Editorial

America's Challenge

Walter F. Mondale

From my perspective as the U.S. ambassador to Japan, I would like to share a few thoughts about the direction in which I see U.S. science and technology (S&T) going and contrast it with what I see happening in Japan. Japan is often portrayed as being proficient at commercializing technologies, whereas the United States is seen as leading in research and development (R&D). This statement may be historically accurate, but today's reality is different. A consensus has emerged among Japan's Executive, Parliament, businesses, and academic institutions that Japan "must stop being a nation of technology followers and become a nation of technology innovators" in order to ensure its future economic well-being.

One clear indicator of the seriousness of Japan's R&D efforts is the level of spending. For several years, Japan has invested a larger percentage of its gross domestic product in R&D than has the United States. In July 1996, the Japanese cabinet approved a proposal to spend $155 billion on government S&T programs over the next 5 years, of which 95 percent is targeted at civilian technologies. As a result, Japanese government expenditures on civilian R&D have caught up with and will soon exceed U.S. funding in absolute terms.

We should welcome Japan's increased efforts. The United States has long encouraged Japan to invest more in its indigenous science capabilities, because Japan shares a responsibility to contribute to the world community's intellectual reserve, particularly in areas such as health, disaster prevention, the environment, and energy. As Japan's abilities increase, opportunities also increase for the United States to benefit from Japanese research in much the same way that Japan has gained from U.S. accomplishments.

At the same time, however, as Japan addresses its relative weakness in basic research, the United States is on a path that will diminish our lead in S&T and constrict economic growth. Science in America today faces decreased federal support, the declining quality of our K-12 educational system, the inability of our budget process to deal with long-range international research projects, and declining interest on the part of our brightest young people in pursuing scientific careers.

Will America respond to this challenge to its technological leadership with complacency or with greater efforts? Last year, I held a series of panel discussions at the U.S. embassy in Tokyo to review the S&T strategies of the United States and Japan. Among our conclusions was the not-so-startling fact that the primary advantage of the United States-the core of our economic competitiveness-is the unparalleled excellence of U.S. scientific research,

undergirded by our entrepreneurial system. We as a country, and Congress in particular, must understand that R&D expenditures are an investment in the future and not a form of short-term consumption. We must recognize that the U.S. university research system is a technology generator for our entire country, creating new technologies that lead to new industries and good new jobs. Reduced funding for our research institutions undercuts our technological and economic leadership abroad and diminishes opportunities for Americans at home.

Similarly, in the private sector, we must be careful not to squander our technological leadership. The Japanese are noted for their patience in the long-term development of markets and technological interests, but U.S. corporate traditions often favor short-term financial gain. We must keep our eyes on the long road ahead. We also must ensure that the process of commercial technology development and transfer proceeds fairly and honestly. Japanese firms are adept at acquiring our commercial technology, but we need a more symmetrical two-way technology flow.

Finally, we must balance the flow of technology between the United States and Japan not by restricting the free flow of information in the United States, but by fostering a greater presence of our students, researchers, and industries in Japan in order to benefit from Japanese research accomplishments. America's challenge is to welcome and respond to Japan's S&T initiative. The two countries should not behave as adversaries but, like the Olympic athletes in Atlanta, as competitors who drive each other to higher levels of achievement for the benefit of all the world.

The author is U.S. ambassador to Japan.

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OFFICE OF THE
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December 23, 1996

The Honorable Walter F. Mondale
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Dear Ambassador Mondale:

I am writing to commend you on your recent editorial, "America's Challenge," in the November 8 issue of SCIENCE.

As your article reflects, I believe it is useful for the American public and decision-makers to recognize that when compared to the U.S., for the size of its economy, Japan invests more in science and engineering research and development.

Like you, I welcome Japan's increased effort in this area. This investment indicates Japanese appreciation of the importance of fundamental science and engineering research to their society and economy. It is also telling that Japan is now emphasizing greater government support of long-term, non-defense research and development at universities, emulating our country's approach over the last 50 years.

Like you, however, I am concerned that Americans better understand the importance of nations investing in science and engineering research and education for the future. I recently addressed this topic, using Japan as one example, this month in a speech. I have enclosed a copy of the speech for your information.

I hope, if you plan to be in Washington, D.C. sometime, that you will try to visit the Foundation. It would give me an opportunity to thank you again for the breakfast you hosted for me in Tokyo in May 1994. It would also be a chance for my NSF colleagues and me to hear your views and insights gained during your service in Tokyo. I also hope that you will continue to speak out and write about the vitally important question of maintaining U.S. science and technology leadership in the next century.

Sincerely,

Neal Lane

Neal Lane
Director

DR. NEAL LANE, DIRECTOR
NATIONAL SCIENCE FOUNDATION
CALIFORNIA COMMONWEALTH CLUB
DECEMBER 6, 1996

SCIENCE AND PROGRESS: LOFTY OR LEVEL-HEADED

I am delighted to be here today. As a mid-westerner growing up in Oklahoma, California always had the mystique of someplace glamorous and free-spirited. But I was reading recently that the comedian W.C. Fields saw things a little differently. He said, "California is the only state in the union where you can fall asleep under a rose bush in full bloom and freeze to death."

However, that's a lot better than the blessedly unknown commentator who might have been referring to Washington when he said, "After all is said and done, more is said than done."

In California things do get done. Today California can boast a state higher education system clearly the envy of the rest of the nation, and indeed the world, and a diversity of high technology business and industry that reflects the finest in American entrepeneurship. Now, more than ever, California is "America's gateway to the Pacific." As the Asian economies continue to expand, California will provide important leadership in both competition and collaboration with this growing cadre of economic powers.

Today I want to talk about the various components of economic leadership in the evolving global economy. I have titled my remarks, Science and Progress: Lofty or Level-Headed, although science, and here I include engineering research and education, is just the beginning of the discussion.

For science in America, World War II was a defining moment. The government called upon the expertise of scientists and engineers to help meet many highly technical challenges of the war effort. The success of this work gave science, and scientists and engineers, a new visibility and a strong reputation for specialized skills to advance our national goals.

After the war, and throughout the four decades of the Cold War, the nation's dominant goal for science and technology was national security. Under that large umbrella, the Federal government funded increasingly diverse research and education activities at many of our universities and colleges. California schools were major participants and major contributors. The government also invested a great deal of confidence and funding in two California scientific citadels--Lawrence Berkeley Labs, and Livermore Labs. This was a wise and fruitful investment initially and continues to be today. These institutions, these universities, these laboratories, will provide California and the nation many more decades of excellence into the 21st century.

In this forty year process, the research community was able, and even encouraged, to be isolated in their labs and on their campuses, exploring the knowledge-frontier. Science was viewed as a "lofty," and not well understood profession. Scientists were portrayed in movies like"Dr. Strangelove" as an absent-minded professor, and as Dr. Science about whom some of you may know. And in literature as eccentric and all too serious. That depicts the "Lofty" in my title, "Science and Progress: Lofty or Level-Headed."

The end of the Cold War, just seven years ago in November, was unpredicted. It did not even show up on the radar screens of foreign policy experts and political gurus. It caught the world by happy surprise. However, policy makers, military strategists, and economic prognosticators had not imagined or planned for a global landscape without the Free World/Soviet rivalry of the previous forty years. Neither had many in the defense industry. California felt the impact more than most. It caught the brunt of that sudden change. The Cold War era closed as the complexities of the global economy emerged.

The transition period in which we are currently immersed will likely continue for a number of years. We, in America, should view this as a time of opportunity to reassess our priorities, revisit our goals, and redesign our plans based on the new realities. And I think we must have the wisdom to recognize that these opportunities are not reserved exclusively for America. The new openness in the world political and economic arena has created a system "in flux" where different leaders, as well as different losers, can emerge. The combination of California's educational resources, its entrepeneurship, and inherent enthusiasm for tackling formidable tasks will help chart national direction for the 21st century.

As America's economic viability in pan-global competition takes precedence over the old dominant national security concerns, we can be grateful for the end of long-lasting tensions. But I am not alone in believing that we must be watchful of diverse new threats, particularly to our economic prosperity and the quality of life in this country. The Cold War rationale for generously funding scientific research, primarily to keep us safe--our freedoms, our families, our lives--has largely disappeared. So the case for America's continued investment in science and engineering research must be articulated; it can no longer be taken for granted. At the moment that investment is, for the most part, stagnating, and predicted to decline, while competitor nations are lifting their research investments toward the stratosphere.

I have spent considerable time over the last year or so speaking to groups of scientists and engineers about this new reality. The Cold War environment allowed, and indeed encouraged, and sometimes even required, the research community to live in an insulated "loftiness." That time is gone, politically and economically.

It's not, I believe, that these researchers and educators did not care about these societal problems--it's not that they didn't realize that research had benefits beyond national security concerns; it's not that they weren't good citizens and interested in helping society in other ways; it's just that we expected them to be in their labs and classrooms and do the job to protect us from the evil empire.

Well many of us in government, industry and academia know that investments in research and development pay off handsomely in many, many ways including economic benefits. In a statement last year on science and technology and the federal budget, the Clinton Administration's Chief Economic Adviser, Dr. Laura D'Andrea Tyson said, "It is no accident that industries that grew out of federal investments in science and technology--industries as diverse as agriculture, aeronautics, computers, biotechnology and medical equipment--today dominate the world's markets. Economists estimate that over the past 50 years, innovation has been responsible for as much as half of our nation's economic growth."

Even using conservative rates of return like 20 percent consistently over decades, we are talking about a stockbroker's fantasy. The American taxpayer, however, is the stockholder in terms of how federal funds are spent. There are many competing and worthy interests vying for a tightening pouch of government funds including such things as veterans hospitals, education, and housing.

The current trend for smaller government will unquestionably impact federal science budgets. In the November 15 issue of Science and Government Report, Editor Dan Greenberg wrote) "don't...expect a continuation of the ax-dodging feats that brought the research agencies through the past two years with minimal damage. The federal budget is now poised for a continuing downward glide, ... and research and many other federal activities are going to pay the cost."

In order to maintain any long-range commitment to federal research funding, the American public will have to be convinced that such research is a high value investment. It is not enough that you and I may feel that way, we are only a small part of that public. The larger voting public must be convinced. And so science, and the nation, can no longer afford for science to be lofty and isolated. The times call for science to be level-headed, for scientists and engineers to be engaged in a dialogue with the public about contributions that research has made and can continue to make in their lives and the lives of their children.

And dialogues, by their very nature, are not one way streets. Scientists must listen to the public's perception of society's problems and needs. When I speak to science groups, I point out that we are able to do increasingly more sophisticated and exciting science at the same time that societal problems and disparities are also increasing. I suggest to them that this illogical disconnect between science and society must be attended to.

Let me not leave you with the impression that I think only science has to move from lofty to level-headed. The model for this shift was actually charted by industry. The corporate successes of the 1950's and 1960's often translated into somewhat lofty attitudes about American market supremacy. The 1970's and 80's were a steep learning curve for American industry as European and Asian companies successfully challenged our consumer electronics, machine tools, automobile and other sectors.

Many businesses and industries finally responded with a no nonsense, level-headed approach toward total quality management, productivity, worker training, and market analysis. Many others are just catching on and catching up. Nevertheless, today the U.S. sits at the top of most rankings of competitiveness. (World Competitveness Yearbook 1996, compiled in Switzerland, rated the U.S. the most competitive nation among a ranking of 43 nations. Singapore was rated number two, Hong Kong was three, Japan was number four.)

This is good, but ever so fragile. We all know, periods of change and transition, particularly, offer opportunities but pitfalls too. On the opportunity side in science, it is looking like an explorers paradise--everything from buckey tubes and nanotechnology to identification of the gene for flowering in plants, new understanding about brain chemistry, life forms in unimagined places like the oceans' darkest depths. This is unquestionably a golden time for new knowledge.

We also know that new conceptual understanding in one area can trigger varied developments in many fields. The Nobel prize-winning physicists, Charles Townes and Arthur Schawlow, now long time citizens of California, proved the concept behind the laser in the late 1950's. That discovery acted like a pebble dropped in a tranquil pond. Small circles pushed into larger circles and on into ever bigger circles. That one discovery led to the commercial lasers that read compact disks, perform eye surgery and burn away blood clots, and pulse phone calls and computer data through thousands of miles of optical fiber. It is speculated that there are many more circles to come from that one pebble.

Those future circles, and many from other discoveries, can only emerge from a level-headed commitment to long-range investments in research. America's pattern of providing investments and opportunities for research is much different today than it was 20 years ago. In 1976, the federal government supported 50 percent of all research and development performed in the nation. Ten years ago, that figure was 45 percent and today it is less than 35 percent. (from forthcoming-Spring 1997- NSF report entitled, *The Science and Technology Resources of Japan: A Comparison With The U.S.*) The combination of balancing the budget, a necessary effort, and the goal of smaller government suggests a continued decline in the federal percentage for R&D funding.

The total U.S. investment in R&D was basically flat in the early 1990's in real terms. In the last few years, industry's modest increase in R&D investments has been responsible for a slight increase on a base that remained mostly flat through the 90's. (from *SRS Data Brief of October 25, 1996*--this is an update since the release of *Science and Engineering Indicators*.)

As I said earlier, times of transition offer larger windows of opportunity and broad expanses for pitfalls. Let me suggest an opportunity for the very near future that has been recognized but only marginally exploited, and then a few challenges that we can address to prevent their escalation into pitfalls.

On the opportunity side--with government carrying less and less unilateral responsibility for the nation's R&D, there is greater flexibility to form creative combinations of R&D performers, larger partnerships, unprecedented interactions. This is not just a matter of financial burden- sharing. Considerable advantage can be gained when two or three partners are linked by a single objective. The perspectives are more diverse and they can generate a multiplicity of ideas and approaches. There is a quality of integration and a depth of understanding in partnerships that unilateral approaches do not easily achieve.

There will be many who will bemoan the loss of long-standing tradition--the Cold War paradigm of the federal government being the 800 pound R&D gorilla. But that tradition has already waned as we have noted earlier. The question becomes--do we know how to take advantage of these different opportunities that have unfolded? So far, the principal partners--industry, academia, and the government have been slow, not derelict but slow, to capitalize on this opening. I will admit that the trend for partnering is growing, but we need genuine enthusiasm and experimentation. And these partnerships must be true partnerships. They must respect the goals and the missions and the constrains that can be quite different for each of the partners. Everybody has to have something to gain in a true partnership.

I am reminded of Franklin Delano Roosevelt's philosophy. In 1932 he said, "...The country needs, and unless I mistake, the country demands bold persistent experimentation. It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something." I think this is probably good personal as well as public advice. We should pay attention to it.

In terms of challenges that we face, they are external as well as internal. As you know, Japan, and several of the developing nations in the Asia Pacific region, are reorienting their investments toward the long-term competitiveness of their economies.

As far back as 1985 Japan was aware of its vulnerability in relying primarily on research generated in other countries and technology borrowed from Europe and America. This was, of course, the same technology they then reengineered to capture major market share in consumer electronics, steel-making and other industries. Despite this success, Japan described its "borrowing" position as unsustainable for the long-term. Japanese officials advocated development of a strong domestic research enterprise.

This summer, Japan announced a major long range initiative to realize this goal. The government plans to spend the equivalent of $155 billion on research and development over the next five years. This is a sizable sum that will leap-frog Japanese R&D expenditures into close proximity with our own, not just as a fraction of GDP but in absolute terms.

In August, Japan's minister of state for science and technology characterized this effort for an audience at the National Academy of Sciences in Washington, DC. Hidenao Nakagawa said, "Our vision is to create a country based on creative science and technology."

The Japanese initiative will make welcome contributions to the global reservoir of scientific knowledge and make the Japanese increasingly important players and collaborators in the world science arena. And that's very good. They are already tough competitors in global markets for goods and services. The projected infusion of $155 billion, primarily in university research, can only comprehensively heighten their effectiveness.

Despite the magnitude of the Japanese initiative, it would be wrong to focus our attention exclusively on Japan. Our concern should be much more encompassing. The highly respected Council On Competitiveness just released a report that I would recommend to you. Entitled, *Competitiveness Index 1996, A Ten-Year Strategic Assessment*, it outlines those areas in which our economy has improved in the last ten years and also lays out critical challenges still to be met.

There is a section devoted to assessments provided by 123 chief executives from industry, academia, and labor reflecting on U.S. competitiveness and tasks still unfinished. Asked about key competitors, the group of industry/labor respondents split down the middle. One half said that their greatest competition has been, and will continue to be, from domestic sources.

The other half of the industry/labor respondents named foreign sources as their key competition in the future. According to the report, "The half that predict the strongest competition from abroad, however, anticipate a changing scenario. They see Japan and Germany as the principal competitors of the last decade but do not believe they will gain ground in the future. Instead respondents anticipate that China, Korea, and India, and to a lesser extent Brazil and Mexico, will increase their competitiveness against the United States during the next ten years." And so we see an increasingly complex scenario for the future.

When asked which country--among developed and developing, in Europe and Asia--would pose the greatest competitive challenge to America over the next ten years, eighty-nine percent of the respondents named China.

Clearly, California's long experience with, and extensive knowledge of, the Pacific-rim nations will make important contributions to any national strategy involving the Asia/Pacific economies. The evolving nature of the global economy will be a growing component of policy-making. We all have much to learn from you.

America's status in the 21st century will also be strongly influenced by the way we address our internal challenges and problems. In some respects the domestic issues seem more problematic because they often represent highly ingrained attitudes and behavior. In a list that changes little over time, there are the predictable thorns of low savings rate, worker skills, market access and rate of corporate investment.

Of all the above, many believe that worker skills pose the most threatening problem to America's future economic viability. The industrial age of low skills manufacturing isolated several generations of American factory workers from the "knowledge workers" somewhere else in the company process. The new trend toward high skills manufacturing in America did not begin until the mid-1980s with innovative companies such as Corning, Motorola, and Xerox.

The task of educating our current workforce to the knowledge skills of the information age is formidable and expensive. That task, however, is not a choice or an option, it is an absolute necessity. This is an area where I believe some creative collaborations and partnerships could make a difference.

The task of educating the future workforce, today's students, to problem solving, critical thinking, analysis and application, and communicating ideas is equally as formidable. The recent results of the *Third International Science and Mathematics Study* are less than exhilarating. This study, financed by the National Science Foundation and the National Center for Education Statistics at the Department of Education, involved the testing of half a million students from more than 40 countries.

In science and mathematics for seventh and eighth graders, Singapore, Korea, Japan, and the Czech Republic were among the top rated nations. Seventh graders from the U.S. scored 24th in mathematics and 13th in science. These rankings could foretell much of the story about America's competitiveness in the 21st century unless we can make enormous strides in the next several years.

In the past, we have been able to succeed with superbly skilled students at the top, despite real skill-mediocrity below. This pattern will not hold up in the future. If this study is any indication, too many nations will "best" us on workforce skills in the decades ahead. If we expect to sustain our economic strength, we must learn to raise the standards of all students.

NSF, which is widely known for its support of excellent research, also invests 20 percent of its budget in education and much of it is targeted to improving K-12 education with an emphasis on standards and an emphasis on inquiry based hands on learning because that is what research shows us is the best way for students to learn.

And so, the era that began with World War II recedes from our mission and our memory. It was an era when many thought that money for science alone was the beginning of a predestined train to a commercial Nirvana. And others believed that American products and know-how were inherently unbeatable.

We are smarter now about the important, but not singular role of science. Hard experience has taught us the ever-present and pervasive lessons of productivity and quality. We can point with satisfaction at the decade of improvements created by American industry, although we are still coming from far behind on worker skills. And the very essence of our future as a society, our young people, must be taught by the highest quality talent in the nation and held to equally high standards.

There is something comforting about moving from lofty to level-headed. It is as chemist Marie Curie wisely said long ago, "I was taught that the way of progress was neither swift nor easy."

I am confident in America's new found level-headedness. This pragmatism about the challenges that lie ahead will keep us ever watchful for opportunities to improve. The knowledge that it will never get easy will make us relentless in our determination.

Although economic competition will likely be the primary focus of our national attention in the 21st century, we should not forget that science benefits us in many ways and that trade is broader than goods and services. It is also ideological, cultural, scientific, linguistic, and much more. The opportunities to be bold and experimental abound, and California, I expect, will once again set the pace for the nation. So my early "Oklahoma Days" impression of California as glamorous and free spirited, we want to be sure to add level-headed. I thank you for the honor of the invitation to be with you today and the patience of listening to me.

Thank you

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