2020 VISION

In Little More Than Twenty-five Years Eight Billion People Will Share Our Crowded Planet. Science and Technology Will Be Their Brightest Hope.

BY JESSE H. AUSUBEL

Arnaldo Pomodoro, Sphere No. 4, *1963–64*

MY PREMISE IS EIGHT BILLION PEOPLE. THE year is thus 2020. The question is America's engagement with the eight billion.

Let me set aside how numbers do not matter. In 1950 Americans made up 6 percent of the world population. Of the eight billion, about 4 percent, or 300 million, will dwell in the United States. In 1800 sixteen million residents of the British Isles were busily transforming a world of a billion. At the peak of British influence in the nineteenth century, the British numbered only about 2 percent of the world population. Their edge came from technology and new forms of social organization.

The fundamental question is not numbers but the power of the cultural message. The question for America is whether its cultural message has been fully expressed. I believe that America has more to say, and a crucial part of America's message is science.

The subject of global development is timely. A conjunctural fluctuation—a time of simultaneous economic, political and technological change—is restructuring the world in the profound way that takes place only about every fifty years. Historically, people often experience the intervals of restructuring as depressions. During such periods the growth potential of one set of organizational arrangements associated with a given cluster of technologies is exhausted and a new one is gestating. Jerusalem, Johannesburg, Los Angeles, Rome and Tokyo, as well as Havana and Moscow, are feeling the painful birth of the new.

The developing countries pointedly call the recent period the Lost Decade. Eastern Europe and the former Soviet Union are experiencing unemployment as high as the West did in the 1930s. They suffer intensely for the Victorian economy in which they froze themselves. The advanced industrialized countries evaded economic crisis in the 1980s largely by creating credit, both private and public. Now that strategy is played out. The debts go bad, bankruptcies surge, firms cut jobs and consumers hesitate.

The late economist Joseph A. Schumpeter and others understood the causes and cures of conjunctural fluctuations as early as 1939. The present period of "creative destruction," as Schumpeter would have called it, will continue through the mid-1990s, when a new cycle of sustained growth will begin. The structural changes accomplished in this decade will frame the prosperity of 2020. As the world economy emerges from the present "season of saturation," new technologies, industries, institutions and geopolitical configurations will appear. So the time is right for articulation of U.S. development policies and programs consistent with new realities, for organizational renewal, and for communication with the U.S. electorate and the people of cooperating countries about U.S. purposes in global development.

A BASIC BIOLOGICAL FACT IS THAT WE HUMANS are territorial animals. We range. If we are rich, we travel fast, and if we travel fast for a few hours, we travel far. Low-cost jet speed makes the game global.

Humans are also, in the main, sympathetic animals. The terrible burdens of illness, ignorance and incompetence that enormous numbers of people bear motivate cooperation for development. One billion continue to hunger.

Empathy and envy interact with our shrinking planet. Quick, cheap transport and communications make large discrepancies among the world's people dangerous, both socially and politically. The tensions that arise from the gaps, both within and between nations, spread like an epidemic, infecting all societies. The wealthy are unable to insulate themselves from the troubles of the poor, even from their diseases. Stalin and Trotsky argued whether socialism in only one country is possible. Today I would say, with Trotsky, that development in only one country, at least a large one, is impossible.

Moreover, poverty elsewhere in the world hurts domestic interests in the industrialized countries. It means threats to health, illegal immigration, cheap labor competition, drains on financial institutions and sad markets. The U.S. wants to sell airplanes and satellites, pharmaceuticals and software, and the experience of nature in the Rocky Mountains. Buyers are scarce in the marketplaces of the poor.

Interdependence is clinched by planetary ecological concerns such as ozone depletion, global warming and the loss of biodiversity. Indeed, the urgency of cooperative global development rests on the emergence of ecological sustainability as an indispensable and feasible criterion for action. Only widespread global prosperity can meet the challenge to collective security posed by the deterioration of the environment.

The challenge in the long run is the multiplication of needs. If many people are to eat, dwell and move better than they do today, meeting the needs of 2020 will entail at least a doubling of agricultural production, energy services, industrial production—and a billion new jobs. If such growth is achievable, it might not be sustainable, at least with current technologies.

EVENTUAL NECESSITY PAIRS WITH MOMENTARY opportunity. In a torrent of events the ice of post-World War II politics has broken and cleared. Freely elected governments and market-friendly economies, which are also parts of America's message, are appearing in most areas of the world. Significant measures of health, education and well-being have shown improvement in most nations.

Science and engineering have given birth to computers, lasers, jumbo jets, cellular telephones and gene therapy. Indeed, systematic research and development is itself largely a creation of the modern era. The industrialized democratic societies have demonstrated the feasibility of generating goods and services on an enormous scale. Does anyone doubt that those countries could double the world manufacture of automobiles, aircraft, pharmaceuticals or PCs? For the industrialized countries, production is largely a solved problem. Extraordinarily high quality and reliability have been attained, though new frontiers always open.

A minority of developing countries has combined innovations in the production of goods and services with sound economics to industrialize rapidly and lucratively. Strength in the newly industrialized countries and in major parts of virtually all the large countries—Brazil and India, for example—provides pillars on which to build. Extensive investment in education and health has improved the capacities of many countries to take advantage of technological

boosts to development, although economic depression, emigration and armed conflicts undermine those efforts.

At the same time, scores of developing countries have lapsed into an underclass. They cannot apply science and technology to meet the basic needs of their people or to enhance the efficiency of their domestic production and services to compete in world markets. Real gaps in human progress persist, both within and among countries, even as the idea of progress itself is redefined.

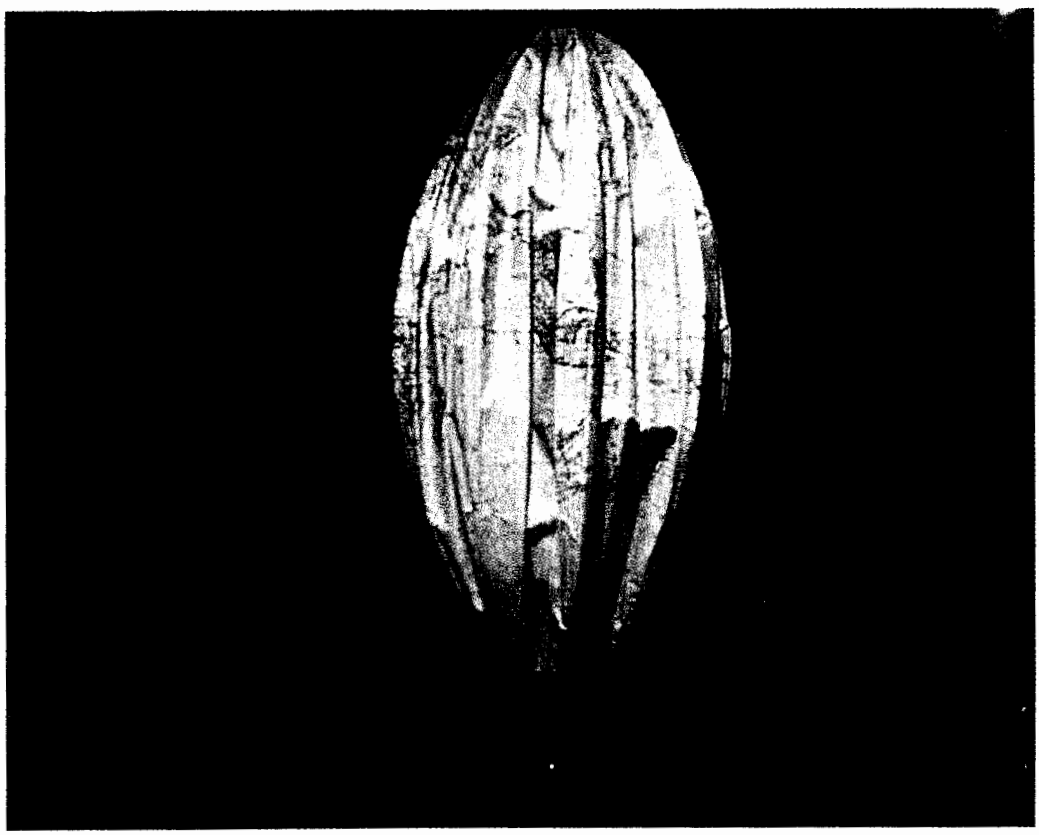
A TASK FORCE OF THE CARNEGIE COMMISSION on Science, Technology, and Government, chaired by the former president Jimmy Carter, argued in a December 1992 report that the changes now in process allow the world to move away from merely preserving an armed truce and toward sustainable economic growth and improvement in the quality of life, peace and democracy. Cooperative global development is the theme for the new international order.

In optimistic moments I speculate that human societies are approaching a planetary "hypercycle," the term used by the biochemist Manfred Eigen to describe a process that unifies several otherwise competitive entities into a coherently evolving unit. Within that unit the advantages of an individual can be used by all members.

Military budgets still drain both industrialized and developing nations. Perhaps the era is finally dawning when many societies can diminish the expenditures on their city walls. Peace could liberate more dollars in the U.S. than anywhere else.

A redefinition of the U.S. posture begins with the reintegration of historically separate policies toward its industrialized allies, the Soviet bloc and the third world, respectively, into the overall concept of cooperative global development. Cooperative global development implies:

- With low-income countries, U.S. interests are now mainly humanitarian rather than strategic.
- With middle-income and advanced developing countries, U.S. interests are growing, along with the capacity of the countries to progress without direct financial aid. U.S. cooperation should primarily facilitate private technical, commercial and investment relations.
- With Central and Eastern Europe and the former Soviet Union, U.S. interests will be served by the achievement of the economic and, in most cases, political progress to which the countries aspire.
- With the advanced industrialized nations, the U.S. must cooperate to restart the global economy. The obsession with national competitiveness, linked to the saturating markets of the 1980s, must be replaced with joint approaches to create confidence and technical visions that will elicit productive investment.



Eve Sonneman, The Deflated World, *1981*

Looking forward to 2020, the challenge is to create the jobs and income that can provide the majority of humanity with the current level of amenity enjoyed by the affluent industrial societies, without corresponding damage to the environment.

In the past 200 years technological and social transformations have enabled about two dozen societies to develop to levels unimaginable at the outset of the industrial revolution. For satisfactory global development a scientific, technological and social transformation as great as the first industrial

revolution is required. For all nations, including the U.S., the future must bring markedly more efficient use of land, energy and materials—in short, a superior "industrial ecology."

THE ONLY WAY TO MEET THE CHALLENGE OF the multiplication of needs is to substantially enhance the contributions of science and technology to development and to enhance the cooperation between the science-rich and the science-poor. Both new ways of doing things and the rapid spread of good ideas are urgently required. All major developmental goals—economic growth, environmental protection, improved health, better farming, population management—depend on the ability of countries to absorb and use science and technology.

Intertwined with the ability to absorb and use, much less generate, science and technology, is institutional pluralism. The main institutional forms are the private sector, with its emphasis on the marketplace and the bottom line; the public sector, with its emphasis on stable and codified process; and the independent sector, with its tradition of critical thought and the checking of inequalities of wealth, status, power and knowledge.

Cooperation for development must encourage a balanced development in societies of the knowledge, organizations and decision-making processes that underlie each of the main sectors, as well as creative interaction among them. It must build an enterprise culture, sound public administration and a lively independent sector.

Science and technology are critical to all three sectors. Propulsion for the enterprise culture comes from science and technology. A modern public sector cannot operate without massive applications of science and technology—handling the flows of data required for social security systems or air traffic control, for instance. Science and technology are indispensable to a healthy independent sector, providing expertise to balance that retained by otherwise more powerful interests and fostering a culture that probes at received wisdom and seeks humane innovation.

An awkward question is whether equity and democracy are prerequisites for development. I share the view that technological, economic and social development are unsustainable in the long run without increasing equity and democracy. Nevertheless, history does not prove that development requires equity and democracy in the short or even medium term. Equity and democracy have often followed development, in part because development creates the demand, first for democracy and later for equity. Development creates a large enough class of people with the leisure and security to think beyond the next day's meal, as well as the social conditions in which the demand for more democracy can be satisfied.

Yet a signal characteristic of the U.S. since its origins has been institutional pluralism. Already in 1835, in the classic *Democracy in America,* the French traveler and politician Alexis de Tocqueville noted vividly the profusion and significance of organizations in our nongovernmental sector, both for-profit and not-for-profit. What distinguishes an inventive and innovative society from one that imitates is cultural freedom in the broadest sense: a faith in the virtue of rebellion against accepted knowledge and social control. Among the indexes of such freedom are independent universities and small-business creation.

It may be helpful to give some examples of the ways science and technology can spur a new wave of global development. An extremely serious problem is the need to improve communication and share information without the written word. Illiterate adults number about one billion globally. In fact, between 5 percent and 10 percent of adults in most industrialized societies remain functionally illiterate, and that fraction may grow. To communicate with illiterate people, we struggle with radio programs, word of mouth, and posters using only cartoons; those people in turn struggle to share their messages and operate in the world. Voice-recognition technologies and voice-activated devices offer extraordinary potential to empower all people.

Another key challenge is to continue the decarbonization of the energy system. Carbon fuels are the culprits in smog, acidification, oil spills and global warming. For more than a hundred years the world energy system has gradually decarbonized by moving from wood and coal to fuels lighter in carbon, especially natural gas. Further decarbonization demands increased reliance on gas and the eventual adoption of carbon-free hydrogen as a fuel. Many countries, including the poor developing countries and China, can leapfrog coal and oil and begin to rely on natural gas. If the nations of the North wish to lessen concern about the environment and development, technologies for exploration and drilling for natural gas, as well as loans for gas infrastructure, should be top priorities for development cooperation.

SCIENCE AND TECHNOLOGY ARE *critical for development in all three sectors: private, public and independent.*

MOST CURRENT INSTITUTIONS AND PROgrams concerned with development were formed in a world far removed from the 1990s. Three old white men—Churchill, Roosevelt and Stalin—divided the world at Yalta in 1945. The World Bank and the Organization for Economic Cooperation and Development (OECD) arose from the ashes of the Second World War. The U.S. Agency for International Development (AID) was created in 1961, during a peak of the cold war.

Since that time, lively new intermediary institutions have energized the developing countries. Those institutions include businesses of all kinds and sizes, cooperatives, unions, associations of professionals, civic groups and, in some areas, local governments. The growth of nongovernmental organizations (NGOs) in Eastern Europe, the former Soviet Union and the nations of the South is a historic development. The North has changed as well. It has more open economies, a larger number of potential partners, new capacities and even greater wealth. Yet the institutional and legal framework of U.S. government cooperation for development has not changed since the early 1960s. The last major U.S. law on foreign assistance was passed in 1961.

The complex ecology of organizations associated with development is now more fully appreciated. That ecology includes entrepreneurial firms quick to seize opportunities;

large national and international agencies characterized by stable behavior, considerable resources and relatively centralized operations; and flexible networks and coalitions able to mobilize large numbers of people and public opinion, even without an assured funding base. The diversity of groups is a tremendous asset, indeed a necessity, if one wants to balance rapid and efficient growth with equality of participation in the fruits of that growth.

THE CARNEGIE TASK FORCE CONCLUDED THAT the overarching need within the U.S. is to harness the full power of pluralism for global development. To foster creative cooperation among the for-profit, governmental and independent sectors for development, the task force recommended the creation of a national action roundtable for international development. The roundtable would link people, assets and ideas in temporary organizations to get particular jobs done.

Within the U.S. government the charter for development needs to be rewritten. Given the entrenched interests, institutional rigidity and organizational complexity created over four decades, the White House must strongly support the change. The Carnegie task force recommended joint presidential and congressional actions leading to major reform of foreign-assistance legislation and oversight. Current legislation impedes all but marginal improvements in cooperation for development. The Foreign Assistance Act of 1961 has now been amended more than seventy times and includes thirty-three objectives and seventy-five equal priorities for U.S. programs.

The complexity of the ways development funds are authorized and the requirements for reporting also create a legal and managerial superstructure that consumes resources that might otherwise be spent on development itself. The critical elements of legislative reform are vastly reduced earmarks on appropriations to allow flexibility in programs, a sensibly limited set of objectives toward which cooperation for development is applied, and measures of effectiveness against which cooperation is accountable.

Foreign aid of the kind that AID offers is just one means whereby the U.S. government can influence development. Constructive, explicitly international policies can also be drafted on trade, environment, immigration, visas for foreign students, and intellectual property rights. Equally important are domestic policies that affect savings, investment and economic growth. Those policies profoundly affect the interactions and behavior of the U.S. and world economies.

THE CULTURAL CLIMATE
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is also what creates an innovative
and dynamic global economy.

In fact, debate over direct aid, or Official Development Assistance, may attract too much attention. U.S. ODA for long-term investment and humanitarian goals in developing countries totaled about $2 billion in 1992. ODA matters less for its absolute level than for its symbolism and leverage on the much larger flows of people, information, technology and goods that are part of normal commerce. The U.S. absorbs about $120 billion annually in manufactures from developing countries. An increase in trade of 2 percent, a typical year-to-year change, can have a larger financial impact than a doubling of the ODA budget.

One of America's strongest levers is its universities. America is the university for the world. For the one million students who travel abroad to pursue higher education, the U.S. is by far the preferred destination. More than 400,000 foreign students came to the U.S. in 1991; science and engineering were the strongest attractors.

Many of the major multilateral agencies were also created in the era following the Second World War. Few have deeply reexamined their mandates and modes of operation, while the world has moved from Yalta to Rio via the moon. One hundred fifty leaders, rather than three, are needed to address the direction of the planet.

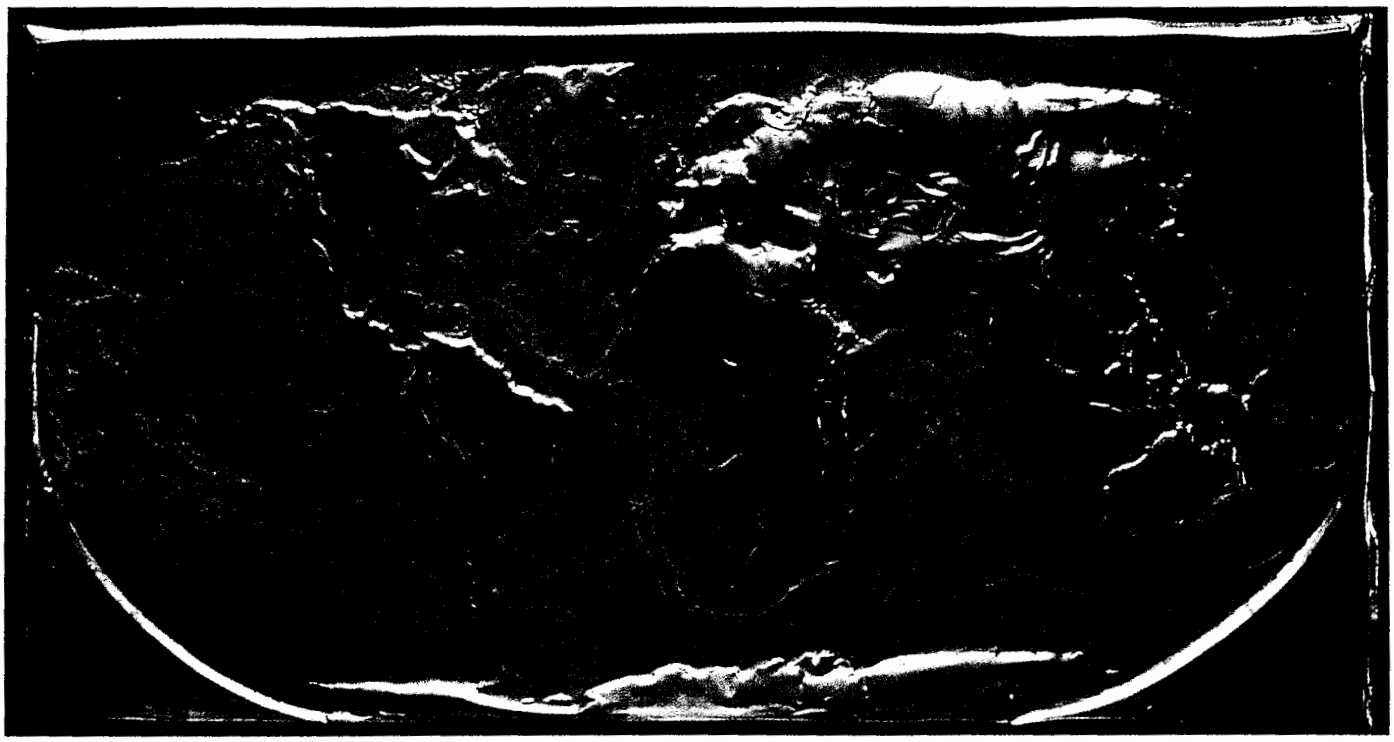
One area of particular need—also evident in the discussions at the UN Earth Summit held in Rio de Janeiro last year—is coordination among donors supporting environmental research. The Carnegie Commission proposed the formation of a consultative group for research on environment (CGREEN). CGREEN would include private industry and foundations, as well as governmental and intergovernmental organizations.

More broadly, I believe there is a need to examine the global and regional arrangements, both intergovernmental and nongovernmental, for the support and performance of research. The present international infrastructure of science will not suffice for the science of the eight billion people in 2020. A thorough look at the International Council of Scientific Unions and at the scientific components of OECD, the UN and other organizations should begin soon.

THE PRESENT APPEARS A RARE MOMENT FOR almost all nations to join to promote global prosperity, peace and liberty through cooperation. It is a time for creativity comparable to that immediately after the Second World War, with a greater chance for success. The U.S., as a large partner with deeply established practices, has some of the most difficult adjustments to make to respond to new needs and opportunities. Its success will be correspondingly significant.

The U.S. also has uniquely powerful assets as a partner in development. The Statue of Liberty rising over Tiananmen Square exemplifies the hope America continues to represent. Moreover, the depth and breadth of U.S. expertise in science and technology are unrivaled—a position that has been strengthened globally in recent years. A review of the contributions to all kinds of scientific literature between 1981 and 1991 shows that the U.S. share had the largest increase of any nation. The measure of the relative impact of U.S. work also showed a robust rise.

The other great home of science, Europe, registered a mixed performance. Although America's scientific production is about five times as large as that of any European country, pan-European science, to the extent it coheres, is roughly of equal dimension and of sufficient scale to conveniently address most questions. But European governments lag in realizing that European science can be at the forefront of European integration. Much more support



Michael Poulton, A Nice Place to Live, *1992*

should be given by European governments and industry to the European Science Foundation, Academia Europaea and other bodies that connect European science. In any case, science will remain strong in America and Europe.

The hard question is, Will science truly root itself in more lands or continue to spread only from the few metropoles? Science is an expensive game. The late historian of science Derek J. de Solla Price conjectured that scientific results grow as the cube root of the expense of research, a discouraging price for all but the Medici and the Rockefellers.

The most successful scientific effort in history has been realized in the U.S. in the past few decades. One reason is sheer wealth. But perhaps equally important is the entrepreneurial, market-oriented culture, and the general truculence noted by de Tocqueville. America supports the heterogeneity of preferences, competencies and expectations needed to keep pushing the frontiers of science. The same venturesome, individualist, experimental spirit that supports new businesses supports new science. That spirit will still imbue America in 2020.

But developing countries may move slowly to tolerate and encourage the qualities that make science flourish. Science may continue to be the comparative advantage and contribution of the West, and the U.S. in particular.

Can the developing countries catch up by 2020? The scramble to join the rich will certainly continue. In the next three decades more countries will successfully climb on our wagon, as others have in the past fifty years. The income ratios of rich to poor, however, will not change greatly by 2020. The best short-run prospect for "catch-up" is that the rich will hit a ceiling. In fact, the ceiling may be near for several measures of human development: infant mortality, life expectancy, share of population served with clean water. Although the middle class will become sizable in many countries, the diffusion processes that set the clock for development will probably take until 2050 for the next group of fast-growing, late-starter nations to pull close. After all, it has taken a half-century for the late-starting OECD nations such as Finland and Spain to reach the pack of leaders.

I have spoken mostly of America. Will Europe take much unified action before 2020? Current events suggest that the political division of Europe will require generations more to be ironed down. The collective impact of European nations on world development will be enormous, but Europe will rarely act collectively. More than a century passed from the formation of France to the political coherence and aggressiveness of Louis XIV. The economic unification of Europe is probably the most significant, and bloodiest, political achievement of the twentieth century, but I doubt Europe will be ready when the eight billion are.

ALTHOUGH POLITICAL EUROPE MAY NOT BE ready, I think its scientists and engineers and those of America and the rest of the world will be. The world of the eight billion could be needier and more contentious, made so by crowding, epidemics, vast migrations, resource depletion and rapidly changing climate. But science, humanity's most powerful invention, is young and vigorous. Science and technology, if they continue to be dynamic, can provide cleanly and comfortably for eight billion people and more. The period of major restructuring now under way is an excellent time to signal feasibility and to set in place the institutions that will fill the new stage.

Perhaps the most subtle challenge is to convey to the world that the cultural climate that makes science flourish is also what creates an innovative and dynamic global economy. That may be America's most important message for the eight billion. •

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