Lessons from Mirrors

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When David asked me to speak at the end of this symposium he gave me an intimidating charge. "Talk about science in general"—he said—"the support of science, the outlook for science ... whatever you want." But he made it plain that I was not expected to talk about current research in my laboratory. It's a lot easier to talk about experiments than the profound matters he suggested and so I nursed a subliminal headache for some months. Then, a distinguished colleague of ours made it worse. "Our friends and colleagues," he said, "will never sit for that kind of stuff. Besides, if you have no slides, they'll be uncomfortable. The only way you'll make them listen is to be funny." Funny. Unhappily, I'm not very good at that. And coming after yesterday's talk by Sidney Brenner, the best stand-up comic in biology, it didn't seem smart to try.

Well, I finally did get a few slides, as you'll see, and I decided to talk about mirrors. Some people are indeed laughing about mirrors this year; others of course are crying. But the tragedy of the Hubble Space Telescope does add an extra dimension to a mirror as a metaphor.

Metaphoric mirrors were very popular this spring. Many op-ed authors and commencement speakers decided that the upheavals that destroyed the metaphorical iron curtain and the very real Berlin Wall, provide an illuminating mirror for just about every aspect of the American scene. "Mirror, mirror on the wall, Are we still the fairest of them all?" was a question on many minds. Some of these outpourings were sterile discussions of who did or did not win the Cold War. But the majority were provocative commentaries.

The American political scene was, for example, held up to the mirror. Our historical political thought and ideals were said to have emboldened and sustained democratic

dissension in Eastern Europe and the Soviet Union. The peaceful revolutionaries of eastern Europe quoted Thomas Jefferson, the Bill of Rights, the Federalist Papers. Yet the mirror image revealed that young Americans graduating from our leading colleges and universities can't quote Jefferson, have only the dimmest notion of what's in the Bill of Rights, and more likely than not have never heard of the Federalist papers.

The economic scene was also examined in the mirror. Our free market economy inspires Eastern European plans. But the mirror shows our dwindling capital resources, the lowest personal savings rate in the developed world, a fall in earnings of various blue chip American companies, and a stock market that began to slip well before the latest Middle East crisis. And, as we daily encounter increasing numbers of homeless people on our urban streets, the mirror's image reveals the deep significance of a failing economy.

A third scene held to the mirror was what is variably called the American "ethos" or "culture." Put most attractively—there is (or was) a uniquely American talent for wedding pragmatism with broadly-held humane values. This combination forged realistic policies consonant with grand philosophical notions. Thus, human rights became an important element in our foreign policy and informed the Helsinki Final Act which, in turn, gave sustenance to the Eastern European dissidents, now leaders. But does this common core of human values still exist in our country? In academic circles we have an ongoing, sometimes uncivil, debate between those who claim that our core values derive exclusively from the western philosophical tradition and those who claim the equal legitimacy of an ethnic panoply of ideas. Down on the street we are hard put to find our common core in the drug gangs terrorizing our cities. And we have to wonder what the term "human rights" means to people who speak of "animal rights."

The list goes on. Our infrastructure, admired from afar, but seedy and unsound under closer inspection, has been examined in the mirror. Astonishingly, to anyone who lives in this city or visits frequently, I even read that the city government of Moscow is sending a delegation of its bureaucrats to study urban management in New York City.

The mirror seemed to have taken in the whole American landscape. Almost.

It is a curious fact that the pundits of our society rarely consider science as a main stream force in 20th Century history. Yet, without science, oxidation of the Iron Curtain would have lacked an important catalyst. For one thing, science provided a constant route across the curtain for contemporary western ideas. The technical achievements of post World War II science and engineering—travel and communications for instance, provided a conduit, however unreliable or thwarted. Scientific journals and meetings, however restricted or censored, directly carried new ideas, and indirectly revealed a prosperous, vibrant, iconoclastic society with opportunities for the young and a standard of living that permits the leisure of free inquiry and experimentation. Furthermore, Soviet and western physicists have, for decades, met regularly to discuss arms control: both formally under the official auspices of Academies of Science and informally in the Pugwash framework. And, to complete a list that is hardly exhaustive, I mention the very direct and energetic activities of the U.S. National Academy of Sciences in the area of human rights, including its bold and principled actions in support of Andrei Sakharov.

It was not an accident, though the point is overlooked by many of our sages, that it was Andrei Sakharov, a physicist, who sparked Soviet and Eastern European changes with his insistence on freedom, justice, and human rights.

These few observations, and others that you can think of as easily as I, suggest that scientists should take a share of the credit for the spread of freedom. But then, we too should hold up the mirror, and examine how American science matches the image our Eastern European colleagues have. No one seems to have done this. And, because making such an examination seemed to fit what I understood of David's charge, I'd like to give it a try this afternoon.

Four reflections yield particularly pertinent lessons right now. First, what I call the Top Down/Bottom Up question (and others call the Big Science/Little Science Controversy); second, the private support of fundamental research; third, the development of scientific talent; and fourth, the question of leadership.

Lesson I: Top Down/Bottom Up.

A few years ago, when I was still chief of the Laboratory of Biochemistry at the National Cancer Institute, I was visited by a small group of familiar Soviet molecular biologists accompanied by a few unfamiliar officials of the Soviet Academy of Sciences—I assumed doubling as KGB agents. The group was touring U.S. labs, asking probing questions about the organization and habits of productive research groups. They wanted, in particular, to know what criteria we used in making appointments and what procedures we used in determining the department's research program. My answers were, I am certain, the same as those they heard in other highly productive American labs. With respect to the first question I said that in hiring new scientists, demonstrated excellence and originality were the primary criteria, not interest in a particular field specified by me or my superiors. With respect to the second question, I said that no one except the scientists themselves determined their research programs. Although some of the scientists and some of the projects would prove pedestrian or would fail, we believed that trust in individual talent was likely to be most productive of excellent research. That approach has of course been proven many times—including today in the talks you heard earlier.

My Soviet colleagues were, I think, happy with the conversation. They had seen enough of U.S. science over the years to realize the enormous pay-off we've had from our habit of giving independence to people when they are young and sustaining this independence throughout their careers. They surely wanted the accompanying bureaucrats to learn that science works best from the bottom up. The top down, hierarchical organization of research customary in the USSR and Eastern Europe often yields stale, unimaginative work. It surely diminishes ambition, dampens the spirit, and wastes resources and talent. The worldly-wise scientists in Eastern Europe will be striving to reorganize their research according to this American image.

And what does the mirror show us? Unhappily, as the eastern style begins to change, from top-down to bottom-up, we show a tendency toward the reverse. Increasing shares

of our research resources go for bureaucratically designated programs. Science and engineering "Centers" designed to foster specified aspects of interdisciplinary research (whatever that term may mean) or to advance some particular line of investigation fall in this class. Similarly, a growing proportion of research funds go for projects that seem interesting and feasible to people sitting in an office in Washington, or in the headquarters of some private foundation. All of these are what I call top/down science.

The issues I include under the top/down, bottom/up distinction are often posed in terms of the "big science/little science" controversy. But the big/little distinction really befuddles the matters. Even individual, investigator- initiated research in small groups, the epitome of what most people term "little" science, is not so little. In biology, such research depends on pretty big commercial enterprises which provide instruments, fine chemicals and enzymes. In the physical sciences, individual investigators are increasingly dependent on massive, centralized computer capacity.

The real issue is how research is organized. The classical examples of "big science" tend toward the top/down mode. Consequently, the bureaucracy that always accompanies large centralized ventures siphons money from research itself. Yet, it is not clear that those bureaucracies are cost-effective, because major decisions are made at further and further remove from those who really understand the scientific and technical opportunities. I reacted with dismay at H.S.F. Cooper's description of how the Soviet space bureaucracy fouled their two spacecraft missions to a moon of Mars called Phobos, as described in a recent *New Yorker* article. Cooper even contrasted Soviet and American styles in this regard, decrying the Soviet's enforced separation of bureaucrats, engineers, and scientists. It was only two weeks or so after this that we learned of the Hubble mirror tragedy. As the story has unfolded it looks as if the American experience was not so different from the Soviet Phobos tale.

Another distinction between "top/down" and "bottom/up" science has to do with the ratio, R, of the number of individuals doing the work to the number of individuals deciding what is to be done. Even if all those in the denominator are very smart, individual initiative, especially that of the very young is lost, if R is big. And, as Lew Branscomb has said, the extent of peer review is generally inversely proportional to the size of a scientific project, that is, inversely proportional to the size of R.

It's not easy to decide when R is too high. The intrinsic interest of the science and the talent of those in the denominator has to be balanced against several criteria—the dollars lost for other, independent scientists, whose projects have small R values; how much significant science might be accomplished by the crowd in the numerator if they had the chance to do their own thing. More than that, some of those in the numerator will be lost to science entirely if they see themselves as drones—their names buried amidst 100 other authors, on even the most exciting of papers. We don't, of course, have many good methods for making these determinations. But we do have historical experience which says that maximizing opportunities for individuals produces an abundance of exciting new knowledge and useful technology.

The evidence of a tilt from bottom/up to top/down in U.S. science is not only in the megaprojects and centers that get covered in the press. There are now, in our universities, a good number of very large research groups. A professor with an outstanding record of scientific achievement, who can command, from one or another source on the order of a half million dollars a year, may preside over dozens of graduate students, postdocs, technicians, secretaries, grant writers and editorial assistants. Often, magnificent science is accomplished. But what, after all, is the difference between this and the old European style, where a senior professor, enjoying a variety of perks, governed research? In time, some of these American labs too will stagnate. And the aging young people will have expended their best years in pursuit of someone else's ideas, interests and glory.

A top/down habit creeps up on us, sometimes for apparently good reasons. And there are situations, such as industrial settings, where it is appropriate. But it is not what made American fundamental research the envy and the model for the rest of the world.

Lesson II. The Private Support of Fundamental Research

The bottom/up organization of research is an American phenomenon—one that developed in the middle of the 20th Century as the core of modern science moved to our country and flourished. Relocation of science was not of our doing—it was driven by the demise of freedom in Europe, and by the necessities of war. It was fostered by a generation of gifted, displaced Europeans who found here, in abundance, and in spite of an indigenous cultural anti-intellectualism, the essential foundations for science—safety, freedom, money, a spirit of entrepreneurship, and a willingness to make a social contract whereby the population at large benefits in material ways by supporting scientists in the free pursuit of their own interests.

Some fundamental research had been carried out in our Universities since the middle of the 19th Century. The American professors who did this work were largely trained in Europe. Their meager support derived from philanthropy and in the late 19th Century, from burgeoning American industry. A major boost to research occurred at the beginning of the 20th Century. The founding of this then Rockefeller Institute, and of my own Carnegie Institution of Washington depended on the vision and philanthropy of two major American industrialists. In both cases, institutions for research, not teaching, were established independent of universities. Yet, in the words of Allan Bromley, speaking at the 75th Anniversary of the Carnegie Institution's Department of Embryology in November 1989:

> "One effect of this arrangement was to give basic research a respectability that it had not previously known in our highly pragmatic society."

These two institutions, together with the private foundations, corporations, and individuals were virtually the entire support available for basic research and training in the years before World War II, and for almost a decade thereafter.

Parenthetically, there are some interesting tales told about the establishment of the Rockefeller Institute and the Carnegie Institution in the *History of the Rockefeller Institute*, written by George W. Corner, and published in 1964. The book also has some fine photographs—formal ones and lab pictures. Here, for example, is Simon Flexner, the first president of the Rockefeller, all dressed up in coat and tie. The illustrations in the next history—say at the end of this century—will show a different kind of world, and a different presidential image.

Establishment of the two institutions apparently involved some healthy competition. The earliest suggestions for a Rockefeller medical research institute were made in 1897 (Frederick T. Gates). The idea was studied and tested, and by 1901 grants-in-aid were being provided from the resources made available by the Rockefeller family, but the Institute was still only an idea. According to Corner, it took the incorporation of the Carnegie Institution in January 1902 to finally stimulate the appointment of Simon Flexner as first director of the Rockefeller, the acquisition of temporary space (50th and Lexington), and the site search that led to the purchase of the land under our feet today. This was keeping up with the Joneses (or I should say the Carnegies) on a grand scale. However, we need to temper Corner's interpretation of the history with the fact that he had been for many years, Director of the Carnegie Institution's Department of Embryology.

Whatever, it is a great personal pleasure for me to recognize that I can, with David, maintain what are long-standing ties between the two institutions, albeit with a style quite different from that of our predecessors.

Corner confirms that the wealthy individuals who provided the money for research at the beginning of the century recognized the importance of fundamental knowledge for the health of the nation. Individual health, social health, economic health. And they understood the principle of banking. They built for institutional strength - banking facilities and perpetual endowments and they encouraged basic research, thereby banking knowledge for the unknown needs and challenges of the future. They supported fellowships and training - banking human resources for our nation's welfare.

Besides institutions like the one we're celebrating today, large American fortunes also established foundations, which, rather than doing research themselves, gave grants to individuals and institutions for research, training and facilities. In the past, support went largely to those who came forward with original and interesting ideas, and some record attesting to their ability to perform. The amounts for research were comparatively small, but they had enormous effects—both alone, and ultimately as a stimulus to public expenditures. The lesson of this farsighted dedication of private fortunes to the public good has not been lost on the rest of the world.

Shortly after President Gorbachev's visit to the U.S. last spring, I received a telephone call from the 3rd Secretary of the Soviet Embassy. Could he come and visit me? Right

away? It's a new world, so no committee of bureaucrats or KGB agents accompanied him. He simply walked the two short blocks of 16th Street from the embassy to the Carnegie Institution. He explained that President Gorbachev asked the embassy to look into various especially interesting aspects of American society. Private organizations supporting research, both operating research institutions and foundations, were among the most admired of American institutions. Mr. Gorbachev understood their capacity for independent, innovative effort—and the philosophical notion that acquired, private capital could profitably be devoted to scholarship. How did such institutions work? What was the relation between the donor and the decision making? Who determined how to spend the money? Who was responsible for the money? There were already millionaires in the U.S.S.R. and Mr. Gorbachev might want to lead them into constructive pursuits.

I was quite astonished. Who would have guessed that these extraordinary institutions, so unique to American society, were appreciated or even recognized in the U.S.S.R.? But I was also somewhat chagrined. In recent months I had begun to wonder whether we can still count on the major foundations for the support of the most innovative and risky fundamental research and scientific training. I'd begun to wonder whether their present stewards remember their historical roles. And others share this disquiet.

Increasingly, major U.S. foundations are focused on the here and now. They have good intentions. The boards and presidents of those foundations are deeply aware of profound problems in our country and the world. And they have properly resolved to use the foundations resources to try to address them. But they are forgetting the importance of investing some part of their assets in the future. They are forgetting how the value of small sums can be magnified many times over when the knowledge gained from fundamental research is later applied to societal problems. In a news story about the spring 1990 meeting of the Council on Foundations—an umbrella organization of 1,000 grant making institutes representing tens of billions of dollars of assets there was no mention of support of fundamental research. And the policies of many important foundations—policies explained in their materials, described in the press and reaffirmed in private visits are increasingly turning away from support of basic research and training. Yet this is the way they can have the biggest impact on the world's problems.

Let me give one example. We are as a nation concerned about the deterioration of the natural environment that has followed upon great population increases and industrial world living standards. We have spent a lot of time and money studying this issue. Time and again, policy studies conclude with words like those found in a recent NAS/NRC study on Forestry Research: "concerns about the global role and fate of forests has never been greater," but "...the existing level of knowledge about forests is inadequate to develop sound forest-management policies." Yet we go on supporting activities designed to ameliorate forest conditions and other environmental problems by recycling the same admittedly inadequate base of knowledge. Recycling has its place in our approach to environmental problems but whoever thought it would become an intellectual program as well. Not only are our activities suspect, but we use resources—public and private

monies, and talented, knowledgeable individuals that might instead be spent acquiring basic understanding.

In the past, in the face of inadequate public funding for such fundamental work, the private foundations, with their capacity for quick response and their visionary leadership would have tended the seed corn. Now, they too are using up the seed corn, recycling existing and inadequate information in support of endless conferences, of intellectual rehashing and of costly, unproven projects.

Private support has been a mainstay for research because it has always been flexible, risk-taking, and relatively free from political influences. If these private institutions turn their backs on fundamental research, no matter how compelling our societal needs, it will be like our economic policy—all
spending, no saving for a different future.

Lesson III. Development of Scientific Talent.

U.S. universities are universally admired. The young people in many nations aspire to attend our universities as undergraduates or graduate students, and if they, or their families, or their countries can find the resources, they do.

To the extent possible, the most promising young foreign scientists and engineers have also been sent here for postdoctoral training ever since World War II ended. In western Europe and Japan the present scientific leadership positions are held by people who spent postdoctoral years here.

Neither our Japanese nor our western European colleagues, nor Eastern European scientists are oblivious to what made American education and training so attractive—fine universities, provocative and dedicated teaching, well-equipped laboratories, and fair credit for achievements. Now, aided by governmental understanding of the importance of trained scientific manpower for economic well-being, similar training opportunities are a reality in other countries. Research, and research training now command substantial financial resources in Europe, and will gain even more in 1992 with economic unity. Anyone who has visited labs in Europe recently has seen the change. Anyone who has been to an international meeting in the last year or two has sensed the subtle shift of identity. And, as young Eastern European students begin to look westward for training, our West European colleagues will aggressively recruit them with attractive opportunities.

This shift will be problematic for us. One reason is that the diminishing quality of teaching in American universities makes them less attractive to foreigners. Another is that we'll be hard put to replace the flow of young foreigners with Americans because we have failed to nurture our own young people. These two factors are of course connected by tensions in our major research universities.

It is commonly understood that a modern university's purpose is the teaching *and* the advancement of knowledge. In earlier times, universities were first and foremost a place for teaching. Research was seen as a separate endeavor. The Rockefeller Institute for instance, was established, at least in part, because medical research was *not* carried out in

universities. Later in the 20th Century, the universities began to recognize that the doing of research is an essential part of the diffusion of knowledge. The balance between teaching and research was shifted by the broad recognition that teaching (in Jaroslav Pelikan's words); "is infinitely more rich and profound when it is in the hands of professors who were and still are engaged in the advancement of knowledge; that is, in research." Finally, today, the balance between teaching and research in universities has shifted substantially in the direction of research.

There are a lot of complicated reasons for this. Most scientists find research more challenging and satisfying than teaching. By and large, money both public and private, comes for research. Reputation and prestige come from research. The situation is further exacerbated by the growing tendency to look to universities for solutions to immediate societal problems. In the late 60s there was a justifiable call for universities to become more "relevant" to society. But the movement to relevancy has gotten out of control.

Altogether, these pressures have brought us to the point where teaching responsibility, being a professor—one who professes special knowledge—is no longer a necessary consequence of a faculty appointment. Universities acquiesce in excusing successful research faculty not only from significant amounts of teaching, but from institutional responsibilities - curriculum committees, promotion committees and the like. And they often mortgage themselves and their students to potential faculty members' seemingly unlimited demands for space, support, salary, and benefits.

Something is out of balance. And the result is a serious weakening of the universities' core. This wouldn't matter a lot if we had other institutions to take the place of universities. But we don't. Who will defend the freedom of the academy? Who will show directions for the future? Who will teach and inspire the young?

In June, *Nature* magazine reported that the number of U.S. students receiving undergraduate degrees in natural science declined about 10% in the two years 1987 and 1988. Although the total number of degrees granted rose to a record high in the same period, 20,000 fewer degrees were awarded in the natural sciences.

Now, we all know that dismal pre-college science education is a major factor in this state of affairs. But surely scientists share a substantial portion of the blame because we have left the effort to others. Many of us believe that modern biology is the most exciting endeavor of our times. Yet according to a very recent NAS/NRC report, most students leave their high school biology courses with the conviction that further exposure to science is something to be avoided.

We also know that about half of those undergraduates who come to college intending to major in science switch to other fields before they finish. Why? There are, and will be, abundant and well-paying jobs for scientists and engineers. The arrogant explanation I hear from faculty is that the students are poorly prepared and can't cope even with the introductory courses. Savvy and responsible students however see those courses as addressed to the professor's interests, not theirs: the professors are inattentive to the students needs and, one hears, often inexperienced and poorly prepared.

Wise university leadership—presidents, provosts, and boards of trustees know that the proper balance between teaching and research has been lost. They have begun to work toward righting the balance. Don Kennedy at Stanford this spring challenged his faculty. At least one faculty response is reported to be that he is "trying to make Stanford some kind of hybrid between a real research university and a liberal arts college." I, at least, always thought that that is exactly what Stanford is. And the thousands of Stanford undergraduates, their parents, and undergraduate alumni believe that also. At Yale, steps are being taken to strengthen the faculties' obligations to students—for supervision, for encouragement, for teaching.

If faculties resist these changes, they will not get much sympathy from those who pay tuition bills, or from state legislatures that foot university bills, or from alumni and other philanthropists upon whom the universities increasingly depend to make ends meet. These constituencies believe that education remains a vital purpose of a university.

More than a renewal of teaching will be required if we are going to ensure the viability of our great universities. We need too to renew our attachments to the places where we work to identify our interests with those of the institutions. We are not, or should not see ourselves as temporary tenants with no obligation to their general welfare. Yet, many of us spend more time in airplanes flying to meetings of dubious significance in Washington than we do at university curriculum or promotion committees. I can't do better than quote Bart Giamatti here:

> "When administrators believe themselves only managers of the public policy of the place and faculty members believe themselves alone in guarding the flame of intellectual values, when presidents and deans on the one hand and members of the faculty on the other may even question whether they share the same goals, the same mission, the same hopes, then they split apart. They speak of US and THEM ... That atmosphere has been growing for about 15 years on America's campuses. It is subtle and dangerous. No institution for teaching and learning can survive it."

Few things contribute more to this subtle and dangerous atmosphere than the failure of common understanding about indirect cost recoveries. The often acrimonious arguments about this are, at one level, the consequence of faculty's determined, blissful ignorance of the realities of university revenues. At another level they reflect the science faculty's narrow view of the university's purpose.

This purpose, to advance knowledge and to teach it, is timeless and unique. American universities are critical to our nation's way of life because it is only they who foster, espouse, and protect society's capacity for change. If, for short-term advantage, we

divorce scientific research from the central purposes of our universities, science will suffer from a diminished flow of young scientists, and a loss of the support it needs to continue.

Lesson IV. Leadership.

The final and the biggest lesson we have to learn from the mirror is the value of bold, imaginative, informed, leadership. In Eastern Europe, the aspirations of many were gathered and made powerfully coherent by a few spirited individuals. Yet in our country leadership seems a forgotten, devalued quality. In science as well as other spheres, it is debased by mean-spirited debate, and by an overly zealous press.

American biomedical science once had exemplary leadership in the person of James Shannon. Shannon built the NIH and the whole of our nation's biomedical research enterprise through enormous dedication and informed conviction. He succeeded better than anyone else in convincing the nation and the congress of the significance of fundamental research to the national welfare. What a sad contrast there is between Shannon's days and the present. The most distressing aspect of the many failed attempts to find a new NIH director was their demeaning messages about the importance we give, as a nation, to leadership. These messages come from the Administration in Washington. But they reflect our national scene. We are afraid to risk bold, empowered leadership. So we limit authority, we underscore our skepticism by low pay for public officials, we hold would-be leaders hostage by the threat of public scandal over irrelevant matters or disingenuous charges. We see the leadership of our institutions as our adversaries.

In the current funding crisis in biomedical research, we have watched as many who should be leaders have instead stood alone, wringing their hands about their own individual plights and calling only for more and more money. I would like to be quite plain about this. Our behavior as a community has been unseemly and counterproductive. As Dave Baltimore recently wrote: "We must be clear that when we request increased funding we do so because it serves the national interest, not just our personal interests."

The NIH budget has risen at a substantially greater rate than most federally funded endeavors for the better part of a decade—from about 2.8 billion to almost 7 billion from 1980 to 1990. During the same period the NSF budget virtually doubled. Our pleas fall on ears that hear many other demands for money - and a crushing national debt. We need to get our act together. We need leadership that will analyze the NIH and NSF budgets and tell us, and the congress, why more money supports fewer individual research grants. Where is it all going? Can it be redirected? To what extent are Requests for Proposals, Centers, congressionally mandated programs, megaprograms, and increasingly bureaucratic, unproductive paper work and administrative personnel continually depleting the share for investigator initiated work?

Where will the leadership come from? We might have hoped that the NAS could represent scientists' interests. But it sees itself as compromised by its quasi-official status. We need to challenge the Academy, our societies, our universities to be innovative, to

represent us vigorously and well—and as boldly as they acted on behalf of Andrei Sakharov.

Few of us are willing to take the time, to make the sustained effort needed to bring our case successfully before the American public. We go eagerly to Washington when requested, and spend a day talking feverently, but mainly to one another. But who spends substantial time with his or her own congressman? Who has pressed for strong leadership for the NIH? Who has done the hard work of analyzing federal budgets? We are too eager to get back to those pursuits which enlarge our personal selves—our own research, the self-aggrandizing major lectures, yet another meeting at some wonderful place where we hear the same papers we heard two weeks ago, the company which pays us well for consulting or which we have started. Communication is vital to science, but not all talk is effective communication. We have forgotten that it takes concerted, group work and strong leadership to make and sustain the point of our relevance to our society.

Conclusion

Fundamental research is the scientific equivalent of money in the bank. If we're not careful, American science, which is still emulated world-wide, will find itself in the same boat as the American economy and our high technology—pale compared to science being done by those who learned from us. Many may consider science marginal to our nation's success, but we know better and there is an opportunity now to display our importance. We are one of the last remaining repositories of that great marriage of pragmatism and humane values that made our country great.

American science has always been driven by an inherent optimism about what is possible—an optimism that succeeding waves of immigrants have acquired from our history and traditions as well as our wealth. Here the cynicism of older cultures, particularly of those who experienced suppression was cast off. It is being cast off now in Eastern Europe and the far east; it is already virtually gone in Western Europe. Yet we see cynicism growing around us. We see it growing in young people's loss of interest in science, in scientists' diminishing concern for teaching and for the institutions on which they depend, in the willingness to agree to top-down decisions about research in exchange for short-term promises of funds. Such cynicism makes an ugly reflection in the mirror.

You at the Rockefeller University are lucky. The Trustees have wisely appointed an optimist as your new president. Cynicism is foreign to Dave Baltimore's nature. And he is bold—scientifically and politically. You will not always agree with him. (I don't always agree with him). But his motives are grand motives. With your support he can raise this institution to even greater levels of significance and excellence than it has enjoyed in the past. And in this, he will lead the way for all the universities in our country and the world.