Prioritizing Science: A Story of The Decade Survey for the 1990s*

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What are the most important aspects of the universe to explore? What are the best ways to make discoveries in astronomy and astrophysics? These are tough questions because researchers have many different approaches and it is usually not clear, until the most interesting problems are solved, which method will yield the most important results. Individual astronomers present strong arguments for many potential approaches that require federal funding.

We are well into an era of limited research budgets, however, and choices have to be made. We astronomers have recognized that if we do not set our own priorities, then funding agencies and congressional officials will do it for us, and will do it less well. Moreover, we have learned over the years that the process of trying to convince colleagues in different specialties both improves our projects and provides a broader and more reliable basis for support.

The Decade Survey of Astronomy and Astrophysics for the 1990s gave specific answers to the hard questions of what to fund and, by implication, what to cut. Working under the auspices of the National Research Council, we astronomers—acting as a community—recommended funding for a limited number of initiatives, ranked in order of priority. Only one out of every ten highly promising initiatives survived this rigorous selection.

We have been spectacularly successful in getting a very large fraction of our recommendations implemented, as can be seen from the tables that are collected near the end of this article. The tables summarize the fate of the projects we ranked highly.

In this article, I will describe, from my perspective as chairman of the survey commit-

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tee for the 1990s, how we came to a consensus on what to recommend. I hope that an understanding of our experience may be useful in future surveys.

I. THE SURVEY COMMITTEE

The group charged with setting priorities, the Astronomy and Astrophysics Survey Committee, was established by the National Research Council (NRC) in May 1989, following my appointment as chair in February 1989. The membership of the committee is shown in Table I. The report of the committee, *The Decade of Discovery in Astronomy and Astrophysics*, was published in March 1991 by the National Academy Press.

The first step was to find an outstanding group of scientists who were willing to sacrifice a significant part of their research time in order to serve on the committee. I spent most of the months between February and May of 1989 talking to hundreds of astronomers about potential members who might serve on the advisory panels of the survey and on the executive committee (hereafter, the survey committee). I also wrote to the chair of every astronomy department in the United States, as well as to many other prominent astronomers, requesting nominations. I invited each person to suggest themes and questions for the study. In addition, I wrote to a number of distinguished astronomers abroad asking about astronomical programs in their countries and requesting advice about possible international collaborations.

I filled nearly all of a looseleaf notebook with comments made by astronomers about the judgment and vision of their colleagues. (I later put this notebook into a secure trash can out of respect for the confidential nature of these conversations.) After many conversations, consistent pictures emerged. Some astronomers and astrophysicists were always mentioned with the highest respect by the people with whom they worked. These were the scientists we wanted to serve and, with only two exceptions out of our first 15 choices, nearly everyone I asked agreed to make the required personal sacrifice.

I am convinced that the unanimity which was achieved among astronomers in support

TABLE I. Astronomy and Astrophysics Survey Committee

John N. Bahcall	Institute for Advanced Study, *Chair*
Charles A. Beichman	Institute for Advanced Study, *Executive Secretary*
Claude Canizares	Massachusetts Institute of Technology
James Cronin	University of Chicago
David Heeschen	National Radio Astronomy Observatory
James Houck	Cornell University
Donald Hunten	University of Arizona
Christopher F. McKee	University of California, Berkeley
Robert Noyes	Harvard-Smithsonian Center for Astrophysics
Jeremiah P. Ostriker	Princeton University Observatory
William Press	Harvard-Smithsonian Center for Astrophysics
Wallace L. W. Sargent	California Institute of Technology
Blair Savage	University of Wisconsin
Robert W. Wilson	AT&T Bell Laboratories
Sidney Wolff	National Optical Astronomy Observatories

of our recommendations was due in large part to the scientific distinction and judgment of my colleagues on the committee. In retrospect, I believe I could have assembled a different committee of 15 people with approximately equal scientific qualifications. But, I am certain that I could not have improved significantly upon the high level of respect of the astronomical community for the achievements and insights of the committee members. This respect was our most important asset.

The 15 members of the survey committee were nominated by the appropriate committees of the National Research Council and were appointed by Frank Press, the chairman of the National Research Council and the president of the National Academy of Sciences. The survey committee contained six members of the National Academy of Sciences, two Nobel Prize winners, and two directors of national observatories. In addition to the committee itself, Frank Press took an active role in supporting and representing the work of the decade committee within Washington. (For astronomers not familiar with Frank's past, I note that he is a distinguished geophysicist and and a former national science advisor to President Carter. Throughout the survey, Frank provided immediate access, strong support, and valuable guidance and insights.)

I believe that the most important decision we made as a survey committee was to base our recommendations on scientific merit, independent of political considerations. We had credibility as scientists judging science. We did not have special expertise in guessing which way the political winds would blow. Early in the survey process, some individuals who worked for a federal agency tried to tutor us in the best political strategies, but I do not remember ever a single case in which these tutorials were repeated after we made clear that we were limiting the criteria for our prioritization to scientific merit. I believe that our insistence in judging only science greatly simplified our task and contributed to the lasting value of the survey report.

If I could made just one recommendation to future participants in decade surveys it would be: "Stick to the science." Other committees and studies are charged with the responsibility for devising the best possible strategy for implementing in a timely way the science priorities. Only the decade committee is charged with setting the science goals for that decade.

II. WASHINGTON VISITS

Prior to the formation of the survey committee, Frank Press and I visited major agency heads and congressional and administration leaders in order to obtain their advice on what issues the report should address and in what form the results should be presented. I did not ask for support of any projects on these "get-acquainted" visits, but I did hope to create a favorable climate for future consideration of astronomy initiatives. I also did not ask what answers would be politically most desirable. Participants in the survey were encouraged to solicit facts from agency and administration authorities, but we evaluated ideas and initiatives independently and in confidence. Agency leaders, congressional staffers, senior people at the Office of Management and Budget, and the President's science advisor (who had gone through a similar experience as chair of a previous NRC decade survey for physics) all provided valuable advice.

The consultations in Washington ultimately resulted in several important sections of the final report: a chapter on the lunar initiative (requested by the Administrator of NASA);

a chapter on high speed computing (suggested by the Director of NSF); an emphasis on priorities for technology in this decade that will lead to science in the next decade (proposed by the Deputy Administrator for Space Science of NASA); recommendations of what astronomers should do *pro bono* to help with the crisis in education (requested by Dick Mallow, then a senior Congressional staffer and now a senior AURA officer); an examination of the technical heritage of proposed initiatives (requested by people at OMB); realistic estimates of the costs for each of the new projects; a chapter on astronomy as a national asset; an examination of the role of American astronomy in the international context with some guidelines for assessing when international collaborations would be fruitful; and thumb-nail sketches of major projects that could be used conveniently by staffers helping to draft legislation. Where I have not made specific attributions, similar suggestions were made by several different people we visited.

III. THE PANELS

The first task of the survey committee was to select the chairs of 15 advisory panels for different subdisciplines, based on discussions with astronomers of different specialties at institutions throughout the country. The survey committee decided that the subject matter covered by the different panels should reflect the subdivisions that astronomers generally use in identifying their specialties, especially the wavelength or technique used to make astronomical observations. It would have been more logical to have organized the panels along scientific goals, independent of wavelength or technique, but I am convinced that the more logical organization would have been less effective. The similar viewpoints and experiences that were shared by people within a given technical subdivision of astronomy made it easier to reach a scientific consensus. The survey committee was responsible for integrating the advice by the different discipline panels and formulating the highest priority science program.

Future decade surveys may well choose to organize themselves differently. The revolutionary opportunities provided by, for example, the VLA, the HST, COBE, x-ray satellites, and the Keck telescopes have all forced astronomers to realize that in order to solve scientific problems they have to use different techniques. Many of the younger astronomers now identify themselves in terms of the scientific problems they work on rather than the techniques they use to solve problems. I think this is a healthy development.

Table II lists the chairs of our panels. In choosing the panel chairs, the survey committee again used scientific distinction and widely respected judgment as the primary selection criteria, but we also took account of the necessity of obtaining expert advice about the major research fields and techniques.

The panel chairs and the survey committee jointly selected 300 people for the advisory groups. The members of these groups had a high level of scientific achievement and also represented different research approaches, different kinds of institutions, and different geographical areas. The survey committee itself considered projects that spanned more than one subfield or which fell between the assigned responsibilities of the panels.

The panels met at different sites in the United States in order to help stimulate wide participation by the astronomical community. I also wrote to each of the panel members and asked them to solicit the views of colleagues at their home institutions. Local discussions of issues in individual astronomy and physics departments generated valuable ideas and helped consolidate support for the final recommendations of the decade survey.

Much of the difficult work of the survey was done within the panels. The panel chairs (see Table II) were forced to exercise tact, scientific insight, and organizational skills. Scientists from groups that had traditionally worked in competition with each other had to develop unified recommendations. Perhaps the most difficult task, brilliantly achieved, was to form a consensus set of recommendations within the optical and infrared community (Chair: Steve Strom). The lack of consensus in this community had frustrated attempts to obtain some needed major facilities in preceding surveys.

The panels began their technical work with essays submitted by individual panel members on what they identified as the most important issues or projects. After the essays were

TABLE II. Astronomy and Astrophysics Survey Panels

Panel	Chair
Astronomy as a National Asset	Virginia Trimble
Computing and Data Processing	Larry Smarr
High Energy from Space	Bruce Margon
Infrared Astronomy	Frederick Gillett
Interferometry	Stephen Ridgway
Optical/IR from Ground	Stephen Strom
Particle Astrophysics	Bernard Sadoulet
Planetary Astronomy	David Morrison
Policy Opportunities	Richard McCray
Radio Astronomy	Kenneth I. Kellermann
Science Opportunities	Alan Lightman
Solar Astronomy	Robert Rosner
Status of the Profession	Peter B. Boyce
Theory and Laboratory Astrophysics	David N. Schramm
UV-Optical from Space	Garth Illingworth
Working Group on Astronomy from the Moon	Charles A. Beichman and John. N. Bahcall

discussed, there were presentations by panel members or by invited outside experts on all the significant questions that were to be included within the text of the panel's report. A core group within each panel wrote the initial draft of the report, which was then iterated within the panel and then commented on by members of the survey committee.

The most intense discussions in the first nine months of the survey occurred within the panels. In order to ensure good communication between the panels and the survey committee, each member of the survey committee served as the vice-chair of one of the panels. This arrangement worked well, keeping the survey committee apprised of ideas as they developed and enabling each panel to understand the goals and procedures of the full survey.

Because of their special responsibilities, two of the panels operated differently from the others. The beautiful non-technical chapters on Science Opportunities and on Astronomy as a National Asset were written almost entirely by the relevant panel chairs (Alan Lightman and Virginia Trimble, see Table II), with advice and comments from their panel members. We were fortunate to have in charge of these activities accomplished research astronomers who are also outstanding writers.

The survey committee avoided many potential problems by deciding that the panel reports would be advisory rather than part of the findings of the survey and that the reports would not be refereed by either the survey committee or by the NRC. The recommendations of the panels were not binding on the survey committee, but the panel reports contain important technical information, as well as detailed arguments advocating specific initiatives. The reports of the panels were published separately from, but simultaneously with, the full survey report by the National Academy Press under the title *Working Papers: Astronomy and Astrophysics Panel Reports.*

IV. DEVELOPING A CONSENSUS

I believe that it was essential, in forming a consensus, to involve the community as much as possible. The survey was organized so that every astronomer who had something to say had an opportunity to be heard.

Open discussions were held in conjunction with meetings of the American Astronomical Society (AAS) and at several other professional society meetings. In January 1990, at the Washington, D.C., meeting of the AAS, nearly 1000 astronomers participated in open sessions that involved all 15 of the panels. The names of the survey committee members and of the chairs of the panels were published in the AAS newsletter, along with remarks encouraging individual astronomers to present their ideas directly to survey committee members, panel chairs, or panel members.

Establishing the recommendations of the survey took 14 months, about a year less than was projected. The committee worked efficiently because we were busy scientists eager to get back to our research, because we had effective leadership and support from the National Research Council (Robert L. Riemer) and from the Executive Secretary of the survey (Chas Beichmann), and because we were the first decade survey to be able to rely on fax and email communications for many of our discussions and iterations of texts.

The survey committee had six meetings at astronomical centers throughout the country.

I was surprised by one thing. Veterans of similar activities assured me that there would be a difficult and tense period of bargaining before we agreed on the final recommendations. This never happened. I believe the reason is that the committee judged the initiatives on the basis of scientific potential, without regard to political considerations.

The list of priorities was established by a gradual process that was much easier than any of us anticipated. The committee voted on straw ballots on three occasions during our regularly scheduled meetings, using as background material the preliminary reports of the advisory panels. The straw ballots focused the discussion on projects that were most likely to be considered important in the final deliberations. As preparation for the final ballot, the committee heard advocacy presentations from the panel chairs. The chairs also participated in discussions of the relative merits of all the initiatives, although the final recommendations were formulated by the survey committee in executive session.

Two strategic decisions helped the committee reach a consensus quickly and smoothly. First, the committee decided that if we failed to reach agreement in July 1990 at the pleasant facilities of the National Academy, within reach of cool Pacific breezes in Irvine, California, then we would meet a month later in the least desirable place in the middle of summer that we could think of, namely, Washington, D.C.

Second, several committee members proposed that I draw up, on the evening before the final voting, a draft list of recommended initiatives in order of priority. They suggested that the committee alter by consensus the draft set of recommendations in order to arrive at the final list of priorities. The proposers hoped that, by this process, the committee could avoid having "winners or losers." I was skeptical of the chances for success when the idea was proposed, but I agreed to try.

Having drawn up a handwritten list of priorities on the night before our formal voting, I was surprised the next day at how rapidly we reached a consensus. We began with those equipment categories concerning which we were most in agreement and then worked our way to the more difficult choices. We went around the table, everyone stating their views about what change, if any, needed to be made in the ordered list that we were considering. By the time we had all spoken, the consensus was obvious and we adopted unanimously our priorities in each category.

In times of budgetary crisis, good citizenship also requires fiscal restraint. The survey committee studied approximately ten times as many initiatives as were endorsed, recommending that funding agencies invest in astronomical initiatives according to the scientific priorities established in the survey report.

V. THE SURVEY REPORT

The 180 page book presenting the recommendations was written in about three months. National Research Council reports are reviewed carefully. They must meet high standards of logic, of evidence, and of objectivity. In our case, the National Research Council selected 18 formal referees, in addition to a report review committee. The reviewers were anonymous National Academy members and other qualified scientists, in physics, in astronomy, and in other related disciplines. The formal review process was painful, but I answered each review comment, even rhetorical questions, with a specific written response in order that we could complete the review quickly. The 18 referees helped to sharpen our arguments and to clarify our logic, but did not suggest revisions of our priorities.

Ours was the fourth in a series of decade surveys by astronomers, led by A. Whitford, J. Greenstein, and G. Field, respectively. The highest priority initiatives in each survey were successfully undertaken, encouraging astronomers to submerge parochial interests and focus on the most important initiatives.

Would another committee of astronomical experts have recommended a similar set of priorities? I think so, provided that they had also spent a year learning about and comparing all the proposed initiatives in this country and abroad.

The report was published under the title *The Decade of Discovery in Astronomy and Astrophysics* by the National Academy Press in Washington, D.C. in 1991. It is still available, and I believe still good reading.

VI. CATEGORIES OF RECOMMENDATIONS

How many categories of recommendations should we have? Should we make separate recommendations for space missions and for ground based projects? Should we have recommendations that prioritized projects independently of the potential funding agency ?

These were the most hotly debated issues we faced in the survey.

In preliminary discussions, most agency personnel opposed absolute rankings that combined ground and space initiatives, worrying that their top priorities might be adversely affected by ineffectiveness at some other agency. We decided not to yield to these worries.

We decided to provide an overall prioritization independent of agency or of technique, because we believed that good citizenship required us to use our scientific expertise to provide the maximum possible guidance to those responsible for making budgetary decisions. We also provided separate recommendations within the categories of Space projects and Ground Based projects. In addition, we decided on a common sense division of recommendations into Large, Medium, and Small, based upon the financial resources required to achieve the projects.

I believe that our decision to provide an overall prioritization was correct and increased the credibility of the survey report in Congress and in the executive branch, particularly at the Office of Management and Budget. Some high ranking agency officials predicted dire consequences for programs under their responsibility if we insisted on prioritizing across the space (NASA) and ground based (NSF, DOE) categories. They feared that their favorite programs would be held hostage to ineffectiveness or budgetary constraints at other agencies. As far as I know, the predicted difficulties did not occur. Recommended programs were not delayed inappropriately because of the competition for higher prioritization between ground based and space based projects.

VII. OUR RECOMMENDATIONS AND HOW THEY FARED

What did we recommend? What was achieved?

The committee assigned its highest priority for ground-based astronomy to the revitalization of the infrastructure for research, both equipment and people.

It is difficult to assess quantitatively the effect of this recommendation for infrastructure support. Unlike new projects which are either funded or not (see Tables III–V below), the support actually achieved for infrastructure has to be judged against what that support would have been in the absence of our recommendation. We can never really know how bad the situation would have been in the absence of a strong statement by the survey committee. Our strong endorsement of infrastructure support has often been cited in discussions within NSF committees and with congressional staffers. Enthusiastic and energetic senior staff members at NSF and NASA, as well as our colleagues on the NRC Astronomy and Astrophysics Committee, have repeatedly used the high priority assigned to infrastructure support in the Decade Survey to argue for the maximum possible resources being directed to astronomy for individual grants and for maintenance of existing equipment.

My own assessment is that our recommendation for infrastructure support for people and existing equipment was wonderfully successful with NASA (which has become the principal supporter of astronomical sciences in the 1990s) and only modestly successful at NSF. The freedom to redirect resources at NSF was limited in part by the large capital investments for LIGO (gravity wave detector) and the Gemini (northern and southern 8-m telescopes) programs.

Continuing to develop a space program with an improved balance between large and small projects, with emphasis on quicker and more efficient missions, was the committee's highest priority for space research. This recommendation resonated with the views of the current NASA administrator (Dan Goldin) and has become a theme of the NASA astrophysics program.

I now want to review informally the fate of our priority recommendations for individual projects.

We recommended four large programs, which are shown in Table III. All four of these programs are being developed! In addition, the AXAF observatory, recommended by the previous Decade Survey and strongly supported in our report, is nearing completion. SIRTF is NASA's next premier astrophysical observatory (concentrating on the infrared wavelengths) and has become an important part of the agency-wide Origins program. The two Gemini telescopes, the infrared-optimized 8-m northern telescope and the southern 8-m telescope, are funded through an international collaboration with important leadership provided by the NSF. At the time of this writing, it seems likely that the millimeter array (the MMA) will be included in the president's budget (for 1998) for a three year study leading to construction (provided no insuperable obstacles are encountered). The current status of each of the two Gemini 8-m telescopes is denoted by a check mark to represent the fact that these observatories are in an advanced stage of construction. I have denoted by a plus mark the status of the MMA to indicate that this major facility is currently in the development stage.

TABLE III. Large Programs

Program	Status
Space Infrared Telescope Facility (SIRTF)	$\surd$
Infrared-optimized 8-m telescope	$\surd$
Millimeter Array (MMA)	$+$
Southern 8-m telescope	$\surd$

Our top six Moderate Programs, shown in Table IV, have all been successfully begun and the status of each one is indicated by a check mark.

Our highest priority, adaptive optics, was largely declassified, and we now have access to important developments initiated in connection with national security activities. The civilian agencies have collaborated with the national security agencies in enabling this technology to be developed efficiently for astronomical purposes. We have a dedicated spacecraft for the FUSE ultraviolet mission, and the contractors have been selected to build and fly the SOFIA airborne infrared telescope facility. The ARC and WIYN telescopes (see shared 4-m telescopes in Table IV) are examples of the successful implementation of the recommendation for 4-m telescopes. The high-resolution upgrade for the Fly's Eye has been effectively achieved, and the marvelous extension to the highest energy cosmic rays, the AUGER project (not a mature proposal at the time of the Decade Survey), seems almost certain to occur. I am personally very excited about the astronomy and the physics that will be possible with AUGER.

The intermediate priority Moderate Programs listed in Table IV have been pursued with significant success. For example, the Astrometric Interferometry Mission (AIM) has been adopted as an ambitious NASA initiative (SIM). The two Moderate Programs at the lower end of our priority listing, LEST and the VLA extension, were casualties (very much regretted) of the budget stringencies.

TABLE IV. Moderate Programs

Program	Status
Adaptive optics	$\surd$
Dedicated spacecraft for FUSE	$\surd$
SOFIA	$\surd$
Delta-class Explorer acceleration (SMEX, MIDEX)	$\surd$
Optical and infrared interferometers	$\surd$
Several shared 4-m telescopes (private)	$\surd$
Astrometric Interferometry Mission (AIM)	+
High Resolution Fly's Eye	$\surd$
Large Earth-based Solar Telescope (LEST)	0
VLA extension	0

I want to recount an illustrative anecdote about Table IV. In the months that followed the release of the Decade Survey, I gave many talks about our recommendations and the exciting science that the recommendations could make possible. I always showed the full versions from the report of Tables III–V, which included estimates for the cost of each project. I asked the audience during each talk if they noticed anything unusual about Table IV. Almost no one noticed the feature that I found most revealing. But, when I gave a talk to the faculty and trustees of the Institute for Advanced Study, one emeritus professor immediately noticed what I found remarkable. George Kennan, former Ambassador to the Soviet Union and a distinguished scholar of Russian Studies, raised his hand and said: "Your highest priority recommendation is by far the least expensive. From all my years in dealing with governments, I cannot remember another example of the least expensive recommendation being the highest ranked."

We prioritized according to scientific importance.

The committee recommended that an increased emphasis be given in the astronomy research budget to small and moderate programs. The committee did not prioritize small programs, recognizing that the agencies could use peer review for small initiatives to respond quickly to new scientific or technological developments. However, all three of our Illustrative Small Programs, see Table V, listed as high priority are under development.

TABLE V. Illustrative Small Programs

Program	Status
Two-micron survey (2 μ SS)	$\surd$
Infrared instruments	$\surd$
Cosmic background explorer (MAP, CBI)	$\surd$

The Microwave Anisotropy Probe (MAP) and the Cosmic Background Imager (CBI) are two complementary instruments, one in space (MAP) and one ground-based (CBI), which, together will observe anisotropy in the microwave background radiation over angular scales from a few arc minutes to many degrees. I am proud that the decade survey helped to facilitate these crucial experiments, which otherwise might have had particular difficulty in obtaining adequate funding.

These are the things that worked for us: enlisting as committee members active research scientists eager to finish the job and get back to their own work; recruiting an effective executive secretary; insisting that the NRC provide adequate budgeting and staff support; having a logical plan and a specific timetable for completing the report; listening to everyone who wanted to be heard; concentrating on issues within the committee's competence, in our case, scientific priorities; having a talented editor (Susan Maurizi) who could sharpen the final report; and working with a community that believes it is better for astronomers to make imperfect judgments about priorities for astronomy than it is to leave the decisions to Washington administrators.

In the years that have followed the publication of the Decade Survey, I have made many visits to Washington to discuss specific projects with staff and members of Congress, with people from OMB and OSTP, and with senior leaders at NSF, NASA, and DOE. I could get in to talk to these important decision makers and could expect a sympathetic reception because the Decade Report had a favorable reputation for having set scientific priorities based upon a consensus within the astronomy community. These visits were, I believe, particularly useful in helping to make possible the SIRTF, SOFIA, MMA, and cosmic background explorer projects, and to facilitate the declassification of prior DOD work, and the initiation of new research, on adaptive optics.

VIII. PERSONAL REMARKS

I enjoyed very much participating in the Decade Survey. I did not expect to be able to say this when I started, but it is true. I learned a great deal about science and people from the process. Many individuals selflessly pulled together to make the survey a success and I am grateful to each of them for the shared experience.

I was lucky that Jerry Ostriker was also in Princeton. Jerry had unique experience as a major participant in both the Greenstein and the Field committee decade surveys; he also chaired the project initiation subcommittees that established the Field committee and our survey. I was not involved in the previous surveys nor with other NRC committees, so it was immensely helpful to me that Jerry understood from the inside how the NRC and the NAS worked. Jerry shared generously his organizational skills and his scientific insights.

I am especially grateful to Chas Beichman, who served both as Executive Secretary and as a member of the survey committee. Chas took leave from his normal research job to become a member of the Institute for Advanced Study during the duration of the survey. The only argument I had with Frank Press during the entire activity of the Decade Survey regarded Chas's presence in Princeton. Frank's initial position was that, according to National Academy rules, the oversight of the survey had to be maintained in Washington within the purview of the National Research Council. I said if that was the case then I could not serve, because I needed a "second-in-command" in Princeton in order to work efficiently on the survey while continuing my own research. We compromised: Frank found a description of Chas's appointment that allowed him to be in Princeton.

Chas understood the big picture. In addition, he knew exactly what things had to get done and he made sure that they got done on time. When it was necessary to get the job completed, Chas did whatever background research, writing, or editing was required. I urge future survey chairs to try to make sure that they have similarly strong support.

I am proud of what the Decade Survey accomplished. We all worked together and our scientific programs were improved because of the collaborations. Our report was welcomed and adopted by the National Science Foundation and the National Aeronautics and Space Administration. It was widely praised in Congress and within the Executive Branch. The media coverage was large and favorable. As a community, we are frequently held up as an example to other groups of what can be accomplished by forming a consensus about scientific priorities. The process and recommendations of our survey were sufficiently persuasive that we have achieved a surprisingly high fraction of what we proposed (see Tables III–V). And, very importantly for me, I made a lot of close friends with whom I hope to share many pleasant experiences in the future.