
Forum

A New Paradigm for Mathematics: Publicity or Perish

Leon H. Seitelman

To secure public support for its programs, the mathematics profession must first educate the public about how importantly mathematics contributes to modern life. The awareness campaign must emphasize the pivotal role that the profession plays in advancing technology and supporting the economy. Raising public consciousness about the value of mathematics is a prerequisite for obtaining funding for mathematics projects. Finally, it is the profession itself that bears the responsibility to carry out this campaign.

The mathematics profession is in serious trouble. Budgets for mathematics, in both academia and government, are under vigorous attack. The balkanized culture of mathematics has stifled concerted action to garner public support.

If the mathematics profession is to survive and prosper, its public presentation must change. Mathematicians must appreciate their shared professional responsibility to show that public support of mathematics provides real value. We need to develop materials to reach the public with this message.

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The January Crisis Was a Wake-up Call

During the mid-January budget crisis, National Science Foundation Director Neal Lane called attention to the need for action:

...if you don't take it as one of your professional responsibilities to inform your fellow citizens about the importance of the science and technology enterprise, then...public support isn't going to be there...the perceived stony silence of the science and technology community...has not gone unnoticed in Washington.

Translation: Scientists comprise an invisible constituency with no (apparent) redeeming social value. In an era of tight budgets it is difficult to make a compelling case for the public support of such an aloof community.

We've been warned before. In the 14 July 1995 issue of *Science*, in an editon entitled, "The Politics of Science", Assistant to the President for Science and Technology John H. Gibbons wrote,

The nation's domestic discretionary budget will be cut and cut dramatically. It will not be possible...to return to the days (of)...expansive increases in science funding and new starts for grand and expensive scientific projects. We must learn to do more with less....

Each of us needs to be a partisan for science, to embrace a partisanship born of hope for the future...Partisanship based on...concern over the possibility that the work of generations that has put us at the forefront of world science and technology could be undone in a few budget cycles.

Lane's observations on the scientific community are mirrored by others. In an editorial, "Desperately Seeking

Friends", in the 17 May 1996 issue of *Science*, M. R. C. Greenwood, dean of graduate studies and vice provost of Academic Outreach at the University of California, Davis, wrote:

...(S)cience can be funded only if the electorate and their representatives remain convinced of its value and contribution. ...Without this understanding between citizens and policymakers, science and the American Dream may be only a memory from the past and not a part of our future.

...There is very limited public understanding of science and, more important, of how science and technology contribute to our lives, our aspirations, and our national goals.

And finally, Neal Lane again, this time in the article, "Science and the American Dream: Healthy or History?", in the June 1996 *Notices*:

When we dramatically reduce science, technology, and education, we are shaking the very underpinning of our societal structure. ...

Damage or destruction to any part of this intricate system could eventually undermine the whole structure. It is the system in all of its complexity and uniqueness that generates knowledge and national wealth. ...

I believe the American people and many of their elected representatives do not understand this.

Taken together, these (and other) assessments of the scientific enterprise present a grim picture for future public support.

And that, as they say, is the good news. The bad news for mathematics is that our profession is worse off than the scientific community as a whole. And this is true simply because the public does not associate with our profession any tangible end products with which they are familiar and which they understand are important.

Other disciplines, at least, have an acknowledged role. Engineers design and build things (bridges, buildings, airplanes). Biologists study nutrition and diseases. Geologists have something to do with oil reserves and earthquake studies. Physicists work on semiconductors and nuclear energy. But mathematicians...?

It's up to the mathematics profession to take the initiative in educating our fellow citizens about the importance of mathematics. And it is imperative that this outreach not be limited to those times when legislation affecting the profession is under consideration. This article recommends specific action to make this happen.

Is Everyone on the Same Page?

Despite all the rhetoric, it is not entirely clear that everyone agrees that there is a real problem. (The fact that very little has changed since Neal Lane's January comments does not support the judgment that the situation is urgent.) And the profession's glacial reaction to the ongoing em-

ployment crisis for new Ph.D.s provides little assurance that immediate, decisive action will be forthcoming.

This seeming indifference to the funding crisis suggests a lack of unanimity within the mathematics profession on the issue of whether there is a serious problem. Indeed, for tenured faculty there may not be a problem, at least in the near term. (That's probably what the University of Rochester faculty felt.)

Part of the problem might stem from a feeling that the mathematics profession is underappreciated. An American Mathematical Society officer told me that the core (i.e., pure) mathematical community "is peeved with the public because they do not automatically appreciate us. ...We, after all, are the very essence of logical thinking, and that should be sufficient for our appreciation." But that is precisely the problem. The core community is not looking for appreciation; it is looking for funding.

To use a familiar (if more controversial) example, the public (generally) supports the right of artists to "do their thing"; they just do not want to pay for art that they feel does not reflect community values (specifically, as it relates to pornography or good taste). The public supports the allocation of public funds consistent with perceived value received. If someone wishes to paint or sculpt or whatever, fine; that is his/her First Amendment right. But that does not confer any special claim on public resources.

Similarly with mathematics. The public does not stand in the way of anyone who chooses to do mathematics. But they will not support paying for it, unless they think it is valuable in their terms. And "the very essence of logical thinking" simply does not resonate with the public.

The Reality of the Situation

The core mathematics community has to understand that we cannot reach the public by insisting that it consider our point of view. It won't. Many citizens do not know any math, did not like it when they studied it in school, and are biased against it by virtue of their experience. If we want to reach the public, we have to talk about what they can understand and appreciate: the applications of mathematics. They will consider buying into the support of mathematics only if we make them understand that mathematics is an essential contributor to these applications.

It is time for the profession to grow up. The mathematics community does not need to be reassured about how great it is. It needs a heavy dose of reality. The future is in jeopardy because our dialog has been limited to people within the profession, and we keep telling each other how important our contribution is. The public does not believe that we actually contribute anything to the nation. Funding is dependent on convincing the public that math is useful, and applications are the only way to make that case to John Q. Public.

When we talk to nonmathematicians, we have to demonstrate value that they can appreciate. When we talk about logical thinking or advancing research or exploring new fields, we are talking about our values. And the public simply does not relate to them.

That is the plain, unvarnished truth. The mathematics community has to hear it and deal with it.

We Need an Attitude Adjustment

To win support from the general public, the profession needs real attitudinal change. Nontechnical people make policy decisions; we have to give decisionmakers the information they need, on their terms and in their language; if we do not, we will not get their support. We have to understand that we will succeed only if we present information that the average person can easily assimilate and only enough to establish the importance of our discipline.

The public sees no real connection between mathematics and their own experience. Because of this, marshalling public support is difficult. Academic scholarship is formal, but effective communication with the rest of society requires the mathematics community to provide information to readers and listeners that is meaningful to them.

We must point to important, understandable applications of mathematics, e.g., recent advances in coding theory that find expression in genetic research or in compact disc technology or that contribute to securing communications on the Internet. We need to show respect to the general public. We must be positive in our approach, demonstrating the vitality and importance of our discipline but careful to avoid disparaging comparisons with other fields. This will require real work; a slipshod approach would be worse than doing nothing. Both effort and tact will be needed.

We Must Start a Dialog

The profession needs to establish an ongoing dialog with every administration and Congress, completely apart from the funding process. We have to show how mathematics contributes to society, national security, and productivity. If we do not, we will be treated as just another special interest group.

We need a unifying theme; a suggestion follows.

Mathematics Is Important and Adds Real Value

Mathematics is the language of technology. It is used to formulate, interpret, and solve problems in fields as diverse as engineering, economics, communication, seismology, and ecology. It is the bedrock for the computer revolution. Mathematics provides us with powerful theoretical and computational techniques to advance our understanding of the modern world and societal problems and to develop and manage the technology industries that are the backbone of our economy.

Mathematics is a living discipline. Some traditional subjects in pure mathematics have been studied for hundreds of years; other topics, developed during the last few decades from the study of industrial issues, form a body of applied mathematics closely tied to the understanding of practical problems and basic phenomena. There is remarkable synergy between these seemingly disparate fields of study; the abstract nature of mathematics supports important applications in an ever-growing number of areas.

The Message Must Be Simple

We must build our message in simple terms. The message must be unmistakable: Mathematics is vital to the health and prosperity of the nation.

- **Mathematics is vital to the national interest.** Strong mathematical capability on a national scale is essential for industrial and technological leadership.
- **Mathematics is an enabler for other disciplines.** Virtually all other technology benefits directly from the extension of mathematical knowledge.
- **Mathematical competence is a workplace necessity.** Mathematical requirements will increase dramatically for occupations in the information age.

The Realities Must Be Presented

It is imperative to explain the benefits that result from mathematics, discuss how its practitioners work, and present the rationale for public support. For example:

- Mathematics enriches our knowledge and technology through continuing improvements and unexpected breakthroughs.

Many important advances in technology apply techniques developed in one branch of mathematics to problems from another branch. The interdisciplinary impact of mathematics can be both substantial and unexpected. Appropriate examples are the application of chaos theory to economic modeling and markets, image reconstruction techniques to medicine and seismology, and group theory to nuclear physics.

- Investments in mathematics provide a high rate of return.

Although many technical fields rely to an extraordinary extent on analytical or computational techniques, they typically commit only a tiny portion of their resources to the support and advancement of these underlying disciplines. Further, the critical supporting role of mathematics is often completely unknown to the user community. For example, HDTV is dependent upon the accuracy and efficiency of data compression algorithms developed in coding theory.

- Budgets for mathematics projects are labor-intensive.

Support for projects in mathematics generally includes relatively modest sums for computing equipment and software compared to laboratory science fields such as physics and biology. For this reason, the true contribution of mathematics is far greater than its relatively modest funding. But limited capital requirements also mean that budget cuts in mathematics affect personnel more than in other disciplines.

- The growth and health of mathematics should be a national priority.

Mathematics has a substantial impact on economic growth and development. Because mathematical knowledge is built steadily on a foundation of previous results, steady progress requires reliable, continuing funding for the mathematical infrastructure.

In Unity There Is Strength

The mathematics profession is but a tiny fraction of the entire scientific endeavor; it needs to present a unified message. But each of the three major professional societies is currently planning to produce its own policy statement. Unless they are consonant with one another, the competing

voices of mathematics will only confuse the listener and cancel each other out.

The traditional academic preoccupation with precision and perfection works against us. The professional societies should focus and unify the effort to get the crucial message—that mathematics is important—to the general public. It is far better to publish a timely message that is 95 percent accurate than to wait for completion of a perfect statement.

We Need an Action Plan

Congressional testimony by SIAM Executive Director James Crowley last summer and AMS President-elect Arthur Jaffe last spring are excellent examples of how to present information about mathematics to those outside the profession. We need to develop public service announcements for radio and television and to encourage the influential print media to present this kind of information. We need to encourage the media to report when mathematics contributes to the understanding of particular social issues (e.g., census estimates, economic studies, epidemiological models). Mathematics needs the publicity.

The reality of the 1990s is that all of our institutions are being examined for relevance and value. Support levels in the future will more closely reflect society's collective judgment about the value obtained for its investment.

The task of representing the value of mathematics to the general public falls disproportionately to the applications community. The transcendent challenge to establishment of a professionwide position will almost certainly be the forging of a consensus position rooted in an applications perspective. It is imperative that the pure and applied mathematics communities work with common purpose to make this happen.

Effective Action Must Be the Result

The profession needs to commit itself to effective action rather than mere discussion. We have a track record of publishing position papers which few read and on which still fewer act; we may be right, but we have also been ineffective. We need to commit ourselves to follow through with a plan of action.

Specifically, we should:

- Endorse the need for a common front for the profession.
- Issue a statement on science policy endorsed by AMS, MAA, and SIAM. (Invite INFORMS, AMATYC, NCTM, ... to sign on.)
- Collect brief descriptions of applications illustrating the impact of mathematics.
- Develop straightforward presentations of interesting and productive applications of mathematics to which the average citizen can relate for the profession's public outreach.
- Establish a permanent, joint committee of the three mathematics societies to develop and maintain a continuing professional outreach, and fund it.

There Is No Substitute for Hard Work

Some readers may be disappointed by the absence of specificity in the above recommendations. But let us be honest;

we have not even formulated a professionwide position on the situation. If we cannot muster enough discipline to do that, there really is no hope.

Unless we unite behind the idea that there is indeed a serious problem and that we have to become involved, no recommendations will be important. There were a lot of recommendations in the first David report; but when it appeared, we sat on our hands, and nothing was done. David II said, "Do David I." Again, nobody did anything, and nothing was accomplished.

We are fond of (and very good at) analyzing problems and proving the existence of solutions. Sully our hands with obtaining the actual solutions is not part of our skill set. If we want to remain a viable part of the scientific scene, this will have to change. If we do not change, we will become scientific dinosaurs. That is reality.

The critical first task is development of a united front to strengthen the profession. We will not go anywhere until we all start to pull in the same direction. But when we do, the country will benefit and so will mathematics—a true "win-win" situation!

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