the mark. My background is not in applied mathematics, but I think those who know me know that I delight in applications of mathematics. Lately, I have been heavily involved in computation and in computer graphics, where I encounter many of the same circumstances and difficulties as applied mathematicians.

In my letter of a year ago, I emphasized the need for finding alternate funding for applied mathematicians if military funding is reduced. This point has been made repeatedly by the sponsors of resolution 2 (on military funding). To oppose increased military funding does not at all mean to oppose applied mathematics. In fact, mathematicians are spread very thin among the many important civilian areas where mathematics could be beneficially applied. I believe that a shift of applied mathematics toward greater civilian funding could be very beneficial.

A number of people have claimed that despite appearances, there is nothing much to get excited about: that the proportion of military funding in mathematics is about 40%, where it has hovered for a number of years. Numbers of this sort are tricky: it all depends on what is included in the tabulation, and which of the many possible statistics you quote. One issue is that the categories of computer science vs. statistics vs. mathematics are not clear cut, and the grouping in official figures has shifted over the years. This makes a significant difference.

On page 39 of the April 1987 *Notices* there is a pie chart giving the breakdown of sources of funding for *academic mathematics*: according to it, the military-civilian split is close to 50-50. Note that this does not include government operations such as the DOE weapons labs or the National Security Agency, which claims with several hundred mathematicians to be the largest single employer in the field.

Even the 40% level is much too high as a presence of the military in our academic departments. But perhaps more important, the nature of military funding has been shifting, away from the traditional modes into much more intrusive "initiatives."

Iz Singer, p. 503 in the April *Notices*, specifically addressed my letter. He gave a (simplistic) summary in five points, and discussed them one by one. On most of these points, he is not expressing real disagreement: I will focus on the two where our differences are strongest.

Point II(1) of his summary is that "he who pays the piper calls the tune," thereby distorting our discipline when their aims are not in accord with ours. Singer agrees that this happens, but says we should fight specific DOD abuses, rather than the broad trend: he points to Serge Lang as a good example of someone who has led worthwhile fights.

But few people have the energy, prominence, and the willingness to devote time to issues as Serge Lang. The ill effects of the trends in science funding are to be seen in lots of small changes everywhere: the problems are not concentrated in scandals where an obvious abuse can be isolated and surgically removed by a Serge Lang. Furthermore, the fights and the circumstances which necessitate them take away a great deal from time which we could preferably devote to mathematics.

Singer's strongest point is probably the final one, II(4), where he paraphrases me as saying that "accepting DOD funding lends support to the military establishment." Singer says "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."

We are not proposing to dictate to Singer or to anyone else where they should seek support. Motion 1 proposes that the Society *as an organization* have no official involvement with SDI. We don't want the AMS to engage in official actions which would express support, on our behalf, for SDI.

Motion 2, regarding military funding, is quite mild. It proposes that the AMS advocate a decreasing *proportion* of military funding, together with increased *total* funding. There is no mention of AMS official involvement with the military (there is an ongoing relationship, in the form of military grants for some AMS-sponsored conferences.) The AMS is involved

(spending hundreds of thousands of dollars per year) in efforts to influence government policy and public opinion. It is entirely proper that members of the AMS have a say in what we advocate.

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I am writing to support Motions 1′ and 2′ as someone who has participated in SDI research (Boeing's AOA project) and who regrets having been party to same. Although many math and technical people have been lured into SDI by megabucks and hype concerning prospects for an effective defense against nuclear missiles the reality falls far short. At best only limited point defenses might be achieved, leading to the standard problems of ABM systems and subsequent offensive escalation to overcome same. SBKKV is as big a fraud as the Star Wars beam and laser systems which were oversold by the Edward Teller- Lowell Wood clique at Lawrence Livermore Labs. (See William Broad's book *The Star Warriors* for background; also note the growing internal dissent from experts such as Roy Woodruff and Chris Cunningham who were overridden and ignored prior to the APS report.)

Aside from the pork-barrel and outright sleaze considerations, SDI is another layer of superfluous DOD budgeting which has already led the western world to the brink of economic collapse (and perhaps over the brink as the events of Oct. 19, 1987, may indicate). It is not an accident that the annual national deficit is about equal to the DOD budget at present; deploying a flawed SDI system in the early 1990s will most likely bring down the whole house of economic debt cards as expenditures reach into the $100 billion range and all existing strategic arms agreements fall by the wayside.

AMS members can help the nation to step back from this abyss and redevote its attention to other pressing problems, e.g., environmental threats from acid rain, CO_2, ozone depletion,water pollution, smog; inadequate health care and delivery; languishing math and science education needs to face a competitive international, multilateral world; world hunger and poverty due to diversion of national resources to a dead-end arms race. Instead of militarizing our last frontier we should be considering efforts to monitor world problems from space and join with other emerging spacefaring nations to explore the solar system. There are plenty of precedents for space cooperation rather than confrontation, ranging from Intelesat communications and SARSAT-KOSPAS search and rescue satellites to the recent success of the coordinated Halley's Comet missions and possibilities for joint Mars exploration. These issues and opportunities would give the next few generations some hope to start answering the real questions our species faces rather than the contrived technical dilemmas of overcoming first-strike offensive systems that we are currently developing and deploying. A vote for Motions 1′ and 2′ is a vote in the best traditions of intellectual honesty and the better uses of mathematical talent. You will also sleep better than I have since my experience with nuclear doublethink.