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Proceedings

Building the Future: Leadership, Technology, Global Citizenship

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Alliance for Global Sustainability

Content

Preface

The Alliance for Global Sustainability (AGS) held its annual meeting in San José, Costa Rica, on March 21-23, hosted by the Instituto Centroamericano de Administración de Empresas (INCAE). This is the first time the AGS has held an annual meeting at a location other than one of its member institutions. In keeping with the location, the annual meeting focused on Latin America while advancing the AGS research portfolios. The meeting was attended by more than 400 participants, including 170 AGS members, presidents of six major research universities, industry representatives from 10 companies, representatives from 12 non-governmental organizations, and a delegation of over 150 people from Latin American industry, government, academia, and NGOs.

The AGS continues to explore ways in which its research institutions can increasingly contribute to solving sustainability problems and preparing the next generation of leaders. A sign of the success of the AGS model was the creation of a consortium modeled after the AGS consisting of 42 Latin American universities focused on sustainability – the Latin American Alliance of Universities for Sustainable Development (ALUDES). Said MIT President **Charles Vest,** "If the activities of the AGS have played even the smallest role in helping to initiate this, this gives us a great vision of how we can both stick to doing what we do best and also greatly leverage and expand our influence around the world."

In cooperation with the host institution, INCAE, scholars met to examine the AGS research and education portfolio and to consider ways in which the academic community – in partnership with industry, government, and civil society – can help generate a clear and focused agenda for the future. As the tenth anniversary of the Rio Conference on the Environment and Development approaches, participants in the Annual Meeting looked forward to building the future through enhanced leadership, improved technologies, and global citizenship.

In opening the meeting, **José María Figueres,** former president of Costa Rica and honorary chairman of the meeting as well as member of the AGS International Advisory Board, said, "If the fall of the Berlin Wall heralded a new era of opportunities, the fall of the World Trade Center towers has marked a new era of vulnerability. In spite of all our progress on many fronts, how vulnerable we have made ourselves to be. Even as these adverse conditions depict today's reality, there are certainly other components of our reality that offer hope as well and upon which we can certainly build. Being the eternal optimist I consider myself to be, I invite you to see the real opportunities that we can leverage out of these adverse conditions."

European Commission member and AGS International Advisory Board member **Margot Wallström,** in a pre-recorded message to the participants of the meeting, highlighted some of the issues facing the AGS and their relevance to the Johannesburg Summit later this year. Said Wallström, "I believe the Johannesburg Summit must be a wake-up call for global sustainability... It is difficult to envisage another policy area being more dependent on research than environmental policy." Wallström emphasized, "We need to understand the natural processes that we are dealing with. Technology is an important part of the solution. And we have to justify our policies on the basis of research and good data." Ms. Wallström suggested two types of outcomes from the World Summit on Sustainable Development in Johannesburg in September: (1) a global declaration and action plan to show the results of the collective effort and of the new spirit of global partnership; and (2) a series of specific commitments or agreements by networks

or partnerships, including governments, the private sector, and other stakeholders. Further, "Johannesburg must deliver regional actions for Africa building on ongoing initiatives like the New Partnership for Africa's Development," said Wallström.

In his keynote address on the prospects of sustainable development for the new millennium, **Jeffrey Sachs,** Director of the Center for International Development at Harvard University, said, "The solutions to the problems of the human impact on the local and global environment, the challenges of raising living standards in ecologically stressed regions, and the challenges of pandemic disease will, first and foremost, be met technologically... The future is not to be predicted but to be shaped. It's not a matter of running our models and deciding which scenario is the most likely; it's a matter of mobilizing human agency to address the ills and to champion the positive tendencies."

In a stirring address at the gala dinner, **Oscar Arias,** former president of Costa Rica and Nobel laureate, exhorted attendees and the countries they represent to embrace and seek peaceful solutions to the problems that plague mankind. Said Arias, "I believe that we all have a vision for the world that motivates us to act in our varied capacities to achieve sustainability as we see it. My motivating vision of the world a hundred years from now is a planet Earth in which each government is democratically elected, is able to fulfill its people's needs, remains at peace with both its neighbors and its internal opposition, and uses the tools of economics and science to the benefit of all its people. This, in brief, is my idea of sustainable development; and though simply stated, these goals will require prolonged and complex efforts in order to be achieved."

Professor **Roberto Artavia,** Rector of INCAE and the host of the annual meeting, described the four-point program of INCAE to promote sustainability, consisting of education, applied research, continuous innovation in the executive training programs, and a strategic alliance for sustainability leading to the formation of the ALUDES consortium. INCAE is a highly specialized school with a single degree, the MBA. But the 250 MBAs that graduate from INCAE each year must complete a course on the principles of sustainable development, and an eco-efficiency management course is compulsory for all of its students. In 1996 INCAE founded a Center for Competitiveness and Sustainable Development that represents up to 40% of its institutional budget.

A set of concurrent **working groups** examined the question of why existing technologies and strategies for promoting sustainable development within both developed and developing countries are slow to materialize and be implemented. One reason that emerged is the difficulty in communicating research results and other information to such disparate audiences as decision makers, policy makers, research peers, the media, the public, and students. New applications and technologies must be developed to help developing countries assess and address local needs. One working group noted that, even though some technological improvements are not as costly as might be thought, poor countries often lack the resources to afford even the most basic technologies. A second session of concurrent working groups examined the tensions generated by the growing divide between affluent and poor people, nations, and regions that threaten to undermine progress toward sustainable development.

The working groups focused on the areas of energy and climate change, water and food, buildings, infrastructure for managing the megacities, digital opportunities, mobility, and vulnerability posed by natural and man-made disasters. While the developed world concentrates on increasing fuel efficiency, searching for alternative fuels, and renewable energy, the developing world continues to struggle with a shortage of energy. Workshop participants noted that the global community must make supplying energy to the poor a priority in order to fight increasing levels of poverty; however, it was agreed that in order to address concerns over global warming and general climate change, a scheme must be developed that provides non-polluting energy to developing countries.

Solving Asia's transportation problem was seen by participants as being one of the keys to sustainability. The paratransit services in large cities in developing countries are labor intensive and are dependent upon cheap labor. As poverty is eliminated, these services will be dramatically reduced, causing a significant problem in the provision of paratransit. Developing countries are at a significant disadvantage regarding the procurement of infrastructure, and the majority of transportation equipment used in developing countries is imported from industrialized countries at high cost. Transferring these costs onto the customer is not a feasible option in many developing countries.

There was also discussion of case studies in areas where water is scarce due to human activity. Of particular concern was the amount of water used in agriculture (70% of global water demand is for agricultural production) and the need for conservation of wetlands and other ecologically valuable regions. With regard to issues of water and food in Asian countries, as in many other areas, water has not been adequately included and accounted for in theories of growth. Agriculture is the biggest user of water in most of the Pacific countries, where more efficient management of water resources is needed.

Attendees were given a demonstration of ThinkCycle by MIT graduate student **Timothy Prestero.** Think Cycle is an innovative program that seeks to create a culture of open-source design innovation with ongoing collaboration among individuals, communities, and organizations around the world. The model sought by ThinkCycle is for NGOs and stakeholders to submit problems and test the solutions in the field, during which academia can perform non-profit R&D and industry can create new models of sustainability and local enterprises.

In his keynote speech on the closing day of the meeting, **Eduardo Lizano,** president of the Central Bank of Costa Rica, said, "No country, no society can live isolated or apart from what we call today the global village. So it is for the sake of our own security and our own prosperity that we must be very much interested in what happens in all the four corners of our planet and beyond." Further, "It is necessary to establish firmly ethical principles and a moral code," said Lizano. "Without them, it will be actually impossible to avoid social conflicts and economic exploitation and will leave many countries and societies outside the benefits of development. Without these two conditions, the institutions and the alliances needed will not be forthcoming and, consequently, development – be it economic, social or sustainable – and progress will not be attained."

Steven R. L. Millman, doctoral candidate at MIT and chair of the AGS World Student Community Symposium in Costa Rica, presented certificates of appreciation to the six members of the Presidents' Panel

for their support of the AGS World Student Community, which held its annual meeting in San José this year prior to the AGS meeting. Said Millman, "These students, some of whom you've heard from already, have created an explosion of sustainability projects around the globe. The World Student Community appreciates this opportunity to say two things to the presidents of the AGS universities: First, we want you to know that your support has led to positive, concrete, and widespread results for sustainability in the lives of our students and in the communities in which they live; second, we are grateful beyond words for your support and your confidence in our ability to succeed when we have the room, the freedom, and the support to do so."

Opening

José Maria Figueres — Meeting Chairman, Former President of Costa Rica
Member, AGS International Advisory Board

In Costa Rica, some of us have worked hard to shift the paradigm of our development towards sustainable development. We can point to some successes in macroeconomic stability, in strategic social investment, and in building an alliance with nature – the three cornerstones of sustainability. And we interpret your presence here – the first time ever that the AGS has met outside your own campuses – as a recognition to what this small nation with limited resources has accomplished in the field of sustainability.

But we also recognize that there is much more that we can do, and your presence in that respect could serve as an inspiration and as food for thought with respect to the challenges ahead. After all, as Stephan Schmidheiny often defines sustainable development, "It is like the North Star that we aim for in a series of approximations, realizing with every closer step the additional opportunities that lie ahead." And, in this respect, if I may offer a special recognition to Stephan Schmidheiny, we recognize in Stephan the individual that over the last decades has worked the hardest and persevered the most in the pursuance of sustainable development throughout Latin America.

Much has changed in the world since our last meeting of the AGS in Lausanne, Switzerland only a year ago. In economic terms, we have seen the markets plunge as the information technology bubble burst and the world sunk into a first ever synchronized recession. In political terms, we have placed ourselves especially on the international scenario in a situation marked by a clear vacuum of global policy, and, therefore, often unable to effectively deal with the shortcomings of a global market. In human terms, what we thought of as the worst horror fiction stories in September 2001 became a reality – a very sad reality – and, in environmental terms, we have witnessed an appalling lack of leadership and vision necessary to move forward an agenda that would have helped mitigate the effects of climate change and the pursuance of the objectives of Agenda 21.

All of this has left us with the sobering thought that if the fall of the Berlin Wall heralded a new era of opportunities, the fall of the World Trade Center towers has marked a new era of vulnerability, in spite of all our progress on many fronts. How vulnerable we have made ourselves. Even as these adverse conditions depict today's reality, there are certainly other components of our reality that offer hope, as well, upon which we can certainly build. Being the eternal optimist I consider myself to be – and I see many optimists in here in the room – I invite you to see the real opportunities that we can leverage out of these adverse conditions that I have mentioned.

In the search for answers and a way forward, out of our present feeling of vulnerability, it appears that we have rediscovered the importance of creating opportunities for individual well-being through good, basic, sound development. In effect, a decade after the end of the Cold War we are discovering that our new common enemies are really not new at all. Today, the enemies to be defeated are hunger and lack of nutrition, poor health conditions in the world, mediocre education systems that are not preparing the young generations for the world in which we are living, deprivation of our natural resources, and inefficient organizations and poor policy making. And the fight against these enemies is also finding new allies that, in a perhaps strange way, are building out-of-the-box alliances with respect to what we have seen in the past.

Gordon Brown in England, from the political world, is now calling for $50 billion per year to be invested in development by the developed world. Bono of the U2 band, from the cultural world, is alternating his singing with work for debt relief and development. Private sector pharmaceutical companies have dramatically lowered prices of drugs for HIV/AIDS and are now actively participating in programs such as the World Economic Forum Global Health Initiative to also readdress the fight against tuberculosis and malaria. And global corporations are assuming new positions as they increase their global citizenship role under the banner of corporate social responsibility.

Though I am proud of my country for having abolished its armed forces since 1948, many countries in the world still need to add another ingredient to this array of possibilities to bolster development in the world of today. And that is that they need to rediscover or discover that their armies, those instruments that they created to fight their enemies of the past, are of no value to them today in the fight against the new enemies we are talking about.

In short, there seems to be a tremendous window of opportunity for the world to move from what has been a very necessary coalition against terrorism to an even more necessary coalition for development. Perhaps, in this opening of a window of opportunity, it is the health of la Virgen de Los Angeles, our Costa Rican national patron, no doubt in a holy alliance with all the other celestial powers to be. This window of opportunity will address again, with renewed emphasis, development issues which would open up against the backdrop of a series of other events that also highlight the urgency to address the creation of opportunities of well-being for so many that need them. And this backdrop of events includes, amongst others, the Millennium Declaration development goals of the United Nations, for which Secretary-General Kofi Annan has just appointed Professor Jeffrey Sachs, our keynote speaker of today, as his special advisor; the Conference on Development Financing taking place in Monterrey as we meet here; this conference of the AGS, focusing on building a sustainable future; and the global gathering later this year in Johannesburg to assess progress toward the implementation of Agenda 21.

Building a future, our common future, will of course require that we tackle some challenges of which, at the outset of this conference, I would like to mention but a few. First, we need to strengthen our resolve to take on development issues with new vigor. This time around it cannot be a fad; it must be sincere, it must be earnest, we must invest our time and our resources in this mission. In this respect, there is, of course, a moral and ethical imperative to do so, but there is also a self-enlightened interest to do so if we want the world to be a safer place from what we know it to be today, if we want to avoid other regional trouble spots from becoming potential sources of new global confrontation.

Secondly, we need to share the understanding that too many paradigms have shifted in the last two decades for a new effort in this direction to be anything less than according to the tenets of sustainable development. If we are going to do it, let us get it right from the very beginning. Third, we need to realize that society today, in the Internet age, is organizing itself in ways that we perhaps yet do not completely understand but that are completely different from those of the past. And, therefore, the implementation of possible solutions to address the divides and the moving forward of an agenda of sustainability are going to necessarily require a new multi-stakeholder coalition, a new approach building alliances between civil society, academia, the private sector, the academic world, and the political world.

Fourth, we need to better address the use of information technology as an across-the-board enhancer of development and well-being by mainstreaming it in everything we do – mainstreaming it in health with telemedicine; in education, to upgrade the quality of our systems of education; in entertainment, in terms of quality of life; and in economics, to lower the cost of transactions. In other words, we need to mainstream information technology in every one of our development objectives.

And, last but not the least of these challenges, we need leadership and vision – strong leadership that will again focus not only on the short everyday matters that are so important but will also be courageous enough to often go against the public opinion polls and the line, the day-to-day decision making process with respect to the medium- and long-term objectives that achieving sustainability requires. And we need vision of the type that I am absolutely sure will come out of this conference during these days. We need to deliver on furthering the possibilities of sustainable development.

Keynote Adress

Prospects for Sustainable Development in the New Millennium

Jeffrey Sachs Director, Center for International Development
Harvard University

I found it a little bit daunting when I was invited to speak on the issue of the prospects for sustainable development in the new millennium. I thought that this is a pretty big topic. But then I was relieved to find that you gave me a full half-hour to lay it out. So I figured I would have plenty of time to delve into the thousand yearsmillennium ahead of us and all of the complex issues that face a very interconnected world in a very wide range of complexity and interconnectedness.ss issues. [laughter]

As I was flying yesterday from the Monterrey meeting where the nations of the world gathered to discuss the gaps of rich and poor in the finance for development, I opened the New York Times, which I got at the airport, and it was amazing that three of the lead stories illustrated , of course, why we are here. The first one, which shocked me, was reported 126 children already dead since September in Guatemala from severe malnutrition since September. Parched soil last summer left thousands of subsistence farmers without crops to harvest. So This is an example in a neighboring region of children starving to death because of crop failures, and are is probably related to broader ecological trends that are under way.

I turned the page to read that the large ice shelf in Antarctica is disintegrating at great speed. Consequently So we saw the stunning pictures of a Rhode Island- sized piece of the floating ice bridge disintegrating before the eyes of the scientists watching with satellite projections during the past month, reflecting, no doubt, a global scale phenomenon. Then I turned the next page to see that the Bush Administration, under pressure from lawsuits by real estate developers, is urging federal judges to roll back legal protections for nearly two dozen populations of endangered species across the United States. And sSo the political challenge of everything that we are here to talk about is also a live issue that we are grappling with day to day. Well tThe issues of sustainable development (I don''t have to tell you, ladies and gentlemen, because you are among the very leaders in the world who are thinking about this in the world) are issues of exceeding complexity, and even to discuss them in a brief period of time in some way that does not do great damage to these issues is not so easy.

There are profound issues of scale when we discuss this. Are we talking about local local-scale dislocations and local local-scale challenges such as the erosion of soils that may lead to malnourishment and death from a transient inter-annual rain failure? Are we talking about regional regional-scale problems where we see whole regions beset by pandemic diseases such as resurgent malaria or, of course, the HIV/AIDS pandemic in southern and eastern Africa? Are we talking about global global-scale phenomena such as what we were doing anthropogenically to the major ecosystems in the world? What is our time horizon when we discuss this? I presume you were not really interested in hearing about the next millennia but rather the new millennium, the next few years as we have entered this new century. But there are very profound questions of time scale as we discuss these issues. There are urgent problems that will not be solved in the short term. There are daunting challenges in the longer term for our grandchildren that I would like to mention.

And then when we discuss sustainable development, whose development are we discussing? And what do we mean by development? Certainly we know averages are not going to workthat progress ""on aver-

age"" is not going to be sufficient in this world or even on the local scale, because gaps between rich and poor are so profound. Do we mean development only of the human species or of other species with which we share this planet, given the rates of man-made species extinction that is are already entrain? How much permanent loss has already occurred in key ecosystems or the loss of vital species? And even to begin to address these issues, of course, the range of expertise that is required is absolutely startling. So all of us here are engaged in a new kind of intellectual exercise as well. There is no discipline in the earth sciences, the biological sciences, or the social sciences that can go it alone can adequately address in discussing the issues of sustainable development. I think we are seeing a major shakeup even in the organization of university research and university organizations, because the old disciplinary boundaries just are not going to work if we are going to be able to address in addressing these issues in a satisfactory way.

We hear, of course, an incredible range of prognostications, from light blithe optimism to forecasts of disaster forecasting, whenever we delve into these issues, and the confusions come because people are talking about different scales, different time horizons, different risks, different groups, and different probability assessments. I think it is fair to say that the issues are not only complex but the prospects of sustainable development are mixed. They are Truth is not to be found in the camp of either the pure optimists or the disaster mongers. There are, I think, four very positive trends that we need to take into account as we think about the coming decades. And I think these are extremely powerful forces at play.

The first trend that I would mention is the slowing of global population growth, something that has been reconfirmed in recent analyses last week at the United Nations by a close look at the so-called middle fertility range of countries, those with total fertility rates between 2.1 and 5. There is, no doubt in my mind, a significant shift in global fertility that will cut population growth rates and that will enable us at least to think about moving to a world of near stable populations within a century, maybe and it may even happen sooner than that.

For almost every challenge that we are going to discuss, the pressure of the size of the human species is a daunting and powerful factor, whether it is at the level of an individual economy's development or the pressures on the global ecosystems. The global shift that is underway now almost in all the countries of the world, save for some particular exceptions that I will mention momentarily, is an extremely important shift. And I think that it is one that is unlikely to be reversed. We know that now about 40% of the countries in the world are actually below replacement rate in fertility and another 40% are in the middle range with continued downward movement of fertility rates. And there still is roughly a fifth of the world''s population that has not entered a significant demographic transition yet. Those happen to be, for the most part, places where the sustainable development challenges are the most intense and the most life-and-death. But I would put the slowing of global population as a first very important deep factor that we need to consider.

A second, and in my view very positive, trend is the increasing proportion of the world''s population that lives in urban areas. I believe that the trend towards urbanization, which now has about half the world''s population living in urban areas, depending on exactly where one draws the line, but probably rising to two-thirds of the world''s population by 2025, is also an extremely positive development for sustainabili-

ty in the long haul. Now when we add immediatelyUp to this point, we have not figured out how to make our urban environments as livable as they need to be, especially in the poor mega-cities of the world. But there are tremendous advantages in the provision of basic services, infrastructure, access to health, education, sanitation, water, technology, and science to a world with a rising proportion of the population in urban areas. And I believe an urban networked global society is one which is far more likely to achieve sustainable development than a world in which impoverished people living on increasingly depleted lands with rising population pressures are is likely to produce. So I see the trend towards urbanization as an important and positive factor.

Third, and without question in my view, the most positive trend is the overwhelming evidence of the continuing explosion of scientific and technological knowledge. We continue to accelerate our capacity to mobilize scientific knowledge in useful technologies, and I so very much appreciate the whole strategy of the Alliance for Global Sustainability in putting technology at the forefront, because I think that the story of economic development in its narrower sense over the last few two centuries is overwhelmingly a story of technological advances. The fact that our scientific enterprise on a global scale not only continues to work but continues to increase in its dynamism is, to me, perhaps the most promising feature of all.

And the fourth positive trend that I would mention is the clear evidence that those technologies are diffusing widely in the world by no means universally. The clearest case without question is China, a country of 1.3 billion people, more than 20% of the world's population, which has had perhaps an eight- to tenfold increase in properly measured per capita gross national product per person since the opening of the Chinese economy in 1978. We are seeing hundreds of millions of people in India, particularly in southern and eastern India but also even in more remote places in the Gangetic valley, also beginning to experience rising living standards on the basis of the diffusion of science and technology. Bangladesh, which was seen to be an absolutely hopeless case a generation ago, is already gaining a foothold in the world economy as well as experiencing the benefits of slowing population growth, falling fertility, and rising education standards. So these are enormously positive trends.

In this great debate about globalization, the completely anti-globalizationed fearmongersfear mongers who hold that globalization is a disaster for the poor have it factually wrong factually. There are perhaps billions three billion or more of people whose living standards have been increasing over the past 25 years and, clearly, through it is the diffusion of knowledge fundamentally and through the diffusion of technologies specifically that have allowed for significant increases of living standards and real consumption, and significant increases in the broad array and multidimensional aspects of material well-being.

Now, on the other hand, there are three deep negative trends as wellthat I must also discuss, just so I do not leave you do not think too enthusiastic or so you do not think that I am a Panglossian ingénue talking to people that know what is really going on. There is no doubt, in my opinion, that there is profound and dangerous ecological stress at every scale of our human society. There are regions of the world at the local scale where soil depletion, degradation of the land, massive erosion, depletion of water aquifers, loss of local species, loss of watershed and broader ecosystem functions are riperife. There is no doubt about it that there are significant places in the world facing ecological collapse. There is no doubt, in my

opinion, that at the global scale we are pushing limits of profound risk, whether it is anthropogenic climate change, depletion of global fisheries, or loss of biodiversity in various parts the biodiversity hotspots of the world (of one of which we are sitting in one of the prime hotspots of the entire planet today). So those who would deny the ecological risks also miss the point that these are profound, these are real, and they are operating both locally and at the global scale.

Second, those who would parade the triumphs of globalization should also be honest to explain that a quarter of the world remains in desperate poverty and perhaps a fifth of the world remains stuck in the most horrific and dire poverty trap. By poverty trap, I mean that the underlying mechanisms through which knowledge, technology, science, and material improvement diffuse are not operating. Globalization has such a mixed perception because the experience in different parts of the world is so varied. Go to Shanghai or Fujian or Hunan IslandSingapore and you will see globalization at work at its best. Go to Monterrey, Mexico, as where I just was yesterday, and you will see what free trade with the United States can accomplish in terms of creating a booming dynamic, and very pleasant large city. But go to WagaduguOuagadougou, Burkina Faso or to Blantyre, Malawi, or the Altiop Plano in Peru, or to Afghanistan even before the Taliban, or the Guatemalan Highlandshighlands, and you will see globalization either not at work or at work even in pernicious ways.

What is the nature of a poverty trap? It depends. Usually there are strong ecological and geographical factors at play. Virtually all of the remote regions of the world – the landlocked countries of central Asia, the Andean Highlandshighlands, and the landlocked countries of Africa – are in desperate shape because globalization does not reach into the interior of developing regions. Usually highland regions with fragile slopes and difficult topography are at risk. Usually ecologically strained regions like the Savannah regionsAfrican savannah (sub-humid tropical) region, with water scarcity often intensified by anthropogenic climate change, are at extreme risk. And these risks are compounded, in many cases, by the emergence or reemergence of pandemic diseases – (AIDS, of course, AIDS being the most dramatic), but also the resurgence of malaria and tuberculosis, for example –, for many reasons including impoverishment itself with the breakdown of health systems in Africa, the failure of the rich countries to let the poor countries off the hook of unpayable debts, and the spread of drug resistance in the first-line drugs for malaria and now, increasingly, for tuberculosis and other infectious pandemic diseases.

I spend a lot of time in these countries. They are not getting better on their own. The forces of globalization are almost not at work except to draw the best minds out of those countries in an international brain drain that has been intensified by globalization, leaving the countries in a downward spiral of disease, violence, impoverishment, unpayable debt, and ecological catastrophe. That isThere are perhaps one billion people in the world that I am describing, the poorest of the poor. It is a fact that you have both a China and a southern India on the one handachieving rapid economic growth on the one hand, and the poorest of the poor collapsing on the other hand, that gives such fundamentally different images of what globalization means. But in a room of scientists we can say they are both true. Define your scale, define your time horizon, and the picture is much more complex than any single and simplistic answer, positive or negative.

And finally, as my third negative factor, while is the point that while globalization creates incredibly powerful positive forces, mainly the diffusion of knowledge, it also creates powerful negative forces as well. When you are together in a network, the ills can be transmitted through the network just like the benefits. The ills of terrorism are networked globally. This is no mirage, this is the real thing. I have had the experience of working in Islamic countries across a swath of 128,000 miles, and I have seen, even before September 11th, how internationally financed programs of destabilization were reaching from West Africa right through the Middle East and the Balkans into Central Asia and into Southeast Asia. So international networking for ills as well as positives is a real thing. The international networks have no doubt accelerated the transmission of HIV/AIDS around the world. This is a pandemic that originated somewhere in the jungles of West Africa probably about 70 years ago when a zooanosis zoonosis crossed from chimpanzees to humans, and it has now reached 65 70 million individuals around the world on all continents. The epicenter remains Africa, but it is spreading to all parts of the world through international sexual networks, not surprisingly in our globalized world. Mass migration, refugee movements, violence, drug trafficking, criminality, money laundering, disease transmission, terrorism; these are the international ills that readily diffuse over international networks as well. It is a complicated picture.

The future, I think, as all of us would agree, is not to be predicted but to be shaped. It is not a matter of running our models and deciding which scenario is the most likely, it isbut rather a matter of mobilizing human agency to address the ills and to champion the positive tendencies. And I think that there are going to be two huge issues-there are many, but I am perhaps being naive or artificially simplifying – in this regard of profound significance for our future. The first is the role of science and technology in our societies. I do believe that solutions to the problems of the human impact on the local and global environment, the challenges of raising living standards in ecologically stressed regions, the challenges of pandemic disease, will first and foremost be met technologically. And the question for me is whether science can preserve the social space that it has had for the past two centuries. I am a naive supporter of technology. I will put it on the table.

If science is politicized, if science loses its public support, if science is overwhelmed by the religious wars that engulf the United States in some ways, I think the risks are vastly greater for all of us. I think we have seen some wonderful international science in recent years showing how, despite incredibly intense political pressures, the directness and honesty that characterizes good science can prevail. I am a huge fan, for example, of the sometimes-maligned IPCC process, the Intergovernmental Panel on Climate Change. I think that, despite huge pressures from some of the biggest companies in the world and big political pressures from the most powerful country in the world, the climate scientists have been able to hold their ground and produce a flow of documentation in a new science of high uncertainty that is rigorous, apolitical, and stands the test of the deepest and most aggressive scrutiny. And that kind of international science is going to have to be preserved. When you think about how wonderful is it was that a skeptical Bush Administration, that does not want to hear about climate change, turned to its National Academy of Sciences and within a few weeks got a report from the NAS that said, yes, the IPCC results are sound, they are good science, they have been well documented and they are right-that is also, for me, an incredibly heartening sign that science can hold its ground in the face of deep political onslaughtpowerful political pressure. But it this role for science is by no means assured, and I do think it is critical for the future. The second factor of human agency that I would mention involves the possibilities for global governance.

I believe that global global-scale problems require global institutions and levels of global cooperation that we have never had before. We are groping towards world global governance, not a single world government, of course, but global institutions that are serious and capable of addressing global global-scale challenges of the kind that we have not recognized or had to face in the past.

I was greatly so honored to be asked by the UN Secretary-General Kofi Annan to be his special advisor on issues of rich and poorglobal economic development. This opportunity is one of my very highest priorities, but felt that I would throw everything down to do that because I think if we cannot make the UN system work, we are not going to be able to face the challenges ahead. I live in a country where the UN became almost an object of derision for 20 years, and that is a great risk for the world, because I also know from work in developing countries and all parts of the world how many people in the world depend on the United Nations and depend on its effective performance, which is not always at the standard that it needs to be.

But our ability to solve these problems will depend on an effective set of global institutions. I will just raise some questions.

Will the rich countries help the poorest of the poor that are in their poverty trap? Two weeks ago you I might have said, no. As of last Thursday, the news is a lot better than it might have been. The Bush Administration announced last Thursday, for the first time in 20 years, an increase of US foreign assistance for the world's poorest countries. I have been waiting a long time for that day. I cannot tell you how many thousands hundreds of speeches I have probably given about the need for the United States to get serious about the poorest of the poor countries. We are only one speech into this, so I cannot say that the deal is done. But I think that an important corner was turned last week. I think the United States learned after September 11th that the notion of just letting the world go on its own, and with the U.S. somehow somehow living behind somehow the illusory imaginary Maginot line of two oceans and a missile barrier was is not going to be sufficient.

So we need to do more and we need to be proactive; and the fact that the United States has now pledged 10 billion dollars of increased foreign aid through fiscal year 2006 is a huge, huge large advance., Not not only in the money, which is real but still much too small, but conceptually more importantly in the fact that that a conservative US administration has become an advocate a true vigorous spokesman for increased development assistance for the first time in 20 years. And I mean vigorous, because since last Thursday they have been defending this new initiative every day at the highest levels, and they will today and tomorrow in the Monterrey Summit.

But here is another question: will the rich countries agree to be restrained in their own damage that they are doing to the global ecosystems? There I am afraid the evidence is much more mixed. We have not had the conversion Conversion on the way road to Monterrey as we did last week. We still have the United States almost pretending that there is no issue, although we now have at least a recognition of the need for something voluntary though completely insufficient. The United States has failed in two ways, of course: a failure to understand the risks to ourselves and an utter failure to understand the damage that the United States is creating for the rest of the world. Every cCongressmaen views climate change

as an issue for their own districts, not the fact that four per cent of the world''s population is creating 25% of the world''s greenhouse gases and risking profoundly putting at risk the ecological balance in the most fragile places in the world, particularly in the tropics where the damage from global climate change is likely to be the very highest or could well be the very highestgreatest.

The third question, on global governance: will we avoid the clash of civilizations? This is a social as much as a political challenge. I deeply hope my esteemed colleague and friend Sam Huntington is proved utterly wrong, utterly utterly utterly, about the growing clash of civilizations. It does not sit right with me either as a prediction (of course, not with him either) or as a normative definition of our global society. But it is a potential reality made very vivid for all of us in recent months. It is not the kind of world we need to create, but ilf we start defining ourselves as "us and versus them" across religious lines or ethnic lines, we are going to be in for disaster, because we will never get our global institutions and global cooperation functioning.

So those are the two great questions that I have. Can science and technology and global institutions do what they need to do? I do think it is fair to say that, at least in the optimistic view, we are passing through a bottleneck. We are not going over a cliff, we are passing through a risky period. That is a quite different vision of the encroaching cliff. I believe that with the positive trends at hand, with the power of science and technology, with the backstop technologies of carbon sequestration and clean energy; even the backstop technologies of desalinization and access improved management of to clean water; with the increasing ingenuity in new material sciences and especially with the increasing ingenuity of the biological sciences; if we can make our way through the coming decades, we will can find marvelous answers to these challenges, to the ecological, and the health, and the energy challenges that we face. We are not that far away as it is. We will also arrive, I believe, at more stable human populations, and more urban-based human populations where basic human services can be delivered.

But getting from here to there is going to be a treacherous and dangerous course to be sure. We have decades to make our way and decades of profound risks.

To conclude, let me highlight the I think there are four main challenges to getting through this bottleneck quickly and safely:

First, breaking the poverty traps of the world''s poorest people: something so easily within the reach of the richest countries where my studies and many other studies have shown that even very modest income transfers, just fractions of one percent of GNP from the rich to the poor, could enable massive expansions of health services, access to essential medicines, universal primary and secondary education, and financing for the research and development in agricultural technologies to enhance nutritional intake and agricultural productivity. Breaking the poverty traps will be the number one challenge.

Second, succeeding in urbanization: making our urban spaces livable areas. We know it can be done. We have existence proofs all over the world, but we also know it has not been done in many of the poorest megacitiesmega-cities of the world.

Third, strengthening the United Nations and other institutions of global governance and making sure that along the way as we reach the levels of clean technologies that we need and population stability that we will achieve, that we don''t destroy our ecosystems in the process: how much effort would it really require, after all, for us to protect the tropical ecosystem hotspots to avoid the mass loss of biodiversity that is in play now? How about a little foresight to end the destruction of the fisheries that now afflicts virtually every major fishery in the world? How about an investment in sustainable management of savannah or arid climate agriculture to avoid the massive loss of topsoils and degradation of land that is afflicting so many of the poorest people in the world? How about technology to enhance the use of clean water and better systems of social management so that we can price water on the one hand and assure that the poorest of the poor are able to obtain the water that they need to stay alive?

And finally fourth, adapting our energy systems to head off the dire risks of despite all that has been said, with modest efforts we know that we could so dramatically change our energy inputs and dramatically reduce the highly unpredictable and perhaps disastrously non-linear responses of the global ecosystems to the increasing forcings of the greenhouse gases in the atmosphere.

These are all achievable, definable goals and they are goals that the people in this room know more about than anybody in how to solve.

Let me finally end just on a personal note: again, thanks, but and also on a note to the Alliance for Global Sustainability. The Secretary-General has asked me to help him for the coming years on the Millennium Development Goals. These are the global objectives of reducing poverty, reducing infant and maternal mortality, curbing pandemic diseases, cutting hunger, curbing environmental degradation, improving the quality of life in slum areas that encompassed the goals of sustainability. These are international goals that will be reconfirmed today and tomorrow in Monterrey. The Secretary-General is fully aware not only of the massive political and organizational will that will be required but also the need for mobilizing the finest thinking in the world to understand as clearly as we can the nature of these challenges and the best ways forward. He has asked me, among others, to help in an outreach to the intellectual leaders in all of these relevant areas to come to the support of this international challenge through networks, through specific studies, and through active interchange.

I think the Alliance for Global Sustainability is without question one of the most important world initiatives in this area. I hope, in my small way, therefore, with the Secretary-General and in the work in our so-called Millennium Project at the United Nations, that I will may be able to continue to collaborate with all of you as we think seriously, hopefully, and profoundly about the challenges ahead.

Panel

Poverty, Demography, Economics and Sustainable Development: Perspectives from the Developed and Developing Worlds

Olaf Kübler	President, Swiss Federal Institute of Technology
Julia Carabias	Former Minister of Environment, Mexico
Peter Gomez	President, University of St. Gallen
Simon Upton	Chair, OECD Round Table on Sustainable Development
Rajendra Pachauri	Director-General, Tata Energy Research Institute

Overview

The Alliance for Global Sustainability was formed because sustainability is not only a research topic but also a matter of utmost urgency. Sustainability is full of fundamental, practical problems, but there is also a set of ethical values associated with it. A simple metric such as economic value in the long run is not what really drives people. Today we see major trends of environmental deterioration, and population impoverishment still persists and is even increasing, and there have been some setbacks in the last few years. Much that takes place in financing and development does not take the environment into account. Merely solving the problem of poverty will not address environmental issues.

It is necessary to use the force of the shareholder value logic to bring sustainability into play, and this not only by convincingly arguing with corporations but also by educating future executives to master this new approach. To achieve more sustainable development in the first decade of the new millennium, we should first return to the 'goals set at Rio in 1992 and then develop the tools to establish whether we are or are not making progress. There must be an ongoing dialogue between science and the policy sector so that we can improve the indicator set and their interpretation as scientific understanding advances.

There has been a benign neglect of the problems facing the developing world and the problems that are inherent in the state of society for the largest numbers of people on this planet. Poverty, demographics, stability, and sustainable development are interrelated, and we need to see how best we can come up with solutions that tackle all of these simultaneously. Growing rapidly is the technology gap between rich and poor. Technology solutions at the basic grassroots level are not a mere technological fix but require the creation of capabilities, knowledge, and a whole set of institutional innovations that would make the adoption, improvement, and use of technology a reality.

Olaf Kübler President, Swiss Federal Institute of Technology

The annual meeting of the AGS is always an event that I look forward to with great anticipation and also a bit of apprehension. The apprehension is there, because I wonder what have we achieved? Are we moving in the right direction? How will things go once the meeting starts? As the AGS grows, of course, we have the opportunity to enrich our personal experiences by interacting with new colleagues and by learning from their experience and their attitudes. So, today, it is a particular privilege and joy for me to be on this panel, which is devoted to poverty, demography, economics and sustainable development.

Now in coming to this panel, of course, there are some thoughts that keep one busy as one tries to think over the strategy of the AGS. We believe that sustainability is not only a research topic but sustainability is a matter of utmost urgency, and this is why we formed this alliance, which is growing. Sustainability is full of fundamental problems – it is full of practical problems – but I think most of us having to do with sustainability implicitly or explicitly believe that there is also a set of ethical values associated with it.

Now if you think that research is not only an academic topic, you want to accomplish something, and you want to implement what you find and what you analyze. So I think it is natural that, from its very beginning, the Alliance for Global Sustainability has tried to form strong links with both the political and the corporate worlds, because, after all, the political and the corporate worlds are important players in making something happen today. Now, such a trans-disciplinary approach between academia and the corporate world, in particular, immediately brings up the questions of metrics and cultures, because we all know a system will only function well if the cultures of the partners match up well and if they share the same value system.

Recently some of the exponents of the corporate world have come under serious attack, and, in my mind, this is just a reflection of the fact that maybe a metric in part of the corporate world has been a bit too simple, has been used over the past decade, a metric which tries to measure value basically in monetary terms. When we look at economic theory, I think the reassuring finding is that a simple metric such as economic value in the long run is not what really drives people.

I think we are embarked on a joint problem, not only of sustainability but also of society, in finding the cultural and moral standards which will promote us. In this partnership between universities, between politics, the corporate world and academia, we will move ahead. And, of course, we will make errors. We will have to correct some of the errors that we make, but overall I think we can move forward in the right direction once we know that all these factors play a role.

Julia Carabias Former Minister of Environment, Mexico

Thank you very much for the invitation to this meeting of the AGS. This is a very important opportunity for all of us to share ideas, because we are at a very important moment. We are in the middle of the summit on financing and development, and, within five months, we will have the other summit in Johannesburg on sustainable development. Already nearly 10 years have passed since the last summit on environment and development in Rio de Janeiro. I think it is a very important moment to analyze where we are, and, as Mr. Figueres said, to deal with the future – or, as Dr. Sachs said, to shape the future.

Mr. Figueres said there is a lot of optimism in this meeting. I have been one of that group of optimists. But I must confess now that my optimism has quite eroded. However, we have to recognize that there are important advances towards sustainable development, of which I want to mention a few:

- Sustainable development is a concept that has been accepted worldwide.
- This concept has brought together economic, social, and environmental perspectives that we have already, in principle, completely accepted.
- We have much better diagnosis and understanding of natural phenomena and social environmental processes.
- Nearly all countries have a programmatic platform and institutional capacity in environmental and social development.
- Social consciousness and participation has increased considerably.

However, we have to accept that, despite these advances, there are major trends of environmental deterioration, and population impoverishment still persists and is even increasing. We have to be very aware that there have been some setbacks in the last few years. Much that takes place in financing and development does not take the environment into account. We are hearing again that we need first to solve poverty and then the environment will be taken into account. This is a false and inadequate statement, because it has been very clear that poverty and environment go hand in hand. We have to construct a positive cycle where poverty will be alleviated together with a solution to the environment, not one first and then the other.

There are some other indicators that tell us that there are problems. The coming Johannesburg Summit on Sustainable Development is not generating the same interest as there was 10 years ago at the Rio summit. I think that there is not enough willingness to go to the Johannesburg summit with as much determination as there was ten years ago. And I also think that, after the September 11th attack, the environment is no longer a priority on many national agendas.

In Latin America there are two main productive tendencies:

- services have increased their worth in the economy, and
- primary and industrial production have proportionally diminished.

However, there is no reduction to direct environmental pressure. The agriculture frontier continues to expand, and extraction of mineral and oil resources is still increasing with a negative environmental impact. Further, the service sector is increasing significantly and is adding environmental pressure.

In Latin America and the Caribbean, poverty has slightly decreased. It is recognized by the United Nations that wealth in the region has increased 5.7% between 1990 and 1999, due mainly to the growth of our economies, the falling of unemployment, and lower inflation. However, in domestic productivity the income gap is increasing, and 211 million inhabitants of this region still live in extreme poverty.

The occupation of the land has not concluded in our region. There is still a lot of new land being occupied. This is a big problem in terms of our natural ecosystems and the impacts on the environment. The area has been transformed very quickly, mainly in the last century, for agriculture and cattle raising. Nearly 40% of our surplus is already attributed to these activities. But we still have nearly a 50% reduction of the natural ecosystems. We have lost one-third of our forest cover, mainly because of change for agronomic purposes and for colonization, mega-project development, and fires and firewood extraction.

In the world about 15 million hectares of forest are lost every year, and nearly half of that comes from the tropical rainforest of Latin America and the Caribbean. So the two main characteristics about this aspect of the environment is that the area concentrates the greatest amount of biodiversity but it also has the greatest rate of land use change in the world. The processes of extinction are occurring very quickly because of the occupation of land in the areas that have a lot of biodiversity.

So there is obviously a need for new concepts, new instruments, new commitment, and concurrent efforts in time, in space, in scale, and in perspective. There are several instruments that have been negotiated at the global level: the Convention on Biological Diversity, United Nations Convention on Climate Change, and the Montreal Protocol to the Vienna Convention on Substances that Deplete the Ozone Layer, just to mention some of them. There is a lack of compliance by the countries that are involved in these instruments, and a very strong polarization.

I agree with Dr. Sachs when he mentioned that the IPCC [Intergovernmental Panel on Climate Change] has done terrific work, and, thanks to the IPCC, we now have a protocol with the intent of being ratified. I hope that this happens at the Summit on Sustainable Development or immediately after. But I think that it is very important to have a similar forum for biodiversity, because we are not seeing equivalent efforts in biodiversity. There are many elements for which to set an agenda, and we have to have a common, worldwide understanding.

We definitely need new input and new challenges. We have to fully integrate social, economic, and environmental considerations. These three elements have to come together, but, unfortunately, as we are seeing today with the Summit on Financing and Development, there is no environmental consideration and unfortunately, as we may see within five months, the Summit on Sustainable Development is not going to provide enough integration of environmental, economic, and social perspectives. There has to be a much stronger effort to link these visions and to understand that sustainable development can only be achieved with these three considerations.

We definitely have to define strategies and priorities – quantitatively and qualitatively – specific goals, timetables, objective indicators of compliance, economic instruments, and green accounting of systems. The Convention on Biological Diversity is not really committed to any target or any goal in particular, and that is why in the last ten years we have not been able to stop the lost of biodiversity.

We need to enhance and integrate diverse financial resources and expand social participation. There is also a need to increase governmental and social capacity and to build consensus at the local and global levels. We need regulations to induce changes in patterns of production and consumption, and this is not just a problem of poverty. We need to combine conservation with a sustainable and diversified use of natural resources. We have to understand that it is possible to alleviate poverty with natural resources and not against them.

We have to find alternatives for the use of natural resources to promote equity and to alleviate poverty, to articulate internal agreements with national policies, and to establish priorities and innovations in the centralized and efficient public policies and economic incentives for clean and sustainable technologies. So I think that we are at a very important moment that needs to have a strong analysis of how we want to shape our future, and the environment has to become a priority issue in the international and national agendas.

Peter Gomez President, University of St. Gallen

We all agree that corporations, multinationals, as well as small- and medium-size companies play a leading role in the context of what we are discussing today. Corporations have their own logic, the logic of shareholder value. We cannot beat that logic, but we can find trigger points to make that logic perform in favor of sustainability.

I am heading a European business university that has followed a holistic approach to management since the early 1970s. In the latest version of our St. Gallen Management Model, we call this approach stakeholder value management. It takes into account all different interests, legitimate interests, towards a company. We can only talk about a company if we take all this into account. But we never had any delusions about the ultimate goal of the corporation. That is, to create value for shareholders or-to say it bluntly-if the shareholders are not happy with the corporation's performance, there is no longer any need for sustainability measures, because the company simply is dead. So we have to find the trigger points to put sustainability in service of creating shareholder value or vice versa.

We do not have to start at square zero, as the development of the Dow Jones Sustainability Index over the last 10 years shows. This index compares the performance of the 3000 highest capitalized stocks worldwide with the subset of the 300 stocks of companies that follow a stakeholder value approach. These other companies among them-companies like Intel, BMW, Sony, and Swiss Re-outperformed the others at an average margin of about 50% points each. This means we have convincing arguments to expect the swing of the value pendulum from the shareholder to the stakeholder.

Before the 1990s we experienced the approach of management value, because managers had the say in the companies. Then in the 1990s we had the swing of the pendulum towards shareholder value. But now we see a movement toward stakeholder value taking into account all legitimate interests within companies. I am afraid to say there is also a swing, and I hope it is not going to last, towards the management value again. If you look at the bonuses and the managers' salaries, it seems to be something like management value again, and we had some problems with that.

But how can this trend be accelerated in favor of sustainability? I see three trigger points and I rank them in order of reliability. First, directing the corporation's focus to sustainability effects on cost of capital. Starting with strategies, companies normally try to improve their operating cash flows, for instance, via sustainability measures or via optimization of their investments. But at one point they very often forget, and that is the point of cost of capital. In the logic of shareholder value (and that is also the language of the analyst), the corporation's future free cash flows are discounted to the present. The higher the cost of capital, the lower the present value of future free cash flows in a distant future. As cost of capital is an expression of business risk, reducing this risk by aiming at sustainability is identical with creating value in the corporation. Let us spread this news to managers and analysts, and then maybe they will concentrate on the cost of capital. I think this is the most important trigger point that companies can improve their value at the same time as improving sustainability.

Second, promote rules of conduct for corporate citizenship. The insight among corporations goes that one dimension focusing on shareholder value leads to sub-optimal stock market performance. Corporations willing to implement stakeholder value approaches should be given advice in the form of case studies, benchmarks, or even integrated models. A good example of this would be the Swiss pharmaceutical company Ciba Geigy, today Novartis, which implemented a stakeholder value approach at the end of the 1980s focusing on an equal basis on economic success, environmental sustainability and social responsibility. That was over 10 years ago. They really stayed on with this, and I think that Novartis today is quite a successful company worldwide. At the beginning they had a lot of problems with their competitors, but finally they had to follow their approach. These kinds of case examples gives you hints how to use value creation in the context of sustainability.

And the third point is substituting financial controlling by balance score card approaches. The balance score card complements financial figures with indicators as to internal processes, customer value, and learning of the corporation. It has gained wide acceptance all over the world but still is not yet implemented in many companies. This approach also has to be coupled with the incentive systems of the corporation.

To finish, let me make the analogy with that famous Japanese sport, jujitsu, which uses the opponent's force to beat him. We have to use the force of the shareholder value logic to bring sustainability into play, and this not only by convincingly arguing with corporations but also by educating future executives to master this new approach.

Simon Upton Chair, OECD Round Table on Sustainable Development

You have asked what the realistic prospects are for sustainable development in the first decade of the new millennium. My short answer is that those prospects will be a lot brighter if those who rally behind the sustainable development banner – particularly in developed countries – confine themselves to a less rather than a more ambitious agenda. Let me explain.

The Rio Summit of 1992 was a conference on Environment and Development. That too was the subject matter of the Rio Declaration. The focus was on meeting the developmental and environmental needs of present and future generations. Significantly, the program of action detailed as Agenda 21 was laid out in two sections: the social and economic dimensions, and the conservation and management of resources for development. There was the human sphere, encompassing economic and social questions, and the biophysical sphere.

It was concern for the relationship between the two that led, on the one hand, to a series of environmental conventions and initiatives; and, on the other, to endorsement of the need to get serious about development through poverty eradication and "a supportive and open international economic system that would lead to economic growth and sustainable development in all countries." That was, if you like, the global 'deal' at the time. Developed countries worried about the globalization of environmental risks, were forced to confront the fact that they could not expect developing countries to engage if, in doing so, they were signing away their own development rights.

Without even opening the cover of Agenda 21 (surely one of the most prolix documents ever generated by an inter-governmental process), a reading of the 27 principles of the Rio Declaration discloses a breathtakingly ambitious policy terrain. But it is still tractable. It adheres to the environment and development dimensions that drove the Brundtland Commission. And, albeit at a high level of generality, most of the principles to this day are principles that can be made sense of and implemented – either in domestic policy or international negotiations – by governments regardless of their political persuasion.

True, there are some that lie in the realm of pious hopes (such as Principle 23's avowal that "the environment and natural resources of people under oppression, domination and occupation shall be protected." And others that, in the absence of definition (what is an 'unsustainable pattern or production and consumption' or an 'appropriate demographic policy'?) beg the question of what should be done. But the bulk of the principles provide useful guidance for those who would seek to align their policies with improving environmental protection and enabling development particularly in the least advantaged countries.

I have no argument with the Rio Declaration as a working guide. But I do harbor doubts about the emergence of an agenda which has been grafted onto it since Rio. This agenda risks skewing the focus and weakening the utility of the concept of sustainability. Specifically, it is about the so-called 'three pillars' definition of sustainable development that has gained currency in recent years. It appears that the division between the socio-economic and the biophysical sphere did not go far enough for some. The socio-economic sphere has now been divided into two separate social and the economic 'pillars' of sustainable

development. I have made considerable efforts to find out when this characterization of sustainable development emerged – without success. It is certainly not part of the Rio outcomes or the subsequent CSD process. But it finds itself firmly embedded now in European Union and OECD literature.

The most carefully elaborated account of the three pillars or 'dimensions' approach to sustainable development can be found in the OECD's Sustainable Development: Critical Issues report published last year. In essence, the idea is that the pursuit of economic, social, and environmental well-being should lead to mutually supporting policies. Policy settings in any one field should not undermine future outcomes in any other and will, hopefully, enhance them. This approach has been taken up outside the public policy setting by companies that have started to engage in so-called triple bottom line accounting.

The European Commission has artfully described the relationship between the pillars as "economic growth [that] supports social progress and respects the environment, social policy [that] underpins economic performance, and environmental policy [that] is cost-effective." The notion is of a virtuous triangle of reinforcing policies that advance "a society that is more prosperous and more just, and which promises a cleaner, safer, healthier environment" not just in the near term but the long term.

This is, unquestionably, an elegant formulation. But it cannot provide any definitive boundaries for the trade-offs that inevitably occur between, for instance, seeking improvement in material living standards and maintaining ecosystems in their natural states or between high levels of investment in businesses and redistribution through taxes and the regulated delivery of social benefits. At the end of the day there are only policy trade-offs with which we have been familiar long before sustainable development entered the lexicon.

There are two dangers. The first is that in the search for 'balance' between the three pillars, we end up in a world where everything is tradable for everything else: where there are, for instance, no environmental bottom lines. The second is that it is hard to see what considerations might be excluded from the shelter of these three all-encompassing pillars. In short, we risk emptying sustainable development of content by seeking to extend it to everything.

Now it might be objected that this is harmless enough; that sustainable development embraces a broad church of disciplines and that anyone worth their salt would know where the live issues are – a sort of 'thousand blooms' approach to policy analysis. What bothers me, though, is the implication that there never was a hard core to what the Rio conference was about; and further, that if there is no minimum content to sustainable development as a policy paradigm, then there is, in effect, nothing that can be measured should we wish to gauge whether or not the ability of humankind to sustain itself on this planet is becoming more or less precarious.

Such a conclusion would indeed be a break with what Rio set in motion, since considerable store was placed – rightly, in my view – on the need to develop robust indicators that can inform decision-making. But a decade on from Rio I can't see that we have made much progress at all – and the extension of sustainable development to a new 'three pillars' approach could mean that we never get there.

Let me illustrate the extent of the problem by way of reference to the problems both the European Union and the OECD have got into in developing their own sets of indicators. The European Commission, in its Strategy for Sustainable Development published last year [2001], referred to the need to bridge high-level ambitious visions with practical political action by focussing on "a small number of problems which pose severe or irreversible threats to the future well-being of European society." It identified a set of 36 structural indicators to monitor progress on the political commitments made by Heads of State along the themes of general economic background, employment, innovation and research, economic reform, social cohesion, and the environment. Indicators proposed under these themes included:

- Unemployment rate (economic background)
- Life-long learning (employment)
- Level of Internet access (innovation and research)
- Prices in the network industries (economic reform)
- Early school leavers not in further education or training (social cohesion)
- Energy intensity of the economy (environment)

In the course of tackling the wide array of specific structural themes, the Commission envisaged generating a further eighteen indicators, including, for instance:

- Potential output (economic background)
- Childcare facilities (employment)
- E-government (innovation and research)
- Business demography (economic reform)
- Biodiversity (environment)

In short, no fewer than 53 different indicators were envisaged that would enable it to chart members' progress across a broad, but by no means exhaustive, front. Significantly, many of the proposed indicators (such as those dealing with childcare facilities or employment rates of older workers) had a uniquely developed country feel to them.

The OECD's approach has been even more disarmingly eclectic. An initial proposal for a limited set of headline indicators to measure both resources and outcomes has led nowhere. Instead, it has decided to generate indicators which will illuminate a 'menu' of policy issues which involve trade-offs between the different dimensions of sustainable development. These indicators will be included in the 2003 Reviews of member economies, thereby placing them alongside long familiar economic indicators such as price and wage inflation, GDP growth, foreign trade, and so on. Unsurprisingly, the initial list (it is to be extended in due course) embraces a small clutch of traditional environmental indicators covering things like water quality, air pollution and CO^2 emissions. But, for the time being, there is just one social indicator – sustainable retirement income policies.

It is not so much the orphan state of this indicator that is remarkable (that will no doubt be cured when other indicators of 'social' sustainability are proposed). Rather, it is the question of what might be excluded as indicators of sustainability if retirement income is a relevant and illuminating subject? Why would

access to adult education or cultural facilities such as museums be any less important elements of a social pillar? I don't propose this in jest since there are perfectly serious suggestions abroad that 'cultural' sustainability is a vital part of the mosaic.

What worries me about all of this is that there is one sure way to render any concept innocuous and that is to expand its meaning to include everything. The notion of sustainable development has such cachet at present that absolutely everything, it seems, has to be sustainable. There is a real risk that the relatively clear concept of the environmental sustainability of economic activity is in danger of being buried under supposedly helpful extensions such as 'social sustainability.'

This isn't altogether surprising. After all, it is hard to be against sustainability. So why not jump aboard the bandwagon? In fact, the less you know about sustainable development, the better it sounds and the greater its range of applications. Indeed, any day now I expect to hear a Minister intone the words, sustainable sustainability! This is all good fun but it comes at a price of increasing complexity and incoherence.

I would not necessarily go as far as Dan Esty does in claiming that sustainable development has become "a buzzword largely devoid of content". But it is interesting to see what questions and complexities are raised by the inclusion (as the OECD plans) of something as socially 'mainstream' as the sustainability of pension schemes. Start with the consequences of settling on an indicator that simply couldn't apply in, for instance sub-Saharan Africa because the average life expectancy is 49, one year lower than it was ten years earlier and, needless to say, well below the retirement age in developed countries.

If the argument were that the retirement income element of the social pillar had some universal validity, would we be arguing that very poor countries lacking retirement pension schemes were 'unsustainable' on account of their absence? Or would it be necessary to amend the indicator by generalising it so measure some level of access to subsistence (that could be based on simple transfers within families)?

Or would the appropriate conclusion be that indicators are not universal but country specific, relating to the level of development. If this approach were adopted, could every country pronounce itself sustainable in terms of the local state of the pillars – sustainability of cash payments related to lifetime earnings for some countries through to well-rooted social acceptance of inter-generational, intra-family support systems?

This seems closer to the logic of the UE/OECD approach. 'Unsustainable' elements of the social pillar would be those that, on account of some flaw, would be vulnerable to collapse in a way that would threaten social stability and cohesion, thereby leading to economic malaise (and, one assumes downstream, environmental degradation). So we might have bankrupt pension funds in a rich northern country and the breakdown of social ties in a southern country. Interesting though this all may be, it is hard to see quite where it leads to in making an overall assessment of 'sustainability' in this more expansive version.

The problems compound if we were to try to introduce normative concepts like social equity under the SD umbrella. What metric of fairness would we choose in seeking to make a judgement about the fairness of social security systems? And if we were to try, doesn't that become an order of magnitude more complicated when we try to make comparisons across the North South divide? How can they be avoided? The trouble with introducing a normative concept like 'just distribution of incomes' between countries, is that it raises profound but unanswerable questions about where the boundaries of normative debate lie.

Sustainable Development as Rio launched it sought to tackle, at the global level, the relationship between development ambitions (in all countries) and environmental sustainability – a big enough task in itself. If we inject a normative premise about distributional justice into the equation at the global level, it calls into question how anyone could be seeking to debate the equity of social arrangements in rich countries when the divergence of incomes between citizens in rich and poor countries is orders of magnitude greater.

Quite aside from the (frankly) offensive optics of choosing indicators (from a developing country perspective) that leave such questions unanswered, they underline the point that if we are not very careful a 'three pillars' approach can quickly become vacuous. Furthermore, by entering into issues related not to absolute poverty and morbidity (the solid stuff of the UNDP's Millennium Goals) but relative concerns about social equity and distributive justice, such a definition of sustainable development will rapidly dissolve any consensus in developed countries about whether we even have a useful paradigm here.

There is an important political point to be made here. If support for sustainable development is dependent on the ideological persuasion of whom for the time being holds office in the very countries being looked to to take the lead on the issues raised at Rio, then it has over-extended itself as a useful organising principle. It has to be remembered that distributional issues go to the very heart of many ideological debates within developed countries – debates that are unresolved and possibly irresolvable.

I should emphasise here that my concern here is not to debunk the notion that social factors are important in the development of economies and societies. Neither do I seek to deny a moral dimension to the case for relieving abject poverty and sickness – it would be absurd to deny that motivation in making the case for tackling the soluble health challenges detailed in the Report of the Commission on Macroeconomics & Health for instance. But there are also good instrumental reasons of an economic and environmental nature and they will command support where more ambitious, all embracing notions about 'equity' will founder.

In this regard, my frame of reference on the social aspect is the UN's Human Development Index (HDI). This indicator set, which is not without controversy, uses indicators of 'health, wealth and wisdom'. An emphasis on a core set of health, education and income indices comprising the socio-economic component of sustainable development may be one way to think meaningfully about how to bring the social dimension into the sustainability debate. This way we focus on a very hard core of issues that have analytical relevance as well as resonance between developed and developing countries.

Such an approach also leaves us in a more analytically tractable world. Rather than pretend that some magical balancing trick is possible between the three pillars, we are engaged in considering a human

sphere of economic and social development that can be managed for better or worse, and a biophysical (or environmental) sphere subject to some real, scientifically demonstrable thresholds. The focus of policy attention is then directed to development trajectories which remain within those thresholds if we are not to destabilise economic and social progress through a degraded environment.

So to return to our chances of achieving more sustainable development in the first decade of the new millennium, I would argue that we should first return to the 'deal' outlined (if never formally struck) at Rio, and then develop the tools to establish whether we are or are not making progress. I am a passionate believer in hard information as a means of changing minds and winning debates. Without hard information erected on uncontentious premises, sustainable development risks being at best a fad, and at worst a cover for justifying any policy outcome you seek to nominate.

I have detailed elsewhere my views on the sort of information gaps we need to close. In summary form, I think we should be trying to improve our scientific understanding of a short list of environmental problems that have trans-boundary effects with a view to establishing whether there are global thresholds within which we must stay if we are to avoid significant disruption to the planet's life support systems. That involves trying to be clearer about the Achilles heels of planetary level biophysical systems. This is the sort of terrain covered by the International Geosphere-Biosphere Programme.

I am not a scientist but the exchanges I have had with IGBP indicate that the key areas for focus would include:

- A more comprehensive model of atmospheric chemistry to identify any other weak links such as were discovered in relate to ozone depleting substances.
- A more comprehensive, data-rich understanding of ocean circulation and the extent to which anthropogenic forcing could trigger major changes.
- An understanding of the relationship between biological diversity and ecosystem resilience (this appears to be a particularly under-defined area).

In addition to developing a more accurate picture of pressures on the biosphere at a global level, we need to develop the tools to relate these pressures back to real economic activity at the level where economic data is collected – the national level. Much energy has been devoted to developing indicators of sustainable development at the national level. But a failure to take trade into account in measuring the consumption that ultimately places pressure on the environment leads to a distorted picture of any particular country's sustainability.

This can be neatly illustrated with respect to greenhouse gas emissions – one area where we do have some reasonably sound scientific knowledge about the impact of human consumption on a significant pressure point. Country emission levels only tell us a part of the story. The role of international trade in carbon-intensive products like steel or chemicals becomes particularly important when talking about sustainable development because it can distort an economy's estimate of its quantity of emissions and thus the level of its contribution to the problem.

A country's emission levels may appear to be set artificially low because it imports significant quantities of carbon embedded in non-energy products. A national-level indicator which fails to take into account trade flows can easily mask this kind of 'carbon leakage'. In this context, global emissions might not be reduced as much as expected or might even increase. The magnitude of this problem is underlined by the rapid expansion of international trade.

Linking data on economic consumption in an accurate way with biophysical thresholds could be helpful in focussing back on the implicit 'deal' embodied in the Rio outcome. Many developing countries are understandably nervous about any proposal for indicators which is likely to shed a rather grim light on the developing world's levels of sustainability as measured by developed-country criteria. Many would not relish, for instance, measurement against many of the social indicators under discussion in the Commission or the OECD. Nor would many enjoy the application of the proposed indicators of air or water quality which are unable to account for the reasons for such changes (i.e. as the consequences of rapid economic development, not least through the production of goods for export to the developed world.)

A particular anxiety about trying to put sustainability on a firmer base through the use of indicators is that a nationally based indicators may lead to critical comparisons being made among developing countries with the logical extension being perhaps some form of conditionality in which the future delivery of development assistance might be linked to positive progress on sustainability.

Measuring consumption in a way that took into account trade effects would illuminate the point that the consumption patterns of the developed world have a significant impact on global sustainability. Further, it would underline the essentially integrated and global nature of economic activity that is making inter-country comparisons in this sphere less and less meaningful particularly when the environmental pressures are being measured at the global level.

In the same way that many environmental externalities do not stay behind national borders, neither do many 'policy externalities' caused by government policies. An authoritative measure of the net benefit/disbenefit of a number of key policies that commonly impact on sustainable development at the global level would be a powerful tool. A synthetic indicator that weighted and then bundled the aggregated impact of development assistance flows on the one hand, and the market destroying or distorting consequences of trade barriers and domestic production subsidies would provide an additional level of richness to data linking consumption to biophysical pressure points.

Finally, if we are (to use my formula) to rely on hard information based on uncontentious premises as a way of focusing our efforts, then any global set of indicators would, to be meaningful, need to possess the following characteristics:

- They would need to be backed by solid scientific understanding. That is, we must be able to measure them at regular intervals, and we must have sufficient scientific understanding to interpret them, particularly when they change.

- They would need to be able to distinguish human interference from natural variability. This is absolutely crucial, as it would be counterproductive to ask societies to make major changes in response to a natural variation in an indicator. This suggests that the paleo-sciences must play a strong role in the development of indicators and their interpretation.

- They would need to deliver timely information; that is, they must be able to give societies enough time to act to avoid crossing a critical threshold. Indicators which only show change after a critical threshold is passed will be of little value. This criterion is actually very difficult in practise, as there is likely considerable momentum built into much Earth System functioning and it may be very difficult to detect a significant change before it is too late. This suggests that decision-making on the basis of the precautionary principle and risk analysis may still be required, even if a set of indicators is in place.

- Finally, they would need to be flexible. Science is never static, and it is always improving our understanding of the Earth System. There must be an ongoing dialogue between science and the policy sector so that we can improve the indicator set and their interpretation as scientific understanding advances.

Rajendra Pachauri Director-General, Tata Energy Research Institute

I am going to provide the perspective from the developing countries, and let me start by talking about the issue of poverty. I will deal essentially with poverty and demographics in the same context because I believe population growth, for instance, is intimately linked with what we do about the state of poverty. It has been established around the world in every country that if you can address the basic issues of poverty and sustainable livelihoods, then population growth stabilizes more or less by itself.

Today we have a far better understanding of the basic elements of poverty and the factors behind it than we did 15 to 20 years ago. That is a very hopeful sign, which perhaps gives us some basis for optimism. But the basic truth is that, at best, there has been a benign neglect of the problems facing the developing world and the problems that are inherent in the state of society for the largest numbers of people on this planet.

The point has already been made that we are living in a world of growing disparities. There are some bright spots with, very heartening growth in East Asia and the Pacific although even there have been ups and downs. In recent times there has certainly been a recession, which has had an important impact. Even South Asia, which until the early 1980s was in a state of stagnation with respect to incomes at least, has shown an upward trend. And, coming from South Asia, I can say we have some basis for believing that the future will be brighter as far as incomes are concerned.

What is most depressing is the state of sub-Saharan Africa and the least developed countries in general. This is where we need to concentrate our energies, because, unless we are able to take care of some of the worst affected societies in the world, the disparities that we see today will only become worse. September 11th should tell us that these societies will remain very fertile grounds for all kinds of distortion in thinking – all kinds of alienation from what is happening in the western world – which could have disastrous consequences.

For the first time, the international system has come to grips with what needs to be done. Certain goals have been targeted, which are clearly noteworthy, but we need to do something really tangible and serious to see that these goals are met. And here is where I think we really run into some serious difficulties. The goals that were established by the Millennium Summit are to halve the proportion of the world's people living on less than a dollar a day, to halve the proportion of the world's people suffering from hunger. It is ironical that today, while the world has enough food and there is an enormous amount of waste that takes place, we still have hundreds of millions of people who go to bed hungry. This is an area that needs to be targeted, and the nutritional status of populations in different parts of the world needs urgent attention as well. Also needing urgent attention are the problems of safe drinking water, universal completion of primary schooling, gender equality, maternal mortality, infant mortality, and, of course, the spread of diseases like HIV/AIDS, malaria, and several others which should have been eliminated ages ago.

Now the point has been made already on financing of development and, essentially, financing the elimination of poverty. But we need to look at what this would really mean in terms of numbers. I am sure this is being discussed in the Monterrey Summit, which essentially came up with an estimate that to

tackle all these major elements of poverty in the world, we need an additional 50 billion dollars. You remember that Agenda 21 in the Rio Summit [1992] had also come up with certain estimates of what would be required to achieve sustainable development in the world. But I think this is a very tangible figure and the estimate that is presented over here does not in any way require only a transfer from north to south. It also requires far more focused, far more efficient methods by which resources in the south itself can be utilized effectively to meet the problem of poverty. And the major distortions we find in the developing world are not merely a neglect of poverty per se, but also the fact that the disparity between rich and poor in the developing countries is increasing rapidly. As long as you have those pockets of prosperity in a sea of abject poverty, then you have an explosive situation, which obviously someone or the other with a distorted mind might be able to exploit to his advantage.

Now how do we tackle the challenge of poverty, demographics, stability and sustainable development? These are clearly interrelated and we need to see how best we can come up with solutions that tackle all of these simultaneously. To give an indication of how these are actually interrelated, look at the case of 1998: 25 million people were forced from their homes for environmental reasons. So environmental security is not an issue purely of academic discussion and debate; it is something that affects the lives of millions of people around the world. The desertification threat is very serious in dry areas, which cover about 40% of the earth's land surface. Soil degradation already affects one billion people, and a hundred million are likely to be displaced due to soil degradation in the next 20 years. So we see that the lives of the poor are intimately connected with the good health of natural resources. And yet over a period of time, most development programs have targeted investments in physical capital and have clearly neglected what really should be the highest priority, which means the growth and the sustainability of natural capital.

I happen to be vice chairman of the Intergovernmental Panel on Climate Change [IPCC], and the current panel is due to change next month. There will be an election, and I'm glad that Professor Jeffrey Sachs was complimentary in his remarks about the IPCC. The IPCC clearly has been able to come up with a body of knowledge, which is policy relevant but not policy-prescriptive. I am glad that the scientific community that is involved in the IPCC assessments has been able to maintain that distance between being prescriptive and being relevant.

If you look at what climate change might do to the poor, just think of the enormous disaster that would overtake the earth with sea level rise if it proceeds as projected. This is not a problem only for the small island states, there are large coastal areas. In the case of Bangladesh, for instance, 7017% of the land area would be lost. There are 70 million Chinese who would be directly affected. The small island states of course would be the worst affected, and we in South Asia would suffer an enormous problem. Reference was made to Antarctica about the huge block of ice that has broken away, obviously because of climatic and weather conditions. But we are seeing the glaciers in South Asia, which provide water to a large part of the northern Indian subcontinent, receding rapidly, and this could impact on the lives of 500 million people who will probably not even get enough water to drink.

There are three issues that I would like to focus on. The first is financing development and poverty elimination as being critically important. And here, as Professor Carabias mentioned, financing the environment is very important. So I go to the next point, which is reversing the trend of depletion and degrada-

tion of natural resources. I find it very difficult to understand that most international, multilateral and bilateral organizations have never really looked at the economic rates of return through investments in natural resources and their growth. Whether it is forests, whether it is healthy soil or clean water, or adequate water supply, these are things that almost every project that has been implemented effectively would establish as being totally viable.

And I think one area where the gap is growing rapidly – and, therefore, we need to do something seriously to bridge it – is the technology gap between rich and poor. And I think this certainly is the focus of the AGS on which I will say a little more subsequently.

Why is investment in natural resources so important? I will give you the example of India. In 1995, when India was preparing to celebrate its 50 years of independence in 1997, my colleagues and I decided to carry out a major exercise to see what India had done to its natural resources in the first 50 years of independence. We put together a team of about 35 people and started estimating the damage to water, to soil, to forests, and to biodiversity, and then we assigned economic values to it. And what we came up with was a shocking set of estimates. For instance, the GDP loss on account of environmental damage exceeds 10% per year, and this is not an isolated case. You will find this in many developing countries, and I would say in several developed countries as well. We lose between 11 to 26% of our agricultural output due to soil degradation. Annual growth of forest is only 88 cubic meters per hectare as opposed to a theoretical figure of 139 to 235. We note 23 prominent species have become extinct, including the Indian cheetah, but there are also several other plants which have vanished and there are several others which we know nothing about. A total of 2.5 million people in India die prematurely each year due to air pollution. And water quality in most major rivers in India is dangerous: you cannot possibly drink that water, and if you did, massive sickness would occur.

Now I would like to submit that there has been a distortion, and I won't use a harsh word like intellectual corruption in defining development, particularly when it comes to the role of multilateral and bilateral organizations. One hears a lot of statements by leaders from the north that money will not be provided because you are dealing with corrupt governments; but I would submit that there is a similar form of intellectual corruption in the north, and I won't hesitate in saying this now, in conceiving of projects by which assistance from the north goes to the south. As Simon Upton has very rightly pointed out, the matrix, the thinking, the measures by which we look at sustainable development are often seen through the eyes of the developed countries. Unless you link up and create partnerships with those in the South, I am afraid something will be missing.

Let me turn to the final point that I would like to make, and that is the technological empowerment of communities in the developing world. Rates of return from agriculture and research are so attractive that one would ask, why is it that we do not do more, as there is a hungry world where tens of millions of people do not get enough to eat? There are shortages galore in different parts of the world. But we are not spending enough on agricultural research, and where we do, it is essentially directed by priorities and programs that have very little relevance to the realities of the developing world.

I would like to submit that, with intellectual property rights being defined now far better than they were, there is a need for partnerships, there is a need for contract research, there is a need for joint research between institutions and organizations of the north as well as the south. This will give you much greater reality in terms of what would work and what would not work, and also much higher returns if feeding the world is an important objective of agricultural research.

And I go finally to what I would submit is what my institute has been working on in a large number of villages, and which we hope to expand in a big way, and that is what we call integrating new and sustainable technologies for the elimination of poverty (INSTEP). Now technology solutions at the basic grassroots level are not a mere technological fix. They require the creation of capabilities, institutional and human, and the creation of knowledge, the access to knowledge, the access to markets, the micro-financing of some of these developments, and a whole set of institutional innovations that would make the adoption, the improvement, and the use of technology a reality. In the absence of that, we are really not going to get away from the syndrome of rural people migrating large-scale to urban areas, creating urban slums, and, of course, depriving rural areas of the opportunity to manage their own affairs.

There is clearly a major benefit in terms of empowerment of local communities and societies if they are able to bring about a major upgrade in technological capabilities. And these would lie in the field of health, biotechnology, information technology and, of course, renewable energy technologies. And it is a pathetic case of research in the energy field where you find that renewable energy research really gets very little attention, whereas what is most relevant by way of energy solutions in the developing world lies in the harnessing, the cost reduction, and the massive spread of renewable energy technologies. It has been found, from projects that we and others have done, that the sum total of benefits from individual efforts in each of these areas is much less than an integrated approach which combines all of them together. This could be an area that the AGS could focus on necessarily in partnership with organizations and institutions in the developing world.

Panel

Merging Risk and Vulnerability with Sustainability: Industry's Challenge

Charles Vest	President, Massachusetts Institute of Technology
Yoram Shoham	Vice President for External Affairs Shell International Exploration and Production
Hiroyuki Fujimura	Chairman and Representative Director, Ebara Corporation

Overview

Industry is one of the most critical agents of change, because a more sustainable future requires the development and deployment of sustainable technologies, organizations, and infrastructure, and because many believe that good stewardship of our environment and of our resources is good business. But the rise of violent conflict in many parts of our world and the growing strains on our global environment are trends that must not be ignored. Immediate concerns about security are linked to the challenge of sustainable development in important ways. Real and lasting security is hard to imagine in a world divided by fault lines that separate the wealthy and those who are locked in extreme poverty.

There is expected to be a huge decline in oil production by 2012, a huge gap of 70 million barrels of oil equivalent per day. It will be necessary, in effect, to reinvent the entire liquid oil industry within one decade. To do that we have to balance profit with our obligation to our shareholders, society, and the environment. To minimize emissions, we will have to develop clean coal burning. The emerging technology renaissance will be of key importance.

To realize a sustainable society we have to conquer the problem of the global trilemma: (1) economic growth, (2) the security of food, energy, and natural resources, and (3) the protection of the global environment. If we could succeed in constructing a social system where we use recyclable resources such as biomass or natural energy instead of non-recyclables, that might be a way to conquer the global trilemma. At present, our economic societies are standing on a base sustained by natural resources such as oil and coal. But these resources are limited and non-recyclable. To realize a sustainable society, we have to make full use of technologies for saving energy and resources and to use limited resources most effectively.

Charles Vest President, Massachusetts Institute of Technology

It is a pleasure to open this panel which will examine the challenge for industry of managing risk and vulnerability while achieving sustainability. From its beginning, the AGS has worked with many kinds of organizations in defining and carrying out its research agenda. We've used an integrated approach that works across disciplines and across regions in order to develop what we have called policy-ready research results. By definition, our approach to research involves working with the agents of change in society.

Industry is one of the most critical agents of change, because a more sustainable future requires the development and deployment of sustainable technologies, organizations, and infrastructure, and because many believe that good stewardship of our environment and of our resources is good business. Many AGS projects are carried out in collaboration with industry and with other stakeholders. A number of these collaborations will be discussed during the afternoon sessions today and tomorrow in working groups that have been organized to examine the issues that are addressed in our research portfolio.

Similarly, the posters on view at this meeting reflect our wide range of partnerships with sectors beyond the academy. These represent work on projects to meet societal needs for food, water, energy, habitat and transportation and to manage the growth of megacities. In the months since the massive attacks of September 11th brought catastrophic terrorism to the United States, the terms "risk" and "vulnerability" have taken on new meanings and new urgency. As we in the AGS develop a research agenda that promotes sustainable development, we must take these issues of risk and vulnerability into account in new ways.

This afternoon we are joined by distinguished members of the industrial community who have agreed to share their perspectives on industry's role and challenge in the movement toward sustainable development. Together, we will examine how perceptions of risk and vulnerability have been altered in the wake of September 11th and what implications that may hold for the future of the development of our research portfolio.

In the last six months, the world's attention has turned more to concerns about security. Current events may seem to be more urgent to some than the strategic need for sustainable development. But immediate concerns about security are, of course, linked to the challenge of sustainable development in important ways. We heard a number of those linkages in this morning's panel. Real and lasting security is hard to imagine in a world divided by fault lines that separate the wealthy and those who are locked in extreme poverty. Many international organizations are in fact working toward the goal of reducing poverty, and we've seen some progress over the last 25 years. For example, economic and educational opportunities have increased over this period, and there has, in fact, been a rise in life expectancy rates and a decline in mortality rates. So there's some reason for optimism.

Nonetheless, the rise of violent conflict in many parts of our world and the growing strains on our global environment are trends that must not be ignored. In this context, the panel this afternoon will ask, where is the world turning now? What are the risks to society that we face in this new era? how does this alter our perception of pathways to sustainable development, and, in particular, what role can industry and academia together play in addressing these risks?

Yoram Shoham

Vice President for External Affairs
Shell International Exploration and Production

Whoever made the title for this session, did an excellent job, recognizing the need to manage risk and vulnerability with sustainability. I will present to you the industry challenge from the oil and natural gas perspectives. The choice of topic of the world's vulnerability is very timely. The future for the next several years' energy market will see vulnerable in all three major sectors – oil, gas, and electrical, for different reasons.

As a scientist, a mathematical physicist who became a geophysicist, I have done geophysics and exploration all over the world. One of the reasons I am proud to be a scientist that ended up in the oil industry is because it is challenging. When I got my degree in mathematical physics, I had a choice: I could have gone and joined the thousands of physicists who make bombs and all kinds of other devices. But I wanted to do something of increasing good for mankind, and this is what I have done with my career.

The present energy consumption of the world is about 110 million barrels of oil equivalent per day. That is the entire energy consumption, Liquid oil is about 70 million barrels per day, and worldwide consumption by 2012 is projected to be 150 million barrels of oil equivalent per day. But the decline in production expected by that year from presently known resources will be 80 million barrels per day. We are staring, within a decade, at a huge gap of 70 million barrels of oil equivalent per day. We will have to reinvent the entire liquid oil industry within one decade.

To do that we have to balance profit, our obligation to our shareholders, society, and the environment. The main reason why we are in business is to make money in the most effective way. And we totally believe in balancing this with social and environmental responsibilities and measuring all of the above by performance and results. This is our definition of holistic sustainability.

Now we have to clean up our act, globally. To minimize emissions, we have to develop clean coal burning. The big question is, to use coal or not to use coal? My resounding answer, is yes. But we will have to learn how to burn it cleanly. Additionally, for alternative energy sources we raise the 'n' word – yes, nuclear energy. We probably can provide safe nuclear energy.

In the deep oceans where we are producing oil today, water depth is not an issue anymore. We can build an oil field in any water depth. The question is cost and economics. For example, an existing platform in the Gulf of Mexico is producing about 80,000 barrels a day from a water depth of about 3000 feet, or one kilometer. Platforms like these are very big structures. But what the public does not know that on a platform that costs over a billion dollars, 8 to 10 per cent of the costs are environmental equipment for all kinds of eventualities. We are the biggest customer of the environmental protection industry.

The oil profession is by its very nature global. We are dealing with entities that, by their very nature due to the laws of physics and geological processes, do not recognize political boundaries. But what is globalization?

What people mean by globalization may be many different things. Globalization is a very interesting process. It makes the world both smaller and larger at the same time. The necessary conditions for globalization are certain levels of deregulation that bring about a certain level of liberalization, the ability of foreign entities to invest in a different country. There is not a single country in the world that is fully liberalized and deregulated, even the US, which perhaps comes the closest. However, we do have multinational blocs or multi-interest blocs: the European Union, OPEC, the Organization of African States, and NAFTA, which became FTA and involves Costa Rica. But please take note, multinational is not equal to global.

Globalization is measured in dollars. It is the amount of money that an entity from one country is willing to invest in natural resources that are within the territory of another country, and that is a very heavy risk. There is another scenario, which is global fragmentation, and the tragedy of fragmentation is whenever a country decides to take non-global or anti-global or anti-liberal positions, the public never opposes it.

The evolution of globalization in the oil industry can be characterized by four major steps. Before the Second World War there was much multi-national presence but it was not really global. And we rode on the coattail of colonialism. And post- Second World War, we saw the emergence of national oil companies, which today hold 90% of the remaining oil reserves and produce two-thirds of all the oil and natural gas in the world. But until 1973, they did not quite know what to do with this wealth, so the major oil companies continued the trend of being dominant. Post-1973 there was a major disconnect. Overnight the price of oil jumped 1000 per cent. This does not happen very often. And then OPEC came into existence, and the national oil companies became more and more important, more and more sophisticated. Today there is a number of national oil companies, which are excellent.

A lot of new technologies will affect our future, and we are working on most of them. I was born in the land of the prophets. And if you read the Bible, the Old Testament, you will see that being a prophet is not a good profession. Most of them found their "terminal" stage in very unpleasant ways. But the emerging technology renaissance – which will enable the critical super-effectivity, a matter of life and death in the hyper-competitive energy market – will happen. Companies which have the ability to make a lot of money ought not to worry whether the power to earn will shift or not, but when?

Hiroyuki Fujimura Chairman and Representative Director, Ebara Corporation

The Ebara Corporation has been in business related to the environment for a long time. Based on our experience in this field, I would like to talk of the risks surrounding our societies to be sustained and of the challenges required to remove these risks from the industrial viewpoint.

To realize a sustainable society we have to conquer the problem of the global trilemma. Here the global trilemma means three contradicting problems imposed on us simultaneously: (1) economic growth, (2) the security of food, energy, and natural resources, and (3) the protection of the global environment. Every one of these three problems is critical for the existence of human beings, and they are so tightly related with each other that we can never dissolve the problems taking one by one separately. The faster the growth of the global economy the heavier are the risks of environmental aggravation and of draining-up of the natural resources.

Speaking of natural resources, the energy consumption per capita is sharply increasing, following the economic growth and the improvement of our living standards. Especially in advanced countries, the information technology (IT) and the aging population are playing more important roles relative to electrical energy, and we cannot depend indefinitely on the limited resources of fossil fuel.

Reportedly the global population will reach 9 billion in the middle of the 21st century. It is feared that this global population explosion will bring a shortage of food essential to maintain human lives, especially in the developing countries where the population is increasing at a higher rate. This is one of the risks. The risks to the global environment are tangible global warming, forest destruction, desertification, acidic rain, destruction of the ozone layer, and poisonous substances such as dioxin and endocrine. The increasing disparity of the rich and poor, the problem of the socially weak, the population explosion in developing countries, and so on, are the risks to hinder the growth of the global economy. It is not an exaggeration to say that the realization of a sustainable society depends on whether we can conquer this global trilemma.

Today, I would like to make two proposals from the standpoint of the industrial field. One is Total Life Cycle Cost (TLCC), and the other is a concept of biomass refineries. Both proposals, I dare say, would be the most adequate themes to be discussed and studied in an organization like this AGS with the cooperation of its international, brilliant brains.

1. Total Life Cycle Cost

Keeping the economic profit from economic activities in mind, industries like Ebara are frantically fighting to offer products and services competitive in the global market, because the market demands benefits per unit cost now. However we have to make a revolution in our mind in pursuing the economic value by which the resources and global environment are exposed under the risks of this trilemma.

The idea of TLCC, I suggest here, is an index that includes the cost of environmental protection in the life cycle cost required to offer economic benefit. I suppose technologies have to be reevaluated and the social systems reconstructed based on this index of evaluation. In the United States, the Environmental Protection Agency (EPA) has a concept called Full Cost Accounting (FCA). Similarly I wish to propose a new measuring scale of TLCC (Total Life Cycle Cost). This is a method to evaluate the economic and environmental

effect of a product throughout its life cycle and express it comprehensively and quantitatively in a value of currency.

The economic effect is calculated by the so-called Life Cycle Cost (LCC) method. Taking a plant for example, LCC is calculated from the total of the initial construction cost, the running cost in operation, the maintenance cost, and the scrapping cost. On the other hand, the environmental effect is calculated based on the Life Cycle Assessment (LCA), a method of evaluation of the influence upon the environment. Environmental load-substances such as carbon dioxide (CO_2) in the phase of plant construction, operation, and maintenance will be estimated in volume, and the environmental loads will be calculated economically as environmental cost. This environmental cost of load substance is calculated based on the marginal cost to reduce one unit every load substance. The sum total of LCC and LCA gives the TLCC. Using this TLCC value, decision making based on both the financial cost and the environmental cost becomes possible.

For a practical example of application of this LCA and TLCC method, I will introduce a case study of plastic waste treatment technologies. The objects of evaluation are the following two technologies. System 1 is a technology of chemical recycling. It is a technology to synthesize ammonium from the product gas by gasification of plastic waste. Recuperated as valuables – aside from ammonium – are carbon dioxide, sulfur, nitrogen, chlorine, metal, glass, and slag. An application of this technology is in commercial operation already. System 2 is power generation by incineration. This technology generates power with heat recovered from an incinerator burning plastic waste in a fluidized bed. Ash will be melted by plasma. Recovered as valuables – aside from electric power – are slag, metal and glass.

On the global warming, the load from the chemical recycling stays at around half of the load of the incineration power-generation, and this means the chemical recycling is the better technology to protect against global warming. The component of the warming effect is mainly occupied by CO_2, and CO_2 content in the exhaust from the chemical recycling is around half that of the incineration generation. The main reason for less CO_2 comes from more recovery of the gas in the chemical recycling as valuables. As for acidic rain, similar results are obtained. The impact of the chemical recycling is around one eighth of the incineration power generation, showing higher superiority of the chemical recycling than in the case of global warming. This difference comes mainly from the less volume of NO_X in the exhaust of the chemical recycling compared with the incineration power generation. From these results of the environmental adaptability based on the LCA, clearly we can say that the chemical recycling is the better technology.

Though the construction cost of the chemical plant is 1.8 times that of the thermal plant, the costs reverse when compared including operational costs. Furthermore, including costs for environmental protection, the chemical plant comes to around $ 48 billion and the thermal plant comes to around $ 62 billion, showing chemical recycling is $14 billion – or more than 20% – cheaper than the thermal recycling. Compared comprehensively from the economic and environmental viewpoints, this concludes that chemical recycling is the superior system.

In the process of aiming for a sustainable society, a measuring scale to evaluate the level of durability is required. This TLCC is nothing but a sort of tool we apply for measurement. If the AGS could tackle this theme, I believe, we could create an evaluation index accepted worldwide.

2. Biomass Refinery

At present, our economic societies are standing on a base sustained by natural resources such as oil and coal. But these resources are limited and non-recyclable. Therefore, to realize a sustainable society, of course, we have to make full use of technologies for saving energy and resources and to use the limited resources most effectively.

In the last few years the recycling of materials – chemical recycling and thermal recycling – based on the zero emission concepts, are striking roots in the society. We may say the introduction of a suitable system of society and adequate development of technology are becoming urgent now.

But stepping a foot ahead, if we could succeed in constructing a social system where we use recyclable resources such as biomass or natural energy instead of non-recyclables, we would find a way to conquer the global trilemma I mentioned at the beginning. That is to say, by utilization of recyclable biomass or natural resources, we will reduce the load to the environment of the earth and save the consumption of non-recyclable resources such as fossil fuels and minerals. It will also make new industries possible in the developing countries taking the charge of the biomass supply, and it will stimulate their economy, and finally we may realize sustainable societies worldwide. To promote this movement, an involvement of economic evaluation standards such as TLCC into our economic activities becomes essential.

I will present examples of Japan now. The biomass resources in Japan are:

- 3,480 million cubic meters as wood, and the annual forestry product is 90 million tons, though the recoverable and reproductive resources are limited to 21 million tons per year;
- The biomass from farming, forestry, and waste treatment system is around 40 million tons per year;
- Organic substances in the waste in general are around 50 million tons per year, and the total makes 180 million tons per year.

Utilizing these enormous biomass resources, we may change our industrial structures, now cored by oil refineries, to new industrial complexes consisting of industrial groups cored by biomass refineries, as required for a sustainable society. In the complex of biomass industries cored by biomass refinery, the energy supplying area, the industrial area with replaced mineral resources, the biomass-rearing area for resources, and the brand-farm-product rearing area will newly join to the waste treatment area.

The upbringing of biomass technology to rear biomass effectively is also important. To produce biomass on a large scale effectively in forestry, ocean, farm, and others, the establishment of a technology and system for gathering, collection, and selection of resources is required together with incentives for that purpose. Also the establishment of technology and system for gathering, collection, and selection of new resources from unutilized biomass, general waste, and industrial waste is required together with incentives for that purpose.

We are developing a new gasification technology that allows using general waste and industrial waste as mixed raw materials in addition to biomass. We call this furnace an Internally Circulating Fluidized Bed Gasifier (ICFG). The use of general waste introduces economic incentives. That is where fossil fuels such as naphtha, LNG, and coal were purchased. The use of various wastes for raw materials brings sub-income

as a commission of waste disposal improving the economy of the introduction of the systems. By-products can be sold at the market price additionally. If the carbon credit is added in the future it will be precious for the economy and the global environment. If the carbon credit is added on, it will bring a big contribution to the global economy and environment. On the other hand, the key to utilize the biomass is an efficient conversion and usage in high grade. In ICFG, no combustion gas comes mixed into the product gas. It makes the use of air possible for non-oxygen gasification, and it obtains high purity product gas containing little CO_2.

By these technologies, coming into practical use, waste with low calorific value such as general waste will attain a cold gas efficiency higher than 50%. In case of woody biomass, the cold gas efficiency will be 70% and the power generation efficiency higher than 35%, and this makes a power generation using waste competitive to a medium-sized steam power generation plant. In addition to the power generation, this technology will make the production of liquid fuel such as methanol or hydrogen easier, and the co-generation combined with gas turbine or fuel cell adequate. Also, combination with solar cell or with wind power generation is possible in the dispersed power and heat distribution business. The basic technology has been proved already.

In the biomass refineries, various raw materials for industrial products will be produced that are applicable as alternatives to mineral resources. Presently the study in this field is mostly limited to organically decomposing plastics, and the study and development in other industrial fields are not sufficient yet.

In the tissue of plants there are hollow, tubular textures that have the possibility to be used as adsorption material of oil and others. Also, from the components such as potassium and nitrogen, some alternatives of chemical fertilizers may come in the applications. There are technologies to extract lignin from plants. And the most of the chemical products now synthesized from oil, such as cosmetics, medicines, etc., might be synthesized from biomass. I think the study in these fields has to be promoted further.

Up to this point, I talked of our studies in Japan for examples. But practically taking into consideration the gathering and transportation of biomass – the main raw material of the bio refinery – the geographical stationing of the refineries in the world should practically be dispersed mainly in the developing countries in rather small to medium sizes. This type of stationing will be beneficial to raise industries and create new jobs in the developing countries, not only from the viewpoint of energy saving. When these biomass complexes are established, using energy from the complex, the local forestry and fishery of value-added type will be reared and contribute to promote industry and job creation in the farm and fishing villages.

As mentioned above, I dare propose the concept of TLCC and biomass refineries as a measure to overcome the problem of the global trilemma. Studies, technical developments, implementation of the model projects, and so on have to be promoted comprehensively and strategically in a cooperation of the farming and industrial fields. Additionally, I believe, the theme of these studies should not be limited to science and technology, because the studies of social system that helps realization of sustainable societies are also necessary. I shall feel honored if this theme is studied in depth by the AGS members.

Keynote Address

Technology and the Future of Sustainable Development: Government, Industry, and Academic Collaboration – the CETP Model

Baldur Eliasson — Head of the Energy and Global Change Department, ABB Corporate Research, Switzerland

co-authored by Marcus Bayegan — CTO of ABB

It is a great pleasure for me to be here today to talk about energy, technology and sustainable development and about what I think has been a very successful ABB-AGS program, the China Energy Technology Program (CETP). It is very difficult to talk about sustainability, because I do not think anybody knows really what it implies. We all know what it sort of means, and what direction it goes in-a better environment and less pollution, bringing in all other aspects of society, not just the economy. We are so used to focusing on dollars, cents and francs that we are slowly realizing that it takes more to survive on this planet. We have to respect and take into account society and the environment in general. There is no doubt that man is influencing climate, and there is no doubt that right now we are influencing nature in a non-sustainable way. I am sure that big block of ice that broke off last week from the Antarctica will not sail back and re-attach itself to Antarctica.

I will be talking about technologies and sustainable development and especially the CETP model, which we think is a great success story. So here is short overview of what I will be talking about – "New Technologies for a Sustainable World, CETP: or, How to Cooperate." I think that it is one of the most difficult things in life to cooperate, especially if you come from industry and want to cooperate with academia or the other way around, or if you want to involve the so-called stakeholders, the people that use your results. It is very difficult but very important. We are entering the age of interdisciplinarity: no longer can we hide in our labs and not have any contact with the real world.

I am reporting from the real world. I will not be talking about dreams or visions. I will tell you something about some technological projects, some of which I am involved in, because I think it is time for action. And I think now people are realizing that we live in a global village-we live in a global environment, and we live in a global market. There is very rapid development of the less developed countries, and, of course, we have instant worldwide communications.

Somebody recently told me that Costa Rica had to have their import and export connections with the United States because it was so close. It was only a thousand miles away. And, as he was not aware of it, I told him that that we were living in a global village, where in Switzerland at least we eat fish from Singapore and chicken from China, and so forth. But the so-called free market-which we all believe in, I think-can be a dangerous juggernaut in a way. It is a wonderful servant but a terrible master. And we are seeing many examples of that in the past two or three years.

One-third of the world's population, or two thousand million people, have no access to electricity. That is something that we in the developed world take for granted, but it is not the case for two thousand million people. One-fifth of the world's people are illiterate. Two-thirds of the world's fisheries are being harvested beyond sustainability. It is the most important food source of the world and it is certainly not sustainable today. And one-third of the world's people face water scarcity. And, what is even worse, almost all of these people are in the developing world.

In 1992 we had the Rio Conference. The importance of that conference is that it made the global village aware of the environmental problems that we face. Some industrial countries promised in 1992 to get their emissions in order by 2000. Nothing of the sort happened. It was business as usual. The worldwide annual emissions have increased from six to seven gigatons of carbon. The IPCC scientists said at that time if we wanted to stabilize the CO_2 concentration in the atmosphere we would have to lower the emissions by about 60% until the year 2050. Anything but that is happening. So I think it is time for action. I am a technologist. I am going to show you some of the technological options we have.

The Kyoto protocol is a very important thing. I was at a conference in the US where Kyoto was declared dead, but it is anything but dead. The European countries and Japan will say or have said they will ratify this agreement. 170 countries have agreed to it. The EU, Russia, Japan, and some other countries will hopefully sign this, so it will become international law, something very new, a limitation put on the emissions of these countries, and something will be put in place to make sure that they stick to what they have promised to do.

What kind of technologies will we have in this new century? Renewable power will increase very much. It is already increasing rapidly. We probably will have distributed power, i.e. more and smaller power plants, perhaps even a power plant in every house in the end. Hydrogen and methanol will be important fuels and energy carriers in the future. Fuel cells no doubt will be very important, probably as power plants and as engines for cars. Today, 90% of the commercial energy in this world is based on fossil fuels; 80% of all the energy in this world is based on fossil fuels, and this will not disappear overnight. But the dangers are great, and we have to do something now. Since we are certainly going to use fossil fuels for another 50 years or even longer, we have to think of technologies that allow us to do that, not forever but in an interim period. And, as I said, renewables are growing very fast, and the fastest of all is wind energy. At the end of this year we will have about 30 gigawatts of wind energy installed. A third of that is in one country, Germany, and it is growing at 20% to 30% per year. This technology basically did not exist in this way 10 or 15 years ago, and now it is certainly taking off.

Another aspect is solar energy, which is a very good example of how we can be caught in the economy trap of cents-per-kilowatt. But the most expensive technology is sometimes the cheapest solution, and here is a real-world example. BP has announced that they are going to install 50 megawatts of solar power in 150 villages in the Philippines. These people have no electrical infrastructure. Once you put up 300 kilowatts of solar power in their jungle villages, when they have clean water for the first time, when they have electric light for the first time, when they can wash their face for the first time, then they do not ask how many cents per kilowatt hour the electricity costs. So I ask you to forget this total reliance on economy, because it is not sustainable. You know economy is only one part of the sustainability question.

The company I work for has built two power plants in the US where CO_2, the most important greenhouse gas, is taken out of the fuel gases. The technology is there, and CO_2 can be taken out, but what do we do with it? I am involved with an experiment of looking into putting the CO_2 into the ocean. We have no idea whether it works, but, because we do not know and because we are all scientists, we want to find out. We were in Hawaii for four years trying to talk to the government there and the EPA in the US about

doing this. I have never before run into such gigantic bureaucracy. So, after four years, we packed our bags, went to Europe, and talked to the people in Norway and other countries.

It appears very likely that we will do this experiment this summer [2002], where we will put 5 tons of liquid CO_2 into the ocean and see what happens. The best place in the world to put CO_2 in the ocean is the area between Greenland, Iceland and Norway. This is where the deep-water formation takes place. There are only two such spots on the planet earth, and this is the best one. The water flows there down to 4000 meters, and we have, through mathematical simulations, found out that if you put the CO_2 deeper than 800 meters, less than one percent will be outgassed after a hundred years. So we will do the experiment. But there are a lot of people against this who say it is irresponsible. I say it is irresponsible not to look into it, and we are certainly going to do it because we are responsible.

I will next talk about the program in China, where ABB is involved. China is a very important country, as you know. We have two laboratories in China that are dedicated to the greenhouse gas [GHG] question. There is a GHG chemistry lab at Tianjin University in Tianjin City, about 150 kilometers east of Beijing, where we are recycling CO_2 and methane and turning them into liquid fuels for the coming Chinese automobile industry. Recycling CO_2 will lower the emissions to the atmosphere very much.

We have a similar laboratory at Tsinghua University in Beijing, where we are doing thermal greenhouse gas chemistry and trying to work towards the same goal. And the second program, a very big one as was mentioned, is the China Energy Technology Program (CETP), which we are doing in China. I will show you a little bit about that, and after that I will show you a video which is sort of an introduction to the program. It is an AGS-ABB program, and it has been extremely successful.

There are 75 scientists in this program from three different continents. The CETP is a three-year program started in 1999, and it will finish this year. We are writing a book about it and putting together a DVD, and we think it has been a successful program. It was also an exercise in how to work together. We had about 11 institutes including ABB, ETH, PSI, MIT, University of Tokyo, the State Environmental Protection Agency in China, Tsinghua University, the Energy Research Institute in Beijing, and the Utility in Shandong Province in China. While China has 30 provinces, we focused on only one province, Shandong, but that one province has around 100 million people, a large percentage of the population of China.

What we are trying to do is understand the full electricity cycle in the sense of cradle-to-grave, from fuel generation, transmission, and distribution to the use of the electricity. What is a sustainable way of generating electricity? As I said, sustainability is a difficult issue. The first step we take here is that we not only include the economic aspects but also the societal and environmental aspects, and we put that into the whole equation. It is an exercise in working together. As you all know, it is difficult. The academic professors will not solve the problems of this world alone, nor will industry, nor will government. We have to work together. That is what we mean by being interdisciplinary, and this is really the hard fact of today. We have to work together, and if we do not, we are doomed.

In this case, industry, i.e., ABB, is one of the players. We supply the money and management leadership while academia supplies the knowledge and the science. The third group, the customers or stakehold-

ers, are mostly government agencies. We had ten Chinese government agencies as our stakeholder group. They told us what they really wanted. We did not want to end up with a book that ended up in a drawer. We wanted to end up with something that could be used. That is why these people were involved, and I must say it was a great success.

And so, as I said, we tried in this case to reach sustainability of electrical systems by taking the environment into account, taking society, health-that is the most important aspect actually in this equation-and then, of course, the whole economy, cost investments, etc. We wanted to come up with the total cost of the system, which is not only the internal cost-that is, the cost we have today, the cost we pay today-but also the environmental cost and the societal cost, and these costs are much higher. It was our goal to find out what this equation really means and what is the solution to this equation.

Emissions of pollutants from China's power sector are about a fourth of the total pollutant emissions in China. The external costs caused by these emissions are ignored today. Nobody talks about it. We are not telling the Chinese what they have to do. We are going to provide the minister of electricity with a tool, which he can use when he wants to build a plant, or ask questions such as where to build it, what effects it will have, and what kind of technology he should choose. So what we are doing is developing a decision support tool.

CETP Video
When shaping the future, one country has extraordinary dimensions – China. The size of China's population and economy makes it a key global player. With economic growth approaching 10%, this role is bound to increase. So will China's appetite for energy. The need for electricity in particular is expected to increase dramatically. China shares the challenges of growth with the other members of the global community. In China alone, one million people die premature deaths each year due to air pollution.

Reducing emissions in a country the size of China goes far beyond simple technical measures. It requires knowledge of complex interactions between technology, economy, and environment. So an international research program was created: the China Energy Technology Program (CETP). The vision of the CETP was to address sustainable energy production – power generation in one of the key areas of the world, namely in Asia and China – and this was based on the conviction that we cannot have a sustainable world in the future, we cannot have a sustainable development in future, without addressing Asia and power generation in Asia.

China is a huge country and issues we are encountering in China are particularly important. The power is in the hands of the corporate world today and partly in politics. So if we can work together with the corporate world, the chance of really achieving something in sustainability in such a big country as China is particularly good.

The goal of CETP was to issue conclusive findings and insights after only two years of research. To do this it was necessary to have the cooperation of many different partners: (1) Industry, which provides the leadership of the money, (2) academia, which provides the science and the know-how, and (3) the customers, who are the stakeholders who provide guidelines to what they really want.

CETP created an international sustainability partnership of nine scientific institutions and a global company joining forces in a unique research effort. From the beginning, CETP also included Chinese institutions, from government, the power sector, and academic research. These stakeholders enrich the program with their participation. They would also in the end draw their own conclusions from CETP results. These stakeholders can consistently use and adapt the models in order to guide the planning, construction and operation of China's electric power generation and Shandong Electric Power Development.

In the CETP, ambitious research tasks were performed by world-class institutions on three continents. At the same time, individual task results had to be brought together and integrated. This process required intense cooperation and coordination as well as new ways to deal with a vast knowledge base. CETP is a very complex project. It was necessary to develop the approach into 12 different tasks. For each task there is a principal investigator who is responsible and oversees all the activities for that particular task.

While addressing one of the world's largest countries, China, the level of analytic detail required CETP to focus on a representative region. One province was chosen, Shandong. Understanding future options begins with understanding future demand. Within 20 years, Shandong's hunger for electric energy is expected to triple. Meeting this demand will ultimately affect the environment, China's population, and other countries. With an array of analytical methods, the CETP has studied potential damage and the expected costs to society. Scenarios provide an important way for CETP to imagine and model the challenges ahead. Thousands of different scenarios were analyzed, from which three representative electricity supply strategies were examined.

The dirty coal scenario assumes that coal is used in power plants without technologies that remove sulfur dioxide. In cleaner coal, most of the sulfur dioxide is removed from power plant exhaust using scrubbers. In clean coal plus, a wide range of measures reduce emissions even more drastically. It is necessary to look at how the coal can be cleaned before it gets to the plants. This means looking at how old plants that are already there can be cleaned up – by adding a scrubber, retiring them early, or running them less – and then it is necessary to look at new technologies that burn coal more cleanly to start with.

The scenarios developed by CETP clearly show that cleaner energy is feasible. In the year 2020, electricity consumption will about triple today's level while sulfur dioxide emissions could more than double with enormous consequences. But better strategies can reduce sulfur dioxide emissions much below current levels. Emissions of carbon dioxide will grow dramatically in spite of successful measures against other gases. This increase will affect global warming, a secondary priority for China given its existing environmental problems.

CETP constructs scenarios to anticipate the alternative futures.
We work together on assignments. Authorities, researchers and stakeholders try to quantify all the different alternatives.

When evaluating alternative knowledge of external cost is particularly important. External costs are social damages, particularly due to air pollution, which are not directly included in the cost of electricity. With desulfurization as in the cleaner coal scenario, external costs could be kept at present levels in spite of a

threefold increase in power generation. Internal costs include all direct investments and operating costs for the whole energy system. Differences between dirty and clean strategies can be relatively small. The total cost of electricity combines internal and external costs. By investing in a cleaner system, Shandong can save billions of dollars in damages to health and the environment.

The investments in clean systems are higher but not dramatically down in the environmentally dirty systems. But at the same time this is more than compensated by the damages we are avoiding by investing in this environmentally friendly system.

Emissions can also be curbed by reducing the demand for electricity all together. This was also modeled in CETP's scenarios.

Energy conservation saves essentially the need to operate power plants and therefore the cost of fuel and the emissions from that fuel consumption and peak load management avoids needing to invest in power plants that won't run many hours. So it saves on investment costs.

Today's research reflects decisions fundamental to the future. What will be the cost of electricity? What will be the benefits of lowering emissions? How much damage is acceptable? How can multiple criteria be considered in complex decision making? CETP results help answer these questions and many more. The insights produced are valid beyond Shandong province: they are applicable to the whole of China and to other countries facing similar challenges.

Margot Wallström — Member, European Commission and Director, DGXI Environment Directorate

Thank you for the opportunity to deliver a short message to this gathering of scholars and leaders from industry, government and the non-profit sector. And let me say at the outset how pleased I am to be a member of the International Advisory Board of the Alliance for Global Sustainability. I fully support your objective of promoting a multi-disciplinary research agenda for environmental sustainability among the AGS member universities and involving the business community.

You have chosen the theme "Building the Future: Leadership, Technology and Global Citizenship" for this year's Annual General Meeting. This is very timely. In September this year, the world's leaders will meet in Johannesburg, South Africa for the World Summit on Sustainable Development. Policy makers need your help in setting the research agenda, which in turn provides the answers to the pressing questions of global sustainability, which must be tackled at Johannesburg.

The Swedish author Rolf Edberg wrote that: "Of all the rubbish we have accumulated around us, worn-out ideas are the most dangerous. They live on in boardrooms, in political committee rooms, in organizations established in the backyard of an industrial society eager to abdicate all responsibility, and in the lethargy and tendency of many individuals to bury their head in the sand."

That is why it is so important for policy makers to keep in close contact with the scientific research that can give us the facts and the new ideas. The European Union last year adopted its sustainable development strategy. And this focuses on four themes: climate change, transport, public health and, natural resources.

There is still plenty of work to do in these areas, both in terms of getting our own house in order and in terms of the global sustainability agenda. Last week the European Commission adopted a report on "Environmental technology for sustainable development." We in Europe need to review our capital stock to improve our economic performance. This gives us an opportunity to invest in an economy that is both competitive and capable of providing sustainable development.

We must proceed in close cooperation with the research community. Proposals must have a solid foundation and be well formulated to gather broad support. They must be based on comprehensive scientific and economic studies.

I am often asked whether we can understand – whether the general public can understand – the scientific findings in these very sophisticated research fields. My answer is, yes, we can, because we must. Democracy requires researchers to make substantial efforts to present their findings in a manner comprehensible to a lay audience. Everyone should have an understanding of the main issues involved.

The next question is usually, can we trust the scientists? And my answer to that is, we need science to provide reliable knowledge in these particularly complicated fields. The way to improve our knowledge is through open scientific debate, by questioning, scrutinizing and developing research findings.

A good example of cooperative research is the work by the Intergovernmental Panel on Climate Change, the IPCC, comprising 2000 of the world's most eminent climate researchers, set up by the UN to establish a scientific consensus on the greenhouse effect.

I believe the Johannesburg Summit must be a wake-up call for global sustainability. And let me highlight a few examples of our unsustainable impact on the globe.

Population: In the last 50 years we have added more people to world population than during the preceding 4 million years since man first stood upright. The earth's present population of 6 billion is projected to rise to 9 billion by 2050.

Bio-diversity: In 1996, 25% of the world's 4,600 mammal species and 11% of the 9,700 bird species were at significant risk of extinction. More than 20% of the world's 10,000 freshwater fish species have become extinct, threatened or endangered in recent decades.

Forests: Between 1990 and 2000, around 140 million hectares of forests were lost. And that is a total area larger than the combined size of Austria, Belgium, France, Germany, Italy, Luxembourg and The Netherlands.

Water: Water tables are falling so that, while consumption is rising by between 2% and 3% annually, resources are consumed faster than they can be replenished. At least 1.1 billion people still lack access to safe drinking water and about 2.4 billion have no adequate sanitation. Or take desertification and soil degradation: These continue to be major problems. Nigeria is losing over 500 square kilometers of productive land to desert every year. Southern parts of Europe are also severely affected. The loss of topsoil from wind and water erosion now exceeds natural formation of new soil. In Africa, the annual loss of livestock production from the cumulative degradation of rangeland is estimated at around $7 billion, a sum almost equivalent to the entire GDP of Ethiopia. I could go on. But we cannot allow the enormity of the task to paralyze us into inaction. And we must also recognize that there are some positive signs too, not least in the following areas: in the health care sector, in reducing child and infant mortality rates, in hunger reduction, and also in providing access to education, safe water, and sanitation.

New advances, whether in the form of wind turbines or hydrogen cell technology, also offer the hope of a break with unsustainable trends. Following the most recent discussions in New York, it seems that there are two types of outcomes to expect from the Johannesburg Summit. A global declaration and action plan, to show the results of the collective effort and of the new spirit of global partnership. And a series of specific commitments or agreements by networks or partnerships, including governments, the private sector, and other stakeholders.

So let me outline today four areas in which I believe we can and must all sign up to concrete actions.

Firstly, energy: We must sign up to concrete action in the field of energy and development, with a particular focus on the provision of reliable sources of energy, improved energy efficiency, clean technologies, and the development of locally-owned renewable sources.

Secondly, water: Johannesburg should launch a strategic partnership with international organizations, governments, and stakeholders to promote sustainable water resource management based on the principle of integrated river basin management.

Thirdly, urban environment: Given that around 80% of Europe's population now lives in urban areas and that this trend is increasingly manifesting itself in the developing world, local urban actions must be revitalized at Johannesburg.

And fourthly, an African initiative: Johannesburg must deliver regional actions for Africa building on ongoing initiatives like the New Partnership for Africa's Development [NEPAD]. It will also be necessary to deliver action in the areas of health, social protection and education.

Today's environmental problems are very largely the result of our lifestyle and the production and consumption patterns it has created. Appropriate pricing, tax incentives, environmental liability and information to the general public are some of the methods and instruments that need to be developed in cooperation with industry and consumers. It is difficult to envisage another policy area being more dependent on research than environmental policy. We need to understand the natural processes that we are dealing with. Technology is an important part of the solution. And we have to justify our policies on the basis of research and good data. Research will be essential in paving the way towards more sustainable policies.

Special Address

Achieving Sustainable Development

Oscar Arias Former President of Costa Rica; 1987 Nobel Peace Laureate

Good evening. It is a pleasure to be here with you tonight to discuss the prospects for the sustainable development of our planet. You have been hard at work in panel discussions and working groups tackling various aspects of this problem, and I am not altogether confident that I will have anything unique to add to your musings. Nevertheless, I have twenty minutes to fill, so I shall try to say something original.

The cynics in our world often tell us that there is nothing we can do to combat poverty and destruction or to achieve lasting peace and development. They tell us that inequality and poverty are inevitable, that cancer will never be cured, that somehow evil always gets the better of good, so why fight it? Part of the tragedy is that these cynics paint themselves as realists, and then argue that anyone who is willing to fight for the underdog, to work for peace, to commit to ending human suffering, is really just a dreamer.

I was labeled a naive utopian back in the 1980s for believing that the self-declared Marxist-Leninist government in Nicaragua would hold free elections, as they committed to doing when they signed my peace plan. Those who called themselves realists claimed that military victory was the only way to end the conflict in Central America. That time the realists were wrong. There is a first time for everything.

When we look to the future, we can only look with optimism. François Guizot once said that the world belongs to the optimists: pessimists are only spectators. However, being an optimist does not mean closing your eyes to the world's problems. As we dine here in this elegant setting, we must remind ourselves that 1.3 billion people live on less than a dollar per day. We should pause from time to time in our routine of reading the morning newspaper to remember that more than 850 million adults in the developing world are illiterate. In the midst of our peaceful poolside relaxation, let us not forget that insurgents and paramilitary groups continue to take up arms and batter their countries in turf wars that they attempt to disguise as ideological battles. Truly, my friends, when we take the time to ponder the ongoing deprivation of the poor and the acts brutally committed on a daily basis, it is indeed very easy to become discouraged about the prospects for lasting peace and development in our world.

Unfortunately, human instinct seems to tell us to focus on the negative. Perhaps this is a result of our built-in instinct for survival; we must be aware of the dangers around us in order to defend ourselves from them. But for every source of danger that captures our attention, we miss a vision of beauty, an act of kindness, a moment of peaceful coexistence. Such pieces of life fade into the background, and the dark spots loom up, using fear and pessimism. But those who have been able to change the world for the better are more likely to have been like the Man of La Mancha, who charged every windmill he could find, and never lost sight of the beauty in the ordinary things of life.

This is why your organization, my friends, is so remarkable. As members of elite research institutions, you could easily put your talents at the service of whoever is willing to pay you most, for your work has a very high value in the market place. Yet you choose instead to grapple with the question of how to put your intellectual, social and scientific gifts to work for the benefit of the world's most vulnerable populations and ecosystems. There must be some Spanish ancestry among us, because you are living the legacy of Don Quixote, charging at the towering windmills of persistent poverty and environmental degrada-

tion which loom over the landscape of so many developing countries – indeed, over the entire planet. Never let the Sancho Panzas of the world convince you that your mission is unrealistic or that any project that has the potential to make some improvement in the health of a community, however small, is not worth undertaking.

In the wake of the events of September 11, the issue of national security has once again overshadowed the need to protect human security in the developing world. Work such as yours which seeks to alleviate poverty and promote sustainable and ecologically-responsible growth in the developing world, has begun to be overlooked in the rush to build better defenses – and, make no mistake, better offenses – against the evils of terrorism. Today, when President Bush and members of his administration speak of aid to developing countries, they are most often talking about military training, tanks and fighter jets, and not hospital supplies, school books or technical cooperation for the development of life-sustaining agriculture.

It is true that President Bush recently announced an increase in US aid for development, so that he would not be arriving in Monterrey empty-handed for the United Nations Conference on Financing for Development. This increase is certainly welcomed and is a step in the right direction; however, it does not go nearly far enough. Prior to President Bush's recently announced increase, the only industrialized countries that gave less aid per capita than the US were Portugal and Greece, two of the poorest countries in the European Union. With the new aid, which will amount to an additional five billion dollars over three years, and which comes with a myriad of strings attached, the United States still will continue to be among the stingiest donors of foreign aid in the world. Compare these five billion dollars to the additional 48 billion that President Bush is requesting for the Pentagon, for this year alone, and I think you will have a fair idea what the priorities of his administration are. This government believes in bombs over books and helicopters over hospitals, and it is prepared to fight Congress for every penny of military spending, while it delays the disbursement of aid for development until 2003.

I do not know whether this is due to the sinister influence of defense contractors within the US government, or simply to the zeal for military solutions that has always been a part of that country's response to perceived threats, and which has only grown stronger over the last six months. In either case, what I do know is that a military means of ensuring security is misplaced. In 1905 George Bernard Shaw wrote these words, and they continue to be true to this day: "Security, the chief pretense of civilization, cannot exist where the worst of dangers, the danger of poverty, hangs over everyone's head." Though some traditional security measures are obviously needed, I believe that if the estimated 120 billion dollars it would take to create a missile defense system were instead invested in nutritional security, health security, and employment security, they would go a lot further towards securing the lasting peace that we all long for.

My friends, I believe that we all have a vision for the world that motivates us to act in our varied capacities to achieve sustainability as we see it. My motivating vision of the world a hundred years from now is a planet Earth in which each government is democratically elected, is able to fulfill its people's needs, remains at peace with both its neighbors and its internal opposition, and uses the tools of economics and science to the benefit of all its people. This, in brief, is my idea of sustainable development, and, though simply stated, these goals will require prolonged and complex efforts in order to be achieved.

Despite the heavy obstacles that remain in the path, there are also reasons for hope. Today there are more countries in the world that democratically elect their leaders than there have ever been in the past. An optimist can see winds of change blowing over Cuba and China, though we must remain vigilant and not be lulled into complacency with regard to such regimes. The possibilities for real change should, rather, strengthen our resolve to do everything necessary to end the repression that is still practiced in these and other countries.

Free and fair elections are only the first step in achieving effective democratic governance. If democracies do not deliver the goods, that is, if they do not provide for their people's basic needs, then they will prove themselves no better than the totalitarian regimes they have replaced. It is absolutely essential that our governments begin to place a greater priority on the health and education of their children and adults than on the purchase of tanks and missiles to defend territory that has become unproductive and uninhabitable. What the children of the world want and need are schools and health clinics, not F-16s and rocket launchers.

Costa Rica is the only Central American country to rank in the "high human development" category, and this is a direct result of the fact that, having no army, we are free to invest large amount of the resources in health and education. As visitors to our nation, you are witnesses to the benefits we have realized by pursuing these priorities. Abolishing our army has given us a moral force that has become our best defense, and our experience inspires us to try to share this message with other developing countries. In 1994 we were able to convince the people and the legislators of Panama to constitutionally abolish the armed forces completely. We believe that reducing the size, budget, and influence of the armed forces is a crucial step for every highly militarized poor country to take, in order to emphasize poverty rather than spending on arms. When governments begin to emphasize human security over national security, they will find that the strength of their country only increases. It is not weapons, but full bellies and decent work that make fear and violence subside.

Peace is an important aspect of our vision for the world. Some think it is a utopian ideal, but in reality there is nothing glamorous, naïve, or idealistic about peace. Peace is not a dream, it is hard work. It is a path that we must all choose and then persevere in. This means resolving even our small daily conflicts with those around us in peaceful ways. For peace begins not "out there", but with each one of us.

It is therefore up to us to ensure that this new century we are beginning is less bloody that the last. We have advanced so much in the science and the art of making peace through peaceful means; we cannot afford to go back to the old ways of thinking. Current events in the Middle East are testimony of the futility and senselessness of the military path to resolving conflicts. Such a path simply does not exist. Peace will always be achieved by its own methods, which are dialogue and understanding, tolerance and forgiveness. No amount of mortars, tanks or bombs can ever achieve true peace; the most that you can do is wreak devastation and perhaps achieve quiet for a time, but we know that peace based on fear and humiliation is not peace at all, and it does not last. True peace is based on justice, which is something that can only be achieved when adversaries have the courage to sit down and face each other as human beings.

As we work for an end to the conflicts that shame and destroy us, I believe that this work must be carried out on both the material and the spiritual fronts. This means dealing with both the weapons of war and the militarisms in our hearts. We must work to put limits on the international arms trade, a forty-billion-dollar-a-year commerce in death, while at the same time working to teach peaceful methods of conflict resolution, and to eradicate the thirst for revenge that is moving so many in our time.

What is most disturbing to me these days, especially in the United States, is the way that war is being glorified and used as a patriotic rallying cry. It is not that I believe that military action is never justified; sometimes, unfortunately, it is still necessary. However, when people begin to embrace a simplistic good-versus-evil mentality and the ideas of the "Old West" about shoots-outs between the good guys and the bad guys, they are falling prey to a dangerous delusion. Wars seldom have winners, but there are always many losers. Every day that a war continues, more people lose their lives, people lose their sense of security and their freedom, and violence becomes more deeply rooted in people's hearts. None of this is victory; it is only a diminishing of the human soul.

I want to share with you something written more than thirty years ago by Martin Luther King, which reminds us of the dangers in believing that through violence we can triumph over evil. He wrote:

"The ultimate weakness of violence is that it is a descending spiral, begetting the very thing it seeks to destroy. Instead of diminishing evil, it multiplies it. Through violence you may murder the liar, but you cannot murder the lie, nor establish the truth. Through violence you murder the hater, but you do not murder hate. In fact, violence merely increases hate … returning violence for violence multiplies violence, adding deeper darkness to a night already devoid of stars. Darkness cannot drive out darkness; only light can do that. Hate cannot drive out hate: only love can do that".

My friends, I do not believe that it is unrealistic or foolish to bring love back into the political discourse. The term may make some uncomfortable, but when you really think about it, our best leaders have been motivated by love and have acted according to its hard demands: Gandhi, Lincoln, George Marshall, Bolívar, Kennedy, and King, himself. In Western thought we separate the mind from the heart, but in Eastern philosophy these concepts often blend into one. In Chinese there is a single word meaning Heart-and-mind. If more of us joined our reason to the principles and values we would hold in our hearts and acted with the integrity demanded of responsible leaders, then this vision I have described would have a much better chance of becoming a reality.

We may be accused of being dreamers with our heads in the clouds, but a line from one of Shaw's plays comes to mind: "You see things; and you say, 'Why?' But I dream things that never were; and I say 'Why not?'" As people with the talents and the resources to make that difference in the world, we all have the duty to be dreamers. We cannot allow this century to be like the last. We must put our whole beings into creating a world with more solidarity and less individualism; more honesty and less hypocrisy; more transparency and less corruption; more faith and less cynicism; more compassion and less selfishness. In short, a world with more love.

You are doing this through your deliberations here this week, and I am proud that you have chosen Costa Rica as the context for this important meeting. Together let us move forward, one step at a time, along the difficult path toward creating the world we dream of. Let us never give in to the cynics, who sell humanity short with their lack of faith in human goodness. Rather, let us be witnesses of the light that can be created by the strength of persistence, and let us share this flame with our students and colleagues, too. As Dr. King put it, drive out darkness with light, and drive out hatred with love. This is the way of the future, and there can be no turning back.

My friends, I don't know how your shopping here has gone. You may have noticed that there is not much in the way of your interesting keepsakes to buy. I suggest that you take back the best souvenir this country has to offer – the air of peace that is breathed by all, from our oldest to our youngest. Take this precious gift with you back to the United States, to Europe and Japan, and share it with your families and your governments. Tell them that you have seen with your own eyes the country with no army that so many cynics would claim is unsustainable. Perhaps one day we will see a world in which no country needs an army, because we are protected by our respect and concern for each other.

All of us have a contribution to make towards bringing this world into existence. Each of us must act in our own capacity, beginning in our local environment, to – as Gandhi put it – be the change we wish to see in the world. The planet we inhabit today is full of darkness. I ask you to make it your personal mission to light a candle. The world needs all the illumination it can get, and you, my friends, are the sparks that will light our way to a better future.

Panel

Human Settlements and Mega-Cities of the Future

Roberto Artavia Loria	Rector, INCAE
Mario Molina	Nobel Laureate and Institute Professor, MIT
Keisuke Hanaki	University of Tokyo, PI of Tokyo Half Project
Claudia Sheinbaum Pardo	Secretary of the Environment, Mexico City
Angelica Castro	Head of Planning Department of TransMilenio, Bogotá, Colombia

Overview

This session focused on the discussion of the general problems associated with mega-cities as well as steps that other rapidly growing cities can take to avoid these problems in the future. The session focused on Mexico City, Tokyo, and Guangzhou as examples of mega-cities currently faced with sustainability issues. Strategies for these mega-cities to become more sustainable as well as for other rapidly growing cities to avoid these problems are to tackle the problems with a multi-disciplinary approach in which all technical, political, social, and economic issues are addressed. It is extremely important to consider all aspects of the sustainability issue such as mobility, land use, urban planning, health effects from pollution, socio-economic factors, and political issues.

The need to create the infrastructure and institutions that allow the political and technical aspects of policy implementation to remain separate was emphasized. Keeping the political and technical aspects separate is seen as a barrier to effective policy implementation in many mega-cities. This session identified the barriers to sustainability that currently face many mega-cities. The need to address these issues in other rapidly growing cities so as to avoid these problems in the future was emphasized.

Roberto Artavia Loria Rector, Instituto Centroamericano de Administración de Empresas

Good morning. The topic that we now have to deal with is Mega-cities of the Future. I have always automatically thought of mega-cities as something negative. However, yesterday we heard Professor Jeffrey Sachs talking about urbanization as something positive, something that will give the populations of the world better access to services, better access to the development technologies that will end up creating the welfare that we seek in the populations throughout the world.

The current situation of some of the largest cities in the world is one in which problems of pollution, citizenship, citizen insecurity, health hazards, and problems of supply of water, food, energy air, and other materials create environments which we find much less than desirable. But these problems are spreading so quickly that we no longer have to go to Shanghai, São Paolo or New York to find them. We now find them in cities much smaller than that because of design programs and because we have not dealt with the issues of sustainability early on in the process of development. We find that many cities around the world, cities as small as one or two million people, are facing exactly the same problems as these large mega-cities that we so much fear in our thoughts.

Some mega-cities result from disorderly growth. They are a consequence of history. And when things are a consequence of history, it is hard to imagine how to begin to change them. The challenge on the other hand for developing nations is that city systems are collapsing long before they reach mega-size, and in that sense the quality of life and welfare of city dwellers in cities of one or two million people in developing countries are usually as bad as those in the worst mega-cities of the world. Better design and infrastructure, better technology and support systems, and better common practices, education and even attitudes have to be important components of the solution to how we are going to live, not only in environmental sustainability but also in achieving human welfare in the future.

The solution to the current problems of the current mega-cities are now relevant for everybody. One thing we can be sure of is that urban dwellers are going to be a higher and higher proportion of the population of the world in the years to come, and dealing with the problems of living and achieving welfare in large cities is something that is going to become one of the key problems of sustainable development and human welfare in the future.

Mario Molina — Institute Professor, Massachusetts Institute of Technology; Co-Director, Mexico City Program

Congestion is a problem not only in the developing world but also certainly in the developed world. But what I am going to focus my remarks on today is not congestion itself but air pollution. We have a situation which deserves more attention than it has received so far, and that is this question of mega-cities – but particularly, mega-cities in the developing world. In the year 2000, for example, there were 80 cities with more than three million people. So there is a major tendency towards urbanization that you have heard about in this meeting several times. But the challenge is how to deal with this problem. It is a big public health issue, because there are literally millions of people that are breathing air that is not healthy. In principle, we know how to solve the problem – here are existing technologies to fix the problem.

Los Angeles is historically very important in connection with smog because that is where the nature of smog – the chemistry behind it – was first unraveled in the 1950s or so. But there is another city that I am going to talk about, and that is Mexico City. I want to describe briefly a project which is headed by myself and Luisa Molina. We are using Mexico City as a case study, but we want to use it to contribute to the solution of the problem of mega-cities in the developing world.

Why study Mexico City? It has been labeled as the most polluted city in the world. That is no longer the case, fortunately, but it is still very polluted. Another reason for choosing this as a case study is because I was born there and I have many contacts in Mexico City. But here is the problem: (1) we have a very large population, 18 million or more in a relatively small area surrounded by mountains at high altitudes; (2) it is exposed to solar radiation with high intensity; and (3) we know that the ingredients of smog – as discovered in Los Angeles, namely nitrogen oxides, hydrocarbons, and solar radiation – are very abundant in this valley.

In comparison with Los Angeles, a city that has had a fair amount of success in dealing with air pollution, Mexico City is roughly equal in population but is much more compact, and hence the population density is much greater. Another important difference, which is the key to this problem, is the GDP, the wealth of the people: Mexico is a developing country, which is the root of the problem. And compared with Los Angeles, in Mexico City the fleet is very old, and only about half the cars have emission control devices: that is what contributes very significantly to the pollution. Roughly 70% of the emissions that contribute to the unhealthy air in Mexico City comes from the transportation sector.

Mexico City is no longer the most polluted city in the world, because the government has taken some fairly strong action: for example, lead and sulfur were very effectively removed from the environment. On the other hand, secondary pollutants – pollutants such as ozone that are formed in the atmosphere by chemical processes – are much harder to control. The level of ozone in Mexico City, while it has not increased, has gone down only very slightly. Another worry we have concerns respireable particles, which have many negative health effects.

Though I said that Mexico City is no longer the most polluted city in the world, there are some reports where it appears it still is. One of the reasons for this is that the pollutants being monitored in Mexico City are not being monitored in many of the other large cities in the world. That certainly needs to be remedied, because,

if you consider the variety of pollutants and the ill effects resulting from them, the least that should happen in our world is that we become aware of what these populations are being exposed to.

I want to mention that we published a book this year as part of the AGS book series – Air Quality in the Mexico City Megacity: An Integrated Assessment. This book summarizes the results of the first phase of the Mexico City project, which is now over, and we are starting with the second phase. What we do in the book is to make recommendations in terms of what the government in Mexico should do, but also recommendations in terms of what additional research needs to be done to better understand the problem – and that is the sort of thing that we are doing in the second phase of the project.

A feature of our project is that we consider it essential to consider many different disciplines. In Mexico City, we know that some of the major difficulties and barriers to solving the problem have not really to do with the scientific understanding, although a lot still needs to be done with respect to the science. But the difficulties have to do with social, economic, political, and institutional issues. So it is very important that we integrate all this knowledge.

However, another extremely important component of our project is that we are working very closely with government officials. This has two very important consequences: First is that we are more realistic in our study – we know what it takes to make decisions, because we have these important interactions. But the second important consequence of this is that we do not expect this book just to end up on the shelf of only the academic community – actually it is already being used by the government in Mexico to some extent to design the next program of pollution control. In fact, I expect that Claudia Sheinbaum will talk a little bit about it later on this panel. Dr. Sheinbaum was part of our academic team when we started this project. She was a professor at the National University in Mexico, but she became part of the government as Secretary of the Environment in the Federal District in Mexico. So this further reinforces our close collaboration with the government.

One of the recommendations that we have made concerns emissions of respireable particles from trucks. We know that respireable particles can do considerable damage to human health. We also have many collaborators. This is a large project where we are working not only with multiple institutions in Mexico but also with collaborators in the US, many of whom are here at this meeting.

But what is going to happen with Mexico City? It is already very congested, so we do not know if more cars can actually fit in the city and still move. The second phase of this project is to do some scenario analysis and ask the question, what would we want the city to be like, say, 10 or 15 years from now? And if you have a vision of how you want this city to be – and, on the other hand, if you can project what will happen if no significant changes take place – then you can make a stronger case for needed changes. But this vision not only requires the multidisciplinary aspects that I was talking about but also requires integrating environmental issues with urban planning, transportation, and the growth of the city. We cannot isolate one problem from the others, and that is the challenge with mega-cities. We hope that what we learn from the Mexico City case study can be applied to other cities as well.

Keisuke Hanaki Department of Urban Engineering, University of Tokyo

My talk this morning will include the general issue of the environmental problem in mega-cities and will be followed by a very short introduction to two of the AGS projects, the so-called Tokyo Half Project and the Guangzhou Project.

The first thing I would like to mention is the kind of environmental problems that happen in mega-cities. There are many kinds of mega-cities in this world, and Mexico City was just introduced by Professor Mario Molina. I will talk about two Asian cities: Tokyo is the typical megacity in Asia, in the developed world, and Guangzhou is another case. Guangzhou belongs to China, which is very close to Hong Kong. China is a developing country. The rate of development there is very, very high, and that is the main issue behind the environmental problems there.

I would like to point out three typical problems. First is the large quantity of water, material, and energy used in urban areas-which afterwards becomes wastewater, waste, air pollutants, CO_2, etc. These kinds of pollutants cause local as well as global environmental problems. We now call it environmental impact that has broader meaning than pollution.

The second problem relates to the human or cultural aspect. When we do material analysis of advanced cities, sometimes we forget about this aspect. This is very important from the viewpoint of the human settlement. Sometimes there is a poor quality of life combined with the loss of traditional culture. Typical problems in many of the developing countries are poor living environments, which include air pollution and/or water pollution.

The third problem we are facing is the accumulation of hazardous compounds seen on a very long time-scale, from 50-100 years, both on the local scale as well as on the semi-global scale, as mentioned in an earlier presentation. And in developed countries, in addition to these local problems, we are now looking more at issues such as global warming and chemical pollution. However, in developing countries, there is a natural tendency in which policy is concentrated on local environmental problems, which is a very urgent issue but we should not forget about the issues of global warming and other hazardous compounds.

Tokyo has various kinds of environmental issues. Air pollution, largely from vehicles, is an issue not only in Mexico City but also in Tokyo. There is also the problem of solid waste management. There is too much solid waste to put into landfill, and a major problem with the incineration of solid waste there is the emission of dioxin.

Further, the "urban heat island" effect causes the temperature to become higher, especially in the summer time in Tokyo, and it eventually results in greater consumption of electricity for air conditioning and increased air pollution. CO_2 emission is also a very important issue in Japan, because we have to fulfill our promise in the 1997 Kyoto Conference to reduce the CO_2 emission by 6% in comparison to the 1990 emission level. It is a very hard target to achieve, but we have to solve the problem.

In summary, the problem in Tokyo, although there is almost no growth in population or growth in industrial activity, is still a high degree of environmental impact. There has to be a compromise between maintaining a high quality of life and decreasing the environmental loading. Actually it is a very difficult question how to decrease environmental loading without compromising the quality of life. Stopping air-conditioning is easy to say, but actually if you stop the air-conditioning in Tokyo in the summertime, it becomes intolerable. So there has to be a compromise to some extent.

In order to solve this problem, there are many sophisticated ways. First there must be integration of policy and technology to solve the problem of the environmental issue in Tokyo, especially that of CO_2 emission. Cost effectiveness is another important issue. There are many technologies which can reduce CO_2 or which can reduce pollutants, but we have to look at cost because our budget is limited. There is the tradeoff between local environment versus global environment. Stakeholders' participation is necessary, especially when we think about energy saving or CO_2 emission reduction. Without the participation of citizens we can never achieve our target.

Now I come to a project of the AGS called the Tokyo Half Project. The purpose of the Tokyo Half Project is to set up a collaborating platform to evaluate the effectiveness of a portfolio of policy and technology options for CO_2 emission reduction. There are many technologies that are readily available, and many policies are possible, but you have to analyze the relationship among these options. They are not independent at all. The Tokyo Half Project is based on various data, such as GIS, traffic and LCA data. After we apply similar models, we finally come to the evaluation of the effect of introducing, for example, the heating system or best power generation mix, the heat island issue, waste disposal, transportation, and others. The important point here is they are very much interrelated.

No single person can understand the whole picture. So the approach we take is that each of the researchers develops his own model, and they plug it into the system called DOME (Distributed Object-based Modeling and Evaluation), which has been developed at MIT. DOME can provide a so-called collaborating platform. Through this platform, you can exchange the output of your model, you can give the output of your model to another, and you can get the output of other people's models for your model. This kind of interaction is very necessary to analyze such a complicated situation.

The other project I am involved in is the Guangzhou project. Guangzhou is a very big city with a population of 10 million. There are many high-rise buildings. It is still growing, and it is very close to Hong Kong, so you can imagine the money invested in the Guangzhou area. The main problem here is rapid growth in population and increased industrial activity. Here the question is, how can they maintain environmental loading at a reasonable level with the rising quality of life. The quality of life is not high enough in China, so they have to spend more money and more energy to improve their quality of life. It tends to increase environmental loading, but we should try to minimize such increase.

The project is called Future City – Guangzhou: A Partnership for Urban Sustainability. We have a very strong collaboration with the Guangzhou City government. We do not just go there and get data and analyze it by ourselves. We talk with Guangzhou City government and other people often, by having semi-

nars and workshops, and we exchange students and invite staff from Guangzhou City to three AGS universities, MIT, ETH, and the University of Tokyo. Through such discussions we identify the key issues which we can contribute to. These are (1) transportation, which is handled by MIT; (2) housing, handled by ETH; and (3) water management, handled by UT.

My group is involved in water resource management. Guangzhou is planning to develop a new area called Panyu, where the population will be increasing from 1.6 million to an estimated 4.15 million by the year 2050. It is a very long-term plan. And here both water quantity and water quality are serious issues.

Every mega-city is different. However, there are many common issues to be solved. For common issues we can have common solutions, such as the application of new technologies and policies. The other type of issue is very much city-specific or area-specific. You obviously cannot apply a Tokyo method to Guangzhou. However, a method of analysis or approach may be common to both.

AGS research can contribute to the realization of a sustainable global city. AGS research teams can provide a holistic view and solution by interdisciplinary and international teams. We are not just one company. We have many faculty members in different countries, so we can provide a holistic view. This is one essential point. Another point is especially important at the university: AGS can contribute to capacity-building, not only in a partner city like Guangzhou but also in our own universities. We can teach our students, and we can teach ourselves as well. I think this is what the AGS should be.

Claudia Sheinbaum Pardo Secretary of the Environment, Mexico City

I will present a general view of environmental problems and the strategies that we are trying to carry out in Mexico City. We will look at local pollution in Mexico City, which will include a view of (1) the water problem, (2) what we call the conservation of land in Mexico City, and (3) how are we linking the climate change program of Mexico City to local strategies.

Mexico City is in a closed atmospheric basin with a population of about 18 million. In the city, around 3.5 million vehicles circulate every day, and there are around 35,000 industries. Few people realize that 50% of Mexico City is still rural and forest. The whole region, not only in Mexico City but the Basin, represents 2% of the planet's biodiversity. Further, Mexico City consumes 17.3% of the whole electricity of the nation, and is responsible for 15% of the nation's greenhouse gas emissions.

Mexico City has a very difficult political organization. In the Federal District, which is what we call Mexico City, the population is almost constant, although the state of Mexico contains parts of the mega-city and is growing very fast. In some of the municipalities, the population growth is around 6% to 8%annually. This creates difficulties for conducting any policy in Mexico City, since there is not just one state but there are different states and municipalities. By the year 2020, the population will rise to around 40 million, with seven states involved and more than 40 municipalities. The main barriers are different administrations in the mega-city, different social policies, different economical policies, and different environmental policies.

Some things are happening right now in Mexico City that are not directly linked to environmental policies but are still important to recognize. Of the 18 million people in Mexico City, more than half of the population is below the poverty line. There are very old technologies in Mexico City, and the income per capita is far below that of developed cities. The new government in Mexico City has a strategy to increase economic growth two ways: (1) to develop high-tech industrial corridors in Mexico City, and (2) through tourism, to put money into the historical downtown. More than one billion dollars are designated to reduce poverty in Mexico City through various policies. An important education program is in place. And also an important urban planning policy is in place, which concerns the reindentification of the central area of the city. Most of the people that used to live in the central areas are now outside the city and the protection of the conservation zone.

84% of the local pollution in Mexico City is due to transportation, and most of the programs are due to high concentrations of ozone and particulate matter of 10 microns (PM_{10}). We do not have a lead problem anymore. We do not have an SO_2 problem anymore. We do not have a carbon monoxide problem anymore. So we mainly have the ozone and PM10 problems.

In terms of water we have another big problem. We consume about 62 cubic meters of water per second. 70% of this consumption comes from the aquifer, which is overexploited. 60% of the consumption is residential, and 30% is lost in the distribution through pipelines. By overexploited I mean that we are taking from the aquifer half of what is infiltrated. To remedy this, we are putting in place policies including artificial injection into the aquifer and re-injection of treated water into the aquifer.

Most of the agriculture is traditional, so this year we are designating 50 million dollars to subsidize a production change in agriculture through natural products, local standards of natural agriculture, and alliances with big city markets. Forestation is also important. We are paying one peso for every tree that is planted. These are local strategies, but we are trying to link local strategies to a global strategy for the city through a climate change strategy for Mexico City. This is helping us to bring the water, air pollution, and forest programs together. Thus we are linking local and global environmental problems, and we are providing an opportunity to increase financial resources through climate change financial research that is now in place.

Lastly, through local and global strategies, we are trying to build a local climate change strategy which will have adaptability, reliability, and greenhouse gas mitigation opportunities. We are creating a portfolio of opportunities, and this strategy will be ready in June, 2002.

Angelica Castro Head of Planning Department of TransMilenio, Bogotá, Colombia

Today I would like to show you how the quality of life in Bogotá has changed and is still changing. We are changing because of 10 years of responsible governors and mayors in the city. I will share with you only one area of our change – mobility – and some aspects about transport in Bogotá.

First, some numbers about Bogotá, a city of seven million people with a population density of 200 inhabitants per hectare. Half a million cars are registered in Bogotá with another half million in 12 small cities that surround the city. Although the latter pay taxes in the other cities, they use the infrastructure of Bogotá, and nearly all their emissions are in Bogotá. We are trying to correct this problem. We have 30,000 buses for public transportation carrying 72% of the city's population. The million cars that use Bogotá's infrastructure transport only 19% of the population. Before TransMilenio (which I will talk about later on), the mean speed in the city was only 10 kilometers per hour. It was very slow. And each person spent on average two hours and 20 minutes a day in transport, or the equivalent, by the time someone is 60 years old, of 10 years in a bus. That is quite a big problem.

Then in the case of mobility, we started with four strategies. First was the normal or traditional means of moving our bodies, and that is walking. But it was quite impossible to walk in Bogotá because all the sidewalks were completely filled with cars and commerce. For the second strategy we started banning cars and commerce and we started building parks – not only big parks for the city but also small parks in the neighborhoods. Then our objective became public space reoccupation in Bogotá. We not only reoccupied space but also have tried to build a very nice space in which people can work freely. In other places, we have tried – in the city center, for instance – to turn some roads into pedestrian roads. In addition, Colombia, not only Bogotá, is traditionally bike country. But normally people use the bicycle for sports, not for transportation. So we tried to exploit that love for the bicycle by encouraging people to use it for transportation. The third strategy was to discourage private car use. The fourth and most important strategy in mobility concerns mass transportation.

As I said, we try to encourage people to use bicycles for transportation, not only for sports. We decided to build cycle routes or bikeways just along the main corridors of the city. Every Sunday we close, from 7 am to 2 pm, the main streets in the city and we leave these spaces for the people, mainly in bicycles but people can do their skating, working, and so on. And we are working to make spaces to park bicycles in order to give the people who are owners of bicycles some safety and security for their bicycles. We have now a network of 200 kilometers of bikeways, and people are using these spaces every day. Parks have sidewalks and bikeways to give them good spaces in which to work and bike.

In Bogotá it was not enough just to build some sidewalks but it was very important for us to build them very large with lights and in very nice places. The reason we have these kinds of sidewalks now, in some sense, is that we have taken space from the vehicles and given that space to the people. Now we have around 3000 square meters in walkways, around 3000 neighborhood parks, and another 300 "pocket parks" which are very small parks inside the neighborhoods. And there are eleven metropolitan parks. Ten years ago Bogotá was not as green as it is today. Now, if they do not have enough money to go outside of the city, people can go on Sundays to the park, and that is really good for the quality of life there.

We have also adopted policies to discourage private car use. Years ago we started with something called, in Spanish, piqui placa, which means "for peak hours and for number plates." Two days a week people cannot use their cars in the two peak hours, in the morning (from 7 am to 9 am) and in the afternoon (from 5 pm to 7 pm). What has happened is very interesting: Some people have changed their habits and have gone very early in the morning, while other people have decided to leave their cars that day at their houses.

Another policy is the fuel surcharge tax – ours is now 20% – which we have to pay if we use our private cars, including 20% more of the charge for oil. This money is used for mass transportation and for our arrangement of some of the roads in the neighborhoods. We have another thing from three years ago that is called car-free weekdays: each year the first Thursday in February everyone leaves their private cars at their houses. Then people go that day walking, skating, by public transport, or cycling, but nobody uses their car. Maybe it is not a very big impact for the city, only one day, but it is a way to raise awareness about what would happen to our city if none of us used our own cars.

TransMilenio was good not only from the point of view of transportation but also in terms of employment. It has changed some policies that we had before it was begun: Just in building the roads, we have 18,000 jobs doing construction, and now we have three thousand direct jobs in operation. In a country with a 20% unemployment, perhaps these numbers are important. With TransMilenio we have pedestrian bridges, and we try to build around the pedestrian bridges bigger spaces for the people. The price of a ticket now is 40 cents US. We carry 150 million passengers each year with around 650,000 passengers daily. We have around 500 buses and 59 stations, and four stations are the main stations where we integrate the feeder buses. We are now operating 38 kilometers and we are going to have 40 kilometers by June [2002]. The average speed now is 26 kilometers per hour. This means people now can use their time not only in transport but also with their families or with their hobbies and so forth. Our target for TransMilenio is to build 388 more kilometers in segregated roadways over the next 15 years.

Panel

Technology and the Future of Sustainable Development

Atushi Koma	Vice-President, University of Tokyo
Hiroshi Komiyama	Professor, University of Tokyo, panel chair
Lloyd Timberlake	Avina Foundation
Francisco Barnés	Secretary of Energy, Mexico
Guy de Téramond	Minister of Science and Technology, Costa Rica

Atushi Koma opened the panel with two over-arching remarks: technological development is an essential tool in the solving of global sustainability problems; and technology covers a wide variety of fields. With this he introduced the panel as consisting of representatives of the governmental, private, and academic sectors.

Hiroshi Komiyama, panel chair, stressed the point that science and technology should be used to shape the future of humanity's sustainable existence. The question lies in answering how science and technology are to be used towards this end. Local models need to be constructed within the framework of a global model to provide answers about the core issues of sustainability, such as food, air, water, the ecosystem, materials and energy. While these models need to be sufficiently simple so that they can be widely understood, they must be based on sound science and technological information. One such global model, of material ad energy, sustainability is suggested:

This model, called the Komiyama Plan, makes three basic assumptions: energy efficiency can be tripled; material circulation (recycling) can be enhanced; and current sources of energy can be doubled. Trends in the 20th century bring to light considerations under which the previous three assumptions were formulated: world population increased by a factor of 3.5; crop production grew by a factor of 7.5; energy consumption multiplied 20 times; steel by 20 times and aluminum 4000 times; CO_2 emissions increased sharply; and waste from construction and social infrastructure is slowly being realized as they come to the end of their useful lives. The three assumptions take into consideration these trends and assume that developing countries will equal Japan in their standard of living.

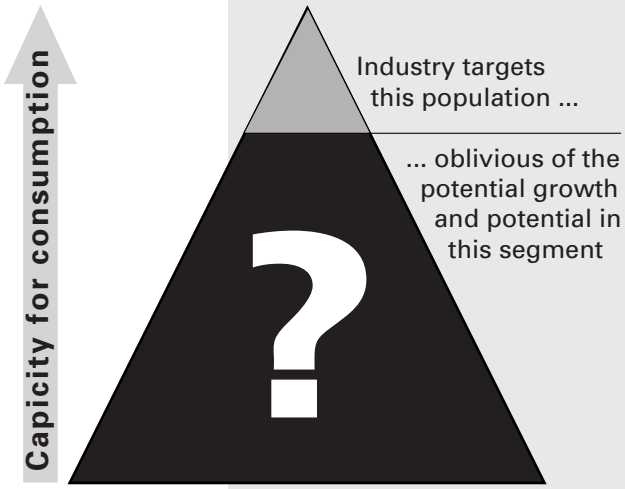
An example serves the function of demonstrating the energy gains that can readily be made through use of technology: Desalination of brine is one of the alternatives being considered for sustainable water production. Theoretical calculations show that the equivalent of 24 atmospheres of pressure is required for the process. Currently we use 80 atmospheres. There is, therefore, potential for a 70% saving in the energy used in the process. Another obvious example is the energy consumption in cement production in different countries. While Japan uses minimal amounts of energy in cement production, the US is notorious for using excessive amounts of energy for the same process. Technology diffusion and a commitment to energy saving would result in great savings.

The tripling of energy use efficiency by 2050 is possible. With current levels of energy consumption, we could have three times the services to address the north-south disparities. The basic assumptions are sound theoretically and feasible technologically. The vision can be realized. Science and technology are the keys to this realization.

Lloyd Timberlake from the Avina Foundation provided a different paradigm for looking at sustainable development. In 1964 a poll was taken in England from 'experts' in different fields, to get an understanding of what they thought the world would look like in 1984, 20 years later. The results showed that by and large, technologists predicted an era of no physical libraries and paperless offices – this was even before the proliferation of the internet! Socialists and anthropologists, on the other hand, predicted little change. In both cases, we have seen very much the opposite. Whilst the internet is increasingly becoming a medium for the transfer of knowledge, paper consumption has grown rapidly. Women's rights and the institutional acceptance of homosexuality are examples of social changes that have occurred, which were far from the vision at the time. These examples serve to remind us of our very modest powers of prediction. We should remember this when thinking of technology and the shaping of the future.

Where population growth rates have dropped, a crucial step towards a sustainable future, this has not been a result of technology, but rather a function of the empowerment of women. Technological fixes are frowned upon as the image of rusting tractors in Africa come to mind.

Companies and manufacturers have traditionally target the 'wealthy' minority of the world's population – technology has been generally developed and designed for this category of consumers. In doing so, they are not tapping into the billions of other potential consumers. Iqbal Quadir, CEO of Grameen-Phone used the philosophy of not looking at how much money rural-dwellers had, so as to support the mobile phone industry, but rather on focusing on how much they could generate from having access to the service. There are only a handful of activities that target the base of this pyramid. This is where the activities are most exciting. One of the themes for the next AGS Annual Meeting should be "think global, think small."



Francisco Barnés, Secretary of Energy for Mexico spoke of the obvious contributions of technology to a sustainable energy policy. The Mexican government's new energy program for more sustainable energy development has as its basis four objectives: (1) a reliable supply of energy for the country; (2) the promotion of a more efficient use of energy; (3) further development of the sources of renewable energy that we have in the country; and (4) probably the most important of the four, to be sustainable in the long term to minimize the impact on the environment that we are now having. A transition needs to be made to replace fuel oil with natural gas; new power plants based on combined cycle technology need to be developed and constructed; renewable energies need to be further researched; and energy saving programs should be established.

In terms of renewable energies, about 25% of the total generation capacity in Mexico comes from renewables. However, most of that comes from the large hydroelectric dams built in the last hundred years. About 12 megawatts of solar power generation has been installed, mostly in rural areas of Mexico, to pro-

vide electricity for those areas that are difficult to bring the wires and provide electricity otherwise. Technological advancement is integral to all of these potential gains towards sustainable policy.

Guy de Téramond, the Costa Rican Minister of Science and Technology, spoke on the use of the global internet for global sustainability, as a powerful instrument for change and the development of society.

Thirty years ago, four computers existed; today the number extends beyond 100 million. Most users, however, are in technologically advanced countries, creating the technological divide. This divide must be addressed. Costa Rica, having recognized the tremendous savings to be realized by addressing this divide, is planning to install infrastructure that will put the country above US broadband connectivity. To improve access, essential to the regions development, a region-wide internet connectivity scheme is being proposed. The idea is to share the costs among 30-40 countries in the region and not have countries pay for single country connections. This is the only financially sustainable solution.

The space at the bottom of the triangle discussed by Lloyd Timberlake is significant. It should be remembered that no person or company has a monopoly over intellect and brains. This portion of the population has a significant role to play in the advancement of the global society.

Panel

The Challenge to Academia: Preparing the Next Generation of Leaders

Jan-Eric Sundgren	President, Chalmers University of Technology
Charles Vest	President, Massachusetts Institute of Technology
Olaf Kübler	President, Swiss Federal Institute of Technology, Zurich
Alberto Bustani	President, Instituto Technológico y de Estudios Superiores de Monterrey
Roberto Artavia Loria	Rector, Instituto Centroamericano de Administración de Empresas

Overview

The panel addressed the issues of how to manage universities to promote sustainability, and how to act at universities to build for subsequent generations. Transforming universities with professors and students such that they place sustainability at the top of their agenda is not a simple task. Awareness has to be increased, and attitudes need to be altered as well. The largest effect with long-term sustainable impact will come from focusing on learning, changing curricula to accommodate relevant courses, and accommodating projects, particularly team projects, which extend across borders.

The mission of the AGS is to build understanding of critical problems that threaten the transition of the world toward a more sustainable system of development, and to assess possible solutions, ways of mediating and helping that process along in a holistic manner that draw substantially on the natural, engineering, and social sciences. The AGS has already proved to be a wonderful mechanism in this regard. We must more of what we do best – research and education, grounded in strong, hard science and technology. Noted was the formation of ALUDES, the Latin American Alliance of Universities for Sustainable Development consisting of 42 Latin American universities focused on sustainability, an organization that is very similar in nature to, yet different, as it should be, from the AGS.

The responsibility of a university, first and foremost, is the dissemination of knowledge and the creation of new knowledge. In order to have this continuous flow of knowledge and knowledge creation, the responsibility of the institution is to have great research programs and visionary, exciting, and innovative faculty, as well as the best and most vital students to be educated as future leaders. Outreach activities are crucial ingredients in a progressive university activity, for example, getting closer to NGOs and working with them on specific agendas. Sustainable development requires commitment and action from all segments of society as well as shared responsibilities among governments, civil organizations, universities, and businesses.

Jan-Eric Sundgren President, Chalmers University of Technology

How are we going to manage universities to promote sustainability, and how do we act at universities to build for the next generation? What are the universities doing and what role do they play? There are, of course, obvious answers to those questions: that we provide the world with research results, and that we educate students with relevant sustainability issues. But I believe there is much more to this than these simple questions.

It is not an easy process to transform universities with professors and students such that they place sustainability at the top of their agenda. The former French president, Charles DeGaulle once said, "How can you govern a country that has 650 different types of cheese?" I note the similarities with how it is to lead universities: they are not easy to change, and perhaps they should not be easy to change. But, as was pointed out by Jeffrey Sachs yesterday, we are in a position where universities need to change. We need to have an organization in such a way that boundaries do not hinder solving complex research tasks that require boundary crossing. Establishing projects that cross boundaries will be of increasingly importance. And I think we have much to learn from the corporate world in this regard. I also believe that university presidents, deans, etc., have to be convinced that sustainability questions are a top priority, and then we have to start "to walk the dog." That is, we need to ensure that these questions are high up on the agenda as we stimulate new research and educational activities in this field.

For many I think awareness has to be increased, and I think, at least for my faculty, that they would have strongly benefited from listening to the talk by Jeffrey Sachs. Many eyes would have been opened, I am sure. Also, attitudes need to be altered. It has been said that attitude is a small thing that makes a big difference, and I could not agree more. The AGS is an excellent example. At Chalmers, in a very short time, the AGS has had a pronounced effect on our campus and faculty and on our students: namely, an awareness among many, not just the "almost convinced" but also others, which has increased simply by the visibility that the AGS has gotten on our campus.

However, the largest effect with long-term sustainable impact will, of course, come from focusing on learning, changing curricula to accommodate relevant courses, and accommodating projects, particularly team projects, which extend across borders – both disciplinary borders as well as cultural and ethnic borders. That is a necessity. And, as has been pointed out by several of the speakers during this meeting, it is also necessary to involve stakeholders to a larger degree. I would also stress the importance of high-quality research for our learning efforts.

At Chalmers, we have made it compulsory for all students to have at least a minimum amount of credits related to environmental and sustainability questions. We have established something called the SEARCH program. SEARCH is an acronym for Sustainability in Engineering and Architecture, education based on Research at Chalmers. In addition to the minimum credit points all students have to earn, we have also made it possible for all students enrolled in any of the programs to finish up by having the last two years completely focused on aspects of sustainability. I am convinced this program will have a long-term effect.

Another important area is, of course, establishment abroad of research efforts and teams across the universities. A couple of years ago, we, with the aid of external experts, identified weaknesses and strengths at Chalmers and then went on to formulate a new research project that complemented existing efforts. We identified seven youth areas with a common denominator, i.e. that they all took a system-based approach, and then we recruited seven new full professors and gave them a five-year startup grant. I am convinced that this will have a leverage effect in the long run.

Outreach activities are also crucial ingredients in a progressive university activity. Sustainable development requires commitment and action from all segments of society as well as shared responsibilities among governments, civil organizations, universities, and businesses. What we manage together we simply cannot manage individually. That is one of the main reasons why I think the AGS is so important to me and to Chalmers.

Panel

The Challenge to Academia: Preparing the Next Generation of Leaders (Presidents' Panel)

Charles Vest President, Massachusetts Institute of Technology

It's a great pleasure to share the platform this afternoon with my friends and colleagues from the AGS universities and from other universities around Latin America. I begin by saying that, despite the incredible daunting challenges that the AGS exists to think about and work toward resolving, I am both an optimist and also very pleased with how far the AGS has in fact come, especially through its influence on our own institutions, in a relatively short space of time. Our goal, as you know, is focused on the things that we do best as universities – research, education, and outreach. Our mission is to build understanding of critical problems that threaten the transition of the world toward a more sustainable system of development, to assess possible solutions, ways of mediating and helping that process along in a holistic manner that draw substantially on the natural, engineering, and social sciences.

The AGS, I believe, has already proved to be a wonderful mechanism to enable the extraordinary faculties of our institutions to accomplish their goals and dreams in this regard. To date the AGS has provided resources to carry out over 60 research initiatives to advance our mission. Each of these projects engages graduate students whose participation in the AGS research makes them full partners in this great endeavor. More than 200 students from around the world have already very directly benefited from these experiences. Within our universities, as Jan-Eric has said, the AGS has stimulated a fair amount of change and developed new approaches to sustainability and environmentally related issues. It has led to the development of new curricula. It has inspired opportunities for students to work in much more multidisciplinary contexts on sustainability issues, and it has fostered, I believe, a greater environmental awareness among the entire body of our faculties and their students.

At MIT we have been very fortunate to have received support from certain visionary donors that has allowed us to provide even more such opportunities for collaborative learning. I want to point to two of them. First is the Martin Family Society of Fellows of Sustainability. The other is the Wallenberg Postdoctoral Fellowship Program on Sustainability and Environment. The Martin Family Society was created in 1996 and provides support for outstanding graduate students from many different disciplines to pursue sustainability-oriented research and dialogue. Seventy-five of our graduate students have participated to date in this program. The Wallenberg Postdoctoral Program brings exceptional Swedish scientists, engineers, and policymakers to MIT for one- or two-year research experiences related to environmental preservation and sustainable development. They also conduct research and, of course, participate in various multidisciplinary activities, often in conjunction with AGS endeavors.

These and other similar initiatives support the work of our scholars with funding that would be very difficult to obtain from traditional sources. They promote scholarly and educational community and encourage students and researchers to collaborate across disciplinary boundaries and to develop, as I said earlier, more holistic approaches to problem solving. This year MIT is going to launch a new and very exciting program on environmental and health management in collaboration with the Harvard School of Public Health. This new masters degree program is aimed at mid-career professionals coming to us from Mexico. We expect to enroll around a dozen such students each year. The development of this new degree program is being overseen by some of our most outstanding faculty and researchers, including Nobel Laureate

Mario Molina and his longtime collaborator, Luisa Molina, as well as Professor of Urban Studies and Environmental Planning, Larry Susskind.

This model that we will be developing with Mexico draws on complementary resources from two leading educational institutions and is, by definition, interdisciplinary. We think it holds great promise. There are many more activities I could point to on our campus for developing our systems initiative, variety of outreach activities to primary and secondary school students, and so forth.

Let me close with just a few personal thoughts about our greater mission, both as universities and as the Alliance for Global Sustainability. It is my personal view that we must do well what we do best – research and education, grounded in strong, hard science and technology. The context in which we do so is changing, the opportunities to serve through this education and research are changing as are the necessary collaborations. But, in my view, our mission and our scope cannot and should not be expanded indefinitely.

But our work and the results of our work and their impact can be expanded in a variety of ways, and I want to close by pointing to two. One is not directly or inherently an AGS activity, but it is very important, in my view, and that is the new MIT Open CourseWare initiative. Our faculty has pledged over the next five years or so to put the basic teaching materials for all 2000 subjects we teach at MIT on the World Wide Web to make them available to teachers and students anywhere in the world at any time, totally free of charge. I point to this as an example of how we can create more open systems, how we can better, more directly share the wealth that we have intellectually with others throughout the world.

Secondly, I have to say that I am both tremendously impressed and extremely encouraged by what I have seen here these last two days about the formation of ALUDES, the Latin American Alliance that is very similar in nature to, yet different, as it should be, from the AGS. And, in my view, if the activities of the AGS have played even the smallest role in helping to initiate ALUDES, this gives us a great vision of how we can both stick to doing what we do best and also greatly leverage and expand our influence around the world. Ultimately, of course, whatever we do, it will be the network, the cadre of students that have come through these programs – knowing each other, having a basis together, having thought about and cared about sustainability and carried that off into their careers – that will be our greatest gift to the world.

Olaf Kübler President, Swiss Federal Institute of Technology, Zurich

How can universities contribute to meeting the challenges of global sustainability and building the future for the next generation? I think this comprehensive question can only be answered in part by any of us. Fortunately, there are enough on the panel that maybe the whole picture will give the full answer. So in aligning my remarks, I have tried to let myself be guided by the keyword, "next generation," and also by "mainstreaming." I will talk more about the normal life of the university, not a particular effort like AGS, since the future, after all, will have to be characterized by normality rather than by extra efforts, which should expand and must expand into something which has normal life.

Every university and every professor at a university wants the brightest and most vital students, and for very selfish reasons: because it is so much fun, the vitality spreads, good students will produce excellent research result – and then, the one thing that should not be forgotten, it gives the professor the feeling of eternal youth and eternal intelligence because he is surrounded or she is surrounded by people of youth and intelligence. Now what that means is that all of us – and that is true for the institutions as well as for the individuals – compete for talents by best topics, and hopefully all of us, in the laboratories, by creating the best peer atmosphere that we could think of.

As to the competition for the best topics, what does that mean? Is it sustainability? Is it understanding the brain? Is it galaxy formation? Is it information science? Is it construction of concrete superstructures? We should not delude ourselves; there are many great topics out there and the competition for all these topics is fierce. The students will choose with their feet what they think is most relevant and most interesting to them.

Now what is the responsibility of an institution in this whole activity? In my mind, the responsibility of an institution – a university first and foremost, of course – is the dissemination of knowledge and the creation of new knowledge. And here technology helps us a lot, as Charles Vest mentioned for MIT where the faculty have pledged to put their courseware on the web. In the same and similar vein, ETH-Zurich has created ETH-World as a platform, which puts all the course notes out there where people might want to look at them and learn from them.

In order to have this continuous flow of knowledge and knowledge creation, the responsibility of the institution again is to get the best faculty and, of course, to have great research programs, visionary faculty, exciting faculty, innovative faculty. ETH was a pioneer in creating a department for environmental science. This has now gone through half a generation – it is thirteen years by now – and just to show the capacity for constant evolution, this department of environmental science has gotten together with the departments for agriculture, forestry, and earth sciences in order to think about new combinations where not only the analytical aspects of sustainability are being addressed but also the engineering side, the constructive aspects, which means focusing more on what we can do rather than what we should not do.

To keep the program alive, of course, we need sustained resources. For the AGS, we have been able to achieve that, and we are working to keep it that way. But we also need sustained student interest. If the next generation is not interested in sustainability and environmental matters, then we have just lost out.

And student interest, we should not forget, is one of the best indicators whether we are really working on relevant research topics or not. Because even though a beginning student may not have all the knowledge he will have at the end of his studies, instinctively, I think, the students know very well what is important for their own lives and what is not.

The goal of these endeavors is to provide facts and conclusions towards policy formation, to be able to formulate metrics, and also to monitor and guide our further research to see whether we are getting closer to sustainability or actually moving away from it – in a way, to create the conditions on a micro-level such that a macro-system can finally come together from components which work in the right direction. Having the best and most vital students, of course, means that we will educate a generation of future leaders, and I am very optimistic that this macro-system of future leaders will deal with sustainability in the ways that sustainability needs to be dealt with.

Alberto Bustani President, Instituto Technológico y de Estudios Superiores de Monterrey

I wish to share with you our experience at Monterrey Tech in regard to preparing new generations of leaders committed to sustainable development. Every ten years Monterrey Tech reviews its mission in order to better serve Mexico and society in general. In 1995 the Tech changed its mission statement and included a goal for 2005 of educated individuals (1) who are committed to the sustainable development of the country and their local communities, to improve them in their social, economic and political aspects, and (2) who are internationally competitive in their areas of knowledge and endeavor.

Based on this goal we started a series of activities directed to increasing the awareness and sensibility of persons in regard to the concept of sustainable development. Interestingly, much of our effort in those first years was focused mainly on introducing the concept by means of courses and conferences. This effort was successful, and soon it became evident that students understood rapidly and well the ideas behind sustainable development and the professors on their part transmitted the concepts readily.

However, the problem was how to bring these concepts down to concrete applications. The student would tell us that he understood very well the philosophy behind sustainable development but that he did not know how to put it into practice. Students soon began to comment that these types of courses seemed to them to be too theoretical and impractical. This led to demotivation, and soon we began to see decreasing enrollments in such courses to such a degree that it led us to redefine the strategy.

We see the challenge today not so much as how to make the student population more conscious or sensitive as it is how to achieve increasing participation and how to demonstrate forms in which this concept of sustainable development can be brought down to earth: How to advance towards sustainable development of a region even though taking small steps? How to climb the first step? How to make things concrete? How to begin to act? Where?

I will now tell you what happened to me just a few days ago when I was writing this document. One evening, when I arrived home, I asked my 12-year old son if he knew what sustainable development was. After all, if we are talking about forming the leaders of the future, the least that we can do is to ask the children of today. My son, who by the way made this trip with me from Monterrey and is present here, looked at me a bit thoughtfully and answered that he did not know what sustainable development was. I then asked him how he would like the world in the future to be when he grew up and were an adult of my age. I asked him to put it down in writing.

His list included the following: That there be no corrupt policemen; that one be safe being in the street; that there not be so much discrimination; that there be more opportunities for work; that the minimum wage not be so low; that public schools give a better education; that there be more prevention against diseases, especially the mortal ones; that schools teach good English; that there not be so much malnutrition in the most needy children; that people, for example in Africa, have enough resources for living; that there be no kidnapping; that public services be improved; that cars be electric or that they use another material that will not contaminate; that there be no unnecessary logging of trees; that industries find

ways not to contaminate and that they not discharge toxic matter or waste into the rivers; that in the city there be a minimum of 5 trees per hundred square meters; and that there be public waste cans for garbage.

It caught my attention to see that the majority of the things that he listed had to do with sustainable development. I also observed that all were very concrete, measurable and, especially, were achievable in a medium-term span of time, and also, that they were disaggregated, that they could be identified with certain clarity with regard to the person responsible with whom to define a plan of action. This is often in contrast to what occurs when we try to work with sustainable development where it appears to be an impossible task to see who is clearly responsible for doing what, and where it is not easy to define a plan of action.

Also, we do not know exactly from which professional discipline will emerge the leaders of the future. In the former Czechoslovakia, a man of literature emerged as the leader after the fall of the Berlin Wall, Vaclav Havel, a playwright. Similarly, other leaders in the world have emerged from many other professions. So, we have decided to implant in all undergraduate courses an introduction to the concepts of sustainable development and also to implant sustainability in terms of the greening of the campus. We consider this to be important to the development of future leaders so that they will emerge with the concept of sustainable development as a natural part of their mentality and training.

We then thought about developing a large umbrella which, under the concept of sustainable development, would encompass all of the institution in such a manner that the student would learn by doing and by seeing done. We have called this program the Greening of the Campus Program. The main goal of the Greening of the Campus Program, or GCP, is to develop and put into practice a model of sustainable development for higher level education, tailored to the specific needs of Monterrey Tech based on cleaner production and eco-efficiency concepts and techniques, that also comply with ISO 9000, 14000.

The Greening of the Campus Program includes, first, greening of the curricula, to ensure that the concepts, values, approaches, tools and procedures of implementing sustainable development in our society are the golden thread of all or most of our courses and curricula; second, greening of research, to ensure that a substantial commitment is made to doing the kinds of research that will help to further our knowledge and to provide the interdisciplinary insights and tools to make sustainable development a reality throughout our society; third, greening of the outreach activities, to ensure that faculty and students, by working and learning together within the real world, have opportunities to test, refine and apply their concepts and tools on sustainable development and thereby make direct contributions to the societal transition to sustainable development; and fourth, greening of the campus, to ensure that the operation and maintenance of the campus' physical and biological system is accomplished in such a way that it is a living example of the best management practices of eco-efficiency with regard to energy, water, toxic materials, health, and safety, as well as landscaping, transportation and esthetics. By so doing, the faculty, staff and students will be living by doing and will learn to practice what they preach, and campus operations will be done in such a manner that waste and risk minimization are the norm, thereby leading to short- and long-term cost savings.

Summarizing, the Greening of the Campus Program of Monterrey Tech is a stepwise process directed to the general and overall educational activities of the Monterrey Campus from which some or many of the future leaders in many fields will emerge. More than a grand philosophical scheme, it is a progressive, practical implementation, by steps, of the outlined program with adjustments and provisions for learning and correction of the program as it advances and in accordance with perceived needs at the campus.

Roberto Artavia Loria Rector, Instituto Centroamericano de Administración de Empresas

The first thing I would like to say is that we have been working in sustainability for quite a long time: the official history of INCAE establishes that the first true sustainability course that we taught was as early as the 1983-84 academic year, in which Professors Robert Mullins and Alvo Romania introduced the first energy and materials management course. At the time, we did not call it eco-efficiency, but this course had a great impact in preparing INCAE for what would become hopefully one of the centers of sustainable development research and knowledge dissemination in the region. I mention our early start because the one thing that we know is that, as much as we are doing, we are not doing enough. There is much more that can be accomplished in this area, and I am just going to summarize now for you what I call the four approaches to the promotion of sustainability in Latin America in which we participate.

Obviously, the first component in all universities and superior education endeavors should be, in my view, precisely the educational program – in this case, our MBA. You have got to remember that INCAE is a very specialized school: we only have a one-degree program, and that is an MBA. We have four sections of this MBA, two here in Costa Rica and two more in our Managua Campus, and in that sense we have tried very hard for a long time to make sure that everyone who graduates from the program is not simply another well-trained manager or another technocrat of business administration, but rather someone who is committed to making a difference for his community and his society.

Of course, this is a lot easier said than done, and in that sense let me just tell you a few characteristics of our program. Obviously, excellence in teaching is something that we strive to accomplish, and in that sense we have the traditional portion of any MBA with the functional areas of business strategy and all the other courses that go into it. We will celebrate the 10th anniversary in 2002 of the first environmental management concentration of an MBA in Latin America, which we presented as our new program during the Earth Summit in Rio in 1992. And interestingly enough, when you look at this program and the other MBAs that we offer, or the other concentrations of the MBA that we offer, only one of the objectives of our program has to do with what I call the technocratic portion of business education. The rest of our program emphasizes ethics, management of change, teamwork, work under pressure, multinationality, passion for excellence, and multi-disciplinary approaches.

The reason for this is very practical for us. We were founded almost four years ago as a multi-national, multi-disciplinary school, and in that sense every working group at INCAE is by definition multi-national: no nationality represents more than 15% of any given class, and we make it a point to make sure that all working groups combine different professions in their work. The 250 MBAs that we graduate each year also have to go through a principles of sustainable development course, and we have made the eco-efficiency management course compulsory for all of our students. Half of our students take other electives related to environmental management, and 20% of them actually concentrate in environmental management, taking a full load of seven courses – including the two that are compulsory – to achieve a concentration in this topic.

So we have been modifying our educational program to include more and more the concepts of sustainability. And the other characteristic that I would point out is that we are trying to educate people who

want to make a difference. INCAE is truly a value-centered, experiential MBA program, and in that sense we hope that we are actually affecting the practices and attitudes so far as students, and not just their ability to understand the conceptual frameworks of the functional areas of business. So in the educational program, the degree program, which is the first of the four approaches to promoting sustainability in the region, this is what we have done.

The second approach is applied research, and in applied research six years ago we founded the Center for Competitiveness and Sustainable Development, which represents today up to 40% of the institutional budget. I mention that because really the commitment to applied research, to the concepts of sustainability as we understand it, is very deep. 40% of the institutional budget means not only that we have grown that much in the past six years but that we have committed a significant portion of very scarce resources and very scarce faculty time to this endeavor.

As we understand it – of course, because we are a business school – we only deal with the social sciences portion of sustainability, but we currently have research programs related to institutional development, environmental policy and management, social policy, business productivity, and economic growth, and we approach all these five topics from the standpoint of (1) sustainability and (2) continuity. I will explain more about the continuity portion of it as we get to the fourth component or the fourth approach to the promotion of sustainability that we follow at INCAE.

The third approach of our promotion of sustainability has to do with continuous innovation in the executive training programs. INCAE trains 3500 executives a year in 12 countries of the region. We now have a permanent presence and permanent executive training programs in the six Central American countries, the five Andean community countries, and the Dominican Republic. And we have been introducing a number of new topics related to environmental issues as a component of our executive training portfolio.

Just to give you a couple of examples, this year we had, for seven weeks, 60 Latin American professors of business and managers of NGOs, who underwent sustainability training. What that means in each case is somewhat different, because to a certain extent the program included things like environmental project appraisal – things that are applying tools of the environmental management component to the situations that these professors and NGO managers face – but it also included, and probably more importantly, the creation of a network of NGOs and universities in the Latin American schools with a common language, a common framework to actually start promoting in their own societies and communities the concepts of sustainability as we understand them.

Also, in most of our executive training programs as much as we can (this is still limited, and I want to be very honest in that), we try to include cases that have to deal somehow with environmental issues at the same time that they are promoting and communicating the tools of marketing or the tools of finance and other things which are traditional in the way that we carry out executive training but which now clearly include as much as possible the issues of the environment and sustainability in general.

The fourth approach, and probably the one that is going to be more important to us in the future, is what I call the Strategic Alliance for Sustainability. Professor Vest already mentioned that we founded just last

Wednesday something called ALUDES, the Latin American Alliance of Universities for Sustainable Development. This network of universities comprises more than 35 universities and 22 different institutions (but some of them have campuses in several countries in the region for a total of more than 30). What this will attempt to do is to replicate some of the groundbreaking research of the AGS, but it will be applied to the reality of Latin America.

Just to give you a practical example, this morning as we were talking about megacities of the future, we already had two people approaching us and asking us, can we get the information from Professor Molina? Can we get information from MIT or from ETH and from the University of Tokyo on how to measure the components of air pollution so that we can start applying those frameworks in the region? The answer is, well, I don't know exactly how we are going to get them, but we are going to be talking to AGS members trying to serve as a channel initially for the transference of technology to these universities, but most importantly, hopefully allowing these universities to connect directly to the AGS network so that we can replicate and apply a lot of this information to our own reality.

This institution of alliances, aside from those that we have with academic institutions, also includes very significant alliances with international financial institutions, particularly the Inter-American Development Bank and the Central American Bank for Economic Integration, which have been significantly generous in supplying funding and interest in many of the environmental and sustainability programs that we have carried out. We also have important alliances with governments in every one of the 12 countries that we work in, and in this sense we have found that introducing the environmental policy component to governments is actually the hardest part of promoting sustainability in the countries. It is actually easier to make business leaders understand the advantages of eco-efficiency, the advantages of green marketing, and the advantages of actually having a real reduction of waste and wasteful costs related to environmental issues than it is to convince the politicians to make new legislation and come up with creative ideas to create incentives for other businesses to do this.

But in any case, we have a strong alliance with the governments of the region and we are working to this end. We also have a number of important counterparts in the private sector, and in fact, in the cases of Central America and Ecuador, we have created something called competitiveness and sustainability boards in each one of the seven countries. What the people on these boards do is serve as our channel and as our ears and eyes in each one of these environments to identify opportunities of intervention for our research center or the executive training programs.

And finally, more and more we are getting closer to NGOs and are trying to work with them on specific agendas. As an examples of this, in El Salvador we currently have a program with an NGO called Construye Ambiente, which is trying to introduce better and cleaner technology in the construction industry of El Salvador and maintain at the same time the specific components of their own business, i.e. what makes them profitable.

So the four components are the interventions in our degree programs, the applied research of the center, the innovation in the executive training programs, and the institutional alliances – but more than anything, the true commitment of our faculty.

Keynote Address

Charting the Future: Challenges and Opportunities for the AGS

Eduardo Lizano President, Central Bank of Costa Rica

The Alliance for Global Sustainability was created to address a pressing need. The AGS tries to understand threats and constraints, so it is not only to mention, enumerate, or make a description of them, it is also necessary to understand them. The AGS intends to look for means to overcome these threats, so it is not only necessary to understand them, it is also necessary to overcome them, and that means pressing for action. The AGS promotes a better scientific understanding – not just a better philosophical, political, or even artistic understanding but a scientific one. The AGS seeks solutions for sustainable development – not economic or social development, but sustainable development.

The idea of the AGS is to generate a clear agenda which will foster a better future for mankind. Such a future will be built by the participation of academia, the business community, political and policy actors, and civil society. This participation will take place to enhance leadership and improve technologies in something called global citizenship. The AGS considers that this meeting is a must, because today's reality does not allow one to be optimistic about the future. So the key question for the AGS is as follows: What are the realistic prospects for sustainable development in the first decade of the millennium?

Many years ago in 1776, a well-known philosopher and economist from Scotland, Adam Smith, insisted that "No society can surely be flourishing and happy, of which the far greatest part of the members are poor and miserable." And a century and a half afterwards, in 1920, another well-known British economist, Alfred Marshall, proposed to his students and readers, "The well-being of the whole people should be the ultimate good of all private efforts and public policy."

Notwithstanding these clear-cut indications by our forefathers, it took economics and economists in general many decades to accept this idea and to incorporate it into a way of thinking. After some time in the 20th century, though, the close relationship between economic development and social development became clear. As a matter of fact, it became clear that the level of economic development depends to a large extent on social development; and the reverse also was true, namely, that social development was a function of economic development.

Both social and economic development are closely interrelated. The one could not take place without the other. Both became part of a single process. But today, a third element has appeared on the table – sustainable development. I do not know precisely when that took place, probably in the last two decades, so that today economic development does not depend only on social development but also on sustainable development. And social development depends not only on economic development but also on sustainable development. Besides, it is very important to realize that sustainable development depends at the same time on both economic and social development.

As we all know, in poor societies people will destroy forests just to get wood for cooking, and, without a certain degree of economic development, there will not be enough resources to keep the air clean and to save natural resources for the use of subsequent generations. Thus, all the three elements – economic, social and sustainable development – are so deeply interrelated that they are part and parcel of the same

and single process that we know and call, simply, development. All three elements have become necessary conditions, although none of them is sufficient for human development and human progress.

In the process to develop an integrated and single concept of development, important progress has been achieved in recent years in the academic field, in public policy formulation, and among the business community. Much less has been attained among labor organizations and public policy and public opinion at large. Nevertheless, the road before us is doubtless long and difficult. Human progress requires a simultaneous and dynamic inter-relationship of the three elements – economic, social, and sustainable development. It is like a chair that needs three legs: production, distribution, and sustainability. If any one of them is not in the right position, the chair cannot keep stable and would fall down.

Now, with much clear criteria of development, let us come to the issue of charting the future. The Oxford Dictionary indicates that a chart is a map on which selected characteristics are clearly indicated. Indeed, to chart is much less than to forecast and even less than to plan. Let me come first to rather obvious questions. Why should we try to chart the future? It is not much of a problem here in looking for the right answer. Many of the decisions that we make today have consequences tomorrow and the day after tomorrow. The decisions that we make today will depend to a great extent on how we think or believe the world will be in the near and distant future. Besides, man is inquisitive; we all enjoy questioning about what is unknown. But above all because we are unsatisfied with the present situation. And this is why we have to chart the future. Development is neither equitable nor sustainable. It is not necessary to dedicate much time to analyze the present situation in detail. The data available is overwhelming, given the high proportion of mankind that lives on less than one dollar per day.

Last, but not least, today the problems in one part of the world do affect the situation in the rest of it. No country, no society can live isolated or apart from what we call today the "global village." So it is for the sake of our own security and our own prosperity that we must be very interested in what happens in all the four corners of our planet and beyond. There is no question, we want and need to chart the future. A second question is that, even if we have good reasons to chart the future, are we actually able to do it? The answer is that we cannot be too optimistic, as we cannot be very precise on the subject. We do indeed know quite a lot about many things, but we also have to recognize that the more we know, the more we will realize, after all, how little we still know.

Let me be more specific on this issue. First, generally speaking, we have to handle many variables, but at the same time, and oftentimes, we do not know how to do so. There are significant limitations and shortcomings regarding the existence and directions of the relationships among the different variables. Second, when there is a given relationship, quite often we do not know the nature of the shape of this relationship, whether the relationship is a linear one or even if is discontinuous. Third, we have little information about the time lags of the reaction of the variables given a shock or modification of some other variables. Fourth, the intensity or the size of the reactions are also often unknown, as the coefficients in the equations are not known. Fifth, because what we cannot measure is often more important than what we can measure, it is necessary to include dummy variables in our models. When we study natural phenomena and, even more, when they are social phenomena, our ignorance remains quite substantial.

Granted, we are not completely in the dark. Jeffrey Sachs, for instance, recently told us that if rich countries would increase their annual aid to the very poor countries by one-tenth of one percent of their gross national product, it would be possible to save eight million people per year over a period of ten years. He established a clear-cut relationship among a given amount of money and the health conditions in the poor countries.

On the other hand, here in Costa Rica we have been studying the functioning of some tropical ecosystems, and we have encountered great difficulty just to get a clear-cut picture about the static way they function, not to mention the complexities when we try to build dynamic models in order to explain how they react to external factors.

Simulation techniques are helping us a great deal. Nevertheless, there are horrible and complex trade options between partial equilibrium dynamic models and general equilibrium dynamic models. The former are more precise but apart from reality. The latter are closer to reality, but their interpretation is extremely difficult.

So, on the one hand, we have been making progress, no doubt, and we have to push in that direction, but on the other hand, we have to be humble and recognize realistically where we are and what can expect when we try to chart the future. We cannot be fully precise, but, nonetheless, we can mention several major issues that will be on the table and will have an important incident in the future.

What are some of the main opportunities and what are some of the main challenges? Let me mention what it seems to me will be some of the key issues.

- Population growth and demographic explosion especially in the third world: world population will attain 9 billion by about the year 2045;
- Urbanization, because a high proportion of world population will be living in cities in the very near future;
- Migration, not only at the national level, but also at the international level: more and more people are moving from one country to another at the present time;
- The knowledge and technology revolutions: the world is moving to a society in which progress is based both on knowledge and on human resources able to produce, disseminate and take care of the administration of this knowledge;
- Environmental quality: here we find well-known issues such as the future conditions of climate, natural resources, and waste management;
- Water management: the use of it is becoming an increasingly complex problem;
- Globalization: there is a great increase in the movement of goods, services, capital knowledge and people among all the countries – the world is becoming more and more, as we said, a global village.

Lastly, we have to recognize that, if it is difficult to promote development, more production, and better distribution of sustainability so that poverty can be overcome in the not-too-distant future, it is much more difficult to promote progress. As a matter of fact, it is easier to have more increased income per capita than to improve living conditions for the people, where developing and relating better to physical well-being probably has to do much more with moral values. There is a real danger of an increasing number of

conflicts as a consequence of problems of ethnic, religious, and language origin: We have to ask, what should be the ethical and moral dimensions needed so that development and progress could go hand in hand?

When charting the future, we have to take into consideration the following facts: the first is that the present situation is not satisfactory, and the second is that there is a list of opportunities and challenges as the one just mentioned, how to solve today's problems and how to cope with the opportunities and challenges that lie before us.

Now, let me come to the question of how to achieve these developments. The two main requirements are basically participation and partnership. The more brains, the more eyes; and the more hands that participate, the higher the possibility of creating new ideas and different innovations to get the history of mankind moving forward. Because nobody is in position of proof, we need to talk, to hear, to dialogue, to negotiate. All of that is indispensable. Partnership and alliances are necessary among the academy, politicians, the business community, workers, media and religious movements.

But will it be possible to reach an acceptable level of development and progress? I just do not know, but it seems to me that at least two basic conditions must be fulfilled: First, to create a system of incentives that stimulate each one of the social acts just mentioned above, otherwise it will be very difficult, if possible at all, to get the participation and the cooperation in the process of development. Everyone has to get real and tangible benefits, and the losers must receive some kind of compensation. Second, it is necessary to establish firmly ethical principles and a moral code. Without them, it will be actually impossible to avoid social conflicts and economic exploitation and will leave many countries and societies outside the benefits of development. Without these two conditions, the institutions and the alliances needed will not be forthcoming, and consequently, development – be it economic, social, or sustainable – and progress will not be attained, and that would doubtless be a great pity for the future of the human race as a whole.

Panel

Are We Ready for the Future? Visions from the Next Generation World Student Community (WSC) Leaders

Steven R. L. Millman	Graduate Student, Massachusetts Institute of Technology; President and Co-Founder, AGS World Student Community
Eri Saikawa	Undergraduate Student, University of Tokyo; Councilor, AGS World Student Community
Patrick Bürgi	Fourth-year Student of Mechanical Engineering, ETH-Zurich
Gerald Heinicke	Ph.D. Candidate in Sanitary Engineering, Chalmers University of Technology
Urs Rhyner	Third Year Undergraduate in Material Science, École Polytechnique Fédérale de Lausanne
Timothy Prestero	Ph.D. candidate, MIT/Woods Hole Joint Program in Oceanographic Engineering
Abelardo Zeledon	Masters Student in the Sustainability Program of the Business Administration Program, INCAE

Overview

The annual meeting of the WSC was held for three days prior to the AGS annual meeting and brought together 80 students, representing 35 nationalities and all the populated continents. The student panelists, both undergraduate and graduate, represented a sample of the many projects that are being conducted around the world by the AGS World Student Community (WSC) – real projects with clear objectives, concrete results, and positive changes.

One project discussed, at the University of Tokyo, is OASIS (Open Assembly for Students Interested in Sustainability), designed to help Japanese students communicate sustainability issues in the English language. The world student community in Zurich has been involved with the Climate Protection Partnership (CLiPP). Another WSC project that was described, in Mauritania, is an effort to support the efforts of the local population to deal with problems of waste treatment and desertification. There is also the solid recycling project at the INCAE campus in Costa Rica. Finally, there was a presentation of ThinkCycle, an MIT based education initiative aiming to incorporate development and sustainability not only into particular programs in the university but also into all facets of university education.

Steven R. L. Millman — Graduate Student, Massachusetts Institute of Technology, President and Co-Founder, AGS World Student Community

I am here to chair this panel because I was serving as the chair of the AGS World Student Community [WSC] annual meeting which was just held at INCAE a few days before this meeting. I would like to first say thank you to the AGS for this opportunity to speak to you all. I know that time on this stage is highly sought after, and we very much appreciate the opportunity to share it with such esteemed faculty, university presidents, and Nobel Laureates.

These panelists represent a sample of the many projects that are being conducted around the world by the WSC. You will be hearing about real projects with clear objectives, concrete results, and positive changes. These are examples of how students, when given even the most minimal freedom and the most basic support, can do great things of importance.

I look out into this room and I see some of the most world renowned faculty within the field of sustainable development and, of course, in your individual fields. And I want you to know just how much influence you can have on the world by giving students the opportunity to follow their passion and their creativity.

I wish to acknowledge the faculty who have been so supportive of me as I have worked for the last few years to help develop the WSC with my colleagues here in the audience and around the world: Professor Nazli Choucri from MIT introduced me to the AGS when she invited me to work on her project, the Global System for Sustainable Development, and she encouraged me to take on aspects of the projects that were interesting to me even if they were not always completely interesting to her; Dr. Joanne Kaufman, Professor Jeffrey Steinfeld, and Professor David Marks from MIT have all been extremely supportive; and also Professors Roger Baud and Claude Friedli from the Swiss Federal Institute of Technology and Professor Mino Takashi and Shuichiro Asao from the University of Tokyo. The reason that I am here today and not sitting in my office in Boston running statistics is because these faculty and staff have really made it possible.

The project I am going to be talking about is the annual meeting of the WSC. It was held for three days and brought together 80 students, representing 35 nationalities and all the populated continents. One hundred academic papers were submitted and thirty-five were accepted after peer review, all of which I have to say were of extremely high academic caliber. I would like to recognize the University of Tokyo's Tatsuya Hanaoka, who won best paper for the conference and who will also serve as the next WSC annual meeting chair.

At this year's annual meeting, in addition to the panel presentations, we also had project presentations intended to get students to engage in projects which maybe they had not heard of or to expand projects to create international versions. Those are what you will hear about today. We also had workshops to help improve skills. Examples were some wonderful workshops on international organizing and the use of network technology, which made the organizing of the annual meeting possible; and how to collaborate when working in a non-native language. We also had many opportunities for interactions to meet,

exchange, and share ideas. There are a lot of new projects that were brainstormed at INCAE, and I have high hopes you will be hearing about these next year. We learned a lot through this experience, this process. I hope all of you who will attend the next AGS annual meeting in Tokyo in 2003 will come by the WSC annual meeting, to which you are all invited, and see what we are doing and how inspired we can be.

One message that I would like all of you to bring away from this panel is the importance of mentorship. All of these projects you will hear about required mentorship and support, sometimes just the willingness of an advisor to get out of the way. I want you all to think about your impacts on your own students and how you can help facilitate the kinds of, I think, really great things that the panelists here have done and are doing.

Eri Saikawa

Undergraduate Student, University of Tokyo
Councilor, AGS World Student Community

The University of Tokyo where I study has a student community, which is the oldest of all the member student communities in the World Student Community. Since its establishment in the year 2000, we have had varieties of activities such as holding keynote speeches and planning a summer school for student community members, inviting engineers from industry, professors from academia, a statesman, and an official from government with whom we have had a thoughtful discussion of solid waste management. We currently have more than 100 members in our student community.

There are three interesting projects taking place at the moment in our student community: One is on English discussion, a second one is on environmental policy, and the third one is on environmental business. At this time, I would like to focus on the English discussion project in greater detail.

This project is called OASIS, which stands for Open Assembly for Students Interested in Sustainability, and this is the current project which has been running since last April [2001]. Before I move on to the content of this project, let me first tell you why this project was launched. There was a student symposium that took place in Lausanne last year, and at that meeting several Japanese participants felt hindered by the language barrier when communicating their ideas in English. In order to overcome this difficulty we, as non-native English speakers, created the platform for students to discuss, in English, the issues related to sustainability. It also had a second aim to create a network of various students inside our student community.

The OASIS English discussion project is a multidisciplinary project gathering students together regardless of their background, culture, or major. Anybody interested in the issue of global sustainability can get together with other students to talk about a specific topic each week. We have covered topics that vary from environmental business to cloning. There are over 40 students including around 10 non-Japanese, and members include undergraduates as well as doctoral students. This, I have to mention, is very atypical for Japanese students, as we would normally be only within our department and with our colleagues.

This huge network can be helpful even in the future. Now we are planning to have a collaboration project with INCAE students to have discussions using various information technologies. I ask you for a minute to imagine a large Japanese student community which is able to freely and easily communicate with the rest of you. The unity borne of this endeavor will create a culture of collaboration and understanding that can further our aims to create an environmentally and socially sustainable future.

This OASIS English discussion project is run mainly by students. The help we get from the AGS supports us tremendously to make our activities become productive. Thank you very much to all who have supported us and encouraged us. It is our dream that we, the students, will become the leaders of a sustainable world. We hope to see you all in Tokyo in the next AGS annual meeting.

Patrick Bürgi Fourth-year Student of Mechanical Engineering, ETH-Zurich

It is a great honor for me to have the chance to speak to such a prominent audience. As a member of the student community in Zurich, I would like to present you one of the projects we have been involved with: the Climate Protection Partnership (CLiPP). My purpose is to get as many people involved as possible, be it in the form of critical feedback, ideas for new compensation projects, or by buying a CLiPP ticket. Before I start, I would like to thank Walter Ernst and Roger Baud from ETH as well as Jeffrey Steinfeld from MIT for their immense support.

So what is CLiPP all about? The idea of CLiPP is to provide a climate ticket, which corresponds to a voluntary surcharge to compensate for the greenhouse gas emissions of your flight. There are several reasons why we focus on aviation. Emissions caused by aviation are not included in the Kyoto protocol. But the aviation sector is growing very fast, especially in developed countries. In Switzerland, for example, emissions caused by aviation already account for 13% of the total greenhouse gas emissions. Travelling by plane is not only ten times faster than car, it is also ten times cheaper because we do not have any tax on kerosene.

Most people are not aware of the huge amount of energy they consume by flying. The average fuel consumption per person in flight hours is about 50 litters of kerosene. The next time you sit on a plane, just imagine yourself burning three buckets of kerosene for each hour you fly. And remember that thirty hours of flight correspond to the annual per capita greenhouse gas emissions worldwide.

The idea of CLiPP is to sell climate tickets and use the money for greenhouse gas reduction projects. The price of the ticket corresponds to the amount of money which is needed to compensate your carbon dioxide emissions. Our administrative and technical advisory board composed of several scientists and experts from different universities and research centres makes sure that the money is well applied and the projects are well chosen. I have to add that the price for the CLiPP ticket is not compulsory because CLiPP works on a voluntary basis.

Further, I would like to mention our first CO_2 compensation project. As was mentioned yesterday, our pilot project will be the installation of solar panels in INCAE, our host, to replace fossil fuel-based water heating. Further examples of compensation projects, which we have been analysing as future possibilities, are:

- Installation of simple manure fermentation technology to produce bio-gas for cooking in rural areas (Costa Rica)
- Replacement of baby taxis in Bangladesh, India, or Indonesia by cleaner technology
- Installation of solar panels in Mexico City

The advantage of projects in developing countries is that the reduction of greenhouse gases can be achieved with relatively small investments and the impact of the project on the local community is relatively strong, improving the local living conditions.

I strongly believe that CLiPP is a step in the right direction. This project contains two aspects that were often mentioned throughout this conference. One of these aspects is the internalisation of external costs, and the second one is individual responsibility. In my opinion, these two points are key elements within the transition towards sustainability. Your support of CLiPP is very important to keep on catalyzing such student initiatives.

Gerald Heinicke Ph.D. Candidate in Sanitary Engineering,
Chalmers University of Technology

Our organization, the Chalmers Students for Sustainability, is the youngest member of the AGS Work Student Community. The focus of our work so far has been on education. The first activity was to encourage Chalmers students to submit abstracts for the annual meeting of the World Student Community that was held last weekend. As a result of this encouragement, six students presented their papers here in Costa Rica; five of them were masters' degree students, three of them from developing countries. And this was only possible thanks to the generous support that we received from the AGS coordinator at Chalmers, Professor Greg Morrison. It is not only that these masters' students made the experience of presenting at the conference. I am also convinced that they are highly motivated to continue working for sustainability and to encourage other students as well to join in these activities. Currently, we engage in fundraising. The idea with this is to send Chalmers students to developing countries to do their masters' theses on topics related to sustainability.

Some weeks ago we were contacted by the organizers of the fifth international COPERNICUS conference on sustainability in higher education, which will be held in Gothenburg this year (June 12–14, 2002). COPERNICUS is the university network for sustainability with over 300 member universities all over Europe. The goal of this conference is to reflect on ways and means for the incorporation of sustainable development into education. It is meant to be a forum for stakeholders in education to show and compare their achievements. At Chalmers Students for Sustainability, not only are we asked to submit papers but the organizers would like us to be an active partner in planning for the workshops in June. We will definitely take this opportunity to receive new inputs on how to increase the space that sustainability gets in university education.

Urs Rhyner

Third Year Undergraduate in Material Science,
École Polytechnique Fédérale de Lausanne

"Ingénieur du Monde" is an association of students and employees of the Swiss Federal Institute of Technology in Lausanne, Switzerland. Unlike the other student communities, our association has existed for 15 years and has been mainly active in the field of development cooperation. Since last year, we tried to extend our activities more towards sustainable development, which is, of course, linked to development cooperation. Our aims can be divided into two groups.

On the one hand, we are active at the campus in Lausanne to inform people about the problems and the challenge of development. On the other hand, we try to promote the contact between students and researchers of Lausanne with concerned people in developing countries.

With the support of the Swiss Agency for Development Cooperation, we can give every year financial support to ten students who are going to do a study project in a developing country. The experiences of these students are afterwards presented to the students at EPFL. Through other conferences and discussion groups, we try to illustrate different views of the world to the students in Lausanne. At the moment we are running two projects in Africa. In Togo, we are trying to give knowledge support to a computer school. The aim of this project is to send every year two students to Togo to give classes in computer science.

In another project, in Mauritania, we are trying to support the efforts of the local population to deal with problems of waste treatment and desertification.

Often, there are no new technologies needed but, instead, what is needed is the application of basic knowledge. One problem is plastic waste. Goats are eating the plastic bags that are lying everywhere and are dying from it. So the people are trying to introduce a system to separate organic and inorganic waste. But the problem at the beginning was that they considered as organic everything that can be burned, including plastic. Another problem that needs more scientific knowledge is the treatment of batteries. Because the village is located at 270 kilometers from the capital there is no possibility to recycle them, and thus they have to be stocked in a safe manner. But is this a sustainable solution?

What we are trying to do now is to integrate the local population. One of our next steps will be to get in contact with the university of the capital. We are also looking for other similar projects to learn from, because not everything needs to be reinvented. We do not consider this project as our project but we think that our role should be limited to that of an external expert who can help when the local resources are too limited.

Just a few words about our approach. Between the village and EPFL, there is not only a huge geographical distance but also a cultural one. For our research, we need data about the village. This allows us to make a scientific analysis. To make real sustainable development, we consider it as important, that something is going back to the local population. The question is what? Or even more important, how?

Our work could not be done without the generous help of various professors. I would like to say thank you to Prof. Friedli and Prof. Jolliet from the École Polytechnique Fédérale de Lausanne.

Timothy Prestero Ph.D. candidate, MIT/Woods Hole Joint Program in Oceanographic Engineering

Briefly I would like to describe a project that we are working on at MIT, which we are calling ThinkCycle. I will start out by giving you the motivations for our initiative.

The issue that we are concerned with is that the homework problems and design projects of students in engineering, the sciences, social sciences, and in many other fields typically represent solved problems. For example, when I was a mechanical engineering student in undergraduate school, my class was literally given the task to reinvent the wheel. The students are not generating new information. This represents a wasted resource. Students are intelligent and can solve problems if they are given interesting problems to solve. At the same time, we have non-governmental organizations and stakeholder groups in developing countries who have an idea of the needs and problems in their communities, but they often lack the technical resources to address them. Our goal is to solve both problems at once. In the ThinkCycle initiative, we are trying to incorporate development and sustainability, not into a particular program in the university, but into all facets of university education.

In our model for collaborative design, NGOs and stakeholder groups will recommend problems in their communities. Domain experts will review these problems and choose those that are particularly suited to student applications. Faculty then can look at a database, a large collection of these kinds of problems, and for any topic they will be able to find something that they can assign to their classes, whether they are teaching hydrology, epidemiology, mechanical engineering, etc. There are problems in all of these fields that have yet to be solved that affect developing communities. Finally, students are given these problems as homework problems and design projects. They document their work so that students who follow in their footsteps can pick up where they left off, so we are again avoiding this problem of reproduction of effort.

If this works what do we get? In the best case, the result is a prototype or a methodology, something that is ready to be sent back to the community for them to try out and evaluate. With many students working in series, we eventually will get a prototype, but it is not necessarily every single group that we are counting on to deliver these kinds of results.

What we can guarantee is that every student who goes through this process – students in industrialized countries – will be exposed to what we are calling the world's most important problems. In my undergraduate education, when I was studying mechanical engineering it was never brought up in the whole four years that the skills that I was learning had application outside of the needs of the wealthiest 2% of humanity. So students in industrialized countries will realize that they can apply their skills where they are most needed.

For students in developing countries, this is a way to address "brain drain". If I am an engineering student in Thailand and all of my homework problems have to do with the automobile or space industry, it seems clear that I have to go overseas to apply my skills. With our program, students are going to be working on problems that they see every time they go outside. Hopefully, many more students will be motivated to stay after graduation and apply their valuable skills at home.

We have been teaching a class at MIT called Design that Matters. This is a course taught by graduate students for graduate students and undergraduates. It is an independent study course, very similar to a basic engineering design course. As an example of student projects, we have had one team working on low-cost eyewear, where the objective is to take an optometrist's office, which is a 100,000 dollar investment, and fit it into something the size of a suitcase that costs 150 dollars. Can you redesign optical equipment such as the focometer that measures refraction so that you can export this technology in a sustainable manner?

We have had students working on the 25 dollar bicycle – at that price, there are 700 million people in developing countries who could now afford a bicycle. We have students working on passive incubators for premature infants. The challenge is to design an incubator that works on solar energy during the day and has some other form of passive heating during the evening. We have had a student working on a Cree speaking toy. It is a common occurrence that Native American groups in the United States and many other small ethnic groups are losing their native language; so, by making a toy that addresses the child in their native language, the students are trying to find a solution for this problem. Finally, we had some student groups working with a home for handicapped children in Oaxaca, Mexico, where they are trying to make expressive interfaces with a sensor that allows children – even if they have limited mobility or limited motor control – to express their needs and interests.

So, in general, our overall goals, as I stated in the beginning, are to incorporate sustainability and development, not into a unique program but into all facets of education. We want to create partnerships in design, connecting non-governmental organizations and academia, so that students and faculty together with industry can find and distribute solutions to problems such as I have described. In the AGS four of the world's leading technical universities are represented, so I believe it is our responsibility to lead by example, to do this sort of thing such as we are doing today.

Abelardo Zeledon — Masters Student in the Sustainability Program of the Business Administration Program at INCAE

We at INCAE are working in and in discussion about sustainability problems in all the regions of Latin America. The project I would like to present today is solid recycling at INCAE's houses on the campus. The project consists of collecting and separating the waste where the students live and selling it for a profit to companies that work on recycling. It is a very simple project, but I wanted to mention it today because it has many factors that make it interesting.

I must mention that this simple project lets us show how sustainability can become a daily lifestyle. We understand that in our region we have problems with contamination, so in using our innovation to create projects such as this we are providing right now solutions for problems that we are going to have in the future. Getting the students to become part of the solutions is the way that we see how we will influence what people do in the future.

As business students, we think it is very important to grant that we are going to have economic benefits and also productivity benefits. We are going to use this program to support one student to come to INCAE to study sustainable development concentration. We are not going to have enough money to pay for the whole program, but at least we can contribute with a partial scholarship.

We realize this project must have an important impact. Having an economic benefit is the way that we can satisfy our needs without sacrificing the resources of the next generation. The direct impact we will have is on the persons we will be supporting on the scholarship. We are also going to directly influence one hundred students who come to the masters' program every year at INCAE's campus in Costa Rica, and we will also influence the more than 300 people that come for short seminars at INCAE. Those are the direct impacts that we hope to have, and we believe we will also have an indirect influence through these people on the work in the organizations where they are going to work in the future.

I would like to thank especially Dr. Roberto Artavia and Dr. Alberto Trejos for all the support they have given to us; we know that we are going to need more support from them. I would also like to thank all the AGS representatives and our colleagues in the World Student Community for this opportunity.

Report from the AGS Faculty Coordinators Round Table

Peter Edwards — Professor, Swiss Federal Institute of Technology Zurich; AGS Coordinator

I have been reflecting that this meeting is different from almost any other symposium I have gone to. But why is it so different? I came to the conclusion that, more than any other type of meeting, this one extended one's emotional range. During the course of the last few days, I have found myself shocked, horrified, sometimes almost in tears, to hear about the disastrous state of the environment, the horrifying problems, the enormous injustices; then a few minutes later, I found myself exhilarated by the possibilities of what can be done. Perhaps more than any other group, the student community has shown that you can make a difference. And that should perhaps be a slogan for the AGS: you can make a difference. I believe the meeting has shown that there really is a role for theAGS and that the AGS can make a difference.

The process of grappling with these enormous problems is extremely complex, and, at times, a meeting like this seems a bit of a mess – either we are going in the wrong direction or we are not coordinating properly or our approach is simply inappropriate; but slowly, we come out of the mess and (to use David Marks' analogy) we produce the sausage. The process of evolving methodologies to grapple with these problems is very difficult – not always a pretty sight – but nonetheless we are clearly moving forward.

Some people have complained that we have not gone sufficiently into detail in this meeting. That is true – mostly we do not go into detail. But we do sharpen up the questions so that we understand better where the problems lie and what kinds of approaches are needed to address them. In my view, this is an essential step before the real work can begin. There is an important debate in progress about how we can best use the rather limited resources of the AGS. This means not only understanding problems but developing solutions and getting those solutions out so that they make a difference. This debate is an important part of the ongoing messy process. I want to stress that it is not just a matter for the AGS coordinators or the executive committee but it is a process in which everyone needs to be involved.

And what makes an AGS project? I think we now have a much clearer idea about what we are aiming for. The essence was captured in a phrase used by Dr. Pachauri: Talking about climate research, he said that what was done was policy relevant but not policy prescriptive. I wrote that down because I thought that's exactly what we are about. We need to do top quality research which is directly relevant and useful to policymakers but does not tell them what to do. It is not policy, it is not advocating any particular policy, and it is not prescribing a policy, but it is information essential for the development of good policy. As universities, we must always defend our objectivity and impartiality. The aims of our research should be to understand problems, to develop technology, and to understand and articulate what the policy implications may be. However, I believe it is not our role to advocate a particular policy in the way that an NGO might do.

A recurring question has been how can the AGS make a difference when the magnitude of the problems is so vast? Billions of people are hungry, billions of cubic meters of water are going to waste, and so on. To put our contribution into perspective here are a few figures: Our budget over the past five years has been11 million dollars, we have funded 60 projects, and they have involved perhaps 200 faculty and 250

students. In one sense that is very impressive, but set against the scale of the problems it pales into triviality. Or rather, it would do so unless those projects had great leverage and were strategically placed so that they can have the maximum impact. And that is another aspect of the current debate. How can we use our resources strategically to maximize our impact?

One plea which has come up several times has been to make the AGS more visible. Our aim, so it is argued, should be to create a brand for the AGS through delivering the highest quality scientific information and presenting it in a way which is directly usable by policymakers. Policymakers should be able to trust that this information is correct and useful. We shall have succeeded if people addressing a complex policy issue ask, "What does the AGS say about that?" Our strategy in developing such a reputation has various aspects. One is simply what projects to choose. What should our priority areas be? How do we ensure that we achieve not only a scientific understanding but the appropriate translation into terms which are useful for policymakers. A second aspect is how do we market our work? I think the issue of developing a brand name for the AGS is one that we need to work at. In doing so, we need to hear the advice and the insights of all participants in the AGS.

The work of the AGS is very complex. It is cross-cultural, it crosses disciplines, and it deals with some of the world's most urgent problems. We already have excellent examples of effective research collaboration and we have heard about a number of them during the course of this meeting. We heard about the China Energy Technology Program [CETP], which I think is a model of how the AGS can achieve the maximum leverage. This project, addressing one of the most serious environmental problems of the world, involves 75 scientists from a whole range of disciplines as well as stakeholders amongst the Chinese community. CETP developed practical technological solutions and associated materials of direct use to the end user community. The wonderful thing about this project is that it did not cost the AGS very much because it was financed by industry. That seems to me exactly the kind of project which should carry the AGS brand. We have heard other examples – for example, the project on air quality in Mexico City, which has had immediate benefits in improving air quality and therefore the health and life expectancy of its inhabitants. Once again, and in a remarkably short space of time, top quality scientific understanding has been translated into policy-useful information and put into practice.

The debate on how we use our relatively small resources most efficiently must continue. We have a peer-review process for our research projects which ensures that the projects are of high academic quality. There is a concern, however, that the AGS does not always have the impact it should have because some projects are too small or too isolated. One remedy which is under discussion is to cluster projects together. For example, we could take a particular field like energy and have a cluster of projects which are both sufficiently linked to obtain synergies from working together and sufficiently interdisciplinary to ensure that the scientific understanding is translated into policy-relevant information and outreach. An important question is how to organize such projects. Who initiates such a project? Most important of all, how do we involve our university colleagues – not the ones sitting here who have already been converted to the AGS cause, but the many excellent people who are not yet involved? I hope that everyone will be interested in this important discussion. So, to conclude, two keywords: firstly, participate, and secondly, communicate.

Working Group

Infrastructure for Urban Systems (Physical and Institutional)

Leader	Fred Moavenzadeh, MIT
Discussion Leaders	Adrian Fernandez, Mexico Ministry for the Environment Margrit Hugentobler, ETH-Zurich
Rapporteur	Satish Lion

Abstract

The objective of the working group was to generate a discussion on the topic of infrastructure for urban systems from the standpoint of both physical and institutional infrastructure. This working group was initiated by a series of presentations, and was followed by a brief period for questions and discussion. The presentations can be summarized in three main areas: 1) an exploration of the institutional structure required for sustainable urban systems, 2) a discussion of the limitations of current academic infrastructures and suggestions for improvement, and 3) presentations from current AGS research topics that address the problems of Urban Infrastructure.

Lessons from Mexico City

The first presentation was given by Professor Adrian Fernandez, General Director for Research on the Urban, Regional and Global Pollution, National Ecology Institute, Mexico Ministry for the Environment. The title of his discussion was "Institutional Infrastructure for Urban Systems: Some Lessons from the Mexico Megacity." In his presentation he used Mexico City as a case study to illustrate the importance of effective institutional organizations to support the goals of sustainability. He identified three key issues that are critical to effective institutional infrastructure. The first is public access to environmental information, the second is the importance of a decentralized Federal government, and the last is the need for integration of policies. Mexico City has made steps to improve their institutional infrastructure, yet this progress is far from where Dr. Fernandez would like to see it.

In 1997 Mexico made a critical amendment to the Federal Environmental Law, which included the access to environmental information as a citizen's right. This amendment was very significant, as Dr. Fernandez stated: "The first step to be taken in a country is to incorporate the right-to-know or the right-to-access information in the legal framework of the country." It is critical for the public to be aware of the environmental conditions, because without this knowledge the federal government can continue to make decisions without being held accountable to the citizens. This amendment was a signal to the public that the government was trying to become more transparent and make environmental issues a priority.

Yet this move in itself was just a starting point. For the amendment to prove fully effective the government would have to address a more difficult problem that was inherent to the institutional framework. The problem was that of federal government centralization. As Dr. Fernandez stated, "Mexico is still a highly centralized country, with a dominant federal government." The dominance of the federal government causes many decisions that affect local communities to still be made in the capital. Furthermore, local authorities have few resources and therefore little financial power. The lack of power and resources within the local governments limits their ability to solve environmental problems and leads to further damage of their ecosystems.

Another cause for Mexico's environmental problems is the insufficient coordination within the government. The government sectors are often isolated and do not collaborate; as a result, there is a lack of integrated environmental policies. As Dr. Fernandez stated, "The lack of integration of environmental policies with urban development, land use planning, transportation, fuel, and services pricing, is one of the most important barriers that prevents an adequate environmental management." It is his feeling that all government sectors should share the responsibility for environmental protection. There have been attempts at integration of policies, yet they have not proven effective. As Dr. Fernandez commented, "The PROAIRE 1995-2000 initiative showed important conceptual progress but it had very modest goals and very little sectorial integration." Further attempts have been made to improve this initiative by additional government sectors, but it still needs further coordination.

While Mexico has made significant steps to improve its institutional infrastructure, Dr. Fernandez feels that they still have much progress to make. He feels this will be accomplished by focusing on institutional capacity building. As he stated, there needs to occur a "gradual strengthening of capacity at the decentralized level of states and municipalities: environmental agencies, qualified personnel, adequate budgets, enforcement capability, and inter-sectorial influence." In addition there needs be a "gradual reduction of the role of central agencies in setting policies and regulatory frameworks", as well as a "gradual increase of participation by other stakeholders, such as the community and the private sector." Dr. Fernandez offered two key areas where AGS strategies for building the future are needed in developing countries: 1) training for leadership, managerial skills, good technology and sound science, and 2) global citizenship: research projects, internships, and other mechanisms to go against the brain drain, INE offers to be a partner.

The Role of Academia

The second presentation was given by Professor Margrit Hugentobler, from the Center for Housing and Sustainable Urban Development at the Swiss Federal Institute of Technology, Zurich. The focus of her discussion was the need for institutional restructuring at the academic level as a means of reevaluating their responsibility to the public. Hugentobler raised three problematic issues as topics for discussion, and then proposed reasons for the problems and made suggestions for improvement.

The first issue she raised is that the technology and policy know-how basically exists to solve most of the threats to sustainable development in megacities, yet these tools are not being used widely and successfully. She states two main reasons for this problem: (1) Academics think that if they produce enough "hard facts" that action will follow, and (2) incentives in the university systems are rarely related to the "real life" impact of the knowledge produced, but rather relate to the number of research grants and publications that can be generated. Hugentobler suggested that academics should "think harder about the benefits that can be conveyed to policy makers and the public when proposing new solutions." She used the following Chinese proverb to convey her massage, "To see something once is better than to be told 100 times."

The next issue Hugentobler raised was that cities are intricate webs of interrelated systems, and that intervening in one area will likely have consequences in another. She feels this is "almost systematically" ignored by academics. Three reasons were raised for this problem: (1) Research is organized in a Taylorist fashion – compartmentalized responsibilities for different specialties; (2) important know-how in one

area remains disconnected from other areas; and (3) meaningful interdisciplinary exchange is "fashionable" but rarely practiced. Hugentobler suggest the following action, "Enhancing the development of new institutional structures – forms of collaboration and information exchange – might be as important as providing specific technical expertise."

The last issue raised was that in theory we know that cultures are different, yet in practice we often get irritated when we find out they indeed are. Hugentobler stated that this is true not only for collaboration between developed and developing countries, but also within developed countries. She offered two reasons for this problem: (1) we prefer "the familiar" over "the strange and unexpected," and (2) we are too caught up in our own culture, know-how and understanding, making inadequate efforts to understand "local thinking," customs and constraints. She suggested that time is needed to build better relationships, and that mutual interest and patience as well as curiosity in other cultures are needed.

The Future of Transportation in Guangzhou

The final group of presentations was focused on the AGS Megacities project in Guangzhou, China. A central theme of these presentations was infrastructure for urban transportation. Satish Lion, a Masters student at the Massachusetts Institute of Technology, gave the first presentation on this subject. His presentation highlighted the premise and background for a current AGS project, which involves the collaboration between MIT and the municipal government of Guangzhou. Satish Lion's summary is presented below:

As the city of Guangzhou continues to rapidly grow, the importance of efficient and sustainable transportation networks becomes ever more apparent. As part of an effort to address this pressing issue, the AGS Future Cities Group at MIT collaborated with key officials from the Guangzhou municipal government and undertook a study of transportation demand management. This study resulted in three core recommendations geared to help Guangzhou manage the transportation demand: Bus Rapid Transit (BRT), Electronic Road Pricing (ERP), and Transit Oriented Development (TOD).

While all three recommendations are crucial to the sustainability of the city's transportation networks, TOD is in particularly important when considering Guangzhou's future Metro plans. The city has recently completed construction of Metro Line 1, and plans to complete Metro Lines 2 and 3 by the years 2003 and 2006 respectively. The total distance of these three lines totals over 70 km. At an average cost of $80M (USD) per kilometer, the price for these three lines will be approximately $5.6B (USD).

The city's long-term plans include building an additional four lines, which would amount to a total length of 206 km. The total price for this completed network of 206 km would be approximately $16.5B (USD). This large price tag leaves the question of how will this project be funded. Guangzhou is currently funded primarily from local taxes and loans, yet this source of funding may be insufficient to support the development of an extensive urban rail network. The development of these proposed Metro lines could be greatly supported by the assistance of external sources of financing.

In the case of Hong Kong, private investors paid for the majority of the Metro system based on the rights to develop the adjacent areas. Such private funding could be available to the city of Guangzhou if the prop-

er development laws, tax incentives, and policies were put in place to encourage such investment. The proper planning and development along these urban rail lines would result in high density zones that would effectively reduce local travel demand and extend the green space between rail stations. Given the right incentives, private investors could also be persuaded to incorporate green building technologies into their developments.

The next presentation was given by another MIT student, Mimi Takayanagi. She discussed the current transportation and environment policies in Japan. A summary of Mimi's presentation is given below:

Environmental problems caused by transport in Japan

In Japan, ambient air quality is generally not bad, except for ozone, NO_X and suspended particulate matter (PM). While GDP rose by 140% over the 1970s and 1980s, SO_X has decreased by 82%. Air pollution caused by carbon monoxide has been overcome to a large extent. Air pollution from lead is not a problem any more. Emission and fuel quality standards for automobiles have been further strengthened, and they are the strictest ones in the world (sulphur in diesel, under 0.05%; benzene in gasoline, under 1%; OECD 2002). This results in Japan's emission intensities for both SO_X (kg/unit GDP) and NO_X being below the OECD average, by 85% and 71%, respectively. However, NO_X and PM remain serious problems due to the continuing growth of vehicles, especially in large cities. Vehicle emissions account for 60% of NO_X emissions in urban areas.

As for greenhouse gas (GHG) emissions, transportation plays an important role. Although the transportation sector accounts for only about a quarter of petroleum usage, the transportation sector is the fastest growing sector in Japan in terms of CO_2 emissions. Automobiles contribute to 90% of CO_2 emissions of the transportation sector.

Another problem is noise caused by traffic. In daytime, 62% of monitoring stations exceed the environmental quality standards for noise. At night, it gets even worse than in daytime, with 70% of monitoring stations indicating violation of the standards.

New policies under development in Japan at the national level

• Regulation

The Automobile NO_X Law, established in 1992, was revised and newly amended as the Law concerning NO_X and PM from Automobiles in Specified Areas in June 2001. (The enforcement of this law will start in October 2002) The new law has been strengthened to cover PM from diesel vehicles. The specified area in the Automobile NO_X Law has been widened from two big urban areas to three (Greater Tokyo, Greater Osaka and Greater Nagoya). The controlled kinds of vehicles have been also increased. In addition to commercial buses and trucks, the new law will be applied to passenger diesel vehicles. For the implementation of this newly amended law, a related cabinet order is in preparation.

Subsidies and Taxation

• CO2 tax

Japan has been preparing for introducing a CO_2 tax. In December 2001, a commission on economic instruments in environmental policies, set up under the Central Environment Council, released an interim report on legislation proposing a system for the CO_2 tax. A challenge is how to deal with materials, such as coal, that are currently not subject to any tax. The report pointed out that taxation upstream (import and refining) would be easier in terms of implementation; however, taxation downstream (distribution) would be more effective than upstream. The report proposed four taxation system options.

- *Introduce a completely new tax upstream, targeting all fossil fuels;*
- *Change the level of the existing petroleum tax (an upstream tax) to be more appropriate, and introduce a new tax on coal;*
- *Introduce a completely new tax downstream, targeting all fossil fuels;*
- *Make the level of existing gasoline and light oil taxes (downstream taxes) more appropriate, and introduce new taxes on materials that are not taxed now (coal, kerosene, and so on).*

The commission will continue its discussion, and will clarify the possibilities of each option.

• Tax exemption for Low-Emission-Vehicles

To enhance the purchase of Low-Emission-Vehicles (LEV) a lower tax is imposed on them than on ordinary cars. The number of in-use LEVs has increased significantly and there are now 3,830 electric vehicles, 7,811 natural gas vehicles, 157 methanol vehicles, and 50,282 hybrid vehicles. However, these LEVs are still a very small share of the total fleet (about 0.1%).

• Environmental Road Pricing

The Ministry of Land Use, Infrastructure, and Transportation is planning to implement environmental road pricing, the so-called "congestion fee," experimentally. Two of the most congested highways, The Metropolitan Expressway, and Hanshin Expressway will be the study fields. A road in an environmentally sensitive area (e.g., residential area) will be charged a higher toll fee than a road bypassing a sensitive area.

• Transport infrastructure

Congestion is another problem, which worsens energy consumption in the transportation sector. The most energy-efficient speed is at 50 to 90 km/hr. However, the national average vehicle speed in Japan is about 40 km/hr, and in big cities such as Tokyo and Osaka, the average vehicle speed is only 20 km/hr due to heavy traffics. To relieve congestion by facilitating traffic flow, several construction plans are currently under development. One of the examples of plans for smoothing traffic flow is the improvement of road networks. The biggest current project in Japan is circular bypath improvement in the Tokyo metropolitan area. The purpose of this project is to relieve congestion by eliminating about six hundred "hot spots" in the area. This huge project will require 9 trillion yen to construct a whole new bypath system (about 7 billion US dollars) and is expected to produce an annual revenue of 4 trillion yen (about 3 billion US dollars).

• New policies under development in Japan at the local level (the case of Tokyo)

In terms of ambient air quality, the Greater Tokyo area is the most polluted area in Japan. In 2000, Tokyo metropolitan government got a head start on the national regulation dealing with air pollution caused by diesel vehicles. When the new Automobile NO_X and PM Law was promulgated in December 2001, the Tokyo metropolitan government immediately announced its dissatisfaction with the national policy, stating that it was too weak and slow. It asked the national government to revise the policy. Meanwhile, the Tokyo metropolitan government announced that a new law with stricter regulations and support systems would be introduced in the metropolitan area. One difference between local law and national law is that, while national law prohibits the registration of cars not meeting emission standards, it still allows cars registered outside of Tokyo to pass through the city; the metropolitan law will prohibit the travel of all cars that do not meet emission standards. The Tokyo metropolitan government proudly announced that it managed to get an agreement from the petroleum industry to prepare low-sulfur fuel twenty months earlier than nationwide. For Japan, this was an unusual situation because normally the national government has such strong power that the local government usually does not rebel against it. To solve these kinds of conflicts, cooperation between the national and local governments at the planning stage is crucial.

AGS Discussion and Concluding Remarks

The presentations were concluded with a discussion between the panel members and the audience that was composed of both AGS faculty and students. The discussion summarized the lessons from each presentation as well as the role of the AGS in future projects.

The lessons learned are as follows: 1) the lack of institutional stability is a critical issue that will need to be addressed before developing cities will be able to have policies and regulation that promote sustainability, 2) academia needs to come down from its ivory tower and take a more "hands-on role" in research, 3) megacities need to focus on transportation demand management as a means to decrease congestion and pollution instead of the usual method of increasing the supply.

The consensus of the group was that the involvement of the AGS in projects such as the Guangzhou collaboration benefits not only the individual city but also serves as a model for other developing countries to follow. The AGS research projects are geared to solve problems with broad implications and, therefore, will have broad benefits. For example, once the city of Guangzhou begins to manage its transportation demand, the benefits will be felt through the entire Pearl River Delta region and will set an example for other developing countries.

Working Group

Climate Change, Energy, and the Development Gap

Leader	*Jeffrey Steinfeld, MIT*
Discussion Leaders	*Ronald Prinn, MIT*
Rene Castro	*UNDP*
Carlos Mena Brito	*Ministry of Environment and Natural Resources, Mexico*

Rapporteur Philip Sheehy

Abstract

It has become clear that human activities have contributed to the observed warming of the Earth's surface temperature. Global warming is only a part of the larger concern that is global climate change. The potential effects of dramatic global climate change are many, and they could be disastrous. With hopes to sustain a delicate global ecology and economy, our global community faces a serious challenge to reduce the impact of human activity – energy consumption, fossil-fuel burning, etc. – on climate change. The task at hand is multi-faceted, and a strong commitment from all stakeholders is required.

Introduction

The megacities of the world and developing countries require immediate attention to meet the objective of reducing and understanding the impression of our global environmental footprint. The megacities of the world commonly face deteriorating air quality, a major problem affecting the health of millions of residents. Efforts to improve poor air quality in Mexico City – due in large part to problems associated with transportation – have experienced considerable success. The multi-stakeholder effort is representative of the top-down, sweeping approach that is necessary to confront an issue with local, regional and global implications. The poorest countries of the world face the challenge of developing in a globalized economy without exacerbating the current level of greenhouse gases, specifically by providing clean(er) energy. With the introduction of electricity via wind-generated power, Costa Rica has made great strides in bringing energy to the geographically dispersed poor. The effort is consistent with the needs of the developing world: the solution is both sustainable and relatively inexpensive. Costa Rica offers hope for similar initiatives within their borders and beyond. Innovative thinking and a strong commitment from local, regional and international parties can facilitate a sustainable future. The preservation of the global climate and ecological systems is a great challenge that invokes the responsibility of this generation to ensure the success of future generations.

One of the key aspects that will shape the direction in which the global community is headed in the area of energy policy is climate change. While our understanding of climate change continues to develop and expand, further research is needed. Although the concept of climate change is often discussed in terms of substantial uncertainty, this does not provide us with the excuse to waver in our decision making. Global climate change is an issue that must be approached with the realization that both the survival and success of the global ecology and economy rely on educated decisions and sound policy. The problems we face in the context of climate change are many and they are challenging, including energy conservation and greenhouse gas reduction, cleaning up megacities, researching and implementing renewable energy sources, and bringing energy to the poor. There is a great deal of attention and care that is nec-

essarily involved with understanding climate change and its role in the future of energy options. We face the great challenge of protecting the global climate system for the well-being of future generations.
The following summary of this working group is based on presentations by Professor Ronald Prinn (MIT), Carlos Mena Brito (SEMARNAT, Mexico), and René Castro (United Nations Development Program), with ensuing discussion.

A Changing Climate

The average temperature of the Earth's surface is increasing at a rate that has not been previously observed in the historical record. Although data are increasingly speculative the further back in the record we go, it is certain that we are experiencing an anomalous rise in temperature. For example, the two warmest years in the record occurred in 1998 and 2001. The data appear to be conclusive: the Earth is warming. But how does knowledge of the historical record help us look into the future? What can we expect in another 30 years? 100 years?

Sound science and continued research are clearly necessary; however, it has become clear that modeling the global system based solely on scientific data is no longer sufficient. Due to the contribution of anthropogenic activity to the budget of emissions affecting the global climate, a component accounting for economic development and expansion is essential when considering the future of climate change. The implementation of this integral economic element has been achieved by a sophisticated computer modeling program developed at MIT. The MIT Integrated Global System Model (MIT-IGSM) has been "designed for simulating the global environmental changes that may arise as a result of anthropogenic causes, the uncertainties associated with the projected changes, and the effect of proposed policies on such changes" (web.mit.edu/globalchange). The model is a comprehensive system that couples the unique dynamics of the ocean, atmosphere, and land with a complex economic model (see Figure 1). Sensitivity analyses using the MIT-IGSM have led to an important conclusion: the increase in temperature of the tropical regions of the Earth will be only half that of the polar regions. Based on this conclusion, an estimated increase in average surface temperature of 2.5˚C (4.5˚F) equates to an increase of 3.5+˚C (6.3+˚F) in the polar region and an increase of <2.0˚C (<3.6˚F) in the tropics.

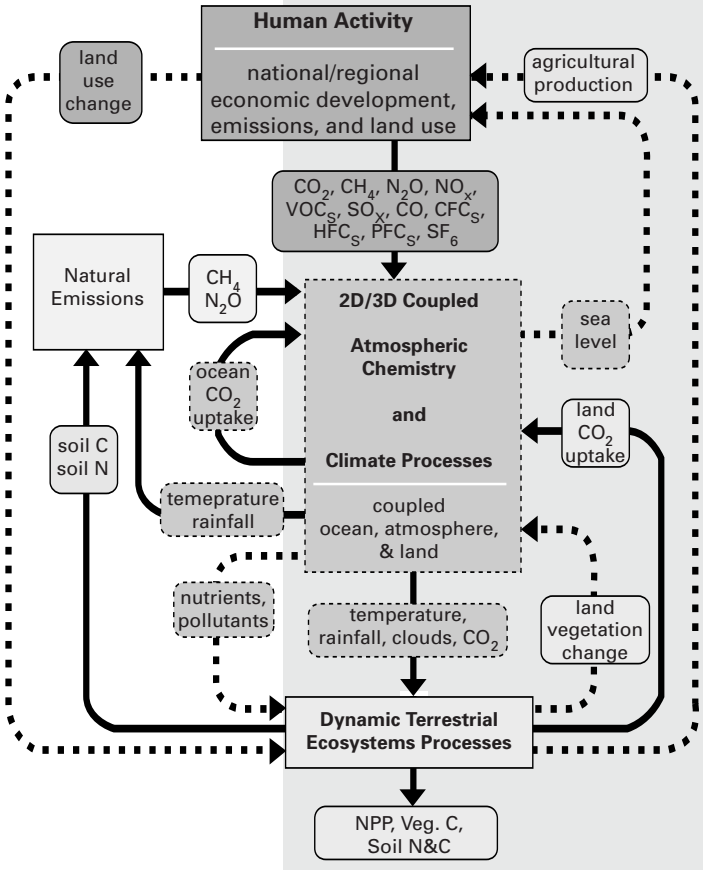


Figure 1. The schematic illustrates the framework and components of the MIT Global System Model. Feedbacks between the component models that are currently included or under development for future inclusion are shown as solid and dashed lines, respectively. (Source: web.mit.edu/globalchange).

The current international policy that has been drafted to address global warming is embodied by the Kyoto Protocol of 1997. Although the Kyoto Protocol was considered a bold step taken by the global community, results of the MIT-IGSM reveal that more aggressive measures must be taken if we are to maintain steadfast efforts to reduce human-induced climate change. The MIT-IGSM and the IPCC have predicted an increase in temperature over the next 100 years – assuming no drastic policy changes – ranging from 0.9–5.3˚C (1.6˚F–9.5˚F) and 1.4-5.8˚C (2.5˚F–10.4˚F). In terms of risk assessment, these predictions reveal a 1 in 40 chance that an estimated warming of 5˚C (9˚F) will take place. Similarly, there is a 1 in 20 chance that warming of 4.5˚C (8.1˚F) is possible. It is also important to note the fact that these numbers are based on average surface temperature increases, with the polar regions experiencing the heaviest effects of the warming, as stated previously. It has been estimated that an increase in the temperature of the Earth's surface of approximately 2–2.3˚C (3.6˚F–4.1˚F) is cause for great concern. Although the results of any model must be treated with skepticism, we must continue to research climate change without relying on business-as-usual policies that could sacrifice the future to an uncertain fate.

Mobility and Energy Consumption in Mexico

As we continue to face the challenge of decision making in the midst of uncertainty, it is important to evaluate and understand efforts being made around the world. Mexico City is a member of the burgeoning class of megacities. With the burden of a rapidly increasing population, the danger of air pollution poses a serious risk to millions of people. Exposure to elevated levels of harmful pollutants – mainly coming from the emissions of fossil fuel combustion in motor vehicles and industrial processes – must be addressed in an integrated fashion. A wide array of strategies and combinations must be presented to have an impact – strategies which include all stakeholders. A bold initiative to retard and reverse decreasing air quality is needed.

The concepts of mobility and energy consumption are a major component of the initiative laid out to address poor air quality. Transportation in Mexico accounts for 30% of final energy consumption – with approximately 80% of this coming from petroleum consumed in the cities. Automobile emissions are responsible for 70% of urban air pollution while transportation, in general, generates 27% of all carbon dioxide (CO_2) emissions in Mexico. In the last decade, progress towards relieving urban traffic congestion has been made; however, urban mobility remains inefficient and exacerbates urban and local air pollution. The pressing need for improvement in urban freight transportation, a significant source of both local and global air pollution, remains a high priority in Mexico.

While confronting pressing circumstances, progress has still been achieved by retarding air quality deterioration – and in some cases, slightly improving air quality – via a coordinated effort developed by the Mexican government and other stakeholders. The program laid out consisted of a variety of approaches, including increased and important investments made in public transportation. Mandatory usage of catalytic converters and vapor recovery systems was issued by the appropriate regulatory agency to update the technology of the vehicle fleet in Mexico. Similarly, improvements in fuel quality – gasoline and diesel fuels – coupled with increases in energy efficiency of vehicles contributed to air quality improvement. Inspection and maintenance programs were implemented to guarantee the success of the aforementioned improvements. Finally, an unprecedented "Hoy No Circula" program – "No Driving Day" – was implemented in an attempt to reduce traffic congestion and curtail emissions.

The initiatives mentioned have been marked by both considerable success, and failures. The challenge of finding strategies that continue to improve mobility without (drastically) increasing energy consumption is a great one. There are still a number of strategies that need to be implemented, but the task at hand is matched by the dedication of a number of players, including the Mexican government, the Massachusetts Institute of Technology and the AGS. Moving towards superior and sustainable urban mobility will require efficient, convenient and affordable public transportation. The coordination of regional development and land use planning must be done in the framework of an environmental perspective. In an effort to modernize the vehicle fleet – especially trucks, buses and taxis – Mexico must take full advantage of newly available technologies to continue to improve fuel quality and fuel efficiency and to help control air pollution. Although programs exist that verify a vehicle's compliance with established criteria, they must be standardized and subsequently improved, capitalizing on the success of similar programs. As the fleet is modernized and technology is applied, the Mexican government must also use sound decision making to minimize congestion and curb traffic growth. Mexico is striving to be both selective and cautious in their use of alternative fuels in high occupancy vehicles.

The solutions and policies implemented in Mexico have been in response to their own unique problems; however, Mexico's progress is indicative of the comprehensive nature with which robust policy must be developed and implemented in cities around the world to confront the increasing dangers of local, regional and global air pollution.

Bringing Clean Energy to the Rural Poor in Central America

While the developed world concentrates on increasing fuel efficiency and searching for alternative fuels and renewable energy, the developing world continues to struggle with a lack of energy, illustrating a correlation between poverty and lack of energy. To fight an increase in levels of poverty, the global community must make it a priority to supply energy to the poor. To address the concern of global warming and general climate change, it is crucial that any proposed system provide clean energy.

In the case of Central America, hydroelectric power has historically provided a significant contribution to overall energy generation. Due to high levels of rainfall and accessible water sources, hydropower has been good to the people of Central America. In the 1980s there was a widespread effort made by Central American countries to decrease their dependence on imported fossil fuels (i.e. oil) and achieve a higher level of self-sustainability via hydropower and other means. This trend was reversed in the 1990s as a consequence of two main factors. The uncharacteristically long lasting warming effects of El Niño resulted in higher evaporation rates and lower precipitation, decreasing both the water level and flow in Central America. Also, privatized utilities seeking to lower capital investments and respond to the energy demand began purchasing fossil fuels. These problems threatened hydropower and in the face of uncertainty, so a large sector of Central America invested in fossil fuels. Costa Rica, however, was the exception.

Costa Rica chose to maintain an aggressive energy conservation strategy despite growing concerns over the blackouts attributed to the aftermath of El Niño. The country added geothermal power and wind to generate electricity, rather than return to a dependence on imported fossil fuels. In order to achieve the desired additions of geothermal power and wind-generated power, the country needed aid, compensa-

tion, new instrumentation and training of local workers. All of this assistance required the investment and commitment of industrialized countries. The original implementation of the wind-generated power resulted in a selling price of US$ 0.074/KWh – and today the same wind-generated electricity sells at US$ 0.034/KWh. The decrease in prices was due to innovative financing from the Central American Bank, technological improvement, carbon reduction credits sold through the Activities Implemented Jointly (AIJ) program, and the acquired expertise in wind-generated power by Costa Rican utility workers via rigorous training.

Although Costa Rica has provided reason for optimism in the midst of uncertainty, many improvements are still needed to bring energy to the poor of Central America. The poor are using traditional fuels – wood, dung, kerosene, and other biomass products – that have been correlated to a lower life expectancy. The energy needs of these poor communities are attainable in Costa Rica; however, the communities are isolated and geographically dispersed. To add these communities to the conventional grid system in their respective countries is both very difficult and quite costly. Opportunities exist to bring poorer communities renewable and clean energy; however, innovative plans and external investment are required.

It is clear that Costa Rica is an example of a country which illustrates the difficulties associated with providing energy to the poor. Although the country invested in alternative sources of energy, it did so with a willingness to pay higher prices. As such, the country developed three main problems: Costa Rican businesses were challenged to maintain competitiveness, the percentage of income dedicated to energy bills increased, and finally the government was unable to extend the energy grid to 6% of the population due to high investment costs. However, solar energy represents a novel strategy for overcoming these challenges and bringing electricity to the poor.

The technological constraints of implementing solar energy are few, and coupled with the commitment of Costa Rica to clean and sustainable energy, the realization of solar energy may be attainable. The success of the wind energy project demonstrates the potential for newly implemented sources of energy in Costa Rica. Introducing solar energy to the isolated poor of Costa Rica would require significant domestic and foreign investment in the program; fortunately, the benefits vastly outweigh the costs. This program is indicative of what might be needed to reverse the energy problems that plague Central America: the program would achieve a reduction in poverty, loosen some of the restraints imposed by increasing oil imports, address the challenge of reaching the dispersed and isolated rural poor, and provide optimism in current attempts aimed at slowing global warming.

Concluding Remarks

Is the adage ‘if it ain’t broke, don’t fix it’ applicable to the Earth? Is uncertainty sufficient to warrant inaction on a global scale? Our planet is not an experiment that can be redone if it fails – the starting materials are not replaceable. To demonstrate a serious commitment to climate change in the context of global sustainability, the AGS can continue to focus – and intensify – its efforts in the following areas: the uncertainty associated with global climate change research, the development gap, and education.

As it stands, uncertainty in climate change research should not be perceived as an obstacle in the path of sound-decision making or in reducing the impact of human activity. Although unavoidable, uncertainty can be thoroughly understood and characterized to facilitate action, rather than providing the means for inaction. Ongoing research efforts like the United States Global Climate Research Program (USGCRP) and MIT's Joint Program on the Science and Policy of Global Change attempt to reduce and characterize uncertainties. Similarly, assessments such as the Intergovernmental Panel on Climate Change (IPCC) and the National Academies Report on Global Warming/Climate Change have been helpful in gathering data and providing focus for future research. The AGS has made a commitment to play a role in additional research and assessment that will offer a more accurate portrayal of uncertainty associated with global climate change. The AGS should offer continued support for the development of models like the MIT-GSM that include an essential economic component. In coordination with modeling efforts, the AGS can provide support for research of the paleo-climate record in an attempt to gain a better understanding of the Earth's climate record on a seasonal to century scale. It is hoped such an understanding will provide a necessary means to better predict future changes in the climate system.

As research and modeling continue, collaborative efforts across the globe aimed at narrowing the development gap have been successful. The multi-stakeholder efforts in Mexico City and Costa Rica demonstrate that the role of the AGS is to promote the implementation of existing technology (i.e. renewable energy, increased energy efficiency, and carbon sequestration) using technological and engineering expertise while continuing support of ongoing research in technology development. The AGS has a unique opportunity, as a conglomerate of respected research institutions, to effect positive change in areas of the world that are in dire need of technological assistance.

In order to continue research and make a sustained effort in narrowing the development gap, the AGS must continue and extend its dedication to education. The AGS can continue to educate students in research as it applies to policy, decision-making, and sustainability, and in its continued sponsorship of the World Student Community. The interface between science and policy has only recently found a place in the curricula of universities. The AGS can increase its support of the involvement of policy in research at the university level, while encouraging the diffusion of new knowledge in science and policy to all levels of education.

The AGS has committed itself to a bold task that requires diligence and attentiveness. Bold ideas coupled with robust policy and sound decision-making offer the global community a unique opportunity: the provision of a better livelihood for generations to come.

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Working Group

New Partners in Development: Sustainable Building Technologies

Leader	Leon Glicksman, MIT
Discussion Leaders	Carl-Eric Hagentoft, MIT
Nie Meisheng	Chinese Ministry of Construction
Carlos Quesada	University of Costa Rica
Rapporteurs	Jason Black and Lara Greden

Abstract

Discussion themes centered on ways to promote change through technology, policy, and cultural acceptance. Overall, the prospects in the countries represented by the speakers appear optimistic. Sweden is building zero-energy homes that do not appear green, thus averting the issue of cultural acceptance of unfamiliar building typologies. China issued Green Housing Standards in August of 2001 and has plans to monitor and verify the performance of the first suite of compliant buildings. Finally, Costa Rica is increasing government funding for urban planning, thus addressing its primary sustainability concern of the effect of unstable, unsafe environments on buildings and neighborhoods. Each of these activities offers valuable experience to other partners in the pursuit of sustainable buildings.

Buildings – homes, workshops, offices, factories, and health centers – are an interwoven part of daily life throughout the world, and thus they lie at the heart of the realization of sustainability. However, even though the construction of more sustainable buildings can be justified on sound economic, aesthetic, and environmental grounds, progress lags in both developing and developed nations. Recently, new activities have been undertaken to promote such developments, including market-oriented approaches in China and greater commitment by large multinational companies for their own facilities in the West. Charged with the task of understanding how to promote and implement already proven, yet underused sustainable building technologies, this working group met to explore two basic policy and technology questions:

- How can the future impact of current activities and new partners be enlarged?
- Can the different approaches be mutually supporting?

Evolution of Green Building Standards in Sweden

Carl-Eric Hagentoft, of the Department of Building Physics at Chalmers University in Sweden, provided insight into the evolution of building standards in Sweden. He began by technically defining a sustainable building. The technical definition of a sustainable building integrates indoor air quality, thermal comfort, human health issues, durability, energy efficiency, and responsible use of natural resources. Each of these systemic factors interacts in physical models of building performance. Tools combining physical and economic performance continue to be developed to serve the decision-making needs of architects and developers alike. These same principals form the basis supporting the advancement of codes and standards.

Discussion then turned to the evolution of Swedish building codes from specification-based to more performance-based standards. The history of building codes in Sweden began in 1945 with a "specification" based code, which required specific insulation thickness, windows, and building heat transfer coefficients

(U-values). The required U-value of buildings in Sweden has progressed from 0.5 W/m^{2}K in the 1950's to 0.2 W/m^{2}K today. Combined with public awareness of energy efficiency, the improved U-value requirements resulted in a drop in heating energy use per unit of floor space of 40%. However, overall, a net savings in energy did not occur. Electricity demand increased as a result of two trends: a) the increased need for mechanical ventilation, heat pumps, and other technologies running on electricity required to meet the codes, and b) an increase in per capita floor space of 40%.

In 1989/1990, Sweden adopted characteristics of a more "performance" based code, with requirements such as "no moisture damage" and overall allowances for building energy consumption leaving flexibility to the designer to comply. The primary advantages of performance-based codes include the ability to tailor building design to the conditions of a specific site and the allowance for innovation in design and technology use. On the other hand, compared to specification codes, performance based codes are more difficult to verify and introduce an element of risk to ensured performance. Whereas buildings based on specification codes are easier to verify, adoption of innovative technologies may be slower as the technologies must be proven before being approved for widespread implementation.

To proceed towards more sustainable buildings, policy instruments of both "carrots" and "sticks" are needed. Carrots include funding for demonstration buildings, technical knowledge, economic incentives such as tax breaks, and easy-to-use, accurate tools to assess sustainable performance. Sticks include inspection, verification, and enforcement of mandatory building codes.

A fine example of a low-energy home in the relatively cold climate of Sweden attests to the feasibility of sustainable design and construction. A series of row-houses in Göteburg feature the absence of a heating system thanks to proper insulation, high performance windows, an airtight building envelope, heat recovery ventilation, solar heated hot water, and good workmanship. The total energy use of a home is less than half that of a typical home of similar size (6,000 kWh/year vs. 13,500 kWh/year). The overall U-value of the home is 0.08 W/m^{2}K. Perhaps most important for the objective of cultural acceptance is that the homes do not stand apart aesthetically from a typical Swedish home.

One important issue raised in the question and answer period was that of how to retrofit existing buildings, as buildings typically last at least 30 years. In Sweden, 98% of construction is the refurbishment of old homes. A tradeoff exists between designing and constructing buildings to be durable versus affording the opportunity to implement new technologies. One idea suggested is to design buildings with a technology management perspective to allow for easier retrofitting as new technologies come along (e.g. better windows). On the other hand, another possible answer is to focus on designing and constructing buildings right the first time. With the high levels of construction in many areas of the world, such as China, many opportunities exist to begin making a base of sustainable buildings today.

Implementation of Green Housing Guidelines in China

Nie Meisheng, Vice Director of the Science and Technology Committee in the Chinese Ministry of Construction, provided an in-depth look into the housing market in China, the rising standard of living, and the implications for buildings. In 2001, China took an important step towards sustainability with the publica-

tion of "Green Guidelines for Sustainable Housing in China." The first five feasibility studies for residential buildings designed and constructed under this guideline will be jointly evaluated by the China Housing Industry Association and MIT, and the performance of the constructed homes will be monitored and assessed. Fierce competition in China's housing market is expected to hasten adoption of the guidelines.

Statistics on the current housing situation in China are eye opening. The annual completion of urban and rural housing in China is 13 billion square meters or 13 million units, of which 5 million units are in urban areas. The total annual investment in housing over each of the past three years has been 800 billion RMB (US$ 97 billion). Investment in housing construction represents 23.3% of national social fixed assets. Housing construction in China is very important to the economy, accounting for 1.3 percentage points of the 7.3% growth rate.

Use and management of land, water, energy and waste are under pressure in China. The loss of farming land grows at an annual rate of 50 million hectares, and urbanization is projected to increase from 37% in 2001 to 47% in 2010. 60% of urban areas face a water shortage, and 80% of rivers and lakes are polluted. Buildings account for approximately one-fourth of China's energy consumption, as compared to one-third in the US. In some areas, China's energy consumption per square meter of housing is 3 times that of the developed world, owing primarily to a lack of insulation and inefficient heating, ventilation, and air conditioning (HVAC) systems.

Varied forms of competition are apparent at all levels of housing provision. Labor intensity competes with technology intensity to construct and maintain buildings. Resource consumption competes with the need for conservation, a common trend throughout the world. Furthermore, some 27,000 local Chinese developers compete with transnational corporations for construction market share.

Last year, China took an important step towards the goal of sustainability in the housing sector with publication of the "Green Guidelines for Sustainable Housing in China" in August of 2001. Developed within the context of China's long-term strategies in sustainable development, the objective of the guidelines is to realize sustainability in the housing sector through the following goals:

- Increased level of functionality and quality in housing,
- Promotion of advanced building technology,
- Definition and implementation of sustainable housing construction, and
- Protection of home ownership rights.

The guidelines are based in part on the technical and policy experience of the US Green Building Council, Canada's Environmental Agency, the US Energy Star Program, the EU Ecolabel, Germany's Blue Angel Program, and others. The evaluation methodology consists of five categories, as described in Table 1.

Table 1. Key design elements of the 2001 "Green Guidelines for Sustainable Housing in China."

Evaluation Category	Key Elements
Urban Environmental Planning and Design	• Site selection • Traffic patterns • Facilitation of construction • Community greening • Air quality • Noise pollution • Outdoor lighting
Energy Resources and the Environment	• Energy efficient building design • Optimization of energy (i.e. HVAC) systems • Use of renewable energy sources • Environmental impact of energy consumption
Indoor Environmental Quality	• Indoor air quality • Heating • Lighting • Sound
Community Water and Wastewater	• Water supply and wastewater discharge • Wastewater treatment and reuse (i.e. gray water usage) • Water usage for landscaping • Water conserving appliances
Materials and Resources	• Sustainable building materials • Utilization of local materials • Reuse of resources • Waste management

Dissemination of the Green Guidelines will begin with construction of ten developments known as the Asia Pacific Green Villages. Vital to the project is an inspection team, led by the China Housing Industry Association, to evaluate and verify building performance after construction. In the question and answer period, the issue of cost drew the first questions. Professor Leon Glicksman, director of the Sustainable Buildings in China project, stated that he often finds that if costs are more than 5% higher than conventional costs, developers are not likely to take on the project. In response, Dr. Nie believes that the heavy force of competition in China encourages developers to increase the quality of their buildings, thus creating a demand for sustainable buildings.

An Urban Planning Viewpoint from Costa Rica

Carlos Quesada Mateo, director of the Research Center on Sustainable Development at the University of Costa Rica, provided an urban planning view on sustainable development and building construction. Oftentimes in developing regions of the world, funds are insufficient to provide for proper land use and planning. This leads to building construction in sensitive and often unstable areas. Once again, the importance of a systems view in the context of the built environment is exemplified. Improvement of urban systems requires investment priority in basic services and long-term land-use planning.

The major challenge to land management is population pressure. Costa Rica is an example of the onset of pressures brought on by population growth. In 1950, the population was only 800,000; today, there are four million people living in its boundaries, a five-fold increase over just fifty years. An increased urban population further exacerbates environmental problems due to increased transportation and energy needs.

Nonetheless, shelter is the most basic need of any human settlement, and a large investment is needed to provide services for such a large number of people. Governments often overlook this need in times of economic hardship, as happened in Costa Rica's recession in the 1980s. Enforcement of zoning standards

was relaxed and construction of low-income housing was deregulated. To increase the amount of investment in housing, the government also relaxed enforcement of building codes, resulting in sub-quality, and often unsafe new homes.

Earthquakes and other natural disasters, as opposed to energy consumption, present the primary environmental problem to buildings in Latin America and much of the developing world[1]. Building codes requiring reinforced concrete and low-cost, box type construction have resulted in relatively safe buildings in Costa Rica's case. Nonetheless, one of the major problems that Costa Rica faces is finding safe land on which to build housing. In the absence of provided infrastructure, the poor tend to settle on cheap, usually unstable, unsafe land. Homes, although small at an average size of 80 square meters, are constructed in watersheds, thereby causing increased runoff and subsequent increased risk of landslides. By law in Costa Rica, it is the responsibility of the government to provide water and electricity services to settled areas. However, this only encourages squatters to stay in unsafe areas, as opposed to developing settlements in more adequate zones.

Improvement of buildings in developing countries is benefiting in some respects from access to technologies afforded by globalization. For example, a building materials exposition held recently in Costa Rica featured nearly every product currently available in the US market. One example is a "smart" house that uses control and sensor technology to enhance security, comfort, and communication. Another example is that of a "smart" office building, with energy management systems and controlled access. A third example is the availability of four types of windows with different grades of emissivity allowing for trade-offs between cost and allowed solar radiation (i.e. low-e windows). Other technology needs that remain to be addressed with urgency include elimination of sources of indoor air pollution from building materials and affordable inclusion of renewable energy technology in building designs.

One of the audience members shared her experience working with a Costa Rican research program to develop sustainable construction systems. Taking into account the factors of quality of life, use of local materials, and water and energy conservation, the program team developed a construction system of micro concrete panels made with plantation wood to be used in affordable housing developments. Cultural acceptance of change to a new construction system, as discussed in the Swedish case, was the biggest problem encountered. Nurturing such change is a long process, and incentives and demonstration are needed to further deployment of new technologies.

Overall, sustainability calls for a systems perspective and a lifecycle approach to constructing urban settlements. Without this view, individual building nodes may be environmentally adequate, but the entire urban pathway may not be. Waste, air quality, and transportation must be understood as interacting forces that behave in a system. Looking at neighborhoods as a functioning whole, not just as individual elements, can improve social and economic development. Human potential, security, and solidarity are important aspects for any technology application, and especially those for buildings.

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[1] See the summary of Sarah Cordero's presentation in the report on working group 2.5, "Vulnerability to Man-Made and Natural Hazards with Case Study Focus on Central America."

Conclusion

Realization of quality of life, productivity, and human potential – resounding themes throughout the AGS 2002 annual meeting – lie at the heart of sustainable architecture and building technologies. Primary technology themes to guide sustainable architecture and urban planning include systems-oriented design of buildings and urban systems, use of simple, culturally contextual technologies, and verification of performance once a building is operating. Policy can hasten adoption of sustainable practices through design guidelines, codes, and incentives. As technology and decision-making tools evolve to mutually focus on quality of life issues, sustainable buildings will have increased potential to form the basis of future neighborhoods.

Looking ahead

As AGS looks ahead to strengthen its research portfolio in the area of sustainable building technologies, this working group raised suggestions in four overlapping categories: policy, demonstration projects, design tools, and fundamental research.

In the area of policy, AGS members have a role to play in working with local governments to analyze, design, and implement policy, as well as to inspect, monitor, and communicate post-construction building performance.

Demonstration projects, which serve to educate and influence cultural acceptance for technical change, are essential to bringing about adoption of advanced technology in an industry with relatively long lifecycles such as the building industry. Examples range from education-type projects with local governments and businesses in developing countries to targeting early-adopters in the corporate world to demonstrate the feasibility, integrity, and cost-effectiveness of advanced sustainable building technologies.

Development of user-friendly design tools will help bring sustainability to the fingertips of those who design the built environment throughout the world. Continued research is needed to apply the concepts of multi-disciplinary, multi-parameter, and parallel design process tools[2] to sustainable building design.

Finally, fundamental research may focus on development of economically effective products for retrofit markets and characterization of the human health and productivity dimensions of building environments, so as to incorporate the knowledge into design tools, material selection, and policy. With such a broad portfolio of important research needs, ample opportunity exists for multi-disciplinary collaboration between AGS members and stakeholders to work towards a sustainably built environment.

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[2] AGS sponsored research lead by Professor David Wallace at MIT has aimed to develop a collaborative Internet-based, environmentally conscious modeling approach for product design termed DOME.

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Working Group

Changing Transportation Needs in the Developing and Industrial World: Similar Problems, Similar Solutions?

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Abstract

The first objective of the working group was to identify the type of transportation impacts that are faced in both the developing and industrialized worlds in urban transportation and to compare the solutions that have been created to overcome these problems. The second was to take a long-term perspective in order to project alternative transportation futures, and to examine the role played by institutions, especially in developing countries, in shaping desirable elements of these transportation futures.

Urban Mobility

To begin, the working group summarized trends in urban transport demand/supply and infrastructure provision in various parts of the world. Christopher Zegras began the session by providing an overview of urban mobility in the U.S., focusing on trends, challenges, innovations and policy issues, and ending with a summary of the current debates. Principal trends in the U.S. are that the growth in person trips has been exceeding the growth in GDP per capita, although there are some indications that this particular trend might be reaching saturation. At the same time, the U.S. is experiencing relentless suburbanization and a decline in city density, with 84% of growth in cities and towns between 1990 and 2000 occurring in suburbs.

Of the challenges Zegras presented for the U.S. transportation sector, two showed signs of improvement. While vehicle-km travel has grown by 3.1% per year, there has been a 30% reduction in traffic accidents since 1988 and the level of local air pollution has begun to fall following the introduction of the Clean Air Act Amendments in 1990. Congestion continues to be a major policy driver but the increase in average commute speed raises the question of how bad the congestion really is. However, the U.S. is still facing significant challenges in reducing transportation related greenhouse gas emissions (transport accounts for 26% of U.S. GHGs), there is an apparent decline in the access of the poor to employment, and the greatest increase in travel per person (1990-95) has occurred amongst people over the age of 65. The emerging travel needs of the elderly were highlighted as being an area where transportation technology has yet to respond.

To conclude his presentation, Zegras highlighted the current critical policies and debates in the U.S. Congestion pricing was described as lacking public support, so it remained an unviable proposition. In terms

of fuel efficiency, the U.S. Senate has recently rejected a further increase in CAFÉ standards. However, General Motors, Dodge and Ford, have all indicated that they plan to release hybrid SUVs onto the market by 2003. Looking at air quality conformity in the U.S., metropolitan areas must achieve air quality standards in order to secure their Federal transportation funds. This incentive has promoted not only substantial advances on the policy front, but also innovations in quantitative modeling and new mechanisms of institutional cooperation. Some additional innovations beginning to emerge in the US include the notion of car sharing; however, it remains to be seen whether this mode of transportation will capture more than 1–2% of auto users in the US.

The second presentation by Angelica Castro provided a contrast to the situation in the US both in scale and type of region, and outlined recent developments in Bogotá's transportation system in Colombia.

In Bogotá, there are currently 1 million cars transporting 19% of the population, and 30,000 buses which make 72% of the daily motorized trips. With an average urban bus speed of around 10 km/hr, urban commuters can spend over 2 hours on public transportation per day. To provide an overview of the important steps taken in Bogotá to overcome these low indices of mobility, Castro highlighted four key strategies; public space recuperation, encouragement of bicycle use, discouragement of private car use, and the development of mass transportation.

The rejuvenation and creation of public space through the construction of walkways, green spaces, sidewalks, and neighborhood and metropolitan parks, has encouraged walking and at the same time improved the quality of life. The use of bicycles is a part of Colombian culture and the combination of new road layouts, bikeways, and bicycle parking, has caused bicycle utilization to increase from 1% of the daily market share of transportation in 1995 to 4% today. However, the security of parked bicycles remains a major problem. The main policy for discouraging private car use has been the use of restrictions during peak hours, combined with a fuel surcharge (the revenue from which has been reinvested in Bus Rapid Transit), car-free weekdays, and higher parking charges. The final strategy presented by Castro described Transmilenio, the new Bus Rapid Transit (BRT) system, and how it had become a way of life for many residents. Today Transmilenio transports 650,000 passengers a day at an average speed of 26 km/hr over a 38 km network, utilizing 457 trunk buses, 198 feeder buses and 59 stations.

In response to Castro's comments, Joel Crawford (carfree.com), raised the question of the relative costs of rail versus bus along dedicated bus lanes. Castro stated that the flexibility afforded by a bus network meant that investments could be made in a piecemeal fashion, avoiding high upfront capital expenses. This was one of the main reasons why Bogotá had invested in the BRT system rather than in a heavy rail solution.

The discussion following Castro's presentation concluded with an observation by a member of the audience that urban transportation development in the US did not in general follow a well thought out plan and that BRT solutions could be considered to be outside of the set of feasible alternatives. Conversely, many developing country cities have the opportunity to establish a different urban structure and take advantage of high population densities and captive transit ridership. Curitiba in Brazil was highlighted as an example of such a city.

The third presentation of the working group was made by Professor Hitoshi Ieda from the University of Tokyo, and continued the theme of Bogotá's Transmilenio project by focusing on transit policies in large cities in Asia.

Ieda highlighted a few of the major problems faced by large Asian cities today; including the immense and rapid demographic concentration in large cities which results in inadequate living conditions, high levels of poverty and potentially severe traffic problems. Solving Asia's transportation problem was seen as being one of the keys to sustainability.

Ieda raised four challenges facing large Asian cities. First, the paratransit service in large cities in developing countries is labor intensive and dependent upon cheap labor. As poverty is eliminated, these services will be dramatically reduced causing a significant problem in the provision of paratransit. Second, developing countries are at a significant disadvantage regarding the procurement of infrastructure. The majority of transportation equipment used in developing countries is imported from industrialized countries which charge high prices. Transferring these costs to the customer is not a feasible option in many developing countries. Third, the growing motorization rate and associated infrastructure development in developing countries is likely to become a significant barrier to the implementation of rapid transit systems. Finally, weak institutional capacity for urban development is likely to compound the problems faced by large cities in many developing countries.

A member of the audience asked whether transportation systems in Asian megacities were sustainable. Ieda responded optimistically and stated that many transportation systems are sustainable as a result of large and dense populations. However, this statement came with a caveat that many cities are now at a stage where a decision needs to be made whether they will become sustainable or not, and the focus must be on high density and the use of public transport if they are to remain on a path that leads towards a sustainable transportation system.

To conclude the first section, Björn Malbert from Chalmers University of Technology, presented methods of design for sustainable urban development in Sweden.

Initial research, undertaken at Chalmers University in the late 1980s, focused on different aspects of the relationship between mobility systems and urban land-use development, and used GIS-based tools for analysis and simulation in order to enhance policy and decision-making. Initial results from the analysis of congestion, air pollution, noise pollution, etc. in cities, recommended investments in bypass solutions in order to separate local and long distance traffic.

The solution has presented a problem, however, because about 30% of all new urban development in Sweden over the last decade has been located along the newly built bypasses. Thus, they have become "local streets" with mixed local and long distance traffic in an urban structure that is very difficult to support with efficient public transportation systems.

Malbert ended by stating that the construction of a transportation system is a step-by-step process which must match demographics and the wishes of the people. In this regard he stressed the importance of shifting from the need to own a car to the need for mobility.

Alternative Transportation Futures

After examining urban transportation problems and solutions, German Lleras from MIT launched the second section of the working group, by providing an overview of alternative longer-term mobility futures. The first selection of mobility futures came from the US around 1925. These visions highlighted the relevance of speed and freedom as the main factors underlying mobility needs; and at the same time they drew attention to the limitations imposed by infrastructure and the desire for more capacity.

The second selection of possible mobility futures was based upon an analysis of historic trends and projections. The main conclusions of this exercise were that 1) motorization rates in developing countries had been growing and this trend was likely to continue, 2) demand for mobility would increase worldwide, and 3) as income increased there would be a tendency to shift from slower to faster modes of transportation.

The third and final set of possible mobility futures emerged from scenarios created by different actors in the transportation business and was composed of two distinct categories. The first category considered the role that new technology might play in overcoming the challenges posed by the increasing motorization rates and demands for mobility. Here, hybrid or fuel-cell vehicles were believed to be central to finding a solution to this problem. The second category focused on future changes in travel behavior as a result of transportation policies rather than technological breakthroughs. In this case it was thought that solutions such as BRT systems or changes in urbanization patterns would play a pivotal role in shaping new futures. To conclude, Lleras presented a set of questions that characterized possible future scenarios; the most relevant being 1) what will become the role of the private automobile in different parts of the world? and 2) are developing countries merely following the path of the developed world, or is there room for leapfrogging in order to take advantage of technologies and policies that will help them save valuable resources?

The second discussion, lead by Dr. Andreas Schafer, began with a response to several questions on the similarities between the transportation systems in both developed and developing countries. Schafer explained how developing countries are currently following transportation development patterns similar to those which industrialized countries experienced during their development. Schafer presented a salient result of his research that serves well as a tool to explain the observed trends. On high aggregation levels, humans, on average, spend a fixed share of money and time on transportation. This finding has significant implications for travel behavior and sustainability. As income rises, demand for travel increases and with a limited travel time budget this means that in order to travel greater distances a shift to faster modes of transportation must occur. This trend can be seen in historic travel patterns on a global scale, worldwide; in urban settings, modal shifts have occurred from non-motorized and public transportation to the private automobile; and in the intercity market, modal shifts have occurred from automobiles, buses, and railways to air transportation and high-speed rail.

While at such highly aggregate levels, all parts of the world seem to move along the path toward rising mobility and higher speeds, there might be traffic solutions on a smaller, urban scale that over time may propagate and bring about some change in the larger transportation system. With that in mind, Joel Crawford finished the second section by examining car-free cities. He opened his presentation by stating that the rapid urbanization trends experienced worldwide will continue, accompanied by constraints in resources and by more stringent air pollution standards that may limit increasing motorization rates. Moreover, the adverse social effects of rising motorization will also hinder a city's development. These forecasts are better understood in the context of the year 2025, when four billion people will live in cities, mostly in the developing world. This situation presents a dichotomy between the search for a better quality of life and the increase in motorization rates; the latter being a poor way to achieve the former, even if improvements in terms of the environmental effects of vehicles are realized in the near future.

Crawford argued that the path towards auto dependence is not a sustainable one; imagining a world that reaches the levels of auto dependence of the U.S. provides a troublesome picture. Furthermore, Crawford challenged the audience to think whether car-centric cities are sustainable, even if the problems of congestion, pollution and energy consumption are solved.

Mr. Crawford compared Venice (a car-free city) and Los Angeles (a car-centric city), through a set of scenarios depicting several aspects of their daily life. The main conclusions were: 1) public spaces created for cars (e.g., strip malls) are convenient for drivers but not for people, 2) in cities such as LA, parking dominates design criteria whereas in Venice, outdoor spaces are welcoming, encouraging people to linger and chat, 3) venues intended to congregate people (e.g. churches) must provide parking that offers no secondary amenity, on the other hand, plazas and entrances serve an informal social function, and 4) shopping in cities like LA happens in large stores that are far from home and dominated by parking lots; while shopping in Venice is done on the streets and on foot.

Crawford argued that a car-free city would contribute to the reduction of pollution, to an improvement in quality of life, and to the creation of a more sustainable urban life. His basic hypothesis was that cities based on the rail transportation of passengers and freight, provide greater benefits and at nearly irreducible economic and environmental costs. Although a 100% reduction in cars is likely to be rejected by the public, evidence suggests that many city dwellers are already searching for car-reduced environments as a way to improve their quality of life, showing that at least some people are ready for car-free neighborhoods.

Crawford showed a reference design for a carfree city of 1 million people. The goal of the design was to provide high quality of life and optimized transport using rail systems.

Crawford's concluding remarks were centered on how to persuade people to give up their cars, especially when the idea of having a car is sold as an equivalent of freedom and is used as a status symbol. To succeed, the concept of the car-free city must begin in industrialized countries through a series of pilot projects. A long list of mostly European cities, where car-free initiatives have been successful can be found at the carfree.com website.

Crawford's presentation raised many issues among the audience; Alberto Trejos (INCAE) asked how the transition could be made from today's cities to car-free cities. The reply was based on the availability of redevelopment areas in U.S. and European cities, for instance brownfield sites were seen as offering opportunities to start car-free neighborhoods. The remaining questions were about the convenience of this design in terms of leisure activities outside the city, extreme weather conditions, how to carry large items (e.g., skis, windsurfs, boxes, etc.), and so on. Crawford acknowledged these needs but made the point that they could be solved by rail alternatives or by using the car outside of the city.

The Role of Institutions

How can desirable transportation futures be achieved? In particular, what is the role of institutions especially in the developing world, where most of the growth in travel demand is occurring? This was the underlying theme of the last section of the working group.

Ralph Gakenheimer from MIT, began this section with a description of the main transportation challenges being faced, mainly by the developing world; 1) rapid motorization destabilizing urban systems, 2) the need for infrastructure capital versus difficulties in recovering costs via fees, 3) the need to reinforce local initiatives, and 4) a lack of interest in long range planning.

In order to propel solutions and overcome those barriers he suggested, 1) the creation of government awareness of serious future problems, 2) an increase in the level of participatory planning to engage stakeholders by including them in the planning of short-term projects, and 3) the creation of budget realism. In addition, one key instrument is Public-Private partnerships since they allow for the assessment of several alternatives, while distributing the risk associated with the policies and projects across sectors. However, Gakenheimer argued that over-privatization could be counterproductive in the long-term, especially for the adequate provision of infrastructure.

Gakenheimer ended by pointing out three particular issues; 1) the need for anticipation – communities should be aware of the potential developments that might occur in their cities and neighborhoods, 2) the need to provide efficient access to the center of a city to protect its relevance and further development, and 3) the need for entrepreneurial effort, e.g. car sharing as a tool to reduce potential automobile ownership.

The final presentation of the working group was delivered by Alberto Trejos from INCAE, and showed a rather different but relevant point of view of sustainable transport in the context of the Central American region. Its relevance lies in the fact that this region, endowed with natural beauty, resources and biodiversity, may have to trade off some of this advantage for the creation of a modern transportation system as a tool for development.

Trejos's presentation was centered on the development of a logistical corridor in Central America; a region that, to a large extent, is already integrated in terms of its economy, population migration, regional firms, and regional institutions. However, because of the region's size, the market is still too small to attract substantial foreign direct investments. In order to overcome this problem the region has to create the right

environment in order to develop. In terms of its integration as a regional unit, there are several challenges to overcome, e.g. slow transport systems, high logistical costs, corrupt customs, and inefficient ports. These issues are limiting the region's ability to trade and to attract investments.

Many of the problems that hinder integration and the creation of a sustainable transport system are logistical in nature; despite the short distances between the capitals of each country, transport costs are very high.

The region is missing a great opportunity because its location would be suitable as the base for a port that would serve the U.S. and the Latin-American market, as Rotterdam, Hong-Kong or Singapore do in other regions of the world. However, due to the lack of an efficient logistical system this goal cannot become a reality.

The proposal for a logistical corridor involves four components: 1) physical infrastructure, 2) customs, 3) logistical markets, and 4) telecommunications and energy. For all these elements, technical solutions already exist, however implementation remains the big problem. Lastly, and perhaps most important, is how to balance the environmental, economic, and social concerns that play a role in the development of this complex system.

Summary

This workshop showed many similarities in the transportation sector, irrespective of the geographic region. Perhaps the most important were that as transportation demand continues to grow strongly with income, people shift toward ever-faster modes; and that there appears to be no saturation of travel demand in sight. In addition, some of the effects of such growth and mode shifts, most notably traffic congestion, seem to have no geographic boundary, as they are similar in Bangkok, Bangalore, and Boston. The main underlying cause of traffic congestion, the lack of infrastructure to provide sufficient road space for a rising vehicle fleet, is however, significantly more marked in the developing world, where the shift toward the automobile has only just begun.

What can be done to deviate from the stable growth trajectory between income and travel demand and resolve the congestion problem, at least to some extent? The workshop showed that solutions to that problem might be more promising if begun on a local level through a carefully composed set of policies which include viable alternatives to automobile travel, land-use policies, and constraints on (or pricing of) automobile use. (Perhaps, in the distant future, some cities might even experience very reduced or zero levels of automobile use.) The path to more sustainable transportation futures requires institutions that envisage long-term plans, engage various stakeholders in decision-making on short-term projects, and create budget-realism through, for example, well balanced public-private partnerships.

Working Group

Issues in Water and Food for Burgeoning Populations

Leader	Greg Morrison, Chalmers University of Technology
Discussion Leaders	Wolfgang Kinzelbach, ETH-Zurich
	Tobias Siegfried, ETH-Zurich
	Barbara Becker, ETH-Zurich
	Kieji Ohga, UT
	Peter Edwards, ETH-Zurich
Rapporteurs	Boyd Fuller and Omid Kassiri

Abstract

Four case studies were presented which demonstrated the water problems in water-scarce areas due to human activity, with an emphasis on water pumping from aquifers. Of particular concern is not only the amount of water used in agriculture – 70% of global water demand is for agricultural production – but also the need for conservation of wetlands and ecologically valuable regions.

Background

It is estimated that there is available 13,000 km3/annum of accessible renewable water resource and that global withdrawals are in the range of 4,000 km3/annum. Averaging, however, hides severe local problems: 1 billion people have no access to clean and healthy water; a global population increase of 3 billion is expected by 2050, with the majority in arid and semi-arid areas; and most of the soil suited for agriculture is already being used for that purpose.

To address these severe local problems, a number of options could be explored: (Bracketed numbers are potential savings per year in km3/annum.)

- Water saving irrigation methods and demand management (1000),
- Change of diet to vegetarian (500),
- Water conservation methods including rain harvesting (100),
- Change of economic activity and import of "virtual water" (currently 500),
- Desalination (currently 20),
- Inter-basin transfer (100),
- Reallocation of people, population policies (currently 20),
- Gaining time by non-sustainable exploitation (currently 100).

These savings are significant given current demands, with an additional expected annual demand of 1000 km^3.

Case study 1: Overexploitation of North Sahara Aquifer System

The North Sahara Aquifer System under Algeria, Tunisia and Liberia, is one of the largest in the world, twice the size of France. With a doubling of the population and agricultural activity between 1950 and 2000 and an expected three-fold increase by 2050, demand on the already overexploited aquifer will

increase greatly. Currently, over-pumping of water from the aquifer draws in water from the sea, causing salts to dissolve underground. Additional demand on the aquifer will increase the salt content of the water and consequently, salination of the soils.

Water crises first appear in marginal arid environments. Classical ways of coping with aridity (pumping) are today infeasible due to high future demand. To stop the degradation process a strong political will is necessary, including abandoning the ideal of food self-sufficiency. A number of countries engage in non-sustainable practices for political reasons.

Case study 2: Salination of Soil in the Murrumbidgee Irrigation District, Australia

The land in the Murrumbidgee Irrigation District is flooded for rice field irrigation. Due to the high water table and capillary action, salts rise to the surface. At the current rate, it is expected by 2050 that 15-30% of agricultural land will be lost. Currently farmers strive to optimize produce in the short-run (at whatever long-term cost to the environment). Inevitably alternative sustainable approaches are needed. These alternative approaches may cause short-term economic losses. These losses, however, would be smaller than the consequential losses due to current practices.

Case studies 3 and 4: Botswana and Okavango Delta

It is a general principle of sustainability that the rate at which water is pumped out of an aquifer should not exceed the rate of recharge of the aquifer over the long-term. Currently 60% of aquifers are overexploited. While the recharge rate of aquifers is an important factor in water resource management, the rate is often unknown or difficult to determine. It is important to begin planning the management of the resource before over-exploitation begins. New technologies are available to help improve resource assessment and to make early planning possible.

The case of the Okavango Delta is a demographic/political international problem. Angola wants to build reservoirs on the river. Namibia wants to draw off water from the Caprivi Strip. Botswana needs the water for the preservation of its delta. The system boundary must include all the countries that have a stake in the water resource. Immediate water needs will often be satisfied at the cost of the natural environment.

It has been observed that in the press there is much talk of the water shortage. This coverage is possibly a consequence of the activities of two major groups: construction companies eager to have more projects, and zealous environmentalists. The press publishes this without hard data. What can be done about this? The AGS should make an effort to better inform the public about the water situation in a systematic way.

In conclusion it should be remembered that people who live in arid areas are well aware of sustainability problems. They have been dealing with it for decades. We should not go in to tell them how to be sustainable, but to stop our own people from doing terrible things to their environment.

Barbara Becker directed her comments towards poverty and land degradation. From a scientific perspective there are many impressive ideas to deal with this issue, but they are difficult to implement, con-

solidate, and sustain in practice (such as becoming vegetarian to save energy). Her organization, the Swiss Centre for International Agriculture (ZIL), based at the Swiss Federal Institute of Technology in Zurich (ETH-Z), aims to harness Swiss scientific resources to promote sustainable use of natural resources in agriculture and forestry in non-OECD countries. ZIL hopes to work with the AGS on livestock systems in the following four research areas:

- Poverty alleviation
- Food security
- Sustainable use of natural resources
- Economic growth

The rationale for focusing on livestock systems stems from the "livestock revolution," the fastest growing food demand in developing countries due to urbanization and growing incomes as well as the fastest growing sector in agricultural production, soon to comprise half of the total economic share. The challenge lies in meeting this demand without damaging the environment and posing a risk to human health. These challenges are exacerbated by extensive grazing systems, mixed agriculture, and intensive "industrial" animal production.

Livestock systems research needs to encompass the entire food chain and be inclusive of all factors along this chain. These factors include:

- Biodiversity of grazing areas,
- Soil conditions for fodder production,
- Genetic diversity and improvement of fodder,
- Genetic diversity and improvement of domestic animals,
- Feeding systems and animal nutrition,
- Animal production systems,
- Human nutrition,
- Food processing,
- Marketing and trade,
- Income, employment, and equity (including gender aspects), and
- National and international policies.

Keiji Ohga spoke to the issues of water and food in Asian countries where, as in many areas, water has not been adequately included and accounted for in theories of growth. In economic theory, land, labor, and capital are represented but not water. Agriculture is the biggest user of water in most of the Pacific countries.

In Asia, food demand is quickly changing from cereals to livestock products, vegetables, fruits, and processed food. Imported quantities of these products have soared because local agriculture production is unable to keep up with the demand, which is increasing due to the regional economic growth. In contrast, rice is over-produced in Asian countries due to improved practices. Paddy rice, however, needs three times as much water as wheat production.

Better management is needed of water resources: more efficient use of water for irrigation; water recycling; and reallocation of existing supplies. In addition to the agricultural demands, urbanization puts an added strain on water resources. In the Pacific region, the urban population will grow from current figures of 1.1 billion to 2 billion by 2025. This growth puts stress on both infrastructure and water supply. The concept of reallocation of water among users (upstream, downstream) is a political problem, as is the modal share between industry, agriculture, and domestic use. Asian countries are at risk for water shortages unless water control facilities are expanded and/or efficiency in water use is achieved. In order to meet this challenge of water scarcity there must be better assessment and monitoring of performance of the water resources cycling system.

Water quantity is not the only concern. Water quality can become a problem too. Immigration to large cities puts stress on the water provision infrastructure. Pollution caused by industry and household waste in urban areas poses a serious threat to human health. Water is also often contaminated by pesticides, herbicides, and fertilizer runoff.

In response to Professor Ohga's comments, one participant pointed out that there was a protest in San José on Wednesday due to the low prices of imported rice, which is competing with the local market. Switching from rice to other food products in Japan has encouraged the Japanese to dump their excess rice in other countries at low prices. Water and food issues get tied into international economic and political agendas. It should also be remembered that rice in Japan was produced with large government subsidies.

Another participant asked how to spread methods and technologies developed in Japan, which reduce water requirements for rice by a factor of 5, to other parts of the world. We are preaching the gospel of market economy everywhere, but in agriculture we do the opposite, by subsidizing, etc. It should be remembered that agriculture does not include food production alone. Through it, we control how the landscape is treated (governments often pay farmers to farm, even when there is no net product from it). The farmer is no longer just a food producer but is also a landscaper and water controller.

Peter J. Edwards discussed the importance of sustaining biodiversity and why sustaining biodiversity is important for sustainable agriculture. Intensive agriculture has resulted in the significant loss of biodiversity: 75% of crop landscape has been lost; 75% of Indian rice is produced from ten of 30,000 species; 80% of cotton is produced from a handful of transgenic cultivars; 90% of all US dairy cattle consist of one breed (Holsteins).

Genetically uniform crops promote pathogen epidemics. If species are rare, they are less likely to be attacked by disease. If common, they are attacked and then become rare. It almost appears as if there is a constant selection against being common, but we have taken particular breeds and made them very common in very short spaces of time. Our agriculture has so far been organized to look for single solutions. A fight has thus developed between the agrochemical industry and pests and pathogens. The amount of crop lost to insects is exactly the same now as it was 40 years ago. If we destroy biological diversity, we take away the natural ability of our crops to fight disease.

One solution is to value the 'service' provided by biodiversity. These services include:

- Maintaining soil fertility,
- Protection against soil erosion,
- Maintaining water quality,
- Provision flood control,
- Detoxification of pesticides,
- Creation of natural enemies to pests,
- Maintaining a source of genetic material, and
- Ecosystem resilience and stability.

Making better use of biodiversity has great rewards. For example, in Japan, two types of rice were mixed. Yields increased by 89% and disease rates dropped by 94%.

Modern agricultural systems are highly simplified and subject to extreme directional selection. Biodiversity is essential for sustainability. This means designing agricultural landscapes in which biodiversity can persist and where one can take advantage of the benefits of biodiversity.

The AGS should help produce synergy between different regions of the world. We do things in parallel. How do we link our efforts? Information and knowledge-sharing are needed. Dialogue between different disciplines is also needed. This should be given greater emphasis by having inter-disciplinary and trans-disciplinary partnerships. The AGS should have more partners from developing countries who can speak for themselves, so that the developed countries are not put in the position of having to invent what is needed on their behalf.

Working Group

Digital Strategies and Opportunities for Sustainable Development

Leader	Nazli Choucri, MIT
Discussion Leaders	Stephen Connors, MIT
	Jens Soth, ETH-Zurich
	Lutz-Gunther Scheidt, Sony Europe
	Eleanora Badilla-Saxe, MIT Media Lab
	Toufic Mehzer, American University of Beirut
Rapporteurs	Ralph Hall and Julia Parsons

Abstract

The purpose of this session was to discuss a variety of IT innovations and their application to promote improved decision making and knowledge sharing in business and industry, government and civil society – and across geographical and economic boundaries. In order to most effectively use IT for Sustainable Development, four shifts must occur: (i) from 'supply-chain' to 'knowledge-chain' networking and management, (ii) from the research and development of products and processes to the development of new organizational modes and approaches to research and development, (iii) from the 'digital divide' between the North and South to 'structural inclusion' of both the rich and poor in all societies, and (iv) from the cost of globalization to the benefits of localization.

A popular misconception of information technology (IT) is that it has solely a negative impact on the environment. Such impacts include the use of toxic chemicals, improper disposal, and the energy required for use and production of computer components. These technologies are also often used for advertising, which therefore encourages consumption of resource-intensive products. Only recently, the industry has been working to reduce these negative impacts by increasing energy efficiency and implementing proper recycling/disposal programs.

The use of these technologies can also have a positive environmental impact through its use in monitoring and modeling the environment or for networking related to sustainable development[1]. In addition, some argue that jobs are created by the use and development of information technology, and that there is a huge energy saving potential in the sharing of electronic (versus paper) documents and e-commerce[2]. Current research being conducted by the AGS addresses issues to help improve the application of IT to sustainable development, such as information dissemination, rural IT development and information quality control.

Guidelines for knowledge dissemination

"Supply-chain" management

Stephen Connors[3], of the MIT Laboratory for Energy and the Environment, stressed the importance of "getting the right information to the right audiences at the right time." Communicating research results and other information to such disparate audiences as policy makers, researchers, the media, and the public is a significant challenge. Therefore, a well-designed knowledge network is necessary to capture and

communicate knowledge in an efficient manner. An effective "knowledge supply-chain" enables solutions to be targeted at the appropriate audience for implementation.

Whether or not such a knowledge network should have two-way communication is an open question. While direct accessibility to researchers would certainly help users tailor the results to their needs, to what degree (and for how long) can such experts be called on for "online assistance?" Connors also stressed the importance of stakeholder dialogs to ensure relevant research. The transfer of knowledge has three levels of feasibility: technical (effectiveness), economic (affordability), and political (implementation). Once stakeholders are committed to a process or project, the general message must be used to reach a broader audience and ensure broad scale implementation of research results.

The role of industry

Efficient knowledge transfer is also an issue that must be addressed by industry. Jens Soth[4], of ETH Zurich, presented three conclusions from his case studies regarding the management of environmental knowledge by corporations. First, the design of IT systems must focus on its users rather than making the users adjust to the system. Next is the realization that knowledge is more than just information – it needs a refined cultural setting to convert tacit into explicit knowledge. Finally, a major problem encountered by designers and product developers is that they rarely have the chance to be trained in the sustainability aspects of their work. This is essential because product development is a critical point in determining the environmental impact of a product. Incorporating these aspects into the development of IT and business systems is essential to changing the impact corporations have on sustainable development.

The above recommendations have been applied in an AGS project entitled "Ecodesign Courses." The concept of the project is to combine sustainability issues with product development in industry, leading to changes in the training and education of product designers, behavioral changes in engineers and companies, and subsequently more environmentally friendly products. This re-education of designers involves seminars and computer aided courses, and brings together mechanical engineering students, designers and environmental managers. An important aspect of the project is that students (the next generation of designers) develop a strong background in sustainable design and are able to incorporate this knowledge into their final products.

Rural IT development

Many believe that, in order to achieve global sustainability, technologies for 'Internet enabled' rural development must be investigated, because such technologies have the potential to expand local/global collaboration. According to Lutz-Gunther Scheidt[5] of Sony-Europe, the key barriers to the success of 'Internet enabled' rural development are (1) inadequate or complete lack of access to infrastructure, (2) poor education and training in basic computer literacy, (3) irrelevant content for the local community, (4) cultural barriers to the acceptance of technology, and (5) inconsistent government support for such initiatives.

The establishment of new markets always requires a different form of user interface combined with robust local connections to the global network. There are currently no established information technolo-

gies in the developed world that can be used to address the needs of developing countries. Additionally, what connectivity is available is of little use unless it provides access to relevant and value creating applications and information. Therefore, new applications and technologies must be developed to help developing countries assess and address local needs.

Moving towards a philanthropic approach to business will be necessary in order to develop these new applications and technologies. Business models must incorporate the needs of the community, utilize existing and innovate new technologies, and be sustainable, scalable, and replicable. The development of appropriate sales channels and partnerships is also necessary to complement these objectives. However, businesses are still in the learning phase and options should therefore remain flexible.

Bridging the Digital Divide

A major concern about the expansion of IT is enhancement of the digital divide between the rich and the underprivileged globally. But is this divide in fact digital? Eleanora Badilla-Saxe[6], of the MIT Media lab, proposes that the social challenges of our time are hunger, poverty, and lack of access to education and health care. Although technology has not been the direct cause of these problems, it does have the potential to decide how these challenges are addressed. In situations where technology has been made available to rural communities, there has been no evidence that it has had any impact on the challenges faced by the indigenous population.

Supplying technology alone is not enough. Therefore the MIT Media Lab has established the Digital Nations Consortium to address the concern that the majority of new technology is aimed at the markets of developed nations. The new consortium connects researchers in both developed and developing countries, with the objective of creating new technologies to help address social and physical problems in each by promoting a shift from technology supply to constructionism and technological fluency. Their research addresses such questions as: How do you empower the learner to learn and create? How do you identify a community's problems and use technology as a means to solve them, and if technology has been transferred, how to you avoid creating dependency? In addition, individuals must become fluent in the use of technology in order to become empowered.

Case Study Example: The Middle East

The need for information technology (IT) development in the developing world is exemplified by the case of the Middle East, as explained by Toufic Mehzer[7] of the American University of Beirut. Besides the basic limitations associated with rampant poverty and lack of education, there are many other challenges that face the development of IT in the Middle East. One of the most notable of these challenges is the third world mentality and lack of passion for reading or knowledge, and therefore a lack of demand for IT development. Additionally, as with many developing countries, other issues take priority, such as political corruption, regional political instability, and growing national and international debt. This last issue also contributes to the high cost of connectivity. Therefore, many countries, such as Somalia, Sudan, Mauritania, Iraq, and Yemen, are still not well connected.

Often, IT that does exist in the developing world is hosted by outside organizations such as the United Nations and World Bank. The information is also usually in a foreign language, and therefore is only of use to the well educated. In some instances there is a lack of reliable information on the local region. Currently there are a number of projects working to address these issues, some of which are hosted by the United Nations Development Program (UNDP). Unfortunately, the results of many of these projects end up buried in government bureaucracy. Other, more effective projects are sponsored by civic societies and implemented at the community level.

Projects to promote IT for Sustainable Development

Global System for Sustainable Development

One medium for facilitating these projects is knowledge-sharing networks such as the Global System for Sustainable Development[8] (GSSD), a project of the AGS. GSSD is a collection of knowledge from evolving Internet materials of roughly 250 international holdings. This collection is hosted on four mirror sites worldwide (in Japan, China, France and the USA) to insure speedy access to the information. Additionally, the site is translated into three different languages, Arabic, Chinese, and English, with other translations in the works. The collection includes 3000 multi-disciplinary concepts, theories, indicators, measures, models, agreements, organizations, policies, strategies, and case studies related to sustainable development.

Current plans for GSSD include extending the knowledge base to include Spanish and French translations, and possibly hosting an additional mirror site in Costa Rica. The expansion of GSSD is greatly limited by local urbanization. For example, there is no mirror site on the continent of Africa because there has not yet been a great demand for this information in that region. Though the content of GSSD may include information (research, data, and projects) relevant to the people of that region, the majority of the general public does not yet have access to the Internet. In a classic catch-22, if the public is not aware that the information exists and how it could possibly improve their lives, then there is no demand for access to the information. However, GSSD will continue to expand its knowledge base, mirror sites and translations as new partnerships and opportunities arise.

Tierramerica

Another project, sponsored by the UNDP, is the digital communication center for sustainable development in Latin America, Tierramerica[9]. Tierramerica was formed in 1994 by the Latin American and Caribbean Ministers of the Environment to fulfill the need to disseminate information on environmental issues throughout Latin America and the Caribbean. Originally this information was disseminated via a paper insert in popular regional publications. However, this strategy was inefficient due to the high cost of publication, as well as the unsustainability of using so much paper. Therefore, the program, with the support of the UNDP, evolved to be more sustainable by producing an online publication. The goals of this program are (1) to build a strategic alliance of real and electronic media, with the Internet as the core component, and (2) increase representation of different cultures' viewpoints on the issues.

The Tierramerica project now consists of three components: a website, radio program and paper publication. The Tierramerica website is published in Spanish, Portuguese and English, of which 160,000 pages are viewed monthly. It features a Virtual community, virtual training courses, and e-commerce. Additionally, the weekly radio program is hosted on 800 community, cultural and commercial radio stations, and the weekly publication is published in 13 different newspapers in 8 different countries, with a combined circulation of around 1,000,000. The coordination of all these components is shared between the various countries involved, including Mexico (editorial coordination), Chile (webmaster), Cuba (technical support), Venezuela (radio), Brazil (Portuguese translation) and Uruguay (general coordination).

InBio

The Instituto Nacional de Biodiversidad[10] (INBio) is a scientific institution in Costa Rica dedicated to the dissemination of information on the amount and sustainable uses of biodiversity. INBio was created 12 years ago with the mission to "promote a new awareness of the value of biodiversity, and thereby achieve its conservation and use to improve the quality of life." INBio realizes this mission through the sharing of information with national and international users via their website, which includes a biodiversity inventory with an emphasis on national protected areas and guidelines for information management and outreach. In addition to disseminating this information via their website, INBio operates an eco-parque (INBioparque) an educational and recreational center where visitors are exposed to samples of Costa Rican biodiversity, programs for national and international leaders (such as Ministers of the Environment) on ecological issues, and interactive educational (on the internet and CD-ROM) programs for children.

The main tenet of INBio's operational policy is the interconnectedness between knowledge, use, and preservation of biodiversity. By promoting knowledge of biodiversity and its sustainable uses, its preservation is ultimately promoted. Additionally, in order to ensure the validity of information shared by INBio, it must meet six criteria: the information must be (1) scientifically valid, (2) pertinent to the problem at hand, (3) representative (i.e. large inventory with variety of samples), (4) up-to-date, (5) multi-scale (specimen, species, kingdom, local, regional, global), and (6) accessible. The process of collecting and distributing this information involves capturing specimens, administering proper identification, and disseminating the information through a rigorous peer review process. This innovative, participatory and multidisciplinary approach extends the influence and effectiveness of INBio throughout national and international sectors. Its operating principles are a model for the promotion and dissemination of information related to sustainable development.

General information control

Quality control of information

A common concern about information shared via the Internet is the lack of quality control and the questionable validity of information presented. A standard web search reveals many websites related to a single topic and there is no easy was to discern which sites present the most reliable information. Search results are often sorted in order of "relevancy" to the query, but this relevancy does not ensure credible information. The Worldwide Web is a free forum, so that anyone with access to the proper technology

can post information and claim it is factual. However, this is what makes the Web so powerful: it is constantly changing with new information being added daily from around the world – a mechanism to freely distribute information. The imposition of quality control measures on this information would greatly reduce the appeal and usefulness of the Web to the general public.

How then, do we prove to the general public that the information we present on the Internet is creditable, and how do we avoid then misleading the public into thinking that all knowledge on the Internet is reliable? Some information posted online is subject to peer review, but has only limited access (such as scientific journals which require a subscription). But this is not a feasible solution when a site is trying to reach the widest possible audience. Even published and peer-reviewed journals occasionally have errors. Differences in quality standards around the world present yet another dimension to this problem.

Information overload

In addition to the problem of quality control of information on the Internet is the problem of information overload. To the general public, the results of a single web search can be quite daunting and discouraging because of their massive content, even when much of the information is repeated between sites. Furthermore, the information generated by scientists and engineers is presented in a manner appropriate for sharing information with peers, not the general public. There is a great need to develop protocols for "translating" this information into layman's terms when it is published to the Web for public use. In many cases, the incorporation of user feedback (bulletin boards, email and feedback forms) needs to be improved, and would be a valuable tool for improving the presentation of the information.

Topics for future AGS research

In order to implement new IT for sustainable development, additional research is needed into information dissemination, rural IT development, and information quality control. This research could be very effectively addressed by the AGS because of its international and interdisciplinary contingency. Related research could include:

- Developing models for knowledge dissemination, starting with creating and rolling out a scheme for sharing knowledge developed within AGS;
- Assisting companies in developing filter and monitoring criteria to recognize when IT can benefit or counteract sustainable development;
- Developing new business models for the Internet to enable rural development – with a focus on changing the interface with which people communicate to best reflect the needs of a given population; and
- Developing effective quality control measures, protocols for presenting technical information to the public, and protocols for the incorporation of user feedback.

In conducting this research, the time must be taken to reflect and learn from past experiences, and analyze the results of the research from various points of view. In order for rural IT to succeed, it is important to remember to have representatives of both the developed and developing world work together to identify appropriate application strategies. Knowledge networks must be built in the local language and con-

tain information that is relevant to the local population. Additionally, a multidisciplinary board, working to addresses the problem from many different aspects, would conduct the most effective research. These things will help advance the successful application of IT to sustainable development through the effective knowledge sharing networks and product development.

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Working Group

Sustainability through New Materials and Products

Leader	Joel Clark, Professor of Material Systems at MIT
Discussion Leaders	Kazuhito Hashimoto, Professor at the Research Center for Advanced Science and Technology at UT Sarah Severn, Global Director for the Nike Environmental Action Team Anne Roulin, Manager of European Operations of PTI
Rapporteur	H. Donnan Steele

Abstract

This working group met to discuss prospects for using new materials and material processing technologies to reduce the environmental impact of consumer products over their entire lifecycle. Specifically, the group was charged with providing a consensus list of research areas for the AGS to consider funding in future cycles. Discussants gave short presentations on topics related to their research or to the activities of their respective corporations.

In the presentations and discussion, the working group focused on four broad topics:
- Structuring environmental regulations to encourage the development of low environmental impact materials,
- Life cycle analyses,
- Recycling, reuse, and trash disposal, and
- The alignment and misalignment of economic and environmental goods.

This review summarizes the discussion in each of these several topics and reviews the list of suggested topics for further research and funding.

Life Cycle Analyses and Environmental Regulation

Consumer products impact the environment during their production, transportation, use, and destruction phases. A lifecycle analysis of a particular product reveals the relative impact of each of these phases, quantifies the inputs and outputs associated with each phase and with the product as a whole, and identifies the most significant impacts (ISO 14000). Environmental regulations intended to reduce the environmental impact of manufactured products seldom take into account lifecycle analyses even when available, which they seldom are. And, in general, separate regulations govern each of the phases of a product's lifecycle and usually offer conflicting incentives when product development is considered as a whole.

The automobile recycling requirements recently legislated by the European Union are a good example of good faith environmental initiatives that fail to consider the full life cycle of a product. The initiative requires auto makers to recover and either recycle or reuse 85% of each vehicle by mass beginning in 2006, and 95% by 2015. At present, approximately 75% of each car is recycled under domestic plans in some EU countries, but the 95% level is considered to be particularly onerous and offers incentives that

conflict with other environmental goods. For example, steel is more easily recyclable than lower-weight composite alternatives, but its use to satisfy recycling initiatives would push fuel economy standards further from reach. Lifecycle analyses reveal that an automobile's greatest impact on the environment occurs during its time on the road, followed next by manufacturing processes and lastly by its decommissioning. If the EU intends to reduce the overall environmental impact of automobiles, fuel economy standards should take precedence over recycling needs and the conflicting incentives should be resolved to favor composite bodies over steel.

Lifecycle analyses, in this particular form of technology forcing regulation, are clearly necessary to guide. In setting particular recycling thresholds, particular fuel efficiency standards, and specific manufacturing requirements, inherent tradeoffs are balanced and decided by government (or left unconsidered and unclear), which is appropriate in some decisions but resembles uninformed micromanagement in others. Alternatives to technology forcing regulation include (1) subsidizing the development of new technologies, which may lead to innovation at the material level which in turn may lead to a lower impact product some time in the future; and (2) introducing price signals according to perceived environmental impact; examples of this include adjusting the prices of landfill use as an incentive to recycling or carbon taxes as an incentive to fuel economy. This second alternative, of course, fails if exernalities are not recognized or are improperly corrected for. But both of these structures devolve the weighing of various tradeoffs from government to the product manufacturers and consumers, who presumably make better and more self-consistent decisions, and both allow for innovation at the product and service level. There are a host of political reasons to favor a list of somewhat conflicting technology forcing environmental regulations over these other methods, and when that path is followed lifecycle analyses are indispensable.

At present, few lifecycle studies are publicly available. Of the AGS member institutions, MIT's lifecycle analysis database is proprietary and Chalmers' is public but not comprehensive. A comprehensive and publicly assessable database of lifecycle analyses should be developed and made available. And the AGS should pursue research on regulation methods of all kinds that encourage low environmental impacts across the entire lifespan of a product.

New Material Innovation: Innovations in Drink Bottles

In manufacturing, source material intensive industries, economics, business strategy, and regulation are an incentive to, and oftentimes determine, companies' environmental behavior. Plastic soft drink bottles offer a good example of a product which has felt and responded to a host of economic and environmental incentives. In the cases when economic and environmental incentives align, innovations were pursued and adopted; in other cases when the two incentives were misaligned, the economic incentive dominates.

The vast majority of soft drink bottles are made from polyethylene terephthalate (PET) through a stretch blow molding process. In 2001, 1470 Kt of drink bottles were made of virgin PET, and 400 Kt of recycled PET. Both numbers represent huge increases from 1995, in which 730 Kt were of virgin PET and 45 Kt of recycled. Over that same period, the simple cost of the material drove innovations in lightweighting and barrier technology. In 1993, a 1.5 liter PET bottle for water weighted 40 g while a 2001 model weighs

26 g. The use of a few micrograms of a low pressure microwave plasma coating improves the oxygen barrier dramatically and allows the use of a lighter, thinner bottle. This innovation coupled with development and refining of manufacturing techniques allowed the dramatic source reduction and the concomitant environmental benefits. But as technology allowed the innovations, economics drove them. The material cost represents a large fraction of the overall bottle cost, and source reduction yields great financial rewards. In this case, economic and environmental goals are aligned. The PET bottle example provides several instances, however, in which they are not.

Due to recycling programs and regulations in the EU and the US, recycling and reuse of PET containers rose dramatically through the 1990s. But recycling as a percentage of bottles used stagnated in recent years. PET is extremely recyclable, and available processes recover almost all properties of the virgin polymer. Even so, recycling as a percentage of total production is relatively low. And the market for the recycled polymer is small and economically inefficient due to high processing and transportation costs. Bottle reuse is even more difficult, as PET shrinks at the temperatures necessary for cleaning, but for certain applications is possible. A handful of European countries successfully operate return and refill programs, although they are declining in popularity. Sweden's program, for example, managed ten to twelve uses from each bottle. But the program is not economically viable without government financial support.

Beyond soft drink bottles, which are very recycling-friendly, most products are of mixed materials and are hard to recycle. The Nike Corporation seeks a move towards fashioning shoes from single polymer materials and away from toxic dyes that prevent recycling. As with the automobile recycling example cited above, however, environmental downsides often accompany materials developed specifically to increase recyclability.

The potential of an eventual move away from a fossil fuel based economy, as well as more quotidian diversification concerns, lead the soft drink bottling industry to prototype the use of biopolymers as alternatives to PET. Biopolymers are derived from renewable resources such as corn and are industrially compostable. Economic benefits of biopolymers lie in their independence from petroleum prices and any future petroleum regulations or taxes. PTI Europe modelled and tested one such polymer, polyactic acid, for beverage containers. It exhibited extremely poor barrier properties as compared to PET and other plastics and cost between one-and-a-half and two times as much to produce. Further innovation of biopolymers and coatings may improve the quality of the product, but the base properties are much worse than those for plastic and so it is unlikely to ever become fully competitive with PET. So economics and innovations are unlikely to drive the use of this (or other environmentally friendly) new materials as they drove source reduction. So the natural market processes align with some form of environmental improvements but are a disincentive to the development and adoption of others.

Trash Disposal in Developing Countries

Developed countries reduce the overall environmental impact of many consumer products by reconsidering how society disposes of the product: simple burning or open landfills give way to sophisticated recycling, reuse, composting, managed landfills, or high-efficiency incineration. Biopolymers, if eventually introduced into the marketplace, will be industrially compostable. Most western countries recycle in rela-

tively large proportions. Japan uses incineration plants to produce electricity. And in Germany, incinerators produce less dioxin than a standard fossil fuel power plant, a shocking inversion of the less efficient equivalent. But in many developing countries disposal is crude, often amounting to unaided burning and open landfills, and the environmental impact of disposal is vastly greater.

Lifecycle analyses of products, we now see, are location dependent. A product developed to take advantage of sophisticated recycling or reuse systems in a wealthy western country may be disproportionately destructive in a poorer one that cannot afford the appropriate technologies. Some corporations and western governments are helping develop the necessary infrastructure. The Nike Corporation, for example, is building recycling plants in Asia in part to serve its production facilities. But the development of low-cost, high-efficiency trash disposal systems or alternative materials with low environmental impacts would provide a great benefit to the environmental health of developing nations.

Recommendations to the AGS

The working group presentations and discussion led to a list of several research areas ripe for further AGS research and funding:

- How to create markets for recycled products,
- How to stimulate recycling amongst the population and within industry,
- New recycling technologies and the development of materials that are more easily recyclable,
- Local, inexpensive, and clean incineration technologies,
- The writing of policies that target environmental goods without simply shifting the environmental burden to other media,
- Substitutes for hydrocarbon-based materials to be introduced as we shift towards a non-fossil fuel based economy, and
- The feasibility of a publicly accessible life-cycle analysis database.

As can be seen from the discussion transcript and list of recommendations, a discussion of innovative materials and production methodologies necessarily leads to the disparate fields of economics, regulation, lifecycle analysis, trash disposal, and societal values. AGS' broad expertise perhaps makes it an ideal forum to debate and pursue solutions to these environmental problems.

Working Group

Technologies to Meet the Needs of the Poorest

Leader	Lloyd Timberlake, Avina Foundation
Discussion Leaders	Timothy Prestero, MIT - ThinkCycle
	Toru Iwami, UT
	Jane Turnbull, Peninsula Energy Partners
Rapporteurs	Audun Botterud, German Lleras, Bruno Miller

Abstract

The objective of this working group was to examine barriers and constraints to the introduction of technologies in developing countries that can help meet the needs of the poorest. The panel examined questions such as: Are the constraints economic, technical or institutional? What are the opportunities that can help to overcome these barriers? What are the challenges to the AGS in helping meet the needs of the poorest? The following is a detailed description of the panelists' presentations and the most relevant issues raised by the audience in the discussion which followed.

Introduction

The main message of this working group was the need for a change in the way technology transfer traditionally has been considered. Changes should occur in order to encourage involvement and participation of the locals in the development and deployment of technology. More attention should also be given to development and transfer of technologies that match the real needs of the poorest. The three panelists looked at these issues from different perspectives. The following discussion in the panel audience raised similar concerns about the same issues, the most relevant being:

- The importance of scale: small and cheap technologies are more likely to succeed;
- Successful aid and technology transfer depends on a range of factors: technological, social, cultural and economic, which all must be taken into consideration;
- The basic demands from the poorest of the poor are often forgotten;
- Problems are usually looked upon through the eyes of the rich world;
- The good intentions behind giving aid are very often mixed with self-interest from the donator;
- It is not just a question of more money for aid; it is also a question of how the aid is organized. There are many obstacles for the money to reach the most urgent targets in today's system. The poorest of the poor do not have a voice;
- The importance of empowering the women in the poor world, and also in an organization like AGS, is a key to reducing poverty.

Presentations

1. Timothy Prestero

Timothy Prestero from MIT, presenting the ThinkCycle concept, stressed the relevance of making students think "outside the box" to help find real-life solutions to problems that matter rather than resolving already

solved problems. At the same time the solutions must be effectively deployed through the participation and commitment of local organizations in the developing countries. Mr. Prestero is currently co-teaching a class at MIT called "Design that Matters". In this class the students focus on solving real-life problems through class exercises. This course, which also has faculty involvement, is part of a broader initiative called ThinkCycle (http://thinkcycle2.media.mit.edu/home), which rests on two basic premises:

- Needs of many people, particularly in the developing part of the world, are currently not being met;
- University assignments and projects are only solving problems that have already been solved; however, if students are challenged by real problems they can provide new solutions.

Based on this premises, Mr. Prestero and the rest of the people involved in ThinkCycle have organized the following approach to help solve the needs of the poorest around the world:

- Projects start when organizations (generally NGOs) identify needs of a specific community, but do not have the technology to solve them.
- The organization goes to the ThinkCycle web page and posts the problem as a design challenge.
- Over time, a database of challenges will be created, and later professors will take them as homework problems for their classes. The students find solutions to these problems and document their work on the web, thus creating a resource for others to follow.
- The organization that is submitting the problem commits itself to do field tests and monitor the results of the technology development being done.
- Ideally, local students will be involved in the implementation of local solutions.

The projects of the students that are taking or have taken the course "Design that Matters" reflect this participatory approach. Topics include: cholera treatment, improvement of conditions in rural clinics in Bangladesh, and devices to test for malnutrition (the project descriptions can be found on the ThinkCycle web page at http://thinkcycle2.media.mit.edu/).

A specific design that Mr. Prestero presented was an intravenous (IV) tube to treat cholera. In order to fight this illness, patients are administered saline solution through IV tubes. However, controlling the flow of the solution can be challenging. An alternative is to use a clamp with a sticker to define the appropriate level, but it introduces a new problem, as the sticker would be difficult to read. A possible solution to this derived problem would be a lens. The lens would cost around 30 cents, but even such a low price is a significant constraint for a device like this in poor countries.

Through the class, a group of students arrived at a subtle but very important change regarding the linear vs. nonlinear operation of the clamp. A linear clamp, one in which the position of the clamp is directly related to the amount of fluid going through the tube, is more intuitive to operate. However, current clamps are non-linear and it is difficult for practitioners to operate the IV tubes correctly. Thus, through the application of "high-tech stuff," such as CAD models and 3D printers, an elegant solution to a simple basic problem was found.

Future directions for ThinkCycle and "Design that Matters" include teaching the same course in universities in different countries (e.g. India, Brazil, Kenya and Portugal), organizing workshops, and maintaining the Internet database of challenges and related resources.

The model sought by ThinkCycle is for NGOs and stakeholders to submit problems and test the solutions in the field. The role of academia would be to perform non-profit R&D. Industry would be expected to create new models of sustainability, create local enterprises, and assist with manufacturing and marketing and not enforcing copyright. Finally, governments and foundations also have a supporting role to play, either economically or institutionally. ThinkCycle seeks to create a culture of open-source design innovation, with ongoing collaboration among individuals, communities and organizations around the world.

2. Toru Iwami

Professor Toru Iwami from the University of Tokyo showed how the choice of technology transfer is usually not based on the needs of the poorest. He stressed the necessity for a change in the political system in many developing countries to enable the voice of the poorest to come through. Prof. Iwami used air pollution in East Asia to comment on opportunities for developed countries to help developing countries through technology transfers. For example, there is a strong correlation between reductions in the concentration of SO_2 and increases in income level: as GDP per capita increases, SO_2 concentration declines. This is because wealthier societies, such as Japan and other developed countries, can afford cleaner and more expensive technologies. The question is then: how can one take advantage of being a latecomer and encourage the transfer of technology from less developed to developed countries?

In general terms, the technological progress is not only the cause of economic development, but also the result of it. Nevertheless, in order to achieve technological improvements, resources to supply certain preconditions are required, such as a higher education level and infrastructure for communication networks. Even though some technological improvements are not as costly as it might be thought, poor countries lack the resources even to afford the most basic ones. Information or communication centers in rural areas can, for instance, benefit poor people by providing information and computing facilities. Initial investments in this type of infrastructure are not very high, but even so, many countries and regions still cannot afford it.

Developed countries can help to implement this type of infrastructure in developing countries through technology transfer. The key to the success of such a project is that it responds to a real need of the recipient country. Aid projects are typically related to big projects (e.g. dams). This trend in foreign aid is spurred by the tendency in developing countries to prefer bigger projects, which act and serve as symbols and provide political power. The issue is then between the real needs of the poorest and the decisions of the governments and aid agencies. A possible way out of this situation resides in changes in the political system so that the poorest people can reach decision makers and influence the direction of foreign aid.

3. Jane Turnbull

Jane Turnbull addressed common problems and success factors for technology transfer to the poorest countries. She argued that involvement from local people is of major importance and that private sector funding and empowering of women often can contribute to create the necessary entrepreneurship spirit for projects in poor areas to succeed.

Similar to Prof. Iwami's proposal, Ms. Turnbull focused on transferring technologies to the poorest nations. Some of the concerns that she pointed out revolved around the appropriateness of the technology. A common problem in technology transfer is that the solution does not fit the context in which it is being introduced. As an example she cited the case of a set of biomass processing plants that were installed in Romania. The plants emulated systems designed for the developed world, but are now out of operation and rusting after being installed in Romania. Many multilateral agencies like the World Bank thought that they were appropriate at that time, but evidently they were wrong. This model of technology transfer has many obstacles. For instance, trained engineers to maintain and operate the technology do not exist in many developing areas. In addition, "parachuting technology" i.e. introducing new ideas without the involvement of the local community in the planning or installation of the project, compromise the feasibility of the solution. In such a case, there are no vested interests, and thus not many people will commit themselves and become involved in the project.

What technologies should be transferred? How many of the technological breakthroughs are really reliable and applicable? The answers depend to a large extent on the recipient country. For example:

- Romania: In order to become a part of the European Union (EU), Romania needs to meet several standards set up by the EU. The technologies and projects to be promoted there should create value added products, so that the investment can pay back and change the economy of the area. There are very important limitations in capital investments.
- Brazil: Energy policies in Brazil are decided through a participatory approach involving public-private partnerships, but most of the initiative should be left to the private sector; if not, the entrepreneurship and incentives disappear.
- Alaska: A waste treatment system designed by the University of California at Davis was implemented to help native villages without waste treatment. The government wanted to pay for the project, but the people did not want to change the status quo. Thus, with no commitment from the community, no leadership, and no motivation, this project was not successful. This example also illustrates some skepticism about the role of government, which some critics say hinders entrepreneurship. In the case of the Alaska native villages, it appears that the availability of government funds only fed the level of passivity in the population.

Another critical issue for successful technology transfer is empowering and involvement of women in discussions and implementation of projects. For instance, ENERGIA is a network through which approximately 1500 women collaborate on topics related to sustainable energy (see: www.energia.org). Furthermore, Grammen Bank, Micro Enterprises and Promujer empower women to start businesses at the local communities. These organizations lend money to women, who must show that they have business

skills. These projects have been very successful, achieving high payment rates of the loans (as high as 98%), which go back to the fund for other women to use.

One last thought that Ms. Turnbull raised is that poverty should be understood as the presence of powerlessness. This thought should be kept in mind when thinking about technology transfer. Therefore, poverty reduction should undergo a process of empowerment where technology is the key.

Discussion

Lloyd Timberlake introduced the discussion by underlining that the cultural dimension must be considered in order to avoid the so-called "parachuting" of technologies. A follow-up question from the audience was whether entrepreneurship, as mentioned in Ms. Turnbull's presentation, is a western idea, and how much this way of thinking is applicable in other parts of the world. The panel did not give a specific answer to this, but agreed that the cultural dimension also must be taken into consideration.

Professor John Heywood (MIT) urged the panel and the audience to "think global, think small/cheap." Projects in developing countries could start at a small scale as means to reduce environmental impacts. Usually, the latecomer advantages are hindered by the fact that cleaner technologies are typically more expensive; therefore, small/cheap projects can be more successful. Professor Iwami responded that there is evidence of this approach already being taken, for instance to combat SO_2, which usually requires expensive technology. Chinese and Japanese organizations, after working with local academics and governments, are designing devices that fit the small/cheap characteristics that Prof. Heywood mentioned. Ms. Turnbull added that there is also a trend to create small power plants that are closer to the demand (i.e. distributed generation).

Professor Heywood repeated the relevance of physical scale as a key to make technological devices more widely spread. This observation can explain why small-scale technologies like cell phones have been so successful in developing countries, while large-scale energy technologies seem to be much harder to transfer. Another person from the audience emphasized the elements of choice, availability and accessibility as key factors to the success of technology transfer. From the discussion it was pointed out that a range of factors influences the process: technological, social, cultural, economic (affordability), etc. In the targeting and interfering we must try to take all these factors into account.

Later, the discussion was centered on the issue of technological leapfrogging. This advantage of the developing countries in adopting a technology seems to depend on the specific technological devices, but it is not clear what kind of technology will actually work.

It was commented that crises could trigger radical changes. Hence, one possibility would be to wait for a crisis or disaster to happen so that they bring about the desired changes. According to the crisis theory, the knowledge of the crisis will create concern among the people and thereby trigger changes. However, people knowing that the crisis or disaster may happen will not be able to "sleep well". In addition, many of the concerns are global, so that a crisis in one region can indeed affect the whole world.

The discussion took another direction as the following question was asked: Do we really offer anything to meet the needs and demands of the poorest of the poor? Are developed countries offering the technology that is really needed? Basic energy and health needs are not met for more than 2 billion people in the world, and these problems are not touched upon: not in our discussion, nor in many of the existing aid projects. The productivity and means of life are, of course, suffering for these people, due to lack of the most basic requirements. Ms. Turnbull commented that we have the technology, but the package is very often wrong. As an example she mentioned photovoltaic cells that are sold in high volumes in many developing countries due to the desire for TV access – and not to supply more basic needs. Mr. Prestero emphasized the importance of dialogue as a way to overcome this barrier. Technology and methodology together can provide a solution; it is easier to build first and then ask, but it does not involve the community. This approach lacks trust. When the community asks for something, it expects answers for a specific question. The intellectual learning process and methodology behind ThinkCycle engages the community, protects sovereignty, and encourages ownership.

When new technologies are being analyzed they are looked upon with the eyes of the developed world, a person in the audience argued. However, in many developing countries the poorest will not be willing to make a trade-off between long-term implications and survival. An example is the use of DDT. The increase in food production due to use of DDT by many poor people is looked upon as more important than the risk of cancer in the long run. Accordingly, they are not willing to stop using DDT. The importance for self-confidence and empowering of the local population as a mean to solve some problems came up in the discussion. An example of water supply technologies in India was described. The problem is that water technologies often are developed in countries rich in both water and money, and are therefore not affordable in countries where they are really needed.

What do the richest of the rich do to meet the demands of the poorest of the poor? The question was raised whether international help is based on good intentions, or are there vested interests in deploying a specific technology – for example, so that some countries can maintain a certain market position. The increasing use of coal in China was used as an example. The US and Europe are horrified by a scenario where China switches from coal to petroleum products. Therefore, they are very eager at helping China with improving their coal technologies.

Another important topic that came up was the importance of clarifying the difference between need and demand. The last one is related to the ability to pay for the needs. This is particularly relevant in areas of energy, food production, medicine, and climate change. Mr. Timberlake followed up by a comment on the policies behind foreign aid. When working with international aid there are restrictions on what you can do in order not to limit your future career opportunities within the organization. First of all, you should avoid interfering with the interests of the donator country. For instance, all US aid is tied to the purchase of US goods. Second, you should also be careful not to go against the donator businesses. Third, disagreement with the recipient country interests could also harm your own progress in the long run. Therefore, it is not just a question of more money for aid; it is also a question of how the aid is organized. The poorest of the poor do not have a voice in today's system. There is no existing pathway of funds available for them.

A question was raised about ideas and technologies coming from developing countries, but did not result in any further discussion. However, it seems to be a very relevant issue since it could address many of the problems raised in the discussion.

The difficulty of giving aid was addressed. An observation is that aid is more likely to go to those countries where you can see results in the short term, due to the donators' desire to see successful results. This theory can also contribute to explain the huge amount of money that has been channeled to the energy sector in China in recent years, since this sector is developing quickly together with the economy in China. How can countries like Niger, with much slower processes of development, become more attractive for aid donators? It was argued that education, and also the power of crisis, can help speed up the process. In the end, a person in the audience underlined the importance of empowering the women in the poor world. The history shows that, while men in poor countries invest excess money in alcohol, women invest it in education. Therefore, the AGS was challenged to increase women's participation when it scopes out its future research agenda.

Conclusion and recommendations for the AGS

The presentations and debate in this working group covered many aspects related to the problem of meeting the needs of the poorest of the poor. The main part of the discussion revolved around how to succeed in transferring appropriate and useful technology to the developing countries. Even though there were many ideas and suggestions, it is difficult to draw any firm conclusions after one single meeting; therefore, it was suggested that the Alliance for Global Sustainability carry more research on projects targeted to meet the needs of the poor, especially those that involve the introduction of technology. In this way, a more comprehensive list of success factors could be identified, which could help the AGS and others to give the right focus in future research projects involving technology transfer.

Working Group

Domestic and International Environmental Standards: Implications for Trade, Finance and Development

Leader	Kenneth A. Oye, MIT
Discussion Leaders	Augustine Falacatana, Fundicore
	Bruce Rich, International Programs, Environmental Defense
	Hideaki Shiroyama, UT
Rapporteurs	David Reiner and Lewis McCulloch

Abstract

This working group was lead by Kenneth Oye, Professor of Political Science at MIT. The purpose of the working group was to examine the central conflict between domestic and international environmental standards. To deepen and extend discussion on these issues, the Alliance for Global Sustainability brought together a diverse panel including experts from developing countries and nongovernmental environmental organizations. This panel assessed mutual interests and conflicts among advanced industrial nations, developing countries of Central America, and major nongovernmental organizations. Differences over diverse environmental standards are at the core of many contemporary controversies. What standards should WTO panels, NAFTA tribunals, and bilateral trade negotiators use as they assess the legality of arcane domestic environmental regulations? Or should domestic environmental policies be subject to international review at all? What environmental standards should national export credit and aid agencies and multi-lateral organizations like the World Band and European Development Bank apply in extending loans and grants?

Overview by Kenneth Oye

There is intense debate within environmental, trade, and financial circles over the causes and consequences of regulatory diversity. Some view differences in regulations of products as bona fide responses to environment and health risks, while others see them as non-tariff barriers to trade. Some see variation in regulations governing production processes – including air and water quality standards – as legitimate responses to national differences in environmental preferences, environmental conditions and wealth, while others see them as parochial efforts to attract investment and improve the competitive position of firms. Some seek high common environmental financial standards for official export credits and aid to improve environmental outcomes and level commercial playing fields, some argue that environmental conditionality may impede the badly needed flows of credits to developing nations, and still others defend heterogeneous environmental standards as environmentally appropriate and economically efficient.

The literature on environmental conditionality and finance and on domestic environmental regulation and trade tends to emphasize conflicts among advanced industrial nations.

Mr. Oye made clear his initial bias towards accepting the diversity of domestic standards due to the inherent variation of cultural values and environmental conditions that are found in the various regions. The three critical issues, posed by Mr. Oye, surrounding the implementation and use of formalized international standards are as follows:

- The "one size fits all" approach to international standards doesn't necessarily work.
- International standards tend to be insensitive to experimentation. Standardization prematurely focuses towards closure.
- Learning is important in adapting standards to constantly improve, and this goal is limited by international standardization.

The cases explored by the discussion leaders ran up against these issues and confronted the following problems:

- Concerns arise over regulation and investment. Incentives exist for companies to manipulate and promote lax regulations.
- Exports promotion and the manipulation of standards (or completely ignoring them)
- Granting credits/trading for green-house gasses. To what extent should international standards play a part of trading?

In addition the role of international standards was addressed in each case.

Hideaki Shiroyama: Domestic Regulation and Trade

Mr. Shiroyama continued the discussion and described the three main issues in dealing with international standards from his point of view:

- How does one decide how to set the standard? Setting uniform standards is inherently difficult because of numerous differences between countries, individuals' behavior, and technological availability. A key difference to be considered is the level of exposure per individual. This factor is critical to the impacts of various pollutants. For example setting food safety standards is highly dependent on diet. This is also true for the emissions standards of cars. It is hard to justify a uniform standard.
- There is also a legal issue. Who has the authority to enforce the international standards?
- The critical need to understand the dynamics of the industry for which the standards are being set and the firms that are acting with these industry.

Mr. Shiroyama presented two cases to allow the participants to think about the three challenges of setting international standards and to discuss the implementation issues facing the North and the South.

The first case examined the difference in vehicle emission standards in the United States, Japan, and the European Union (EU). In the 1980s the EU paid little to no attention to the emissions of NO_x from automobiles despite the fact that both the US and Japan had set limits on the emissions of these gases. This was primarily due to the supposed uncertainty of the scientific information. However, when effects began to be seen on forests and acid rain, the EU established their own standards.

There has been a continuing convergence of these standards over the 1990s. This harmonization was led by industry (as opposed to being mandated by governments.) However, this harmonization did not have the necessary impact on the international arena.

The second case focused on the food safety standards of Japan and the United States. The case focused on the procedure of food irradiation. The major differences between the United States and Japan on the standards surrounding this issue were due to the differences between customer and industry attitudes between the two countries. The international standard for food irradiation was much more permissive then either of the domestic standards that were set.

Bruce Rich: Environmental Eligibility for Exportation Credation Authority

Mr. Rich spoke at length about a little known but significant set of organizations in the international development arena. He argued that Exportation Credation Authorities (ECAs) are the single most important organizations for issues of the environmental impacts on developing countries and global climate change.

Mr. Rich described ECAs as national banks supported by national governments. They are huge multinational organizations that hand out billions of dollars for exports and large development projects. ECAs distribute on the scale of trillions of dollars per year to mobilized OECA countries. In the 1990s they funded between 60 – 90 billion dollars/year for large infrastructure projects, mostly in developing countries. The biggest problem, in terms of the impact of the global environment, is that the agencies are non-transparent and do not provide figures on their transactions. Another key fact is that a majority of developing countries' debt comes from ECA loans.

Mr. Rich described the environmental and social impact of ECA funded projects and highlighted the key differences between the decision making process of ECA's and other private businesses:

- ECAs support projects that are too risky, from an economic as well as environmental point of view, for the private sector.
- ECAs also support projects that the World Bank dismisses because of the economic/environmental costs.
- Military arms are also a major component of many ECA projects.

There are WTO trade issues associated with the work of ECAs. ECAs have exception in WTO due to OEC declaration. Developing countries need to conform to industrialized ECAs or they are not allowed to join the WTO.

ECAs fund projects that no other group or organization would even consider, due to the associated environmental and economic risks. US ECAs, due to pressures from environmental groups, at one point adopted some environmental standards similar to the World Band and similar to requiring environmental risk assessment. Many other ECAs had no environmental standards, no public transparency, and all activities were conducted under a veil of commercial secrecy.

In 1996 the World Bank refused to sponsor the Three Gorge's Dam development project in China. The US ECA refused to touch the project due to the fact that the project would not pass the environmental risk assessment process that had been established. Other ECAs approved billions of dollars for the project before a transparent process occurred. The US ECA used this as an example to make a push to drop their environmental standards, which they have since done.

This led to G7 and OECA trying to promote environmental standards for these huge organizations. The recommendation was to push for uniform environmental standards across the board. These negotiations have now been going on for five years. There is a draft agreement which has no mention of environmental standards or public transparency, and there is no consensus on this yet.

There are numerous political conflicts over standards and approaches to this problem. It is so contentious that even the word "standard" is taboo in the ECA negotiations. At a minimum, NGOs want oversight capacity to monitor and provide some check on these multi-national organizations.

Augustine Falacatana: Redefining Domestic Externality Issues with Global Commons Problems

Mr. Falacatana described the market potential of a new type of company, one that provides environmental services and explained the current work of the Fundicore Corporation. Fundicore Corp. has focused on the issue of deforestation in Costa Rica and has successfully reversed the rate of deforestation. They have primarily accomplished this with promoting the concept of providing environmental services. Fundicore creates a market for these environmental services by soliciting sponsors or customers who are willing to pay money to land owners not to cut down the trees on their land. The motivation for paying for this service could be as simple as ensuring that the clean river flowing through the forested land remains clean downriver for local populations, or can even be as far-reaching as a polluting company wishing to ensure that rainforests, and their air-cleaning potential, remain in tact.

The main assumption behind the development of these markets is based on classical economics. i.e. (1) by providing a profitable alternative activity that can compete with traditional forest uses, there is less motivation to pursue the traditional means of making money out of a forest; (2) moving the services provided by the forest to the forest owner. Fundicore certifies forest owners who follow these practices.

Local services are purchased by global partners. Investments are being made to stop deforestation. $ 45 million has been sold so far in this market-based approach.

The approach does not include using bans or subsidies or other traditional regulatory approaches, but simply pays for services that are being provided. There are many different players and many different products. $ 30,000/year is being provided to forest owners for certified wood.

Increasingly international treaties are being used to create markets for sustainable forestry.

Mr. Oye summarized the discussion of the work group by mentioning the following common themes:

- Many areas of domestic regulatory standards are not converging, and some of the reasons for this were explored.
- ECAs: There is much variation and no clarification of what projects should be funded due to environmental regulations, and there is currently no oversight mechanism to regulate or even monitor these organizations.

- Emerging markets have the potential to provide solutions to traditional development problems of deforestation and land use. The key question is how do you come up with appropriate costing schemes to avoid free riders and impact on international environmental issues?

Discussion

The following questions were posed at the conclusion of the working group presentations:

Question: Why is there a disconnect between the European Union, Kyoto, and ECAs. The US seems to have consensus on a mechanism for oversight but Europe does not. How do you get pressure on economic ministries to address this issue? Answer: The disconnect exists even between some financial institutions. These disconnects exist down the line of each government. The WRI calls it "policy perversity."

Question: One question about the idea of creating a market for environmental services is, who are the competitors in such a market as the one described? Answer: Workshops are being done by NGOs based on the Fundicore model to introduce additional companies to the area and the ideas. There are many interested parties who want to become competitors in this area. This is an emerging market. Fundicore is attempting to transfer these technologies to other countries. There is difficulty in finding buyers of the environmental services as opposed to loans or charity.

Follow-up question: There are a fixed number of purchases (or services available): is there an incentive for creating competitors? Answer: We have not come close to making the "fixed number" of services available through this model, so there is a space for competitors. Costa Rica is willing to sell knowledge/expertise to other countries to create these types of markets.

Question: There are many other uses of forests, so do you have a guarantee from forest owners not to do anything other than sustainable maintenance? Answer: Fundicore writes this into contracts (its main purpose is maintaining forests), and economic incentives are at the base of these contracts. There are other potential markets as well: market for food futures (reforestation promises) pay forest owners for replanting to provide advance purchase wood to provide a cash flow to forest owners or potential forest owners.