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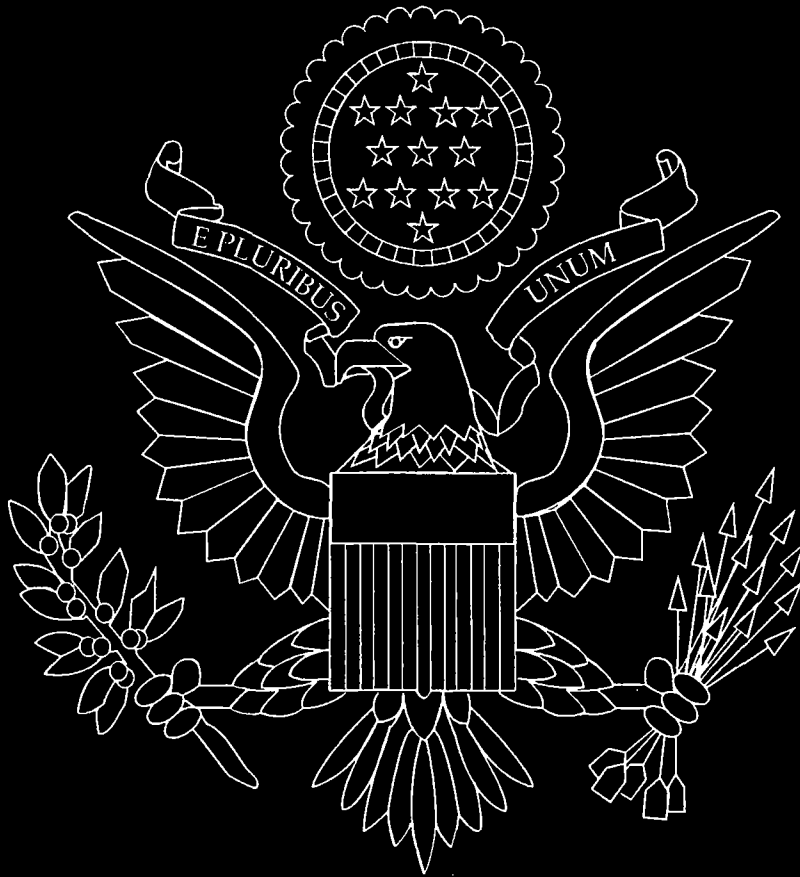
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THE ROLE OF SCIENCE AND TECHNOLOGY IN PROMOTING NATIONAL SECURITY AND GLOBAL STABILITY



White House Forum
March 29-30, 1995

WHITE HOUSE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

The Role of Science and Technology in Promoting National Security and Global Stability
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**THE ROLE OF SCIENCE AND TECHNOLOGY
IN PROMOTING
NATIONAL SECURITY AND GLOBAL STABILITY**

**March 29-30, 1995
National Academy of Sciences**

INTRODUCTION

JOHN H. GIBBONS

Assistant to the President for Science and Technology and Director of the Office of Science and Technology Policy

Good morning and welcome to the White House forum, "The Role of Science and Technology in Promoting National Security and Global Stability." I would like to thank our co-sponsors—the American Association for the Advancement of Science and the Council on Foreign Relations—for their support, and the National Academy of Sciences for its cooperation and use of these wonderful facilities.

I would also like to take time out to thank those of you in the audience today who have helped us to shape this forum; to those of you here who have a designated role as speaker, as chair, we thank you also for your time and expertise; but most importantly, I want to thank each of you for contributing your time and wisdom toward the end of improved governance and brighter horizons for our children.

We have brought together for this forum a unique group of people with expertise in a diverse range of topics. We have one mission in mind—to use our science and technology enterprise and position of global leadership to make this world a safer place. While we agree on the mission, I am confident that this distinguished group will have richly different ideas about how to accomplish our mission. That is why we need to hear from all of you, for as Lincoln said, "The dogmas of the quiet past are inadequate to the stormy present."

I believe this forum for dialogue comes at an important juncture in terms of the future that we choose. The realities of today's world present us with as many opportunities as problems.

The rapidly changing geopolitical scene offers us the potential to use science and technology to reach out to former adversaries, create new partnerships and develop a basis of working together. Rapid advancements in our science and technology base afford us the opportunity to be better guardians of both national security and global stability.

For example, technological capabilities in verification enable us to live in comfortable

coexistence with other would-be adversaries. Meanwhile, innovations in areas such as telecommunications technologies are helping us reach our economic, national security, and global stability goals. New advancements not only create new markets for United States products and services, but allow us to foster a global community of learning, one based on democratic principles of freedom of information and broad-based social discourse.

We are typically drawn—like summer moths to night lights—to issues of the moment; partly because if we do not take care of tomorrow, next week may not matter that much. Paradoxically, it is the slower-paced changes taking place around the world that may present the greatest challenges for us. The issues are profound, but they fail to grab our attention through screaming headlines that demand immediate action.

The issues are complex and demanding, as Adlai Stevenson once said: "...not a short and frenzied outburst of emotion, but the tranquil and steady dedication of a lifetime." Whether it be the impacts of human activities on the earth's atmosphere and ocean life, the inexorable buildup of human population pressures, or the steady loss of arable lands, we must guard against the inertia that can plague the resolution of profound but slowly moving problems such as these that require long-term solutions and sustained commitments.

This forum is also timely in that it is part of a process designed to make government work better and comes at a time when we are reviewing United States priorities and making increasingly tough budget choices. The Administration is working hard to marshal its assets so that the whole is greater than the sum of the parts. We now have a cabinet-level body, the National Science and Technology Council (NSTC), dedicated to coordinating overall science and technology policies. The NSTC, chaired by the President, has its roots in the Vice President's National Performance Review.

Unlike previous multi-agency bodies that helped to shape federal policies and goals, the NSTC has authority to establish priorities, direct policy, and participate fully in the budget process. Two of the nine NSTC committees—the Committee on National Security and Committee on International Science, Engineering and Technology—have been central supporters of this forum. Much of the agenda that we are covering reflects the priorities and strategies of these inter-agency groups.

We are also fortunate to have many of members of the President's Committee of Advisors on Science and Technology as participants in this forum. This talented group of 18 people from all walks of life, academia, business, and research institutions, was brought together to provide the Administration with quality advice on a range of science and technology issues and to ensure that federal policies reflect national needs.

At the most recent PCAST meeting on Monday and Tuesday of this week, in fact we heard among other things a subpanel report from PCAST on United States-Russian cooperation to

control and account for fissile materials and an update on a PCAST study assessing the origins of civil conflict. Moreover, this Administration in general and the Office of Science and Technology Policy in particular also rely heavily on forums such as this to solicit additional input. For example, the Forum on Science in the National Interest, held last year here at the Academy, was a milestone in shaping this Administration's goals and strategies for science. Likewise, the White House Conference on Environmental Technology held several months ago brought together almost 1,300 representatives from government, industry, and nongovernmental organizations to set new approaches to developing and deploying environmental technologies both here and abroad.

At this time, I would also like to announce that this forum has a "sister" forum to be held this Fall—"The Role of International Cooperation in Advancing Scientific Discovery and Technological Innovation."

This next forum is based on our philosophy that so much more can be accomplished if we wisely pool our resources with our global neighbors. It will be designed in many ways to celebrate the numerous benefits arising from bringing together the best the world has to offer in terms of scientific expertise. We will also want to use the occasion to think about how we approach international science, to seek out advice on the parameters, the mechanisms and financing tools we may want to consider.

Finally, before we get started, I have a word of caution for all of us who are responsible, in government or outside government, for moving the science and technology agenda forward. We must ensure that what we do today, what we learn and discuss, what we gather in terms of sound advice, is translated into actionable policy and that it does not remain unused or, even worse, misused. As we reach out to new frontiers of knowledge and applications, I am reminded of the experience our forefathers and foremothers had as they settled this land and explored the Western frontier.

I think of John Wesley Powell as one of this country's first PCAST members. In fact, much of the history of how we approach science and government can be traced back to Powell and his relationship with the National Academy of Sciences in the late 1800s. As you know, Powell is largely credited with the first expedition to use scientific instruments to classify and understand the Western lands. His report on the lands of the arid region of the United States sent a cautionary note to government planners that the settlement policies they were pursuing, while okay for much land west of the Mississippi, were inappropriate for many Western areas.

Unfortunately, much of Powell's advice was largely disregarded as an unnecessary inhibition to progress. At the time the rains were big and the crops plentiful and his concerns were beaten back by optimistic politicians and land speculators. It was only after the screaming headlines of disaster in the newly-settled West in the late 1880s—blizzards, droughts, and floods—that the significance of Powell's report on the Arid Lands was appreciated.

The lesson here is that much of what Powell had to say (had it been heard) could have prevented much human tragedy. Much of what Powell had to say (had it been heard) would have meant our settlement policies would have been more friendly to the land and nature, and would have left fewer scars for future generations. This is why the partnership we are nurturing today in this forum is so essential.

Late in his extraordinary life, Albert Schweitzer once said, "The promise and gift of science and technology is that, given nurturing, guidance, and time, the opportunities to help solve problems are infinite."

Although the challenges and choices—and indeed the responsibility—ahead of us are sometimes sobering, I am hopeful and confident about our abilities and intentions to succeed at the task.

To tell us more about our mission and how we can position ourselves to make the right choices, I proudly introduce a woman, who—along with her hard-working staff—in many ways made today possible, OSTP's Associate Director for National Security and International Affairs, and Senior Director at the National Security Council, Jane Wales.

JANE WALES

Associate Director of the Office of Science and Technology and Director of the Office of Science and Technology Policy

Over the next two days we will consider ways to use the tools of science and technology to build stability abroad and prosperity at home.

We have organized our program into three broad categories: (1) Sustainable Development and Economic Integration, (2) Defense and Arms Control, and (3) Economic Security.

Sustainable Development

We will begin our day with two panels on sustainable development. Speakers will explore the role of Science and Technology cooperation in overcoming the problems that condemn whole nations to poverty, disease, hunger. We will ask the question of whether social science can show us a clear correlation between the outbreak of civil conflict on the one hand and the inability of governments to meet the food, health, and safety needs of their citizens on the other.

Economic Integration

We will then discuss the promise of technology not only in meeting development needs but also in helping to integrate previously isolated nations into the larger economic order.

Conversely we will ask the question of whether these same technologies can drive an ever greater wedge between the technology haves and have-nots.

Corresponding white papers have been drafted that will point to the Administration's strategies for sustainable development and to its vigorous advocacy for American corporate investment in the telecommunications, energy, and transportation infrastructure of Asia, Africa, Latin America, Central Europe, and the Newly Independent States.

In breakout sessions we will take up the case study of the bilateral relationship between the United States and China—in which science and technology cooperation and investment play a pivotal role—and we will give special attention to telecommunications technologies.

Defense and Arms Control

Tomorrow we will turn to the category of defense and arms control. In the morning, we will reflect on ways of reducing the risk that nuclear, chemical and biological weapons will transform local conflict into global war.

Our emphasis will be on policies of prevention: The Nunn-Lugar program in which American scientists and engineers are helping to downsize former Soviet arsenals and weapons industries, and current United States government efforts to ensure the safe storage of nuclear weapons materials in Russia and the United States.

We at OSTP and on the NSC have viewed fissile materials control and accounting as among our highest priorities. Given the importance of the problem, we have asked an independent panel of scientists to conduct a study of the problem and how best to manage it. They will complete their classified report this week and make their recommendations to the President.

The threat posed by "loose nukes" is among the greatest dangers of the post-Soviet world—and this issue will be the subject of a breakout session tomorrow.

Economic and National Security

The final session will focus on ways to exploit path-breaking technologies to meet new defense needs. We will discuss the importance of information technologies to training and equipping our forces, ensuring battlefield communications, and to designing the most modern weapons in a cost-effective manner.

We will focus on programs to capture commercially developed technologies that have military applications. Finally, we will explore the value of investments in our national technology base.

As you see in your notebooks, white papers have been drafted to correspond with plenary sessions. Over this two-day period, drafting groups will meet to revise these white papers to reflect comments made during plenary and breakout sessions.

Drafters will be asked to supplement the papers with their responses to three cross-cutting questions: First, "To what degree do we rely on cooperation and to what degree do we rely on technological advantage to achieve our policy aim?" Second, "What is the role of federal agencies, labs, industry, universities, and NGOs in meeting the policy objective?" Third, "What are the obstacles to success—be they political, budgetary, bureaucratic, or diplomatic?"

The white papers thus revised and supplemented will then comprise the chapters of the Forum report—which will serve as the basis of a new National Security Science and Technology Strategy. That document will be submitted to the President and the Vice President. Once approved by them, it will be sent to you.

Policy Context

The point of departure for our work together is the President's National Security Strategy. I would like to make a few key points about the Administration's objectives, its methods, its assumptions in pursuing this strategy.

- Our objective is first and foremost to prevent conflict. To stand ready to respond decisively should conflict nonetheless occur. Prevention and response—twin objectives.
- Our method is to shift from a strategy of containment to one of engagement. That is, rather than isolate a state as we did the Soviet Union, we now seek to integrate states like Russia, China, and others into a larger political and economic order—creating a web of relationships, including scientific and commercial relationships, that give us more in common than in conflict.
- Finally, our assumptions—I will note five:

First, we believe that our nation's security derives as much from economic strength as it does from military might. Military readiness is a top priority. So too is economic revitalization and the expansion of markets. In this conception, science and technology have a central role to play.

Second, we believe that the costs of responding to conflict outweigh the costs of preventing conflict from occurring in the first place. Problems like endemic poverty, environmental degradation, food scarcity demand the sustained engagement of many nations, rather than the

occasional interventions of one.

Third, having said that, we see little evidence of a domestic political consensus on this point. The politics of national security support dramatic interventions in times of crisis. The hard work of preventing that crisis has no constituency. As we speak, budgetary decisions are being made on Capital Hill that may deny us the tools of preventive diplomacy.

Fourth, it is our view that the problems we are trying to address cannot be overcome without expanding economies and broadening participation in those economies. Hence our emphasis on sustainable development and a growing role of science and technology cooperation, technology transfer, and the advancement of knowledge.

Fifth, and finally, we recognize that the federal government is but one player on the policy scene. As we consider the importance of science and technology to policy goals, I hope that we will gain appreciation for the significance of non-state actors. One need only look at the role played by Western scientists and scholars who, throughout the Cold War, interacted with their Soviet counterparts. [Their motivations may have been professional, self-interest, or humanitarian. Their effect was geopolitical. And,] by sustaining these professional ties in the post-Soviet era, they serve to strengthen the Russian scientific community that is a force for political reform and whose participation in the Russian economy is essential to economic reform.

Corporate America has long engaged in commerce in China, where it is tapping into a growing, and often Western educated, entrepreneurial class that is very much a part of China's future.

It is because of this involvement—and because your knowledge, your experience and your judgment that we so value your participation in this exercise.

As scientists, engineers, and scholars, you all know the importance of sound scientific advice to the formulation of security policy. In the Eisenhower, Kennedy, and Johnson years, [throughout the post-war era] scientists made prevention a central tenet of military planning—then it was the prevention of nuclear war. They played a decisive role in integrating arms control into the security agenda. The role for scientists to help shape our nation's response to new challenges is as important in the post-Cold War era.

You can help provide the Science and Technology underpinnings to a strategy of prevention. In this case, the threat is more diffuse, but prevention is still the best cure. You can help us identify it, address it, plan around it.

Specifically, you can:

- Advise us on the origins of conflict—its causes and its cures. You can tell us if there are clear patterns that give us predictive capacity and preventive opportunity;
- You can help devise policies to ensure that conflict is not fueled by weapons of mass destruction; and you can
- Identify ways that Science and Technology cooperation can help build viable economies and governable societies that can contribute to international community and commerce.

Because of the importance of the topics and of your contributions, both the President and Vice President have chosen to join us. The Vice President will be closing the conference at 4:30 tomorrow. Because the President is in Atlanta en route to Haiti, he has taken advantage of technology to allow him to open the forum today. So, before we roll up our sleeves and begin our work together, I introduce a videotape of the President of the United States, who will now give the Forum its charge.

BILL CLINTON

President of the United States

Good morning. I want to thank you all for attending this important White House Forum which offers an opportunity to consider how we can best put science and technology in the service of our national security, economic prosperity, and sustainable development. Our ability to put science and technology to work for us will play a vital role in ensuring our success as a nation in the years ahead and in the 21st century.

First of all, our economic prosperity will depend upon our mastery of emerging technologies. We must invest wisely in science and technology to produce the quality jobs of tomorrow, as well as new markets for American goods and services.

Second, improving global stability demands that we put scientific insights in technology into action to promote sustainable development. In that way, we can work toward a world of free citizens, consumers and producers, instead of combatants and victims.

Third, we must also stay at the cutting edge of new developments to preserve our national security so that our Armed Forces remain the best trained, best equipped, and best prepared in the world, and so that we have the intelligence and monitoring capabilities we need.

The post-Cold War world has revealed a web of trans-national problems and demands that require vigorous action and innovative solutions: Overpopulation, environmental degradation,

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the spread of weapons of mass destruction, and new and dangerous health threats. Our Administration is working hard to meet all these challenges. To give just one example, we are advancing an ambitious agenda of nonproliferation efforts. We are working for ratification of START II and the Chemical Weapons Convention, as well as for the indefinite extension of the Non-Proliferation Treaty. We are working for a comprehensive test ban and a fissile materials ban, and we want to strengthen the Biological Weapons Convention. We must do more, and our success will depend upon making wise choices in the areas of science and technology, which is why your work is so important.

The report of your discussions and the conclusions will form the basis for a new national security science and technology strategy. I look forward to reading your report, and I hope that these two days are productive ones for your efforts to put science and technology in the service of our national security and global stability. Thank you.

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SESSION ONE

Science, Technology, Sustainable Development, and Preventive Diplomacy

First Panel Discussion

Understanding the Role of Science and Technology in Mitigating Civil Conflict and Societal Stress

JANE WALES—Introduction

The first panel will be chaired by Jessica Tuchman Mathews, who is a heroine of mine. Jessica is one of the few people who foresaw the interactions interconnections among these various issues, who saw national security as not being simply a matter of weapons and arms control, but as encompassing a large number of global issues I am very pleased to introduce Jessica, who will pull together her first panel.

JESSICA TUCHMAN MATHEWS

Senior Fellow, Council on Foreign Relations

This is an effort to bring together people from a lot of different perspectives, which is always an endeavor fraught with pitfalls. I am reminded of the story that has been told about Enrico Caruso, the Italian tenor, who was asked in an interview what he thought about Babe Ruth. He answered very politely that he had heard the name, of course, but he had not yet heard her sing. There are lots of opportunities for our perceptions to fall through the cracks here, but we will attempt to do our best.

I have been asked to set a framework for this first panel, which I will do very briefly. As I see it, the issue of national security (one can argue forever about definitions) is around the core of national security which, in its very traditional sense, faces issues that need to be addressed and can only be addressed with military force. There are at least now two other aspects which are much less susceptible, or maybe even not at all, to those sorts of responses.

On the one hand, we have a new set of concerns that are caused by an unprecedented combination of economic, environmental, and technological changes that are making national borders steadily less relevant and less powerful barriers between countries. These concerns have led to a whole range of challenges, from weapons of mass destruction to global warming, in which governments are basically less and less able to defend their own territory and people within a defined set of borders.

Security is becoming less a matter of national security and more a matter of international

security. Some people call it "global." I think that generally, there are a few threats that are truly global, but the majority of threats affects regions and hemispheres, and the key change is from individual nations as the primary actors in ensuring security to groups of nations acting in lots of different international groupings, occasionally globally.

At the other end of the spectrum, the end of the Cold War has unleashed a set of concerns that are increasingly being called "human security." People's attention is increasingly focused on those things that affect their daily lives: Sluggish economic growth, unemployment, poverty, pollution, drugs, ill health, overcrowding, and environmental degradation.

The cause, I think, is in part being freed from the overriding fear of nuclear calamity, and is in part also an extraordinary increase in literacy and media coverage around the world in the last 20 years or so. In this period, the adult literacy rate has grown by 80 percent in the developing world, which is an enormous change. We now live in a world in which there are 18 television sets (God help us!) for every 100 people.

So we have now this core of national security in a very traditional sense, international security issues that require multinational groupings of behavior, and this new set of concerns that can be called "human security," all of which I think fall in the domain of these panels and of the work of the next couple of days.

Finally, we also have (and it needs to be remembered) a brand new economic framework. Particularly financially, we used to operate by a set of rules shaped by governments. One of the nice things about those rules was if you did not like them anymore you could withdraw, as the United States did from the gold standard in 1971 under President Nixon.

What we now have is a standard shaped by technology, what Walter Wriston has called an "information standard," and no government can withdraw from it. There is no place to hide from the instantly transmitted judgments of the marketplace.

So that is another profound change. I will not; there is a lot more I would like to say, but I will not take the time to do that. I will instead go directly to our next speaker.

David Hamburg is currently President of the Carnegie Corporation of New York, probably known most to you as the "Carnegie Foundation." During his career he has been a professor of psychiatry and behavioral sciences at Stanford, and of health policy at Harvard. In between he was president of the Institute of Medicine at Harvard from 1975 to 1980. He has also found time to be president and chair of (AAAS), the American Association for the Advancement of Science, and to have served the public interest in ways too numerous to mention, a few of which are in your program. I give you David Hamburg.

DAVID A. HAMBURG*President, Carnegie Corporation of New York*

Thank you very much, Jessica. It is a privilege to be introduced by you. I, like Jane, am a long-time admirer of Jessica Tuchman Mathews. I want to congratulate Jack Gibbons and Jane Wales. This is a very farsighted program, and I think it will open up major opportunities.

What the scientific community does first and foremost is to provide understanding, insight, and stimulating ways of viewing important problems. I want to first address a very fundamental (but at the same time a very difficult) part of this whole problem area: What are the actual potential contributions of the bio-behavioral sciences and the social sciences to conflict resolution and conflict prevention? Particularly, what are the ways in which these contributions might increase substantially in the years ahead?

High standards of systematic objective inquiry simply have to be applied to this field, involving in a variety of combinations and collaborative ways, the biological, behavioral and social sciences. Such crucial world problems as those involved in human conflict do not come in neat packages that fit the traditional disciplines.

In point of fact, this terribly important area of human experience has not been, a major subject for scientific inquiry. Even now, it is largely a marginal subject, both in research and education, even in the world's greatest academic institutions. Nevertheless, some interesting and potentially useful approaches have emerged. Let me first just very briefly mention some of the areas of active inquiry and then focus in on one.

The topics under study include: (1) The neural biology of aggressive behavior, (that is, cell circuits and chemistry mediating such behavior); (2) biomedical aspects of individual violence, including the role of drugs in precipitation, exacerbation, and therapy; (3) child abuse and its effect on subsequent development; (4) the study of conflicts at various levels of organization (such as families, communities, and nations) in the search for common factors and principles so that discoveries at one level may illuminate issues at another level; (5) detailed, systematic inquiry into the origin and resolution of past conflicts and ongoing efforts in relation to contemporary ones; (6) formulation of fundamental concepts pertinent to a wide range of conflicts, such as ideas about justice; (7) experimental research on simulated conflicts; (8) the study of various intergroup and international institutions and their relation to conflict; (9) the study of negotiations, both in real-life and simulated circumstances; and (10) research specifically focusing on war and peace, including ways to diminish the likelihood of nuclear war. These studies flourished during the Cold War and are in a somewhat peculiar position at the moment.

The needs and opportunities for major contributions in understanding human conflict and

paths to conflict resolution are simply immense, but there is much to be overcome. The inherent complexity of the subject matter is one obstacle. Old conceptual rigidities like the heredity-environment dichotomy is another. Proper ethical limitations on experimental control in human research is yet another obstacle. There are also ancient prejudices against objective inquiry on human behavior, dogmatic social ideologies, and an institutional inertia regarding any kind of major change.

I believe one of the great challenges is for science policy to organize a much broader and deeper effort to understand the nature and sources of human conflict, and above all, to develop more effective ways of resolving conflict short of disaster, as Jane Wales just said. Let me give a very brief perspective from research on evolutionary biology, anthropology, and history regarding this problem area.

First, a quick word about research on nonhuman primates, a field in which I used to be very active. Research on nonhuman primates in the past few decades, both in natural habitats and in experimental settings, has turned up three very interesting convergent points on this subject. In most nonhuman primates, the more complex monkeys and apes, the strong bonds of attachment between individuals are crucial to survival and reproductive success, and protection of such bonds is a major context for aggressive behavior.

A second important context for aggression is competition for limited and highly valued resources, especially the crowding of strangers in the context of premium resources. Third, in most species, individuals show a strong attachment to one group and are antagonistic toward strangers from other groups. Those observations, to some degree, foreshadow what has been learned about the simplest human societies, the hunter-gatherer societies.

A word about the human group in adaptation and deadly conflict: There are powerful links between human groups and human survival. The basic facts have implications for conflict resolution and mutual accommodation. There is a very long evolutionary background of human groups. As I said, monkeys and apes typically live in groups whose internal structure is based upon intense and persistent attachments between individuals. They have long-term, complex relationships that are crucial for their survival and reproduction.

The hunter-gatherers, the earliest form of human societies in which our ancestors lived for some several million years, typically lived in groups of about 20 to 50 members. Reciprocity is crucial in relationships, both within and between groups. Disapproval is enforced by jeopardy to sharing in the future and by the threat of rejection from the group. Powerful sanctions reinforce conformity to group norms. The importance of sharing is conveyed to children from infancy onward. The primary group, the small society, changes slowly in the lifetime of an individual. The primary group is the main locus of problem-solving for adaptation. In other words, belong to survive. Group membership is a key to survival.

Over many millennia in simple societies of human origin, over many millennia a sense of personal worth was built upon one's sense of belonging to a valued group. A sense of belonging in turn depends on the ability to master the traditional tasks of that society—to engage in social interactions that are mutually supportive. All of this is further reinforced by participating deeply meaningful group rituals where of social identity is shared (this is my group, these are my people)—and invested with deep emotional significance.

All of these traditional experiences occur within the context of the small, enduring, face-to-face group of great intimacy that provides the security of familiarity, support in time of stress, shared coping strategies, and enduring attachments to sustain hope in the face of adversity. That is how we evolved. That is how we got here over millions of years—the small group in adaptation.

The evidence of modern biological, anthropological, and historical research indicates that these basic facts of small-scale, traditional life that applied during the several million years in which our ancestors organized in hunting and gathering societies also applies to the extended family of agricultural village society that began to appear about 10,000 years ago, as well as to the primary group of the homogeneous neighborhood in pre-industrial towns within historical times.

As times have drastically changed, especially since the Industrial Revolution throughout the past two centuries, and as people have flowed over the earth like flood waters, they have fervently sought to maintain social support networks similar in basic functions to the small societies in which our species evolved. Such social support systems facilitate the development of coping strategies that help us make a living, keep distress in bad times within limits that are tolerable, maintain self-respect, preserve human relationships, meet the requirements of new situations, and prepare for the future. There is a tremendous amount riding on group membership, on identification as a group, and on the identity of a person with a group.

During the past few decades fruitful insights about these matters have come from experimental research on the psychology of intergroup behavior. Social psychologists, as well as anthropologists and sociologists, have been interested in the truly pervasive human propensity to distinguish between "in groups" and "out groups." Both in field studies and in experimental research, the flow of evidence is very impressive. Human beings find it exceedingly easy to learn "in group" favoritism or "in group" bias.

People are remarkably prone to form partisan distinctions between their own and other groups, to develop sociometric preferences for their own group, to discriminate against other groups, to accept favorable evaluations of the products and performances of the "in group," to accept unfavorable characterizations of other groups that go far beyond the objective evidence or the requirements of the situation.

This is true, by the way, not only of long-standing group commitments like families, but even in experimental situations where only a brief orientation is given to distinguish a newly-formed group. In fact, experimenters find it difficult to avoid invidious distinctions, even when the experimenter wishes to do so.

Overall, it is very easy to stimulate a strong sense of "my people," or the "in group." This easily learned response may well have had adaptive functions in human evolution over a very long period, but now our circumstances have changed rapidly. They are much more complex, and very different than those from which we evolved. So these "in-group, out-group" responses are, to say the least, highly problematic in their consequences. It is important to note that invidious distinctions can be readily and powerfully exacerbated by political demagogues, as we have seen so vividly in this century. Such exacerbation can have disastrous consequences.

Many different political, social, economic, and pseudo-scientific ideologies have been utilized in support of these hostile positions. Groups have been specified in many ways. Although we often speak about ethnocentrism, it might be better to speak of "groupocentrism," because groups have been specified by religion, race, language, region, tribe, nation, and various political entities.

The worldwide historical record is full of hateful and destructive activities based on such invidious distinctions, often associated with deeply felt beliefs about superiority, or a sense of jeopardy to group survival (a very important consideration) or justification by supernatural powers. All that is an ancient part of the human legacy and now more dangerous than ever before.

There is a probability of mass violence in contemporary circumstances by conjunction of several factors that bear on these "in-group, out-group" distinctions. Consider the background of underlying ethnic tensions, religious tensions, and inter-group tensions, waxing and waning over centuries. Against that background comes a circumstance of economic deterioration or free-fall which elicits great fear. Consider also erosion of social norms and in the most extreme case, the failed state, with exacerbation by political demagogues.

This conjunction of circumstances—underlying intergroup tensions, economic deterioration, the erosion of social norms, and exacerbation by political demagogues—we see now in the former Soviet Union. We also see it in the former Yugoslavia, and we see it in many parts of Africa and Asia.

A quick word about prejudice and ethnocentrism in child development and education. The Carnegie Council on Adolescent Development last year sponsored a research symposium on this subject, in which we had strong representation of the NSF, NIH, and various private and public research granting agencies. We all realized that we had not paid much attention in

recent years to the formation of highly prejudicial and damaging attitudes and behavior in the course of growth and development through childhood and adolescence. I think we are taking a new look at that whole subject.

How do we acquire our orientations of ethnocentrism, prejudice, dogmatism, and a susceptibility to hateful pseudo-solutions? Are there ways to foster more constructive orientations? The nature of parental care; child care; experience with siblings and with peers; exposure to hatred and violence in schools, streets, and the mass media; and the cumulative effect of severely frustrating conditions are all important factors in shaping prejudice and ethnocentrism. So, too, in some places are official propaganda and religious cultivation of stereotypes.

The extent of prejudice can be affected by all those factors—home, school, community, and media, as well as by opportunities to gain familiarity with other groups under constructive circumstances. This is a very interesting research area. It has been clarified by a fine research tradition over several decades, reflecting such contributors as Moussa Farsharif, Gordon Upworth, and Martin Deutsch. Yet, curiously enough, it has been out of fashion in the past decade. Very strange—the low level of research in this field at a time when arguably the need is greater than ever.

How can contact between adversarial groups help in preventing violence? This is a very fundamental question. [End of tape; thought missing here.]

There is a strong positive effect of friendly contact in the context of equal status, especially if such contact is supported by relevant authorities who recognize equal status, and if it is embedded in cooperative activity and fostered by a mutual-aid ethic, especially superordinate goals. By "superordinate goals" I mean goals that are important to both adversarial parties (the avoidance of nuclear war between us and the Soviet Union probably constituted such a superordinate goal) and cannot be achieved except by a high degree of cooperation. Under these conditions, the more contact the better. Such contact is associated with improved attitudes between previously suspicious or hostile groups, as well as changes in patterns of interaction between them in constructive ways.

Superordinate goals indeed can have a powerful effect on unifying disparate groups. In classic experiments, adolescent boys, strangers in a boys camp, were quickly made quite hostile to each other and then converted by superordinate goals, transforming enemies into friends. These experiments have been fundamentally replicated in work with many different kinds of groups. My favorite experiments are those involving business executives—even business executives can be converted in this way.

Such effects are particularly strong when there are tangibly successful outcomes for cooperation; for example, clear rewards from cooperative learning, which is a major thrust of

educational research of the past two decades. Indeed, this problem of inter-group relations importantly involves child and adolescent development and presents crucial new opportunities, not only in schools but in many organizations and the media, both print and nonprint. In short, what I am saying is the scientific community can challenge pivotal institutions to consider how various groups of this global human species can at last learn to live together. Perhaps it is something like learning that the earth is not flat. We may need a paradigm shift in our outlook toward human groups.

Education in all of its forms, from family to schools to mass media, can increasingly convey the facts of a pluralistic and interdependent world, not one that is strange and hateful. Yet today's education, to be honest, is ethnocentric on a worldwide basis. We bring up our children everywhere to be negative to some degree to some other group or groups. Education could convey an accurate concept of a single, highly interdependent worldwide species, a sort of vastly extended family sharing fundamental human similarities and a fragile planet.

In fact, all research-based knowledge of human conflict, diversity, and mutual accommodation should be grist for the education mill. Research in the biobehavioral sciences can illuminate the ways in which we humans can at last learn to live together. This research is being drawn upon as one pillar of the Carnegie Commission on Preventing Deadly Conflict, co-chaired by Cyrus Vance and myself. We are trying to build a preventive system that the international community might construct in the decades ahead and consider how it might be implemented, with a significant role for the international scientific community in constructing and maintaining the preventive system. But that is for another day.

I close now with a crucial question for the human future, and I would like you to think about it: Can human groups achieve internal cohesion, self-respect, and an adapted efficacy without promoting hatred and violence? I hope so. But the answer is not obvious. A deeper understanding of factors that influence "groupocentrism" could have much practical value in preventing deadly inter-group conflicts both within nations and across international boundaries.

I believe that even though "in-group, out-group" distinctions are ubiquitous in human societies, including our own; even though they are easy to learn and hard to forget—and to some extent a legacy of our evolutionary and historical experience in which such distinctions were related to survival—despite all of that, there is the possibility that we can learn to minimize such harsh distinctions in the future.

The conditions for survival are in some respects very different than they were when these orientations evolved in human development. We must now find a basis for a fundamental human identity across a diversity of cultures in the face of manifest differences. We are indeed a single, interdependent worldwide species. That is one of the central facts for modern education and a great challenge for the scientific community.

JESSICA TUCHMAN MATHEWS—*Introduction*

I thought as I listened, as I have on many previous occasions, that there is no one with a broader knowledge or a greater personal wisdom who better connects the insights of basic social science with the formation and the demands of national security policy than David Hamburg.

Our next speaker I think is very well known to probably almost everybody in the room, although it is probably not so well known that he began his Washington career as Deputy Assistant Secretary of Education under President Nixon, actually as a White House Fellow under President Johnson, I should say.

Since then, Tim Wirth has served his terms in the House and one in the Senate, one by choice, I should add, where he focused, particularly in the House, on telecommunications policy and on fostering greater competition in that sphere, and both in the House and Senate on a very broad range of energy and environmental issues.

He also picked up an interest from his academic career, he got a Ph.D. in Education and Economics, and along with Senator Heinz created a really ground-breaking framework for folding economic considerations into environmental analysis.

Tim Wirth is currently serving as Under Secretary of State for Global Affairs, where he has a small portfolio including population, environment, migration, refugees, human rights, democracy, narcotics, terrorism, and a few other odds and ends.

TIMOTHY E. WIRTH

Under Secretary of State for Global Affairs, United States Department of State

Thank you very much, Jessica. Thank you all very much for being here for this remarkable gathering of great talents: Jack Gibbons, who does such a superb job of reminding us all of the role and responsibilities of the scientific community—Jack, thank you very much for your great work; and David Hamburg, who has been a cogent mentor, as Jessica said, to so many of us for such a long period of time.

It is a great pleasure for me to be with you all this morning to share some thoughts about several of the issues engaging this country and this Administration, a set of new, cross-cutting global issues we are confronting in the context of profound change for our country and the world.

All over the globe, nations are beginning to recognize their opportunity and responsibility to look beyond the crisis of the moment toward the underlying causes that are making the world ever more complex, and redefining the priorities for long-term national security and global

stability.

With the Cold War ever more a distant reflection in the rear-view mirror, there are those who would suggest that the United States mission is domestic only. They argue that since our interests and responsibilities around the world are greatly diminished, we should simply maintain a strong defense to guard against military threats and traditional security concerns. This view ignores much more than the increasingly interdependent nature of the world. It ignores the tremendous suffering and lost opportunities that exist in today's world. It ignores our responsibility to ensure progress and hope for our children and for the world of tomorrow.

Passive isolation will not enable us to fulfill these responsibilities. Instead, the challenges of the 21st century point us toward sustainable development, toward the central concept agreed at the Earth Summit of 1992. Sustainable development fundamentally means that the economies of the world, including our own, should attempt to meet the needs of today's generation without compromising or stealing from future generations. It is a concept rooted in the recognition of the mutually reinforcing nature of social, economic, and environmental progress.

Ecological systems are the very foundation of modern society in agriculture, in social organization, and in economic planning. Over the long term, living off of our ecological capital is a bankrupt economic strategy. At the same time, most peoples and nations aspire to economic growth and social, scientific, and technological progress, which, in turn, are the essential building blocks of environmental protection.

Understanding these new realities and stresses of economics and the environment means coming to grips with some difficult scientific information. The issues involved are devilishly complex, ranging all the way from global warming and rapid population growth to biodiversity and international health. Important for this city and for public policy is the fact that with knowledge comes responsibility, and if you do not know or do not want to know, you therefore do not have to act.

Central to these concerns and setting the pace for change all over the world is the spiral of population growth. If every ten years we go on adding a China's worth of human beings to the planet, the human population will triple from today's 5.5 to almost 15 billion by the end of the next century. To stand by and let that happen would be to doom every hope of economic progress in the developing world and most every humanitarian endeavor.

I would suggest that this generation of leadership must embrace the fact that global threats are replacing Cold War confrontations as primary challenges and catalysts for our common purpose. At the end of this century we will be measured by how well we made the transition, redirected our national efforts, and refocused our scarce resources. The incorporation of global threats into the post-Cold War definition of American national security means that we

have to break down barriers. In the words of Abraham Lincoln, "...to disenthral ourselves from old ideas."

We are accustomed to searching for the causes of international instability in such factors as ideology, geopolitics, economic inequity, or intense hatred spawned by nationalism, race, and religious fanaticism. To these we must now add such heterogeneous factors as soil erosion, air pollution, overgrazing, fresh water supply, loss of biodiversity, shortages of firewood, infectious disease, and many others.

Compared even with the complex considerations that determined our national security during the Cold War, the new global threats to international stability are bewildering in their interplay of manmade and natural phenomena. All of these factors are linked through a complex chain of cause and effect, resulting in issues that can make even the arcane calculus of nuclear deterrence seem like a simple proposition. Climate change calculations, for example, challenge even the most complex and powerful computers that were designed for our Cold War weapons programs.

Complexity need not be the enemy of a coherent concept for policy related to global issues. The Clinton Administration has emphasized a shift toward preventive diplomacy, incorporating support for democracies, sustainable development, traditional diplomacy, and military strength, aimed at preventing conflicts before they happen, addressing underlying factors that lead to undesirable political and economic competition, and containing conflicts that do occur. These measures are, it seems to us, a wise investment in our national security because they offer the prospect of resolving problems with the least human and material cost.

I want to highlight some of the major components of our prevention strategy, beginning with the Administration's vigorous efforts to promote sustainable development, both at home and abroad. Sustainable development is inextricably linked to the notion of preventing global threats before they occur. It requires discipline, sophistication, and a commitment to long-term interests. The indicators of success will not always be trophies or victories. They will often be measures of undesirable events that did not happen.

While the indicators are at times elusive, the tools, particularly as they relate to science and technology, are clear. In addition to the traditional analytical tools of the political, social, economic and military sciences, decision makers must now incorporate with increased frequency the expertise that resides in the realm of the physical and biological sciences. Science and technology are crucial to a safe and sustainable future. Indeed, given their interdependent nature, global issues require rigorous application of the basic principles of the scientific method—careful, informed and disciplined approaches.

Science is essential if we are to understand the causes, characteristics, and consequences of global problems, and in teasing apart the tangled relationships. In many cases, the scientific

course bears great responsibility and opportunity for alerting the public and governmental leaders to emerging problems and new understandings of long, vexing trends. For example, scientists warned about the dangers of ozone depletion long before the ozone hole developed over the Antarctic and public policy moved dramatically forward.

Space science allows us to accumulate an invaluable record of the state and evolution of the basic components of the biosphere—crop lands, forests, grass lands, oceans, fresh waterways, and grappling with global climate change. Newly emerging infectious diseases and protecting the world's biodiversity require immense scientific capabilities. Precise measurements and the development of predictive quantitative models are essential tools for policy making in the post-Cold War security environment.

While we are committed to helping ensure that scientists have the resources they need, we also recognize the limits of science in some of these areas. Rooted as it is in the irreducible properties of the natural world, science does not and cannot always provide a simple answer. Ranges of uncertainty, which we are accustomed to in economic policy making, must be accepted in these new elements of national security policy. And, after all, security was equally apparent during the Cold War, when we did not know precisely when or if the Soviets might rush through the Fulda Gap. We took a precautionary approach and bought insurance.

The parallels with the Cold War do not end here. As we reach out to expand the network of allies in our generational struggle against communism, our new international agenda must also include development of appropriate technology for meeting the needs of countries in the developing world. There is a great thirst in these countries for the enormous economic, health, and personal benefits that technology can bring. We know that it is impossible to extend overnight the current technological standards of the industrialized countries to the entire population of the earth, but we have to continue to cooperate.

While rapid technological change is taking place throughout much of the world, we must be concerned about countries that are falling further and further behind, feeding dangerous gaps between socioeconomic groups and between nations. Successful assimilation of the latest technologies, on the other hand, may help us allow countries to leap-frog certain investments and stages of development, leading to less pollution, higher productivity and, we hope, to elimination of absolute poverty and some higher incomes.

Because the new threats are global, international science and technology cooperation is essential. Often the research must be done *in situ*, as in the case of assessing and preserving biodiversity. We also recognize that though we remain a world leader in science and technology expertise, some of the best scientific minds can be found abroad. Not only does cooperation strengthen our talent through exposure to new ideas, but it has built bridges among nations, often when no other avenues were available.

Perhaps most important, during these times of severe budgetary pressure, international cooperation reduces the cost of scientific endeavor borne by any one nation and helps to ensure that scientific results are disseminated and used worldwide. The best way to promote and achieve sustainable practices globally is through participatory research, development, and commercial partnerships among developed and developing countries. Developing countries need the opportunity to develop adequate science and technology infrastructure to incorporate and utilize sustainable technologies.

An honest appraisal of these issues must also include acknowledgment that misuse of science and technology, whether deliberate or not, and the unanticipated consequences of technological development, are often among the causes of environmental stress and potential global dangers. It is ironic that many of the marvels of our scientific age could in fact imperil future generations.

Advances in medical equipment and procedures that prolong life spans, development of pesticides, fertilizers and irrigation systems, constructions of dams and roads, introduction of enormous oil tankers and logging equipment, and fish-processing ships, wide-scale use of gaseous refrigerants and aerosol propellants, nonrenewable energy generation schemes, and the ubiquitous automobile, not to mention the dazzling sophistication of modern weaponry—all of these technologies can generate stress that contributes to some degree of global instability.

We should have learned an important lesson. Our stewardship of the earth implies a responsibility to be stewards of manmade technology as well. We must routinely investigate and evaluate the economic, social, and environmental costs of the technologies that we propose to use on a broad scale. We must also accept that the public's attitude toward science and technology and support for federal research and development expenditures is often undermined by a perception of unexpected difficulties and unfulfilled promises.

No doubt our efforts to anticipate and wisely direct the course of science and technology will only be partially successful. When the transistor was first developed during the late 1940s, no one could have predicted the full impact of the technology that would follow through application of this century's perhaps most important invention. Similar surprises are in store for us and for future generations. Still, our legacy to those generations must include our utmost efforts to use our skill and knowledge in a responsible and beneficial way.

I would like to close by highlighting just one example of the tremendous importance and promise of these new challenges. I am increasingly convinced that the biodiversity issue may dwarf all others in the not-distant future. The 21st century will certainly be the century of biology. Compounds of undiscovered promise await us. Already more than 50 percent of today's top-selling pharmaceuticals come directly from plant biochemicals. I need not remind this distinguished audience of such a list: Periwinkle, foxglove, quinine, penicillin—the list goes on and on, providing immeasurable assistance and comfort to mankind and creating

multibillion dollar markets, which are overwhelmingly American.

Similarly, our food base comes from the reservoir of nature. Just three species of grass—rice, wheat, and corn—have become humanity's principal food, and as with plants possessing medical potential, we have barely begun to understand the abundance of the natural world. We can measure the distance to the moon to an accuracy of centimeters, but have not explored the wonder of our own world species. Are there 10 million? Fifty million? A hundred million? What genetic wonders do they hold? Certainly this is the overwhelmingly important frontier of the future in which we can prospect for food, fuel, pharmaceuticals and fiber as we once prospected for gold and silver in our own back yard.

Yet, there are forces afoot in our country bent upon crippling our own nation's biological survey, repealing the Endangered Species Act, ignoring the International Biodiversity Treaty. One of the major challenges that we face is to change the terms of the biological debate so that it does not take the form of oppressive government regulation, but rather is understood as a phenomenal future dominated by United States scientific, pharmaceutical, biotechnological, agricultural advances. Here, too, we can prove that economic prosperity and environmental preservation can be linked with enormous promise for posterity.

In what is left of this century we together have the responsibility to change much of the way that the world does its business so that the earth, as we know it and love it, can survive in the century to come. The partnership between the Administration and the scientific community is crucial in reaching this mission. That is why we are all here today and tomorrow, and we deeply appreciate your coming. Thank you ever so much.

First Panel Discussion Questions and Answers

JESSICA TUCHMAN MATHEWS—Questions

What do we know about the process of communication? What evidence is there of the effect of training in communications on inter-group conflict? Carnegie is currently funding a project on communication between school children in Russia and the United States as a means for mitigating tensions between East and West. What, if any, insights from this research into the process of communications can be applied both to this forum and to the design of the global information infrastructure?

DAVID A. HAMBURG—Answers

Let me quickly respond. On the question of training, much more attention is being given to training with respect to inter-individual conflict than inter-group conflict, at least in terms of systematic research. There is some rather interesting and encouraging evidence that, under the rubric of "life skills training," a particular category of behavior, learning to be assertive

without being destructive is a very useful technique. Learning techniques of nonviolent conflict resolution in interpersonal relations, particularly in adolescence, is an ongoing, active field.

With respect to inter-group conflict, we and others are supporting all over the former Soviet Union, Eastern Europe, and elsewhere in the world the training of people who really have had no exposure to concepts or techniques of conflict resolution, negotiation, and mediation. You really have to start it at a very basic level, mainly to have a sense that there are ways to resolve conflict short of violence. This includes sharing a sense of what is possible, engendering hope, and then teaching basic concepts and some techniques for conflict resolution.

It is going to be important to have people all over the world who are capable of mediating and negotiating. It is certainly teachable, but how it fits into particular cultures is a very complex and often sensitive subject.

Concerning the question about the so-called "Vega Project," it started shortly after Gorbachev came to power at a meeting of the Academy's International Security and Arms Control Committee (CISAC), of which I was then a member. I had a private meeting with Velachov, who was then chairman of the Russian group, in order to see what might be possible beyond the subjects on the agenda.

Gorbachev had just come to power at that time and I raised the question concerning whether there was anything that might be of interest to him, beyond the arms control field, that might provide some opportunity to see the benefits of cooperation, explore any curiosities he might have, or whatever.

So I had the opportunity to meet Gorbachev, an extraordinary human being, and he expressed an interest in having school children learn how to use computers. He told me with great agitation, "We cannot even make the simplest computers. We cannot use them outside of our military sector. What is wrong with our society?" This was three or four months after he came to power.

In any event, Velachov and I cooked up a project which was about elementary school children in both countries using computers for educational purposes, and communication between the children and between the teachers in the two countries, as well as between social scientists in both countries who were overseeing the work. It was a long-running project which is now being analyzed. It will be written up by Michael Kohl, known to many of you, a professor at the University of California in San Diego. Michael can say much more about it than I could.

However, I would make just a couple of quick points. The marvelous curiosity of children, which is, after all, what we tap into in science education and education in general, came

through very clearly. These kids were terribly eager to learn not only how to use computers but even more so about their counterparts in the other country—before they had developed powerful stereotypes and immense personal barriers. They had this remarkable opportunity to communicate directly with their counterparts across national boundaries, including indeed across highly adversarial boundaries. So it was certainly a stimulating and worthwhile experience. What the ultimate sense of it will be for lessons about social science cooperation between adversarial groups is a matter that Michael Kohl will clarify, I am sure.

JESSICA TUCHMAN MATHEWS—*Question*

Tim, there is a question here from Jack Gibbons, who writes: Perhaps the national laboratories represent the largest concentration of science and technology for the United States or even the world. In view of the ongoing debate regarding the missions of the national laboratories, has the time come to consider redirecting their enormous pool of talent and technology to an international mission for promoting sustainable development? Is this potentially feasible?

TIMOTHY E. WIRTH—*Answer*

Clearly, the national laboratories are going through a major transition. When I was in the Senate we spent a lot of time trying to figure out what a long-term mission for the national laboratories might be and how this might engage environmental issues overall, population issues, and a series of related concerns.

I believe that the movement toward sustainable development is still a broad term that sounds a little bit like Bambi for the environmental and economic communities. It is a good thing, but maybe people do not really understand it. I think sustainable development has a dynamic to it, an excitement that can be a deeply important instrument for grass roots organizations, community involvement in the country, for the engagement of the scientific community, and on a local basis and global basis.

I think it is an extraordinarily exciting idea. I think that it has potential that ought to be harnessed, not only in the national laboratories. It ought to be harnessed in the universities, in grass roots political organization, and in small political organizations. It ought to be harnessed in every way, and certainly getting the national laboratories engaged in this more broadly could be very helpful.

JESSICA TUCHMAN MATHEWS—*Questions*

Several people have asked about science and technology in the State Department. Let me read one of them: With the stated emphasis on science and technology for our good and the world's well-being, why is the science and technology part of the Department of State

being reduced in size and stature? Would not the opposite be more appropriate if we really believe what we say?

TIMOTHY E. WIRTH—Answers

I do not think the science and technology side of the State Department is being reduced in size and stature, at least not in fact across the street. It might be being done in theory in some of the legislation being drafted downtown, but not in fact across the street. For example, within the next six weeks we will be announcing two major new initiatives, one on a global AIDS strategy that came out of that group working very closely with NIH, HHS, and nongovernmental organizations around the community and the world, relating the scientific community and what we know to an overall foreign policy emphasis, particularly in Africa.

Second, we are going to follow that with introduction of a major program focused on infectious diseases. Both of these are extremely important initiatives that should be part of a foreign policy on the population side. Some of that relates to the scientific and population research community. How do we embed the ethic of focusing on stabilization of population in each embassy, into the mission of each ambassador around the world, and of cooperation between USAID, USIA, and the State Department? We are moving in that direction, and that is a lot stronger today than it was a year ago, two years ago, or three years ago. So I strongly disagree with the assumptions of the question.

If, however, the base of the question is, do we have the funding necessary to do this kind of a job, obviously the answer is no. It is becoming a more and more difficult to maintain the kind of support necessary not only to maintain our current momentum but to increase it as it should be increased.

JESSICA TUCHMAN MATHEWS—Questions

The perception of scarcity seems to be a leading cause of conflict, regardless of actual levels of abundance. Does this perception of scarcity motivate an identification of "out groups" to justify garnering resources for oneself? Can we mediate this perception of scarcity, and if so, how?

Social stress generated by concern for the environment is in cases imposing great financial burdens to address "problems" which have no real scientific basis. What initiatives can social scientists take to foster the education of societies to adopt risk-based versus emotionally-based priorities for environmental protection and restoration?

"In-group, out-group" dynamics are well understood at all levels of society. Is it also clear that the dynamic becomes more intense as resources become scarcer? It is hard to be generous when you are poor. How will we move academic concerns out of the ivy tower

and into more intense application of our long-standing understanding?

DAVID A. HAMBURG—Answers

There is a lot there. Before I try to answer any of that, let me add a coda to Tim's response. I feel obliged to say that the Carnegie Commission on Science, Technology, and Government recommended a science advisor to the Secretary of State, and I think we will probably make another run at that problem before long.

There is a great richness embedded in those three questions, and I cannot possibly do justice to them. It certainly is true that the perception of scarcity is a very important exacerbating factor, intensifies the dynamic of "in-group, out-group" tensions, and of course political demagogues and tyrants have long known how to utilize that perception.

In a general context of perceived economic decline, it is not too difficult for a clever politician, or a putative leader to inflame that by accentuating the negative, by making the case that the deprivation or the perceived scarcity is very lop-sided. It may be lop-sided, but that lop-sided character can be sharply accentuated and add much to the tensions that are involved.

These maneuvers go on all the time. In fact, if you listened this morning to so-called "talk radio" in this country, most of which is "hate" radio, you will see exactly that dynamic going on. It is a pervasive one, and I think the main antidote is a much more general understanding of the dynamics of these tensions and the way they can be artificially and dreadfully exaggerated. So that is why I think it really has to be a fundamental part of education.

Now, a rather specific proposition, mentioning "hate" radio: "Hate" radio has been used in Rwanda and Bosnia, to name two countries, to very disastrous effects, as a way of quickly dealing with perceptions of scarcity, injustice, and vulnerability. When people are feeling afraid, you turn their fear into desperation and challenge them to anger against well-specified targets.

Serbs against Bosnians, or whatever you want: Just fill in the blanks, but the essential dynamic is very similar around the world, and yet very little has been done. There has been some effort to undertake what you might call a "reconciliation" radio.

The pervasive character of radio is really dramatic. The interior of East Africa is wall-to-wall papered with radio. There is no place in the world that you cannot reach with radio, and we have only begun to think about ways of getting information about conflict resolution and conflict prevention to masses of people we have seen stirred to antagonism through the use of radio.

JESSICA TUCHMAN MATHEWS—Question

David, for most of the issues that Tim raised, their management depends on our ability to act now on issues that will affect our children or great-great-great-grandchildren and our ability to basically care about the future. Are we such an adrenaline-driven species that we will always have to wait for crises to act? Will we ever be able to develop the means to anticipate and act early?

DAVID A. HAMBURG—Answer

At one time when I was deeply involved in evolutionary matters, I really tried to search the then-existing evidence regarding whether long-range foresight was a part of our heritage, and I reluctantly came to the conclusion that it was not. I really could not find evidence that our ancestors over millions of years adapted very much to the kind of long-range time scale that we are now faced with. By and large, our ancestors did not have the capacity to destroy the environment, even if they intended to do so. Now we are just lucky; we can do it.

I do think that it is probably a really major and wrenching psychological transition for our species to take the kind of long-time horizon that we simply have to take now to recognize impending dangers and the inadvertent damage that we can do—and are doing—to the environment. I think that needs a lot more attention, and for some cultural reasons that I certainly do not understand, we seem to have a harder time in this country with the long-time horizon than some of the other major democracies in the world do. I do not understand why that should be the case, but I think it is true—and I think we need to face up to it.

JESSICA TUCHMAN MATHEWS—Summary

Thank you. As I listened to both talks, a line of Gregory Bateson's kept echoing in my head, which I will leave with you. It is a wonderful one, I think. He wrote that the major problems in the world are the result of the difference between the way nature works and the way man thinks. I think it is probably applicable to both talks we heard. I want to thank both of our speakers.

TIMOTHY E. WIRTH—Summary

Jessica, can I make one brief comment? We believe there are four priority issues which we face: (1) Population stabilization, (2) climate change, (3) biodiversity, and (4) the extraordinary spread of persistent organic pollutants around the world. I think these are the four fundamental issues. Each one of these has the long-term scale that Jessica is referring to.

I come out of an institution where two years is a long-term planning cycle. These are ones that really demand us to think more broadly, and we cannot do that without your help. We ca

not focus on climate change without clear messages and understanding of what the evidence shows put in a way that is understandable to the public. That is a problem that we have, and it is a problem that Alan Bromley in the previous Administration had.

We cannot bring about population stabilization without your help, both in looking long-term at contraceptive research as well as at the very kind of social science that David was talking about.

Concerning biodiversity, can you imagine the country saying we are not going to send John Wesley Powell to explore the West, or Lewis and Clark to explore the country? That is what we are doing now, in terms of the biological survey; we need that information, we need your help, and we need your engagement.

On the question of organic compounds moving around the world and threatening our very reproductive capability, we need your help desperately. We need it not only in terms of a scientific base, but also in terms of helping us to explain to our publics why these issues are important. If we do not have that kind of explanation as to why they are important, there is no way we are going to be able to take a long-term perspective—which we are trying to do at this meeting and overall in this Administration.

I really wanted to jump in on that question, Jessica, because in many ways it summarizes what this conference is all about. It is your expertise, your knowledge, and your engagement in these kinds of issues that help us to take a longer-term perspective that goes beyond the next election and can help to explain to the American public where their taxpayers' dollars are going and why.

Second Panel Discussion

Advancing United States Foreign Policy Objectives: The Use of Science and Technology for Promoting Sustainable Development and Preventive Diplomacy

JANE WALES—Introduction

Adele Simmons is a remarkable human being whom I am proud to call a friend. We know her from her many lives: As a scholar, an Africanist, and an academic at both Princeton and Tufts. We know her as a college president at Hampshire College, where she promoted the education of many of the people we are relying upon today to help us address the kinds of problems we are facing in the future. We know her as an activist who has brought public attention to some of the most pressing policy issues of our time, and as a visionary who has used the presidency of the MacArthur Foundation to support the development of ideas and actions that will help us move into the 21st century. I am very pleased that Adele Simmons has agreed to chair this session.

ADELE SIMMONS

President, John D. and Catherine T. MacArthur Foundation

Thank you, Jane. I would also like to thank Jack Gibbons, whom I have long admired, worked with, collaborated with, and conspired with, for organizing this very important two days. I would also like to thank Dave Hamburg for reminding us that much of this begins in our homes and in our schools.

I remember leaving for a conference at the Rockefeller Foundation on Shared Values, and turning over to a baby-sitter two-and-a-half-year-olds, each sitting on the floor pulling ferociously on opposite ends of a teddy bear, each trying to gain possession of that teddy bear, and each of them had learned something. Each was saying to the other, “share”. I guess I should tell you that I know one of them pretty well, and I think he has learned a little bit more since then.

I would like to make three points as a backdrop for our discussion today about the role of science and technology in promoting sustainable development, and particularly as it relates to advancing United States foreign policy objectives.

As we all know, science and technology represent an extraordinary comparative advantage for the United States, and we should be seeking every means we can to employ that advantage to meet our national and international interests. Our accomplishments and the contributions they have made to economic and social development both here and abroad are well known, but I

would note that they have been encouraged and facilitated by a valuable relationship between the Federal Government and the private sector, particularly our universities and our land-grant colleges and, more recently, business, a relationship that is in some cases faring quite badly right now.

We all know that knowledge is the key commodity for human and economic development, and it is the key factor in better intelligence and understanding of global threats and sharpening the possibilities for preventative action. Today's session begins to explore how science and technology can contribute much more successfully to early interventions, from disease control to crop production.

Second, sustainable development is a global goal that is in our national interest. It is not just an assistance program. Earlier this month the Chicago Council on Foreign Relations issued the results of an opinion survey, the first in the post-Cold War period, about United States attitudes toward foreign affairs. It will not surprise you that the list of public priorities did not include many major foreign policy problems.

To the extent that there was interest, it was about stopping the flow of illegal drugs into the country, protecting American jobs, preventing the spread of nuclear weapons, and controlling illegal immigration. There was far less interest in the past broad goals, such as promoting democracy and human rights, or raising living standards around the world. It may not be old-fashioned isolationism that we are dealing with, but rather a confusion about what to do now, and also a sense of insecurity about one's own future within this country.

Third, beyond articulating our goals and objectives, we need to think strategically about how to accomplish them. There is an incredible complexity of issues, players, and levels of decision making that we need to think through to reach meaningful action. We have not spent enough time plotting our strategies and addressing barriers to action. We have to prioritize and explain why certain things should be done today and others can be done later. We have to think through (as Tim said) much more carefully than we have now, how to design better public and private partnerships and how to inform the American public about the importance of these issues.

Our panelists today need little introduction. Our first speaker will be Brian Atwood, who is the Administrator of USAID. Before joining the Clinton Administration, Brian served as the President of the National Democratic Institute for International Affairs, which promoted democracy in transitional societies around the world and achieved a number of notable successes, including Chile, Nicaragua, Namibia, Panama, and the Philippines; and we are seeing much success in the nations of Eastern Europe from the former Soviet Union. At least he took on the challenge.

J. Brian Atwood joined the Foreign Service in 1966. He went on to work on Capitol Hill,

and then went to the State Department in the Carter Administration, where he served as Assistant Secretary for Congressional Relations. It is a pleasure to welcome Brian Atwood here today.

J. BRIAN ATWOOD

Administrator, United States Agency for International Development

Thank you, Adele [Simmons, MacArthur Foundation]. And special thanks to Jack Gibbons, Jane Wales, and OSTP for calling us together today. I want to begin by acknowledging Dr. Peter Raven, with whom I am privileged to share this platform. Dr. Raven and his colleagues at the Missouri Botanical Garden are world leaders in the cause of conserving biodiversity—a defining science, technology, and security issue for the 21st century. USAID is pleased to join Dr. Raven as a partner in this effort.

As a nonscientist in a room filled with Ph.D.s, I am more than a little humbled by this opportunity to share with you some of my thoughts. Let begin with some personal memories.

In 1979 I had the privilege of attending the United Nations Conference on Science and Technology in Vienna. Notre Dame President Ted Hesberg led a United States delegation, that spent weeks in debate over the role of technology in development and North-South scientific cooperation. In spite of our best efforts, the conference foundered over differences between developing and developed countries. The issue was access to technology, access to information. Failure to resolve questions of law and procedure—patent law, telecommunications policy intellectual property—effectively stalemated meaningful progress on North-South cooperation.

We have come a long way in the intervening 17 years. Technology increasingly has come to define the global political economy. It has helped redefine our notions of national power. There are still differences between North and South, but the great ideological debates that once divided us are no longer a significant obstacle.

The pace of change and the rate of diffusion in technology is stunning. Just look at what is going on around the world. Joint ventures are being formed between American and Latin American companies to "bio prospect" in the rain forests of the world for potentially valuable pharmaceutical products and to protect those forests in the process.

Computer programmers in Bangalore, India, are working through the night to get software ordered at the close of business online by the next business day in New York. The market potential for such services in developing countries will soon reach \$120 billion, according to a recent World Bank estimate.

Advanced battery technology developed in the United States and exported under USAID's

Asia Environmental Partnership is being put to work to clean up Bangkok's air through the introduction of electric scooters and three-wheel taxis.

At this very moment, thousands of people from all over the world are "surfing the net," accessing information and sharing data in the cyberspace we call the Internet. Some of them focused on innovative ways to meet the challenges of sustainable development, and USAID is very much online. The list goes on. The global economy is being knit together today in a way and at a pace that was unthinkable 17 years ago.

USAID is proud to have been a leader in technology cooperation between developing and industrial economies. We have helped to eradicate polio from the Western Hemisphere. We hope that with continued work, polio will join smallpox as the second disease to be rendered functionally extinct, saving the American people the \$300 million annually it spends on immunizations.

Our work with the International Centre for Diarrheal Disease Research in Bangladesh pioneered the use of Oral Rehydration Therapy as a usable and cost-effective treatment for the dehydration that was once the world's primary killer of children. Our support of vitamin A supplementation, of improved vaccines, maternal health, and infant nutrition have reduced child mortality by 10 percent in the countries in which we work and as much as 50 percent in places like Egypt.

We have been in the forefront of every advance in family planning, expanding the choices available and helping to meet the unmet needs of more than 100 million people worldwide. We helped President Carter lead the fight against Guinea Worm, a dreadful parasite that prevented tens of thousands of people in Africa from working. Once commonplace, the Guinea Worm is now close to being eradicated.

In places like Bangladesh and the Horn of Africa, we have established satellite and ground-based early warning systems against natural disasters. These systems observe weather patterns and the impact on agriculture and markets. They enable poor nations to avoid famine, keep people from leaving their homes in search of food, and enable relief efforts to be better targeted.

We have been a major funder of a worldwide network of agricultural research institutes. Results at one of those, the International Rice Research Institute, created high-yield rice that is adding \$30 billion every year to the economies of Asia. We have aided in the development of sorghum and millet that are resistant to weeds, a critical consideration in Africa where these crops predominate. We are doing research on the new agricultural technologies that will enable us to overcome drought and pest infestations.

What are the challenges that lie before us? As we rush into the 21st century, we face a

daunting new set of truly global problems—biodiversity loss, global climate change, population growth, and infectious diseases. Our understanding of these phenomena remains poor, but we know they will have profound impacts on our lives and livelihoods. Developing countries play a central role in all of these challenges. They are increasingly the key contributors, as well as the most unfortunate victims.

For example: developing countries are truly on the anvil of global environmental change. They soon will be the leading source of greenhouse gas emissions. And the resulting climate change will take a heavy toll on their crowded coastal areas and already fragile agricultural systems. The extraordinary biological wealth of these countries is threatened by poorly planned development which undercuts the natural capital they—and we—need for the future. We need to invest if we are to develop the science to understand these problems better. We need to work with developing countries to adapt technologies appropriately to combat environmental degradation.

USAID is focusing increasingly on such technological challenges. We are supporting the development of renewable energy technologies which will help meet the growing energy needs of developing countries while avoiding the environmental impact of conventional energy systems.

We are field testing a cheap and accessible means to purify water with ultraviolet light, a process many times more energy efficient than boiling water. Last year over four million children died due to poor quality drinking water.

Through our Global Energy and Environment Network, we are helping developing countries gain access to the information superhighway. We are assisting developing countries to acquire the hardware and human "software" they need to employ modern communications technology to aid in solving technical problems.

Emerging diseases such as AIDS, hantavirus, dengue, and yellow fever represent another compelling challenge. These are not simply medical phenomena—they are development phenomena. They take root in areas where development has gone awry: In the stagnant pools of clear-cut rain forests, in jerry-built urban areas that lack sanitation services, and in remote regions where medical care is rudimentary or unknown.

Twenty years ago HIV was an obscure family of African viruses. Today AIDS threatens millions of people in Africa, Asia, and of course, in the United States. If AIDS is a paradigm of what the future might hold, it is a sobering one indeed; it targets the very people—adolescents, young adults, and city dwellers—who are critical to the development process. We believe that our efforts can help contain this disease and enhance the ability of developing nations to confront other infectious threats that may emerge. USAID is developing and fielding cheap and reliable diagnostic tools for detecting AIDS and other

diseases at a fraction of the cost of current laboratory technology.

Tumult in the developing world is not someone else's problem. It is ours—all of us. Every industrial nation will pay the price if nations fail, if people starve, if entire regions are swept by plague, and if billions of people are unable to lift themselves from poverty. Our children will pay the price not only in purely humanitarian terms, but in lost markets and exports that never materialized for lack of customers and capital. They will suffer the effects of unchecked biodiversity loss, global climate change, infectious disease, and other environmental and health threats that easily cross borders.

Sustainable development must occupy a prominent place in our diplomacy. No foreign policy can succeed if it fails to treat the conditions that contribute to instability. To support global development efforts, America must maintain its leadership role. Our country must make the critical investments in new technology and in the institutional capacity to deliver development to treat the conditions that create chaos.

The ideological posturing that doomed the 1978 Vienna Conference is behind us. With the end of the Cold War has come a new pragmatism and a real opportunity to share knowledge and experience. At international conferences from Rio to Cairo to Copenhagen, it is increasingly clear that we have unprecedented opportunities to build lasting partnerships for common development. Just as we are able to imagine this vast potential, some in Congress today would have America turn inward and turn away from engagement in the world.

During the Carter Administration our government released a report called Global 2000 that instigated a national debate. The report made some dire predictions about what the world would look like by the year 2000 if governments did not intervene.

People took sides in that debate: They were either optimists or pessimists. The optimists opposed government action. They argued that people would use their ingenuity to correct the problems, perhaps through a process of natural selection. The pessimists believed that both people and governments needed to begin now to attack these issues and that scenarios of coming anarchies (as they have been called more recently) would mobilize people to action.

The optimists challenged the methodology used in Global 2000, and they called its predictions a doomsday message. Whether you were an optimist or an pessimist back in 1979, I suggest you read that report today. Fourteen years later it is instructive. It talks of destroyed topsoil, the problems of urbanization, and the loss of biodiversity. It talks of new drug-resistant diseases, greenhouse gases, and ozone depletion. It does not use the term "failed state," but it describes in detail the prospect that nations would utterly fail under the pressures.

Perhaps it is my age, but I am on to these so-called optimists. They were wrong then and they are wrong today. I am not even sure that their optimism about the future is consistent,

because they seem to become terribly pessimistic pretty fast when contemplating a possible military threat. They would spare no expense to develop new weapons technology, but they do not want to invest to avoid the threats that can be treated with development technology.

If we listen to them again in 1995, what will the world look like 14 years from now? It is time for people of common sense to come to the aid of their nation and their planet. The budget cuts now being contemplated on Capitol Hill will not enable our nation to respond to its own needs.

I do not call what I am hearing on Capitol Hill optimism: I call it neglect. I call it penny wise and pound foolish. I call it very risky business. In the years ahead both national leaders and local communities in the developing world will have to make informed decisions on biodiversity, pollution, public health, natural resource use, and so many more issues. We can help them meet these challenges. Indeed, in our own self-interest we must.

Why? Because we in America—our children and our children's children—will unquestionably be affected by these trends. Their quality of life in the next century will be determined in large measure by how we meet the global challenges of today. If we fail to provide leadership, if we turn our backs on the opportunity to make a difference in that future, we will be held accountable by future generations.

Science and technology give us the tools to meet the challenges of tomorrow, and it gives us something more. It provides a rational basis for hope. This is neither wistful optimism nor cynical pessimism. It is a hard-headed realism that should oblige our continued commitment and our continued investment. Thank you.

ADELE SIMMONS—*Introduction*

Thank you, Brian. Peter Raven is director of the Missouri Botanical Garden and a former MacArthur Foundation fellow. He is home secretary of the National Academy of Sciences and a member of the President's Committee of Advisors on Science and Technology. In the interest of saving trees, Peter's office does not routinely circulate the list of 450 scientific articles he has written. Peter's passions are plant collections and the animals of the world. He has encouraged the MacArthur Foundation to help to preserve, for example, the botanical collections in St. Petersburg. He is frequently found in China, and probably the most frequently asked question at a MacArthur board meeting is, "What does Peter think?" Peter is in every sense a citizen of the world, and it is a pleasure to welcome him here today.

PETER H. RAVEN

Director, Missouri Botanical Gardens

Thank you for the very generous introduction. As the first speaker from the National

Academy of Sciences, I want to say on behalf of the Academy how glad we are to have this forum taking place here today and what a wonderful start has been made.

In an effort to get at the strategic questions that we are confronting today, I want to set the stage a little bit. Then I will turn to my views of biodiversity which have been so well presented by the earlier speakers. I think it is important for us to talk explicitly about America's position in the world by noting in the first instance that we are about four and one-half percent of the world population; and as we have been doing since the 1870s, we base our prosperity on about 25 percent of the world's economy. The only time at which we varied very much from that kind of proportion was in the 1950s. In those "Leave It to Beaver" days we were able temporarily to use about 40 percent of the world's economy, thanks to the dislocation that came about as a result of World War II. Unfortunately, our politicians seem to have fixed on the 1950s as a kind of dreamland to which we can return and in which we will find the same kind of prosperity and easy living that we did then. I think you would have to be a madman or somebody completely unconscious about the international scene to believe that we ever would be able to appropriate more than 25 percent of the world's economy that we depend upon now. If we do depend on 25 percent of the world's economy, does that not say something about USAID, international assistance, and international science and technology cooperation? How can we be so foolish and shortsighted as to ignore that?

Despite the clear statements that have been bombarding us (and Brian Atwood just made a very fine one), America does not seem to be interested in improving its position as the lowest donor of foreign development assistance on a per capita basis of any industrialized country. In fact, we seem to be engaged in a mad rush to cut that low record of foreign development assistance still further.

How can the richest nation that has ever existed in the history of the world, not only the richest one that exists now, assume tacitly that our relationships with other nations are unimportant—are not an essential ingredient for our prosperity? It seems like it is not only short-sighted; it seems like it is nonsighted—almost blind to the world's realities.

When you think about the national debate we have on things like our inter-relationships with Mexico, you would assume that very few people have ever been able to look at a map of North America and understand that the United States and Mexico are managing their resources in a common way. Not only are they ignorant of that map, they seem to be ignorant of the cultural, financial, and personal relationships that exist between the United States and Mexico. They seem unaware of the absolute necessity for us to coordinate our strategies with Mexico if we are to find any success nationally or on a continental basis.

Even worse, we seem unable to assimilate the views of the world that were beamed back to us from the Apollo space missions. Hearing the debate on policy that is going on at the present time, you would assume that America is spinning around somewhere out in space with

a completely self-sufficient economy, not on that single planetary home that we call Earth. You would assume that we somehow transfer in 25 percent of the Earth's economy, but we are untouched by the rest of the Earth and have no obligation or interest whatever in dealing with the rest of the planet. That is really incredible; but unfortunately, it is true.

How can we forget about population? At the time when our ancestors were building Stonehenge or the great pyramids, there were about as many people in the entire world as there are now in the State of Ohio. That was 6,000 years ago in a 4.5-billion-year world history. Yet, since the start of the industrial revolution when there were not even a billion people in the world, we have rocketed on upward to 2.5 billion in 1950, and over 5.6 billion people at the present time.

The Cairo Conference on Population and Development pointed out very clearly that if we were to join in a worldwide effort to supply contraceptives to the 300 million women in the world who want those contraceptives, there might be some hope of stabilizing world population at a level of less than 8 billion people. The way that we have answered that nationally is by the House of Representatives recently engaging in rescission of \$50 million of our assistance to the United Nations Family Planning Association.

Where is this nation going and how does it relate to the rest of the world? This is a serious question, and one that we can ignore only at our peril. We are the lowest-taxed country of any industrialized nation. Our individual tax burden is less than that of any other industrialized country in the world. The entrepreneurial spirit is set by our laws to be as free as it could conceivably be.

We seem to think that we can solve the policy and fiscal questions of our country by lowering those already bottom-load taxes still further. We like to live in the delusion that something like 15 percent of our national budget goes to foreign development assistance. The truth is, it is well less than one percent—including military assistance.

One of the most important aspects of the world (and one that I hope would be central to our considerations here) is that which was first presented to us by Abdus Salam, the distinguished founder of the Third World Academy of Sciences. He pointed out that the developing countries of the world, with what now amounts to 78 percent of the world population, are home to six percent of the world's scientists and engineers.

The industrialized countries of the world, which have shrunk from a third of the world population to a fifth of the world population today and will be down to a sixth of the world population by the year 2020, are home to 94 percent of the world's scientists and engineers. Combine that with the well-known fact that among developing countries there is a particular concentration of scientists and engineers in just a few countries—China, India, Mexico, and Brazil stand out among them.

You can immediately see that for over half of the countries in the world—for over a 100 countries—there is virtually no scientific or engineering base at all. If there is no scientific or engineering base, how can those countries be expected on their own knowledge and in their own interest to cooperate with us in conventions, to manage their resources in a sustainable way, to comport themselves as responsible trading partners, and to avoid military action or anything else?

I submit that building the scientific and technological base for the countries of the world is the surest way to build global stability. I submit that a country that has less than five percent of the world population but causes a third of the world's pollution and benefits from a quarter of the world's economy has the most direct imaginable interest in building the scientific and technical bases of those countries so that they can be stable. Not to do so is the surest folly. I regard the cuts in the U.S. Agency for International Development made by the present administration as a disaster, and the further cuts that are contemplated now as a further disaster.

Our country spends one-sixth of our gross national product for health care, and half of that is for the last year of a person's life. Our country sells itself gasoline at a 25 percent reduction in constant dollars from 1945 prices and taxes itself at the lowest level of any industrialized country. Our country has to find its true stability in building global stability. There is no other way. The times call—the times cry out—for a new way of thinking, and we are not exercising a new way of thinking. We are instead exercising a new breed of selfishness. It is not going to get us, our children, or our grandchildren to where we want to go.

What about the environment? If you read the opinion and editorial pages in The Wall Street Journal, you would conclude that the world radiates around arguments between economics and the environment. Cut down those forests; get some money; pollute this. What we forget is that on this planet we call home it is collectively the environment, the biodiversity, the organisms, the forests, the air, and the water which constitute the only place in which our actions can occur. This is all we have. The environment is what makes our planet live. It is what allows our planet to capture energy from the sun, transform that energy into chemical bonds in organisms that stabilize the soil, the water, and the air—the resources that make human life possible.

The economic equivalencies that have been worked out in the United States, Japan, and Europe over the last few hundred years would show you how commodities can be transferred from one form to another. How human societies do that is not in any way equivalent to the environment in which all the rest of our activities must take place.

When we destroy the living capacity of the earth through our negligence, our shortsightedness, or our greed, there will be no more room for calculating economic equivalencies. There will be no more room for writing books or poetry. There will be no more room for music. There

will be no more room for civilizations like the United States. We cannot prosper in a world that is devoid of life. We cannot endlessly go on with this false dichotomy. We desperately need a new way of thinking.

Biodiversity is the stock of life on which we depend. As Tim Wirth pointed out so eloquently, to say that the 21st century is the age of biology is to say that we shall be able to capitalize on biological organism and on biological communities in the 21st century. Those of us who have considered the question seriously have concluded that up to one-fifth of our global biological diversity may disappear forever within the next 25 years. That amounts to two million species of organisms, most of which never would have been seen by anybody, catalogued, understood, sequenced, used, or prospected in any way.

It is basically a tragedy of our time that we pretend that ecological disaster is something that is going to happen in the future when we are right now in the middle of an ecological disaster of a dimension that has not occurred for the past 65 million years.

We cannot solve the problems of our economy. We cannot give ourselves more health. We cannot give ourselves more money. We cannot give ourselves more prosperity. As citizens of the richest nation that has ever existed on the face of the earth, we cannot make ourselves any richer by ignoring these problems.

It is a time of extinction—a time when as human beings we are unable to manage the biosphere properly. Why is it that in the middle of these times we cannot bring ourselves to take the question of biodiversity seriously? Biodiversity is the only sustainable resource that we have. To allow during our lifetime the extinction—the permanent elimination—of such a high proportion of what are (as far as we know) our only living companions in the universe is morally and ethically an unforgivable crime. From both an economic and environmental point of view, it is an absolutely unforgivable thing that we in this generation are doing for one another.

This wonderful country has fewer than five percent of the people in the world and a concentration of 25 percent of the world's wealth. We have the knowledge and the institutions to deal with the world's grandeur and diversity at a cultural, biological, and intellectual level. We must get hold of ourselves and develop a new way of thinking. We must begin to lay the foundations for stability now.

The world has not been managed in a sustainable way since at least the end of World War II. The loss of topsoil, changes in the environment, changes in water, cutting of forests, loss of agricultural lands, and all the negative things that have happened since the end of World War II cry out for action and attention.

There is no more significant definition of national security than building a stable world in

which we, our children, and our grandchildren can live in peace and exercise our human abilities. We must *do* so, and we must begin to do so *now*. I am delighted that at this forum we have the opportunity to make a genuine beginning. Thank you.

Second Panel Discussion Questions and Answers

ADELE SIMMONS—*Questions*

It is painfully clear that access to technology in the third world as well as in the United States is essentially a human resource issue. What is the mission of educating and training “have nots” here and abroad for a technology-driven future?

This is complemented by a question that points out that a 25-year old central research program which linked United States and developing country scientists has been eliminated. What is the importance of scientific literacy in the developing world?

J. BRIAN ATWOOD—*Answers*

It is obvious that in addition to some of the things I mentioned in my opening remarks that we have got to emphasize education as a cross-cutting issue in the development process. If we are going to sustain development, we must have productive people whose imagination can be tapped to handle and solve these problems.

Because of budget cuts, we unfortunately have had to reduce our research budget by 40 percent (as some people in this audience painfully know). We do not have enough money, and I agree with Peter’s assessment of it. Partially it is our fault. However, we have been paying the bill for 12 years of overspending. We are trying to reduce the deficit in a responsible way. The budget cuts that I am talking about that may be coming down the road in the future are not responsible cuts in my view. There is not even a question of whether or not we will decide what priorities we have within the development business. If the budget cuts that are being speculated about in the budget committees come to fruition, we simply will not have a development program.

ADELE SIMMONS—*Question*

A next set of questions has to do with the emphasis about population. Overpopulation yields principal problems that you list, such as environmental, and climate damage issues. Yet the solutions USAID is working on are all designed to keep that population alive and growing. Is there a conflict here?

J. BRIAN ATWOOD—Answer

No, there is not a conflict. Our population stabilization program is one of the most comprehensive in the world. We provide 43 percent of all of the family planning services that are provided in the world, but we look at health and child mortality issues as part of a population stabilization effort. The relationship of maternal health care and even something as remote as the Micro-Enterprise Initiative we are in: We are trying to engage women in economic endeavors; this will have an impact on population stabilization. I think we have estimated that over \$1.2 billion of our approximately \$2 billion of development assistance is going to the program for action that was approved in Cairo.

ADELE SIMMONS—Question

To pick up on that would you like to talk about the role of science and technology for the empowerment of women in developing countries and the potential benefits that grow from that?

PETER H. RAVEN—Answer

About 600 million people in the world are malnourished, and about twice that many are living in absolute poverty. In general, the women in those societies have to spend all their time getting firewood or water and then coming back to unhealthy surroundings, and the same is true of all the children. Basically, the lack of empowerment of women in about a quarter of the world's population—and their marginal empowerment in most of the rest of the world—is wrong for the same reason that discrimination is wrong in the United States.

It is not only morally and ethically wrong, but it denies the world the ability to gain the strength and the intellectual contributions of the people who are involved.

Our world can really succeed only if every segment of the society participates in its success. By operating in a way that does not empower such a large proportion of the world's women, we are basically denying ourselves the wonderful abilities that they would bring to the problems of scientific and general development that we are talking about here. The preservation of biodiversity or anything else worthwhile will be carried out only if social justice becomes a world characteristic along with the other aspects of global sustainability that we have been talking about.

ADELE SIMMONS—Questions

Peter, in a world where we are not sure whether there are 10 million or 100 million species, are there approaches to quantifying such notions as minimal or critical? Are there ways of making choices? How do we get beyond "more is better" in promoting this obvious good?

How do we advise governments? How much should we spend on this, and what do we expect developing countries to contribute?

PETER H. RAVEN—Answers

Swinging back to the education question for a minute, I want to cite the example of Costa Rica and the Costa Rican government in general, where Dan Jansen who is here and many others have played important roles. If governments will regard their own natural resources properly as their stock in trade as well as study and conserve them, then they will benefit from them economically, and the problem will be solved. The proper utilization of biodiversity can be attained only in a context of global sustainability overall. There is no such thing as preserving organisms separate from creating a stable and sustainable world. If we can help to create the kinds of institutions in each country in the world that operate for their own benefit and for the benefit of the people of that country, then the problem will be solved. I agree with part of the intention of the question, I think, which is that the precise definition of the contours of biodiversity, while very interesting, informative, and worthwhile, are not and will never be the driving forces of conservation or proper management.

ADELE SIMMONS—Question

In the early 60s we undertook a major developmental effort in the developing world. It was based on the premise of take-off. Growth would emerge and prosper by an infusion of aid. It did not happen then, and why do we assume it is going to happen now?

J. BRIAN ATWOOD—Answer

I think we have a unique opportunity. First, I think everyone has to be humble enough to understand that we have learned a lot about the development process over the last 48 years since we have been engaged in this. First, I think it is clear that all of the things that we are talking about are interrelated. We have tried in this Administration to define what we call sustainable development. It not only includes the environmental definition of that phrase and that part of it which involves population stabilization—it also includes the notion that we have to treat poverty at its root causes.

We have to deal with governmental institutions to assure that they are strong enough to sustain growth. We have to make sure that we are allowing people to participate in the development process, and we have to take a more strategic approach to development. Unfortunately, there were many investments that were undertaken before that caused people in the industrial world to be very cynical about whether or not development could be successful.

There have also been tremendous successes in Asia, Latin America, and parts of Africa. We have reduced infant mortality and done a lot of things that have more successfully treated the

functional issues the globe faces right now.

We did use our USAID programs to battle the Cold War—that was part of what we did. We invested more money in four nations in Africa—Somalia, Sudan, Liberia, and Angola—for Cold War considerations than for development considerations. We no longer have that problem.

We are now better able to invest in partnerships that work to achieve development results. We are also seeing the end of the ideological debate within the developing world. There is now enough of a consensus for us to work on market economies and democratic government principles. So we feel that the chances for achieving results are better now than ever before. The question is whether or not the developed world will have the resources to do this job.

ADELE SIMMONS—Questions

Dr. Raven, you gave a defense of why we should do something in developmental assistance. I think a lot of frustration is over what we should do. Should we continue to fund USAID's current efforts? What type of changes should be made in the way the United States provides assistance?

PETER H. RAVEN—Answers

I think that building and encouraging the formation of comprehensive institutions stocked with trained people who operate in the benefit of the countries involved is the single most important component of USAID overall. The continuing emphasis of our USAID programs on training certainly feed into that. When institutions are operating in countries in ways that can be seen and accepted as being clearly a national benefit to those countries, then trained people will really have places to work and will be supported.

ADELE SIMMONS—Question

How can we not have enough money when we are spending so much money in our military budget?

J. BRIAN ATWOOD—Answer

Recently I had the wonderful opportunity to speak to the World Resources Institute Board. Ambassador Blake (who is in the audience) was there, and Robert McNamara, and others. I explained how difficult it was to be the administrator of USAID today. We have been trying to responsibly manage budget reductions over the last few years. We have reformed the agency, cut some 1,200 people, and announced the closure of 27 of our missions overseas.

I think the choices were responsible ones. They reflect the reality of the post-Cold War world wherein capital flows to enable some countries to continue the development process without grant assistance. They also reflect our desire not to be working with governments that do not allow their own people to participate and are not as concerned about development as we are.

I told the board “You know, when we looked at all of the priorities—especially in the science and technology and research area—we had, because of certain items that were exempt from reductions, to cut our research budget by 40 percent. That made the university community very angry with USAID. It has made people who care about agricultural research angry. Being administrator today puts us in the position of seeking praise and applause when you only cut the agricultural research facilities by 32 percent as opposed to the normal 40 percent!” Whereupon, Robert McNamara burst out in applause; it is something I will always remember.

PETER H. RAVEN—Answer

USAID by definition deals only with the less developed of developing countries, and actually there are many forms of international development assistance: People-to-people contacts, university contacts, government contacts, stimulation by the MacArthur Foundation, joint grants funded by the National Science Foundation or the National Institutes of Health, and so forth.

I think the most essential item is for Americans to spend a great deal more time thinking about four-fifths of the people in the world who live in developing countries, dealing with them, and finding creative ways to support them in their efforts to develop.

ADELE SIMMONS—Questions

With respect to the current actions of the optimists on Capitol Hill, what do you view are the driving forces? In particular, to what extent is it special interests and to what extent misguided environmentalism?

J. BRIAN ATWOOD—Answers

While some people on Capitol Hill (particularly the newcomers) are motivated by ideology, others are motivated by a not-very-well-defined sense of isolationism. “America First”, they call it. They protest that it is not isolationism. Some of us are old enough to remember when that phrase was used by the isolationists between the wars.

Nonetheless, they are also very strongly pressured by the need to show that the budget can be balanced by the year 2002. The problem is that the President proposed an international affairs budget that is receding by two percent over the next five years—and a defense budget that is

receding by .3 percent over the next five years. The nondiscretionary items in the budget—social security, interest on the debt, etc.—are dramatically growing beyond control.

So, if you think you want to increase the defense budget, and you want to give people a very large tax break, and you look at the budget as it exists, what do you do? I suppose you cut the international affairs budget even further, but you get pennies in reaction to that cut. I have tried to make the argument that there are two ways to balance the budget by the year 2002.

One way is to cut government spending, but you do not get very far that way if you are going to leave these nondiscretionary items untouched. The other way is to invest in the world economy—in particular, to invest in our export sector, which is now only ten percent of our gross national product, but it has doubled in the last ten years. If you do that and you are only able to increase by only one percent in economic growth over the next five years, the Congressional Budget Office projects we have American revenues totalling \$100 billion under the current tax code.

I was accused of being a supply-sider when I made that argument the other day, but I think it is still a legitimate one. We have got to invest in our future economic growth, and we cannot do that in a global economy unless we remain engaged.

ADELE SIMMONS—*Summary*

Thank you. I would like to thank Peter and Brian for wonderful introductory remarks and for responding to a wide range of complicated questions. There are still many more unanswered questions and I hope that the questioners will find you during the break. We certainly have a great deal to talk about and many provocative issues on the table. Thank you very much.

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SESSION TWO

*Social and Economic Integration:
Building Capacity in Emerging Markets*

Third Panel Discussion

ROBERT WHITE*President, National Academy of Engineering*

This morning we heard a set of very wonderful presentations and there were a lot of common themes running through those presentations. This afternoon we are going to talk principally about what we see as science and technology opportunities in a more specific way than we heard this morning. The title is Social and Economic Integration: Building Capacity in Emerging Markets. It might be better if we had retitled it Building Markets by Building Capacity, because that is really what the subject of this afternoon is.

I was thumbing through a document the other day and trying to see what the ratio is of scientists to the population in various countries. Peter Raven gave us some statistics this morning. In developed countries the number of scientists and engineers runs anywhere from two to four per thousand population. In developing countries it is an order of magnitude less, from about .1 to about .5 per thousand population. That is a very, very telling number and raises what I think is perhaps the most fundamental question about science and technology, and the opportunities for the use of science and technology to build emerging markets.

The central issue is harnessing science and technology for economic growth, and the key to building that kind of economic growth is, in large part, indigenous science and technology capacity. We have lots of examples of successful building of emerging markets, largely in the Far East—Singapore, Hong Kong, Taiwan—but in other parts of the world, too. These countries have learned over the years that harnessing science and technology is key to economic growth. All of the remarks this morning were centered around what we could do for them. I think the other half of the question which was not addressed this morning is: “What can they do for themselves?” We have seen what countries have been able to do for themselves.

First, many of them have taken the first step of educating their people in science and technology. Here in the United States we are hosts to hundreds of thousands of students from developing countries, both at the graduate and undergraduate level, in various fields of science and technology. Half of these students remain in the United States and become productive members of our science and technology, industrial, and government enterprises. Half of them return abroad and strengthen the science and technology capacities abroad. By being there, they help with the economic growth of those countries.

These countries have learned that if they can provide incentives for private investment, they can attract the kinds of industrial activities which are important to their economic growth. Some of the features of their incentives have been troubling for us, like very low wages, protection of home markets, and protection of infant industries. However they have done it, they have taken actions on their own part. I really want to leave the thought that there is a lot to do on both sides, both by ourselves in the developed world and by the developing world.

The problem in emerging markets is enormously complex, as we all know. It involves questions of economic policy, trade policy, and education policy. We are deeply concerned about intellectual property policies. Education has to be at the root of building this capacity in emerging markets. The next session will address the educational dimensions, so we are not going to focus on the educational dimensions of building capacity in this session. However, we want to indicate that we do recognize the central role of education in building that capacity.

Economic growth by itself can get you into deep trouble. One of the things we heard this morning was that nurturing economic growth without also maintaining a sustainable environment is something that gets you into very, very deep troubles in the end. The thing we want to do is to have both economic growth and environmental sustainability. In my mind, that is not an impossible twin set of objectives, and we will hear more about it this afternoon.

If one wants to look at where opportunities exist for science and technology to build a capacity in developing countries, you have to start with infrastructural problems. A large part of the problems that developing countries face deal with their infrastructure, including their water resources infrastructure, their transportation infrastructure, their food production infrastructure, their communications and energy infrastructures, and their industrial infrastructure. If one thinks about economic growth and emerging markets one also has to think about jobs. Economic growth in large part depends upon industrial development; we are going to be able to build capacity in these emerging markets by building industrial activities there. You heard this morning that water resource infrastructures in developing countries are a potential source of widespread disease. Nobody as yet has mentioned the environmental consequences of transportation such as urban air pollution.

We are seeing a tremendous acceleration in the growth of mega-cities over 10 million people. Estimates indicate that within the next 10 to 15 years we will see mega-cities grow from a total of 13, which we have today, to about 25. The environmental problems of mega-cities, largely (but not solely) related to transportation, represent opportunities for science and technology to help with these problems. The food supply system problems of these countries, whether they deal with soil erosion or the applications of genetic engineering to develop new crop strains, represent magnificent opportunities for science and technology.

I think we understand where science and technology can have its greatest impact, and there is no mystery about the science and technology application to these areas. The problems are largely problems of diffusion.

I would like to talk for just a moment about industrial technologies and environmental sustainability. Economic growth, which is largely based upon industrial development, carries with it problems of environmental sustainability. Jim Baker, one of our speakers in this session, will talk about some aspects of that. He will talk about the use of space technology and other technologies for monitoring environmental conditions.

There is a fundamental problem where science and technology has a lot to offer. We in the developed world now have begun to recognize the need for a gradual transformation of our industrial systems into systems that will be able to control industrial processes in ways that minimize pollution. Industrial systems in this sense mimic natural ecosystems, where the waste streams from one part of industry can be used by other parts of industry. We are beginning to see corporations throughout the developed world take these kinds of concepts to heart.

We are beginning to introduce industrialization in such a way that we do not encounter the kinds of problems that we have encountered over the past decades. This means technological leapfrogging in a sense. We are beginning to think about the diffusion of technologies that are now becoming available which can help with increasing productivity, building industrial capacity, and also protecting the environment. We will hear more about these topics as our speakers for the afternoon present their ideas to you.

Our first speaker is Esther Dyson, who has just returned from Moscow. She is president of EDventure Holdings, a small, diversified company focused on emerging information technology worldwide and on the emerging computer markets of both Central and Eastern Europe. She is active in industry affairs as a member of the U.S. National Information Infrastructure Advisory Council and vice chair of the Electronic Frontier Foundation. EDventure manages a venture capital fund dedicated to active investment in software and information start-ups in Eastern Europe, including Russia. The fund's goal is to foster companies that service local markets and add local value. EDventure also publishes *Release 1.0*, a monthly newsletter, and sponsors two annual conferences, PC Forum and East-West High Tech Forum. Let us welcome Esther Dyson.

ESTHER DYSON

President, EDventure Holdings

Good afternoon. I have three things I want to do this afternoon, and I would like to do them quite quickly. First, I want to explain the implications of how I look at the questions I am going to address. Second, I want to talk about how important networking and electronic

networking information services are for the development of the rest of the world and how that can contribute to national security. Third, I will give two small pieces of advice to our government.

I will not try and cover the whole world and speak as a statesperson, but rather talk from my own experience and give you some concrete sense of how I see networking changing the world. I am a member of the National Infrastructure Advisory Council, which means I am very concerned with what the government is doing about our own information infrastructure and the kind of rules and regulations that will govern its development and health.

I have some of the same concerns in Eastern Europe, but I am not advising any governments over there. I spend about half of my time in the United States. I am very much a part of the computer business. Somehow I feel as if I am in the middle of a family squabble between Microsoft and everybody else. Then I have this other life that most people in the United States do not know about, which is in Eastern Europe where I am trying to foster the Microsofts, Lotuses, and similar companies of the future.

When I heard Bob White talk about the number of scientists in developing countries, I thought about Russia—which certainly has a lot of national security concerns. In Russia there is a very large proportion of scientists. I do not know what the ratio is, but I think it is higher than in the United States. The problem with these scientists is that they have this notion that being a scientist is a very special career (which indeed it is) and that the government owes them a living because they are scientists. Russia cannot.

People in Russia are going hungry, and it may not be because there is not enough land to produce enough food. It is because there is not enough commercial infrastructure because the country is in chaos. It is disorganized, and yes, this does matter to us. A disorganized, chaotic, desperate, struggling Russia is a real danger to the rest of the world. A healthy, flourishing, commercially sound Russia would not only *not* be dangerous to us, but it is a market.

People keep looking at business as if when we win the other guy has to lose—and if those other markets become successful, we will lose jobs to them. We will not; we will sell more goods to them. This really is a positive sum game. If we can turn Russia into a healthy market, it will be healthy for us, too. The goal here is not to be better than other countries—it is to help them succeed and then still to stay better.

I would like to talk a little bit about what is happening with networking. The first thing to understand about Russia, which a lot of people do not know is that it actually has a fairly well-established Internet equivalent called Relcom. This is something that began 10 or 15 years ago, much like in our universities and research institutes, and with a fair amount of interest from the KGB. Russia's first server was fondly called Kremvax. About two or three

years ago Relcom became commercialized. Constantine Borovoi, who was head of the Russian Commodities and Raw Materials Exchange, recognized the value of this network and invested in it. In some ways they are even ahead of our Internet. Relcom is now pretty much commercial, but it is still disorganized and unreliable. But it exists, and it has had a fair amount of influence on the development of Russia.

Bob White asked me today, "How is it in Moscow?" The answer is that there are two Moscows. One is the old Soviet chaos: It is a corrupt government with a lot of disorganization—it is people who do not really know what is going on—it is everything that we fear. It is not a nicely, well-organized Soviet society; it is Soviet society disintegrating.

On the other side in the world, I know that people are tapping into Relcom. They are sending messages back and forth to the United States. When I go to Russia, I find that scientists have heard of the Santa Fe Institute, which is more than a lot of Americans have. Russia is connected to the world. They still have the problems of living within Soviet society, but these people are literate; they are contributing; they are writing software programs; they are part of a commercial marketplace.

According to Russian journalists I know, the computer industry is probably the cleanest marketplace in Russia. The computer business in Russia is a real business that is based on profit, not on bribes. It is the kind of market economy we want to foster in all of Russia, not in just the computer community. Networking is enabling one small sector of Russian society to leapfrog. Many of the scientists who I mentioned are becoming programmers. They are designing accounting systems and transportation systems; they are making Russia's economy more efficient.

There is now a business in Russia called Office Club which is very similar to Staples or Office Depot which sells staplers and computers and software and paper—and one of their best sellers is wastepaper baskets. Office Club has changed the life of many businesses in Moscow.

The first thing networking is bringing to Russia is real, economic development and transfer—not just of science and technology, but of commercial ideas which are so important.

The thing that is so tragic about Russia is how much it has in the way of natural resources and how much they are wasted. They take iron ore out of the ground, and they subtract value from it at every step of the way. It is well known. The things that Russia produces cannot be sold at world prices. That is slowly starting to change, but a lot of it is still dependent on better communications and infrastructure.

In other sectors of Russia's economy, you can now order things over Relcom. This is not a well-established marketplace, but there is a lot of electronic communication. If you want to

get the thing that you ordered, your uncle has to go to Moscow on a train to pick it up and bring it back to you in the provinces. What is still missing is a normal distribution system, normal transportation, the ability to make reservations, and the whole market economy which is more and more based on information processing and networking. This is about to be built.

The second thing that networking is bringing to Russia is better communication. To call it a free press is like talking about having a vacation home on Mars: You can imagine it, but the context is so different it is not really relevant. There is more communication—there is more information being passed around. People are beginning to go outside the traditional channels to get real information. It is a slow process, because if you have been fed lies for 50 years, you do not know what to believe. The Russian mind set does not have the same understanding of truth or the same habit of resolving contradictions and trying to figure out logically whether or not something makes sense.

The more that information networks are out there, the more that trust will start to happen. There are honest journalists there. There is a news service that comes over Relcom and now, of course, there is Reuters and CNN. Not only are people getting the news, but they are beginning to talk back and communicate with each other. That is a very important part of a free society in Russia as it is in the United States.

The network is a free market. People are beginning to get less scared of saying what they mean. It is exciting. Frankly that is why I go to Moscow every chance I can get, which is about every other month. It is a new frontier, and it is based on the spread of electronic networking and communication.

Let me give two pieces of commentary for those of you in the government who control resources. I sit on the board of the Eurasia Foundation, which receives USAID money. It gives grants to small, nongovernment organizations in Russia and the rest of the CIS. This is a very exciting organization to be part of. They do not invest in huge infrastructure projects, and they do not deal with large corrupt governments. They go out and find small organizations all over Russia and the Republics and give them small grants, like \$10,000 to buy a Macintosh and two printers; \$20,000 to buy some textbooks or to go to some course. If you look at them from the format of a traditional charity they spend a huge amount of money on overhead which everybody knows is a bad sign. You should spend all the money on grants to people. The Eurasia Foundation goes out and talks to the people it gives grants to. It advises them. It helps them. It makes sure it is giving the grants to the right people. So there is a huge amount of overhead in giving small grants. It is much more expensive than giving large grants, but those grants are tremendously productive.

Recently they had a contest. The 70 or 80 people who applied for this grant did not just send in application forms. They came to a meeting, and each one presented his idea. They all learned from each other. Three or four people actually got grants, but 70 or 80 people

learned a lot from each other and from the Eurasia Foundation people. This communication was taking place where they were able to learn from each other and get new ideas.

It is very important for the government and anybody else who is going to Russia to take the time to spend their money wisely, and take the time to look for people who are not “approved”. The governments in some of these other countries are not quite as benign as ours, and you cannot look for a seal of approval from the government. You might be steered wrong.

The second piece of advice is to be very careful. Putting a different twist on what Bob White said earlier, we should not just ask what we can do for them, but we should ask what we can gain from them. When an outside organization goes into Russia with a whole lot of money and starts a communication service, they may be providing something of benefit to certain Russians, but they are competing with local efforts. It is important to move carefully and not trample on what is already growing underfoot. This requires not a lot of money, but a lot of manpower. If there is anything our government can do well, it is to provide a communications infrastructure and trained people. This will help much more than huge amounts of money.

These are my comments; I look forward to listening to the others and answering questions. Thank you very much.

ROBERT WHITE—*Introduction*

There is a lot of wisdom in what Esther has said. Our next speaker is William White. He is the Deputy Secretary of Energy and serves as the Chief Operating Officer of the Department. He has a very large number of employees, both in the department and under contract. They are on a budget of over \$18 billion. Before becoming Deputy Secretary, he practiced law in Houston, Texas, and served on the management committee of one of the most successful law firms in the country. He has taught anti-trust and voting rights law at the University of Texas in Austin. His involvement with energy policy began back in the mid-70s with work at Harvard University and for the United States Congress in support of deregulation of natural gas and oil. Let us welcome Bill White, Deputy Secretary of Energy.

WILLIAM H. WHITE

Deputy Secretary of Energy, United States Department of Energy

What new can be said to an audience that has heard a lot about and believes in sustainable development in science? You all know that we have undergone a revolution in the world—not just in technology, but there is another revolution that affects energy, and it affects the emerging markets. It is the revolution of the introduction of market systems. The dead hand of state control and ownership has come off businesses in many lands. We have

seen an advance in the educational system occur throughout much of Asia, which has allowed productivity to increase enormously. We have seen an explosion in the opportunities that people have in the world that is similar only to the explosion of opportunities we saw in North America during periods of this century.

This has implications far beyond energy. It has tremendous implications for the environment, and it has some implications on energy development that I want to share with you. We cannot have the same patterns of energy consumption in the emerging markets as we have seen historically in North America if we are to be able to preserve the air and water of our planet.

That is not to say I am at all a doomsday person. It does mean that we must carefully monitor the economic revolution that is now overtaking the planet and which gives us and our children and our children's children the opportunity to live in a economically truly integrated world. It does not mean that there is potential for vast and deep middle class throughout much of the world's population rather than a middle class being confined to some number of G-7 countries. It does mean that we face some challenges if we are going to avoid the degradation of the environment that is already occurring in the emerging markets as their idea of consumer culture looks more and more like our own. A lot of this has to do with energy.

If we survey the world including Asia, over a trillion dollars of electrical capacity infrastructure is going to be built in the next decade. That is assuming a much lower level of electricity utilization per dollar or GDP than we have experienced in North America.

If a person in China or India wants to have the advantages of mobility that have been given to us by the automobile and bless so many American families, there is going to be an explosion in the use of oil. Already in the last several years we have seen oil markets and oil consumption increase very significantly—a million barrels per day, per year in response to the growing Asian demand. All forecasters predict that in the future.

That has consequences beyond the environment obviously. There is a consensus among forecasts that the growing Asian demand for petroleum will require 15 million barrels more of oil by the year 2010 than the world currently has capacity to produce. Almost all forecasters believe that unless there is some dramatic change in institutions or technology, the bulk of that oil will be produced in the Persian Gulf region, and Iran and Iraq will be responsible for much of that increase. We are talking about some serious issues on sustainable development, not only for their environmental considerations but the national security concerns that you addressed this morning.

Technology has offered in the past and does offer in the future a very interesting way out of these dilemmas. There are going to be tremendous opportunities created here and in emerging markets for those who are agile enough to respond to the opportunities.

Let me share with you some of the things that the Department of Energy does by way of example. One of the ways that you attack this problem of the insatiable and growing demand for electricity and oil is by increasing the technical efficiency of energy consumption. Nowhere has there been a greater impact than in the increased fuel economy in the United States and Western Europe in automobiles from 1975 to 1985 and the changes which occurred in Western buildings over the last 10 to 15 years.

We have had tremendous technological advances in buildings, windows, and lighting, often because of government research. The use of ballast lighting was a result of a \$3 million program at a DOE national laboratory. It now saves this country over \$900 million a year in reduced energy bills. There is a lighting revolution. Incidentally, I too spend some time in Russia about every two months, and as I go to Russia and the Ukraine and see the tremendous potential that is there in the energy efficiency arena, it is incredible. There are bottlenecks in the form of incentives; they have the same bottleneck that we do, some even worse. An example is the extremely limited number of individuals who are proficient in diagnosing how you can change out the insulation, lighting, windows, and other characteristics of a building. Because of their limited number, they have return on investments which typically average between 50 percent and well up into the hundreds of percent on investment, with recovery of the investment within a year.

There is a revolution which is now occurring in renewable energy resources; let me share something exciting with you on that. It used to be that there was a big gap between the hype—the advertising—and performance on some of the renewable energy resources such as photovoltaics and wind energy. It was sort of new age. It was the "in" thing to endorse in the government in the 1970s. We spent billions of dollars and gave tax credits and benefits, and still we did not see products that were truly competitive and commercial in the market place.

Well, consider this for a moment. There are now projects being undertaken in the Western United States that are 50 to 100 megawatts and above. There are two wind projects and a solar project with financing of that scale which produce energy from a large photovoltaic array and from a number of windmills that cost half the price of the average nuclear power in the West, and only a slight premium, 20 to 30 percent above current coal fired and gas capacity in the Western United States. Now that is progress. In my travels through emerging markets, I find that there is an insatiable curiosity and interest in these technologies.

Just this morning I was in a conference with many of the energy ministers of Latin America. They put on the board their plans for energy development in Latin America. There is a tremendous, almost inexhaustible demand for capital as the countries are privatizing. They want their kids and their grandkids to be able to live in a natural world that resembles the one that we know. They want these technologies. They want technologies that could promise to preserve the land while creating prosperity at the same time.

There is an almost limitless capacity of these nations to invest in these resources so long as the technology is bringing them to economic parity with some of the more conventional resources. The same thing exists in pollution prevention. We have learned the hard way in this country. There has been a revolution that other countries can learn about, and we are creating partnerships in other countries to share experiences in pollution prevention of industrial processes.

There is no reason why the refining and petrochemical businesses or, for that matter, metals or pulp and paper, need to produce the levels of excess product pollution (often toxic) that have been produced in this country.

The companies in this country which have invested in pollution prevention have found something interesting. First, they obtain very high returns on investment. In the Department of Energy's first major-scale pollution prevention projects, we averaged a return on the investment of 160 percent. Dow Chemical Corporation averaged 200 percent return on investment just because their mediation costs are so high. There is a tremendous opportunity for the use of these technologies and market for these technologies in emerging markets.

Last week I was in Mexico. Mexico wants to dispose of its petrochemical plants. It will announce which specific plants they intend to sell this year. This is a big thing for Mexico. This is the first major privatization divestiture of assets in the history of their state-owned oil company since nationalization in the late 1930s.

What do you imagine is one of the biggest impediments? The biggest impediment to privatization is that few people want to accept the liability of that pollution stream at the end of the plant—at the refinery. Mexicans, just like us, and just like other people throughout the world, do not want to be responsible for destroying neighborhoods, for creating a workplace in which workers get sick, or for creating air pollution (of which they are reminded daily in their capital city) that decreases their life span. So efforts that the United States government can make to try to share with other countries the benefits of our experience will not only assist in this revolution that is occurring and promising economic prosperity, but they will create tremendous opportunities for those Americans that want to invest their time in it.

I think our emphasis at the Department of Energy in our international programs has been sustainable development. Not only in DOE, but throughout the government, we need all the help that we can get from the many people in this audience and other places. We need to reach out to people who are not so aware of what is going on in the world, to help them realize how important this is. Thank you very much.

ROBERT WHITE—*Summary and Introduction*

There is no area of technological development advance that is more central to our ability to

bring about an environmentally sustainable, economic growth than the energy technologies. Bill has given us insight into some fascinating and exciting developments that have taken place in energy technologies; the challenge is to see these technologies diffused not only in the developed world, but through the developing world as well.

Our next speaker is Jim Baker. Jim is Administrator of the National Oceanic and Atmospheric Administration (NOAA). He also carries a title of Under Secretary for Oceans and Atmosphere in the Department of Commerce. Way back in the Mesozoic Era, I also bore those titles. He worries about things like the weather service, the fisheries service, the national ocean service, and how you observe the atmosphere and the oceans with earth-orbiting satellites. There are few organizations in the United States government that have more to do with worrying about our environment, observing it, and making predictions than Jim Baker's organization.

Prior to his appointment as Under Secretary he was president of the Joint Oceanographic Institution Incorporated. Incidentally, I preceded him in that job, too. He was Dean of the College of Ocean and Fisheries Sciences at the University of Washington and has been on the faculties at Harvard and the University of Rhode Island. He has many, many publications. He has been a stalwart in serving on various committees and boards of the Academies of Sciences and Engineering. It is my pleasure to introduce the Administrator of NOAA, Jim Baker.

D. JAMES BAKER

Under Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration

I want to say a few words about natural disasters and global observations as we look at that in the context of national security. We have two problems that any country faces when it looks at trying to have national security. One is trying to protect itself against invaders. That is why we have Defense Department. We also have to protect ourselves against natural disasters. These are critical elements as we try to build our society.

As we do that, we have growth in the United States, but there is a more rapid growth in developing countries. As we grow we become more vulnerable to natural change. Our population, even if it grows slowly, also moves. Our population is more closely attuned to the coast these days than it is to the center part of the United States as the population migrates. We also become more vulnerable in that way. We have a world population that is growing and becoming more vulnerable to natural change.

Every year we have billions of dollars of property loss and loss of thousands of lives because of floods, droughts, hurricanes, tornadoes, earthquakes, volcanos, landslides, and wildfires. You can list all of the natural disasters the world has and the poorest countries are the ones

that suffer the greatest impact. We have examples where the GNP from a small country can be reduced by 25 percent just because of a single natural disaster like a volcanic eruption.

The recent floods in Europe and California remind us of the 1993 flood and the Midwest flood in the United States, and of the vulnerability of our society to natural change. We have a disruption of transportation and communication systems. We have a disruption of drinking water, gas, and other pipelines and a huge impact on the financial markets, insurance practices, and government functions. The overflow of the Mississippi is just a simple example of that. In fact, 85 percent of the presidentially declared disasters in the United States are a result of weather or weather-related drought and flooding.

A second example of this is Hurricane Andrew. Since Hurricane Andrew in 1992 we have been losing about a billion dollars a week in natural disasters—public and private funds that otherwise could have been invested in education, health, research, and other areas that are important to our countries. In these past few months Holland has complained that the recent flooding of the Rhine has been exacerbated by Germany's actions or inactions upstream. We know that the Kobe earthquake will have an economic impact not only on Japan, but also on the United States and its other trading partners. We cannot prevent natural hazards. At least, we do not know how to do that today, but we certainly can reduce our vulnerability to natural hazards, and that is absolutely critical. We have been able to reduce the number of casualties from natural hazards because of better warnings, better construction materials, better architectural designs, and better evacuation systems.

In fact, economic losses have continued to escalate because of growth in urban populations, construction in hazard-prone areas, and the increased value of urban infrastructures. By improving our observation systems, we have the opportunity to prepare for natural hazards and take steps to prevent future disasters.

We just heard some interesting discussion about information technologies and energy technologies. These are critical elements of technology to protect us against environmental change. The recent White House document, *Technology For A Sustainable Future*, presents a list of environmental technologies, those that avoid the production of environmental hazardous substances, those that control or render harmless hazardous substances, remediation technologies that reduce the impact of hazardous substances, restoration technologies, and monitoring and assessment technologies.

I want to spend a few minutes looking at monitoring and assessment technologies. Here we have technologies that help us achieve this world where societal and economic decisions are coupled with a better understanding of how the environment works. The health and stability of economies around the world depends on the health of the environment and then how well we are able to describe, predict, and prepare for these changes.

Let me give you two examples, and the first one is reduction of natural disasters. We working very closely in a multi-agency effort between FEMA, NOAA, and the U.S. Geological Survey to predict storms, weather, and floods and to look at geological changes from volcanos and earthquakes. We are currently in the midst of a \$4 billion investment to modernize the National Weather Service. We have already had major improvements in weather forecasting. We deployed new kinds of radars, new kinds of in situ systems, new satellites, and new software systems to make all this work. We have a much better system for disseminating this information, called the NOAA, FEMA weather radio network—which is being expanded to a NOAA, FEMA network. In 1903 the Galveston Hurricane caused the loss of lives of about 6,000 people. In 1992 Hurricane Andrew took only about 24 lives. We made a direct impact there, because we could do a much better job of warning. We are regularly providing this technical assistance and equipment to other countries to help them predict and assess changes in their natural environment and minimize the loss of life and property.

With today's technology, we have weather radars that allow us to look out and actually see much further than ever before. With a Doppler system we can see the motion of rainstorms and the amount of hail and rain that we will have. A Doppler system provides advance warnings that covers the entire United States and gives us much better information about short-term and explosive storms. We are putting in about 160 of these radar systems that will cover the entire United States. Just recently UNYSIS, which is the company that is installing the radar systems negotiated a \$4 million sale of the Doppler radar to Taiwan. UNYSIS has also made a similar arrangement to sell about 160 of these radars to China to provide better systems for weather warnings.

We also have a system that helps us provide information about weather to the aviation community. This is a joint effort (as was the radar) between NOAA, the Federal Aviation Administration, and the Department of Defense as we put together a system that gives us better aviation warning. When we combine the ground information and the radar information, we can, with new software techniques, provide pilots with information that shows them exactly what is happening with weather in the air and on the ground. They can see an aerial wind burst and wind sheer on the ground. They can see clear air turbulence, and they can see turbulence behind other planes directly on a screen with new measuring techniques and with new software techniques. Hollywood technicians who are doing morphing for films are also working for us to provide better visualization of aviation weather.

We are also using this same kind of technique to provide better information about hydrologic forecasting, so we can do a better job of forecasting floods. We are saving millions of dollars per year that would have been lost as a result of large and small floods. In fact, we have a number of international agreements where we are providing this same kind of system and techniques to other countries. We just set up a prototype flood forecasting system for China, for example.

The other pieces of this observing system are satellites. We just put up a satellite that sits out at a geostationary orbit and stares at the earth. It is a new technology for civil systems, and it has allowed us not only to look at the weather that you see on the nightly television, but it also gives us an immediate and direct indication of the growth of small storms. These storms can grow from inception to full intensity in about 30 minutes. If you use a regular polar orbiting satellite, it takes 90 minutes per orbit. You cannot see that growth, but with a geostationary satellite, you can see it immediately. These new satellites are very important; in fact, the Japanese have decided they are going to buy a satellite very similar to what we have for the same kinds of warnings.

We are an important player in the United States in what we do, and we also participate internationally in United Nations activities to reduce natural disasters. There is an international decade for natural disaster reduction. And, of course, we have a large research effort that we coordinate through the National Science and Technology Council which is a subcommittee on natural disaster reduction chaired by Bill Hook from NOAA.

We have also been working very closely with the commercial sector in helping to develop technology and providing necessary the licenses for them to develop new technologies for land remote sensing. This has worked very well. There is a whole new activity of commercial remote sensing that is going to be an important activity.

We have another set of satellites which is the Global Positioning System (GPS). It sits out at a 12-hour orbit—not quite half way out in space—that provides us with a very accurate positioning reference system to tell us where we are at any one time. We are replacing all those little brass plaques you see around the country with global positioning system reference points so that you know exactly where you are.

There are a whole host of things that we can do with this new positioning information. We can monitor and assess land use patterns and ecosystems in ways that were not possible before, because we did not have the accurate positioning.

We are looking at ways of automated, precision agriculture, for example, where you send out your tractor in an automated way and it can go up and down a row. Because it has accurate positioning from its GPS locator, it can actually do that. The smart highways are done in the same way. Tracking loads on trains is also possible because of the GPS.

We have just been working, interestingly enough, with Romania, giving them technical training and equipment to facilitate the change from state-owned farms to private farming and to use these kinds of geographic information systems to make this work. This is the first use of the global positioning system in Eastern European surveying and mapping, and it gives an opportunity to provide additional information as these regional economies are becoming stabilized. The Romanians do the training, and we provide close cooperation with the World

Bank and the European union to make sure that all of this can be put together.

These are just a couple of examples of the technology that we have that is driven by military technology being applied to civilian use. It is a very exciting time for us to have this technology and to have these joint activities so that we can help other countries. I think it is a good question to ask if it would make sense for us to look at our foreign aid and determine if giving environmental monitoring technologies might not be just as effective as giving countries weapons. It is worth some thought. Thank you.

Third Panel Discussion Questions and Answers

ROBERT WHITE—Questions

Esther, what do you think about the dangers and benefits of encryption technology? What are the ways in which telecommunications in Russia as it develops might be encrypted? What would be the implications of that for national security?

ESTHER DYSON—Answers

This is a very important issue, and I do not know the answer. It is something we need to think about. With my electronic frontier foundation hat on, I think it is very important for citizens to have the right to private communications as part of free speech and privacy. With my experience in Russia, I am also very conscious of the dangers of all the things that governments try to prevent, including everything from drug dealing and terrorism to various kinds of criminal activity. I see encryption technology as a defensive weapon. If the government can watch everything that goes on and the government is good, that is a very good situation. If the government can watch everything that goes on and the government is bad, that is a very bad situation. So you end up in this kind of neutral position.

Fundamentally, I feel encryption is more powerful as a weapon of the weak against the strong than as a weapon of the strong against the weak. It provides privacy and safety to individuals more than it provides the same to large, powerful organizations. Large, powerful organizations have other strengths, but encryption fundamentally is something the small can use to defend themselves.

I am still not sure what that comes down to in terms of policy. I do know that there is very powerful encryption technology all over the world already. Not having the ability to break it is a problem for governments. It is also a problem for the Mafia and for various powers of evil. I think having strong encryption is going to be very important to encourage the free flow of commerce. People are not going to start doing business and they are not going to start doing all these other things we want them to do that are fundamentally positive if they do not have privacy, confidentiality, and security over the network.

I am not sure how we resolve this contradiction, but they are great contradictions. It is a big issue, and it is worth thinking a lot about in the drafting committee.

ROBERT WHITE—Questions

Good point. Let me address the next question to Bill White. The question goes something like this: Will renewables and conservation satisfy all the world's energy needs for the next 50 years? If not, what other technical options should be made available, and what are respective roles of business, universities, and national laboratories in providing these energy options?

WILLIAM H. WHITE—Answers

The answer to the first question is no, but I think that we probably are going to underestimate the role that they will consistently play. I think they will play a very a major role. I think the principle bottleneck I see is transportation technology. I believe that we will see some transformation over the long run of electrical power generation. Certainly there is a worldwide boom in utilizing natural gas, which has less harmful environmental characteristics.

I do not have a good crystal ball on nuclear energy, but I will say that we as a country do not seem to have been able to come close to a solution on nuclear waste. So long as that is not accomplished, it will be a big impediment. My crystal ball is not very good on fusion. The problem, though, is the automobile and what we do about that. I think it is certainly possible for us to have automobiles that are fired by alternative fuels or that consume half as much oil as the automobiles today. That would have a tremendous impact on worldwide energy consumption.

As far as what roles the government laboratories and the private sector play, I think these are technologies with governmental, nongovernmental, nonprofit, for-profit, and private-sector implications. All of these types of institutions tend to systematically invest too little in this particular issue when you consider the stakes.

ROBERT WHITE—Question

For Bill White: In the morning session the suggestion was made that the Department of Energy laboratories should expand in new economic and environmental directions. The Galvin Report gave quite a different recommendation. What position is DOE taking on this issue?

WILLIAM WHITE—Answer

The Galvin Committee said that the DOE laboratories as a whole should be focused on three principal missions: National security, energy, and the environment. We think they are on target on that.

There are some very good questions regarding the human genome project in the various laboratories and debates on where the margins are and how you build on the competency. There are suggestions in both the Galvin Commission Report and in reports by distinguished review panels in prior Administrations that the Defense laboratories not lose a national security or defense nuclear focus, in order to preserve their competence in that area. That makes a lot of sense.

However, we, as well as professionals in the field and laboratory observers, believe that there is a question regarding how you best utilize those competencies for the benefit of the taxpayers as a whole. We want to keep the competence, but because of the cessation of nuclear production, we have excess capacity. We need to build on the competencies of the laboratories as is done in the advanced computing field. There we do a fair amount of work with NOAA and identify very specifically what the competencies are, and then determine what the real market is for those competencies in the scientific community. Not that we would be trying to create a mission for a competency that does not exist, but where there is excess capacity in an important competence which is necessary to support national security, then we would not be doing our job if we allowed that competence to be underutilized.

ROBERT WHITE—Questions

Given the tough budgetary climate and major energy needs, what is the rationale for DOE pursuing topics such as the genome project? Energy research and development is a small percentage of the DOE budget and is in the process of being cut further. Is there any support for increasing this investment for such a critical need?

WILLIAM WHITE—Answers

The human genome project and our creation of nuclear isotopes are examples of research that is undertaken within the Department of Energy laboratories that you would not immediately

think of as being within the domain of the Department of Energy. As a matter of public policy, what we ought to be asking ourselves: Is this science that should be pursued? Is the market going to underinvest in this type of science? Is it good basic science and of the type that we all support? What scientists are capable of doing this? Who should the source of funding be?

Where good, basic types of science are studied within our laboratories, they are often funded by other agencies. I would welcome any volunteers to offer to fund us if there are some things within the Department of Energy that might not fit within its mission but do serve the public interest and should be done by the scientific community, and most competently by laboratories within our jurisdiction.

Concerning energy research and development, there are going to be hard times ahead. The thing that we all have to be most apprehensive about is that we not discourage an ideological approach to what is often called "applied science," that is the substance of a lot of the energy research that we are talking about here.

We are trying to move closer to the model which has succeeded in other countries, such as Japan, where there is better integration of basic science, manufacturing, design, and marketing capabilities. The role of the federal government should principally be in the basic science part of that. What we are trying to do is better integrate with the private sector so that the public can see some of the benefits that are generated from basic scientific research. That is not to say we should adulterate basic scientific research. We are trying to better integrate basic science into the industrial base of this country and other nations so we can get the benefits of that science out more quickly. That comes under ideological attack.

ROBERT WHITE—*Question*

In telecommunications in Russia there are so many players and programs, how can we promote cooperation, coordination, and collaboration?

ESTHER DYSON—*Answer*

One response to that is having many players is good because it creates a vigorous, open, competitive market. What has actually happened in Russia is quite interesting. For starters, the government itself has become privatized in many ways. In a lot of places it is difficult to figure out what is the Mafia and what is the government, or are they really the same thing?

In the telecommunication business there were a bunch of different networks and different players: For example, the Moscow City Telephone Company, the Moscow Regional Telephone System, the Saint Petersburg Telephone System, the Telex Network, the KGB Network, and the Oil and Gas Network. Now they are all separate units competing with each

other, and many of them have found Western partners. Each jurisdiction is trying to grab everything that it has under it and avoid the grasp of whatever it has over it, so you have a very vigorous and competitive market. I would not say it is exactly open, but it is actually pretty exciting.

There is a lot of investment going on, although there are a lot of associated problems. People are nervous about investing in Russia for a lot of reasons. There are certainly problems there. Fundamentally, we just have to be in there. More American business practices would help. Do not be scared to go in. There are a lot of potential users there who, if they used such a network, would become profitable and would be able to pay for it. I see it as a huge opportunity.

ROBERT WHITE—Questions

Are you optimistic about the "joint implementation" of climate change options? Do you think that the cooperative efforts between the United States public and private sectors and developing countries can effectively reduce greenhouse gas emissions? Should the United States and other industrialized countries get greenhouse gas credits for their contributions?

WILLIAM WHITE—Answers

I am optimistic. I think that joint implementation in the concept has a bright future and will result in a significant reduction. How quickly and how much is something that we all have to root for, but it is something that we have got to watch for. Obviously, we have several very large, growing Asian economies, like China. What China, India, and the former Soviet Union do will determine to a large extent the impact of the energy sector on global warming.

D. JAMES BAKER—Answers

Joint implementation is absolutely critical, and it is the only way that we can address the problems. We are now engaged in discussions in the framework for the first conference of the parties in Berlin, trying to understand how we can do that. We are coming to the table by trying to understand how we can put this together. One of the pieces of this is a better understanding of how the whole climate system works, because the more we know about how the system works, the better we can make our decisions about exactly how we have to mitigate the greenhouse gases. We are only partially there.

We put together a Global Change Research program in the late 1980s to tell us exactly how the system works. We learned a lot, but we still do not know that much about what is going to happen as you add greenhouse gases to the atmosphere. So it is absolutely critical that we get this scientific base as well as continue our negotiations with other countries.

Fourth Panel Discussion

JOHN H. GIBBONS—*Introduction*

The chair of this panel, who will presumably do a good job of introducing the others, is Rita Colwell, who is the President of AAAS, one of our co-sponsors. She has been in so many places in the area of biotechnology that I will not give you even a partial list. She is a major thinker and doer in this field. Let me turn you over to Rita Colwell as Chair.

RITA COLWELL, *Chair*

President, American Association for the Advancement of Science

Thank you, John. This afternoon we will conduct the second portion of the session on Social and Economic Integration: Building Capacity in Emerging Markets.

The panelists will include Jean François Rischard and Shirley Malcom. Unfortunately, Bruce Alberts is not well enough to join us. He of course has come back from the hospital, but he has been suffering from a viral pneumonia. Fortunately, he is recovering well, but he will have his paper available tomorrow. That is Bruce: Even on his hospital bed, he is preparing a document; he will have a paper for us tomorrow.

What I would like to do in introducing this session is to use biotechnology as an example of addressing the cross-cutting questions that we were provided: The balance between international science and technological cooperation and the pursuit of competitive advantage to achieve policy objectives and the roles of agencies. What I would like to do is lay a little groundwork with respect to biotechnology and the industry, and then explore how it is emerging as a major component in development in developing countries.

The time we find ourselves in is about 20 years after Watson and Krieg's paper, when the stones were laid constructing the path to commercial genetic engineering, and the major experiment of Stanley Cohen of Stanford, and Herb Boyer of the University of California at San Francisco Medical School, when they and their teams succeeded in cloning a gene into a bacterial plasma. They formed the first recombinant DNA. The first United States biotechnology company, Genentech, was founded in 1976. Just 18 years later, it is joined by more than 1,300 other companies in the United States.

In 1982, the following year, the first recombinant DNA pharmaceutical, Eli Lilly's Humalin, recombinant human insulin, was approved for sale in the United States and in Great Britain. The Humalin sales a year or so ago was \$600 million, and the European rate of increase of companies is also equally dramatic. In 1994, the United States biotechnology companies had a market value of \$41 billion and over 100,000 employees. Keep in mind, this is an industry that did not exist 20 years ago.

Europe's 360 biotechnology companies are located in Great Britain, Germany, Belgium, and the Netherlands. From 1986 to 1992, about \$600 million was pumped by venture capitalists into the European biotechnology space industry. There are also nascent biotechnology firms in the developing countries that are beginning to play a role.

In the developing countries, the government researchers are really the source of the companies that are being formed. For example, the International Center for Genetic Engineering and Biotechnology, originally stimulated by UNIDO, but now supported by Italy and India, have two laboratories, one in Trieste and the other in New Delhi. With respect to outlays in Hong Kong, there is the Biotechnology Research Institute, and an International Vaccine Institute in South Korea.

What I would like to point out is that we do have a major problem to address: Even under the best of circumstances, there is going to be a major population increase by the year 2000. We are going to have to expect a few extra people for dinner. One way is to utilize the newly emerging economic sector, which is marine biotechnology. There are marine pharmaceuticals that are being developed and marine biomediation.

Let me speak very briefly to one aspect, and that is aquaculture. It is an example that fits perfectly to the subject of this two-day conference. The maximum sustainable harvesting of the world oceans has been estimated to be 100 million metric tons. A few years ago we were harvesting 90 million metric tons. This past year we dropped it to 80 million metric tons, but the projection, with this increased population and the demand for seafood, is somewhere between 135 and 165 million metric tons. That is a serious impedance mismatch—a gap that has to be filled.

Aquaculture will have to close that gap. At the present time aquaculture is roughly about 14 million metric tons worldwide, with a market value of approximately \$28 billion. You know from the newspapers that we have a serious problem in that the growth has decreased considerably, and unfortunately, most of the world aquaculture is low technology. The good news is that marine biotechnology offers some very useful advantages.

The problem is that the oceans are fished out. This was taken from *Newsweek* last March, in which the *Newsweek* article indicated the regions of the world where the fisheries are at risk. Alaska pollock and Atlantic cod are all declining. In fact, the Grand Banks have been closed to fishing, and cod and haddock have been decreed commercially extinct. This past week Canada and Spain have been exchanging shots over the bow, as it were, with respect to fishing rights and fishing in the Grand Banks area. The tragedy of the oceans has been outlined in *The Economist*; it has also reached the *New York Times*.

What can be done about this problem? First of all, there is the genetic manipulation of marine organisms, and the successful production of transgenic fish through, in one instance,

the original transgenic fish several years ago was the growth hormone gene was introduced from trout into carp, and the result was a faster-growing carp. It achieved a third larger size. This is very significant, because it means that in a closed, highly mechanized culture (as we assume we are going to be coming to, as with poultry) we will be able to have three crops a year and we will have a more efficient way of rearing fish to meet this growing international need.

Another aspect of using biotechnology for industry and for international security is that of controlling disease. This is a very serious problem. In Ecuador, 40 percent of the gross national product—about \$600 million a year—is shrimp exports. They have suffered severe disease problems, mainly viruses but some bacterial, and \$100 to \$200 million has been lost in a very short time over a year or so. This translates very seriously into the economics and the employment in that country.

Another aspect, then, of being able to produce vaccines for fish is that it has two great benefits: The use of antibiotics and drugs decreases significantly. In Norway, where the second most important export is fisheries—second to oil, gas, and minerals—the increase in harvest is dramatic with the use of vaccines. That is a biotechnology application that changes the industry.

Commercially important species are being spawned in captivity in Maryland, California, and Vancouver, Canada. This is achieved by determining where the hormone that stimulates the production of eggs and sperm is located and then synthesizing a hormone and injecting a synthetic hormone, which is very similar but smaller and shorter than the natural hormone. This synthetic hormone is resistant to degradation when used in the field. Work is being done by Dr. Zoeharian and his colleague in Chile, including their recent discovery that by using sonication and entraining the fish through a sound chamber, they can vaccinate large numbers of fish at once.

These changes are allowing us to address the issue of declining world resources and permit the opportunity to use the bounty of the ocean.

I would like to move to the aspect of education, because it is a major part of the ability to achieve a new world economy that will be addressed by our speaker, Dr. Rischard. Education is the issue that would have been made here by Dr. Alberts.

In earlier talks to bodies such as this, Dr. Alberts has outlined what he sees as an essential role for science education partnerships: K-12 and precollege teachers as well as scientists from research laboratories and from industry work closely together with maximum partnering to improve science education, then volunteer scientists and engineers work in partnership with outstanding science teachers in each school district.

The first function of this partnering team is to serve as a decision-making body that integrates the efforts of outside groups who are working locally to assist and improve science education in the schools—to mobilize and unify them so that there is direction to this external support provided for science education. The second function of this partnering team is to provide strong, local political support for continued, improved science education.

Dr. Alberts sees three very important requirements for science education as a wedge for revitalizing our nation's schools: Having thousands of informed local scientists and other citizens as effective volunteers, allowing for continuous improvement through the wisdom of the best teachers being applied to the school systems' science programs, developing a large cohort of young scientists prepared as full-time precollege teachers. This is an issue I think Dr. Malcom will address, especially including the role of women in science education.

A new concept along the lines of what Dr. Alberts is espousing is the Columbus Center in Baltimore, Maryland, on the Inner Harbor—a new science teaching resource center. It is a cutting-edge research laboratory, but it also is very unusual in that it has a major exhibition and teaching area for the local school children as well as for workshops for industry. It is a user-friendly, interactive science center with research scientists interacting with school children, both in teaching as well as in showing them the process and excitement of science.

The topic that we will be addressing in this panel this afternoon is one that is of the total system—a holistic approach to national security with respect to the economic sector, including education.

I would now like to introduce Jean François Rischard, who has served as Vice President of Finance and Private Sector Development in the World Bank since 1993. In this position, he is responsible for organizing a new central vice presidency covering the development of a private sector and a financial sector, as well as the Bank's strategy for energy, industry, mining, and telecommunications. He has already warned me that he is high on telecommunications.

Mr. Rischard joined the World Bank in 1975 and has held several positions with responsibilities for financial policies related to the Bank's overall assets and liabilities management. In mid-1989 he took over as Director of the Investments Department, with responsibility for trading the \$25 billion liquid assets portfolio of the World Bank.

He is truly an international citizen, a national from Luxembourg, with Bachelor's and Master's degrees from the University of Marseilles, a J.D. from Luxembourg, and an M.B.A. from Harvard. I guess that is about as international as you can get.

Finally, I would like to say that one of the topics that he will be discussing is telecommunications; and one of the developments that is occurring is linking for real-time teaching that is being developed in several institutions, including our own in Maryland, for

joint partnering in education and research through telecommunication. Jean François Rischard.

JEAN FRANÇOIS RISCHARD

Vice President of Finance and Private Sector Development, The World Bank

Thank you very much, Rita. I will talk about three things: First, the new world economy and what is happening in it; second, what developing countries can do to take part in this tremendous potential that is coming up; and third, what the World Bank can bring to the table.

On the new world economy, there are two big forces that are reshaping everything right now—a technological revolution and an economic revolution.

The technological side is the topic that you have been debating all day. We have been hit by a very powerful cluster of innovations in telecommunications, informatics, transports, advanced materials, microelectronics, robotics, biotechnology, and software applications. What is so exciting about the heart of this information technology revolution is that it is still very young, and there is still a lot more to come.

We now think in the Bank that we may have interAtlantic phone calls down to three cents per hour around 2010—it is almost free. We think that the voice traffic cost through undersea cables will be about one percent of the 1987 cost by the year 2000. There are a lot of things coming down the pike in digitalization and data compression techniques.

The other fascinating thing about this information technology revolution is that it shrinks time and distance and that it causes knowledge to flow very liberally throughout the whole planet: Knowledge suddenly becomes a key factor of production.

The result of all of this is that we have a companion revolution in business practices worldwide, and this is the one that is so important for developing countries as well. This business practices revolution is highly accelerated business processes.

There are lots of examples of highly accelerated business processes: Just-in-time production, very fast ordering cycles, and outsourcing exploding everywhere. Second, we now have hypercompetitive purchasing going on everywhere, be it for car parts or cotton goods or anything, with interactive catalog shopping this will become even more spectacular. Third, we are now seeing that smaller units are gaining over larger units; flatter units are gaining over hierarchical units; and basically, the speed of response in a company and its size are becoming actually assets.

Fourth, we now have services which were completely and utterly untradable which are

suddenly becoming tradable. We have phone operators in the Caribbean working for United States companies. We have the Indian software industry having popped up out of nowhere. Swiss Air has its accounting done in India. In this town, we have my favorite example: Doctors dictate memos over the phone that get typed in Bangalore, India, and seven seconds later they are returned.

We also have this boundaryless flow of capital now throughout the whole planet—\$175 billion in private funds last year to developing countries. These are just a few examples of the revolution that is coming in the business practices area.

Longer-term, it will be even more spectacular. With low-cost digital systems, we will have education becoming a traded commodity available anywhere life-long. We will probably see deposit banking almost disappearing during our lifetime and being replaced by paperless money systems and securities. We may see teleshopping completely changing the way people buy and sell. We may see teleworking within and between countries occupying almost 20 percent of the work force at some point. A sort of global highly competitive tele-economy will be born within a generation.

Then there is the other revolution—the massive entry of new players like China into the world economy. In general, the Bank now projects that two-thirds of the increase in GDP from hereon will be coming from nonrich countries—that is, from developing countries and from the so-called "transition" countries.

These two big forces combined produce what I call this new world economy, and it has four features. It is a high-speed economy; it is global; it is knowledge-intensive; and it is highly disciplinarian because it is so competitive. This new world economy will bring two good things: High efficiency and high opportunities. We may have a sort of Golden Age in that the four billion people in the developing world may now have a real chance at catching up, and we may have a more balanced planet as a result.

At the same time, it will be a stressful Golden Age, if we get one. It will be stressful because not only will there be demographic and environmental stress, but there will also be a sort of rat race for competitiveness, and it will be expressed in four terms: Agility, networking, learning, and reliability.

Agility means that every country will have to achieve higher and higher agility standards, not just for their companies, their firms, and their industries, but also for their governments.

Countries will have to become very good at networking, because these days if you are not part of big commercial networks you are going nowhere. That will be a way for distinguishing winners from losers.

Countries will increasingly have to become what we call "learning nations." This means nations which keep upgrading their systems, and not relying on static comparative advantages.

Finally, countries will have to become very good in competing through their legal, and political reliability, because if you have so many alternatives, business can always shift somewhere else.

In the future there will continue to be the distinction between rich and poor countries. In addition, there will be new distinctions between fast and slow countries, plugged-in and isolated countries, and learning and static countries, as well as 100 percent reliable countries and those that are less than 100 percent reliable.

How can developing countries seize these opportunities from this new world economy? It is clear that there is a negative to these new technologies, and the negative is that we may see an increase in the information and knowledge gaps for many countries, which would then make the income disparities that we have today even worse. That is the threat.

At the same time, there is this tremendous opportunity in that the developing countries have probably the biggest chance at leaping forward in development, in growth, and in competitiveness—therefore in poverty reduction—than they ever have had before. This is particularly clear for information technology and low-cost telecommunications.

These technology opportunities will be clear in three areas: They will be important for poverty in people, for the environment, and for growth in competitiveness.

In terms of poverty in people, we will see the importance in the next decades of new technologies in the areas of health, population planning, basic education, technical education, biotechnology, food, high-tech aquaculture, and in general, knowledge-based agriculture, and of course, infrastructure in all kinds of forms.

In terms of the environment, we will see the importance of new technologies in the areas of new forms of energy (particularly solar energy) transportation, new forms of fertilizers, field remediation, and in general, ecologically balanced aquaculture and agriculture.

In terms of growth and competitiveness, developing countries can really get a lot of help from new technologies in the telecommunications and information technology area. Let me give you a few examples, using these four buzzwords of mine—agility, networking, learning, and reliability.

Regarding agility, developing countries are full of entrepreneurs, but they are generally dragged down by their governments, which are not as agile as they are. This is an area where information technology can help a lot. You can have tremendous improvements in customs

and tax administration, for instance, with digital systems, with electronic data interchange systems, and so forth.

In Singapore, the customs system runs through about in 15 minutes thanks to these sort of techniques. You can have computerized land mapping and land titling systems that will help small entrepreneurs and businessmen access collateralized credit because they will have a title on their land. You can make an enormous difference by having cellular phones in rural areas, helping farmers and local businessmen bypass the postal system, which is generally very slow or misleading.

In terms of networking, developing countries can now leap-frog ahead across their information handicaps and use electronic bulletin boards and data services between companies in a way they have never been able to do before: There are already four or five of these systems afoot.

Teleconferencing and networking between universities, applied research laboratories, and productivity centers will make an enormous difference as well. In the Ivory Coast, the farmer who has a hand-held phone can find out the real cocoa price instantaneously as opposed to getting ripped off by the traders.

The learning side is probably where the biggest leap-frogging can occur. You can take mediocre universities in East Africa and almost instantaneously hook them up to good European or United States universities. We hear about a business school in Madras that will be hooked up to a business school near Paris that way. With a cellular link and a cheap PC, you will be able to completely reinvent the concept of the village school itself, as well as the concept of the teacher, and turn the whole thing into a community learning center.

With a simple CD-ROM, we will be able to give highly task-specific technical training in virtually anything. In other terms, distance learning will completely change the education equation and the quality of education in developing countries.

On the reliability side, I have no doubt that just increasing the access of developing country citizens to information and to these low-cost telecommunication methods is probably the best way to lead to more transparent, better, more democratic governments, just as has happened essentially in the Eastern Bloc. In our view at the Bank, low-cost telecommunications information technology is a major strategic factor of development from now on. The same is true for other technologies, from biotechnology to knowledge-based agriculture. All of these things have to be now factored into the long-term development game plans in developing countries.

That leads me to my third point: What is the World Bank doing about it? We have been around for 50 years. We have done virtually everything from reconstruction in Europe and Japan after the War to basic services infrastructure in the Sixties and Seventies.

Then we went into social programs, agriculture, and the debt crisis. These days we are involved in environmental work on a large scale, social programs in private sector development, and we are now beginning to see that bringing these new technologies to developing countries will be one of the next biggest challenges that we will have to face.

What are we doing about this? Right now we are raising the awareness of Bank management and Bank staff about the importance of the technology-development link, and we are doing this mostly through partnerships with others. We have an important partnership with the NRC. We are now in a commission called the Global Information Infrastructure Commission, a member of which is here, and we are trying to get alliances with others to be able to be much better in this whole area.

We have a little initiative which is an information and development fund, which will not be very large. It will be about five million dollars a year and we will use it systematically to do advanced regulatory work to help countries open up their telecommunication systems to private participation. We will use it for awareness seminars and workshops in developing countries about all these new technologies and the importance of them, and we will use it for advanced work, pilot projects such as bulletin boards, distance education pilots, distance health, and so forth.

In our daily work, country by country, sector by sector, we will try to get the World Bank staff and the other agencies that work with us to experiment and incorporate the new technologies in actuality in the projects, be it in education, health, or anywhere else, and we have a few initiatives launched in that area as well.

One is dealing with solar energy, and one of our pet ideas is to take some countries and do so-called "knowledge assessments" in them, which would be a way to figure out how well-equipped the country is to process knowledge: Get it, absorb it, transform it, and turn it into operational products. This will be an ambitious concept where we will look at everything from the telecommunications and information infrastructure of a country to technical literacy, science education, and even the way countries are hooked up to foreign information through their embassies. We will look at the whole question of knowledge acquisition, transformation, and utilization in countries.

Thank you very much for allowing me to share the background to all this and what we are doing about it.

RITA COLWELL—*Introduction*

The next speaker is Shirley Malcom, who is a zoologist who received her Ph.D. from Penn State University, and studied also at UCLA and the University of Washington. She is currently the head of the Directorate for Education and Human Resources Programs of the

AAAS, where she has oversight of education activities for under-represented groups and public understanding of science and technology.

Dr. Malcom was head of the AAAS Office of Opportunities in Science from 1979 to 1989. She is very busy at the present time. She was recently appointed by President Clinton and confirmed by the Senate as a member of the National Science Board, and she was named to the President's Committee of Advisors on Science and Technology. She serves on a number of boards, including the American Museum of Natural History, Carnegie Corporation, and the National Center on Education and the Economy. Shirley will speak to us today on the education aspects of development.

SHIRLEY MALCOM

Head, Directorate for Education and Human Resources Programs, American Association for the Advancement of Science

Thank you very much, Rita. It has been said that a picture is worth a thousand words, and I want to paint some different pictures here.

I still remember my own reactions to the pictures of the earth from space: The big blue marble still sticks in my mind as the catch phrase that was used to describe its appearance. In that instant, the notion of one earth, interlinked ecosystems, and the dynamic character of the earth's systems all became very real to me as well as to a lot of other people. I visualized weather patterns moving across the globe and volcanic eruptions spewing forth, sending ashes high into the atmosphere and around the globe, affecting worldwide weather.

The view from space did not include the borders and the boundaries of the nation-states that we are so used to seeing in our atlas views of the world. Living things, as well as weather and radio waves and flora and fauna, and now we find capital, also move across these borders, unknowing, unseeing, and unheeding the lines drawn by the planet's human inhabitants.

More recently, we have been struck by the pictures of human populations moving to avoid the wars and conflicts around them. The movements of refugees from Rwanda and the ethnic conflict that erupted between the Hutus and the Tutsis made graphic the human and the environmental toll of war and armed conflict. For me, a news story brought home the real face of this as I sat with my own family at the dinner table and viewed the effects of the displacement on families. It was a picture of a woman, her husband, and her eight children. He squatted on the ground, his head in his hands, the pain and the distress on his face, separated from his land and his livelihood. She was a constant motion machine, taking charge of organizing their space: Setting up camp; finding fuel; food and water; preparing the food; feeding and caring for the children.

There are multiple stories from this conflict—too many people in too small a space; the lack of sanitary conditions; the spread of disease; the loss of life; the orphaning of children; and the degradation of the environment; as well as individual stories of heroic people trying to survive in the face of incredible odds. Heroic people tried to help them survive, and tried at the same time to keep from despoiling the environment. At once the human and environmental ravages of wars and conflicts were made real by this picture.

There were deeper implications to be drawn from these stories as well: The peace that we continue to seek, the challenges of development that we have yet to meet, the tools that science and technology can provide for addressing challenges of development, the worldwide responsibility to address development issues, and the fact that our efforts at development are probably doomed to failure without the active participation of women.

At this point we have to ask: What is our vision for our planet? I want to stop here and say: Let us begin with the assumption, and a quote from Dorothy, from "The Wizard of Oz," and that is, "There is no place like home." Literally and figuratively, there is no place like home.

Surely for most of us this vision of the planet must include control of population, decreasing influence of humans on climate, protection of species, and on and on with the things that we heard from our speakers.

The speaker that just preceded me has a vision that has a major goal for technology, but I am anxious to get into the question and into the discussions, because in some ways I think that our solutions have leap-frogged our problems.

We want to live harmoniously with nature within our ecological means. As a whole for humankind, I propose we introduce the notion of sustainable human development. United Nations Secretary-General Boutros-Boutros Ghali talks about envisioning development as the most important task facing humanity today, and defines those elements essential to development as peace, economy as an engine of progress, environment as the basis of sustainability, justice as a pillar of society, and democracy as good governance. Within us all there is this notion that a country's principal asset is its people, and within a favorable international climate their development is how the country's development is achieved and sustained.

Education is a key aspect of human development, including education in science and technology.

I want to focus much of the remainder of my remarks on a high leverage area that I believe responds to all of these visions that we might have for development and sustainability for our earth and for the people who inhabit it. I want to emphasize the role of science and technology in achieving these visions, and emphasize what it can mean to those most in need.

I had an opportunity over the past year and a half to serve with a group exploring the gender dimension of science and technology for sustainable human development. This work was done by eight commissioners and eight advisors; I was the advisory representative to this group from North America, under the umbrella of the United Nations Commission on Science and Technology for Development, the Gender Working Group. This work from the Gender Working Group is going to be considered by the full Commission for its contributions to the deliberation of the World Conference on Women to be held in Beijing in September of this year.

Why women? Because they, that is we, and those for whom we care, the young and the old, are the overwhelming proportion of the poor; because women are over half the world's population; because we cannot afford to ignore their talents; because their roles and responsibilities and family and community place them at the center of sustainable development issues.

In many parts of the world, it is the women who have responsibility for food security. Women carry most of the responsibility of reproduction and family maintenance. Women are the care-givers, the gatherers of fuel and water. In addition, our efforts within the Gender Working Group pointed out that a substantial amount of local traditional knowledge is held by women, especially in the areas of agriculture, environmental resource management, and health.

Given the areas of women's responsibilities, it should be easy to conclude there is a major role in science in technology, and yet discussions of women in development often move forward with no input on the possible role of science and technology.

Those of us from science and engineering are often on the margins of national and international discussions on women in development. At the same time, and on the other hand and in a like manner, we have moved forward in discussions and strategies about development without considerations of women, without the involvement of women, without an understanding of its effects on women, without the understanding of the need to consider women's roles and responsibilities in the family and in the life of the community.

Whether science-based development or not, it is hard to see how it can be effectively mounted or expected to succeed without women. Yet, this is what has been done. As we have moved from the panel to break-out groups and back, we are reminded again and again that the pressing problems of the world are ones which must have women at the center of those discussions.

This morning, Tim Wirth talked about issues of population growth and the problems with a population that is outstripping its ecological means. While we recognize the need for continuing research for contraceptive options, we also have come to understand the links

between higher female literacy rates and lower fertility rates. UNICEF's "Strategies to Promote Girls' Education," a publication from UNICEF, points out this link between population and the education of women and the effects on the—[End of Tape]

... contribute to and benefit from development efforts, especially in areas of health, nutrition, water and sanitation, and the environment. The links to science and technology in these areas are obvious.

Then there are links in the other direction as well. The same report pointed out the link between large gender gaps and primary education, and its correlation with lower GNP. It is not clear to me whether this is considered cause or effect.

We talked about species diversity. There is much in the research that points out that indigenous knowledge systems are gendered, and that within women's indigenous knowledge systems are understanding of utilization of species and forest products that are extensive and that would be valuable to the rest of the world if they were tapped.

There are opportunities for connecting modern science and indigenous knowledge to the betterment of all: For example, using the local knowledge that women have about food characteristics and species characteristics and varieties, and issues such as taste, storage characteristics, etc., to be able to select and utilize modern techniques of biotechnology, and put together the characteristics, or the selection of characteristics, which these women desire, which they are willing to use, and which are likely to be incorporable into the life of the community.

At the same time, we ought to be able to acknowledge these local communities and compensate them for their contribution to our knowledge base and to our product base.

In her plenary address at the recent AAAS Annual Meeting in Atlanta, the Honorable Gertrude Mongala, Secretary-General for the United Nations Conference on Women, noted that in Africa 75 percent of the food is produced by women and with simple tools. She stated, "With science and technology, they would be great farmers."

Beyond the daily basics of food, shelter, water, fuels, and health maintenance, we must build local capacity and infrastructure to address the long-term problems that they and we face. Basic education for women in science and technology in developed and developing countries, this in the context of schools as well as in the context of something called "public communication" or "public understanding." We need to tap into our old technologies as well as the new ones, and look for the opportunities to use these as the basis of educating and continuously educating about science and technology.

We must recognize the role of women as scientists and engineers, and the value that they play in policy-making and decision-making roles in science and technology. I have been at the