Proceedings

Research Partnerships toward Sustainability

Alliance for Global Sustainability

Annual Meeting 2004

Chalmers University of Technology
Göteborg, Sweden

March 21–24, 2004

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Editor

ALLIANCE FOR GLOBAL SUSTAINABILITY

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Above: Chalmers President, Jan-Eric Sundgren, opens the 2004 AGS Annual Meeting. (Photos: Jan-Olof Yxell)

Above: Chalmers President, Jan-Eric Sundgren, welcomes AGS Annual Meeting participants at the Opening Reception at the Universeum. Below: AGS Annual Meeting participants.

Outgoing MIT President Charles Vest receives special gift.

Preface

The year 2004 annual meeting of the Alliance for Global Sustainability (AGS) focused on building research partnerships for sustainability. The meeting brought together over 300 scholars and representatives from public interest groups, industry, and government. The goal for the meeting was to engage various stakeholders in dialogs on issues of sustainability. The core of the AGS strategy is a fully integrated style of research aimed at strengthening the knowledge base needed for better decisions, policies, and the development of new technologies. The AGS projects that have been most successful in moving through the full research sequence are those that engage stakeholders at an early stage, such as the Mexico City Project, the China Energy and Technology Program, and projects focusing on China coal and coke-making.

Through the research partnerships, which were introduced into the AGS portfolio in 2003, the AGS seeks to promote greater collaboration between universities, industry and government in forming and carrying out leading research on key issues of global sustainability. Although we believe we are on the right path, we continue to strive to improve the basis of good scientific knowledge for decision-making. EU Commissioner and AGS International Advisory Board Member, Margot Wallström noted in her remarks that "accessible" research means that "policymakers need to understand the results of your research to make the right decision; business leaders need to understand them to invest in new technologies; and the wider public needs to understand them to accept the necessary changes."

In the proceedings that follow, we share what we learned about effective research partnerships that advance the cause of sustainability. Over three days we discussed the importance of and obstacles to collaborative research in plenaries, panel discussions, and intensive workshops. The report that follows raises important questions about communicating complex scientific and technological knowledge to the public, and about the role that scientists in collaboration with industry and government can contribute to the global debate on sustainable development.

Organization of these proceedings

The proceedings are organized into two sections beginning with the distinguished plenary speakers from government, industry and civil society who shared their thoughts on partnerships for sustainability. Industrialists encouraged AGS researchers to discover, innovate, and advise them on practicable strategies to achieve competitive and sustainable industrial processes. Leaders from the NGO world provided important perspectives on what the priorities for sustainable development should be. Government leaders stressed the vital contributions that science can make to politics.

In the second section of the proceedings, we explore ways in which the AGS can build upon what it has learned through the development of a multi-stakeholder approach to solving complex issues in global sustainability. This section features the reports of the workshops captured mainly through articles by AGS students working in these areas. Intensive workshops were structured to include "industrial challenges" articulated by leaders from businesses involved in the relevant topics in order to structure and aid future AGS research. Three of the workshops focused on the existing AGS research partnerships in carbon management, competitive advantage and regulation, and sustainable materials.

Our speakers from government, public interest groups, industry, and academia provided us with valuable insights into their arenas and offered strategies for how to better engage others from their communities. We wish to thank all those who graciously shared their wisdom with us at this meeting, and to invite their continued participation in our work.

How Can Research Contribute to Sustainable Development?

Margot Wallström Prepared by Ian Clark and Irja Vounakis, with input on the Environmental Technologies Action Plan (ETAP) from Pierre Henry

Introduction

Science is necessary for political decision-making. There is a need for more scientific input to political decision. But politics can also support science by creating the necessary legal structure and by funding and translating scientific results into reality by making the necessary political decisions.

R&D is one of the priority areas of the Lisbon process. The role networks like the AGS can play in promoting scientific research into issues related to sustainable development is significant.

Climate change is a major threat. Science played a decisive role in ringing the alarm bells on climate change and in pointing at the need for action. But this was just a beginning. If we are to achieve the long-term goal of cutting emissions by 70%, new scientific research is necessary in many concrete areas.

New environmental technologies are necessary, but we need to overcome barriers to the use of these technologies. This is the aim of ETAP. ETAP will provide a platform for research into environmental technologies and establish links between the needs of business and research. But politics and science need to work together.

Ladies and Gentlemen,

The relationship between science and politics has long been a matter of discussion. In some circles there has even been a certain level of mutual suspicion between scientists and politicians.

I am sure that some scientists would still agree with Hendrik Ibsen when he wrote, "It is not excusable for scientists to torment animals with their experiments; instead, they should make their experiments on politicians." I am not here today to offer myself as a guinea pig. But I do believe that science can make vital contributions to politics and, if used and presented well, can provide the necessary impetus for political action.

To cope with environmental challenges we need more research. We need relevant research. We need accessible research. When I say "accessible," I mean that policymakers need to understand the results of research

to make the right decisions. Business leaders need to understand the results of research to invest in new technologies. And the wider public needs to understand the results of research to accept the necessary changes. So I encourage you to torment us, the political decision-makers. Provide us with scientific input for our decisions—and tell us when we are wrong.

Science has a big responsibility here. But the responsibility of policy-makers is just as great. Politics can provide a vital platform for science. Of course, science should not be lead by politics. But, science very often needs politics. We have to provide scientists with the right framework for their work and with sufficient funding. We have to tell scientists where we need their advice and help. And, of course, once we have this advice we have to act on it. Very often it is only through political decisions that the results of your research can be put into concrete use.

During my speech, I would like to raise two key areas of EU environmental policy for which science and politics have to work together:

- Climate change and
- Environmental technologies

I will attempt to clarify the new opportunities that climate change and environmental technologies provide for science and how we, within the decision-making structures of the EU, need your input and contribution.

But before I do so, let me first say a few words about the role of the AGS. We are meeting here three days before the annual Spring European Council where EU heads of state and government will review progress with the Lisbon Strategy since 2000. The aim of this Strategy is to turn the EU economy into "the most competitive and dynamic knowledge-based economy in the world" by 2010. One year after Lisbon, in 2001 in Göteborg (and the fact that we are in this town today has a certain symbolism!), EU leaders complemented the Lisbon objectives with an EU Strategy for Sustainable Development.

The strategic importance of research and development (R&D) for the Lisbon Strategy for Sustainable Development was recognized when EU leaders met in 2002 in Barcelona. They agreed that overall public and private spending on R&D in the EU should increase to approach 3% of Gross Domestic Product (GDP) by 2010. At that time, in 2002, EU spending on research and development stood at 1.99% of GDP, compared with 2.7% in the US and more than 3% in Japan.

In line with the overall aim to increase spending on research in the EU, the recently proposed EU budget for the period 2007-2013 envisages a significant increase in EU research funding. The current priority areas for EU research programs are sustainable development, global change, and ecosystems—which are being provided with a budget of slightly over 2 billion euros.

Alliances like yours, based on international partnerships of leading world academics, are extremely important. They help us to improve our knowledge of complex issues and to find sustainable solutions based on technological innovation. I am impressed with the activities of your Alliance and the projects you have initiated. Together we need to look to the future, to meet the challenges. Some complain that science has always been

too dignified to invent a good backscratcher. You have not been too dignified to engage fully in the debate on sustainable development. I would like to thank you for this.

Our civilization can be traced back by about 10,000 years—exactly those 10,000 years that were characterized by a relatively stable global climate. Now we are endangering this stability with unpredictable consequences for the lives of our children and our grandchildren. Our capacity to fight climate change will determine what kind of world we leave to future generations.

Climate change touches at the very heart of our political and economic structures. It challenges our readiness to change—to make the necessary shift from the current carbon-high economy to one with significantly reduced or zero emissions—and it challenges our ingenuity. The solutions are out there. But we need to zoom in on them, thoroughly explore them, and put the best ones to use.

The Kyoto Protocol is the only credible and comprehensive international framework for addressing climate change. This is why the EU is fully committed to implementing it. On March 10, 2004, a decision went into effect. It implies that the EU has now set up all the necessary instruments to comply with its commitments under Kyoto. We would never have got this far without science. It was science that rang the first alarm bells. It was the International Panel on Climate Change [IPCC] that produced the necessary scientific evidence for political action at the UN level.

But the fight against climate change is only beginning. The Kyoto Protocol is only the first step. To stop global warming, we need long-term greenhouse gas reductions on the order of 70%. Decisive actions will require new science, new technologies. We will have to develop a new energy system that will underpin a low-carbon economy.

Some sectors are of particular interest. We need to improve energy efficiency by promoting energy services and energy-efficient equipment and products. The EU has put in place new EU legislation to increase the share of renewables in the energy mix. There are also measures to promote bio-fuels in road transport and to improve the energy performance of buildings. Hydrogen power and fuel cells are now receiving considerable political interest. There is scope to improve the efficiency and capacity of photovoltaics. And we need to improve the availability of other renewable energy sources.

A low-carbon economy is not a distant goal in the future. We are actively working towards it. In the short-term, CO_2 capture and storage might buy us some time—I know that you are looking into this. Another interim solution might be cleaner coal through the gasification of coal to reduce emissions.

In addition, we need to improve our knowledge of climate sensitivity. We need to understand the factors currently responsible for the rather large element of uncertainty in estimates of global warming. We should also look at means to improve regional climate forecasting, especially forecasts of temperature and precipitation and how we can improve the global climate observing system. In short, to fight global climate change there is no shortage of areas where we need research, where we need your help.

Environmental problems imply costs, not only to our environment but also to our economies. Limiting huge amounts of waste makes a lot of economic common sense. But it also represents a huge business opportunity and will improve Europe's security of energy supply. Being the first mover can give European business the competitive edge. Environmental technologies can help us raise productivity, increase employment, and improve our environment. Across the globe, carbon constraints are becoming clearer. This is giving EU companies new market shares thanks to the international framework in which we operate.

To use these opportunities, European business needs science and new technologies. At the moment, various barriers slow down the development and wider use of environmental technologies in the EU. Addressing these barriers is the aim of the new Environmental Technologies Action Plan [ETAP] that the Commission adopted a few weeks ago. ETAP recognizes that many environmental technologies have a great potential to boost the competitiveness of companies while decoupling growth from pressure on the environment. ETAP is also an inclusive process: It works with all relevant stakeholders including business and, in particular, the scientific community.

I would like to thank the members of the AGS for their active contribution to the preparation of ETAP during the consultation phase, including a brainstorming meeting with my Cabinet last October. We now have the final action plan. Among the key proposals of the plan are technology platforms: These will bring together the research community and industry, and through them we will try to identify research needs in the long term and future market developments. We will also set up networks of testing centers to assess the performance of new technologies.

We have already begun to implement the Action Plan. We are currently establishing two technology platforms, one on hydrogen and fuel cells and another one on photovoltaics and the networks of validation centers. We are also planning to closely involve researchers, because, in the end, they have to push for implementation of the action plan on the ground. To this end, we are establishing a European Panel on Environmental Technologies. It will allow researchers, business, decision-makers, and other stakeholders to exchange information, advise the Commission, and develop concrete actions in support of the action plan. I very much hope that the AGS will continue to be actively engaged in this process.

To sum up, we need research to cope with the environmental challenges of our time, not just climate change but other challenges as well. At the political level this has been recognized and is slowly being translated into concrete action. We need you, the research community, to deliver robust and meaningful research to allow us to understand the nature of our interactions with the environment and to help us find sustainable solutions. And, as I said, I believe that you need us to provide you with the political framework for your work. I welcome your contribution and look forward to hearing your ideas on how we can do better.

An American humorist once said, "If politicians and scientists were more lazy, how much happier we would all be." Let's prove him wrong.

Energy – A Necessity for Sustainability

Lars G. Josefsson CEO of Vattenfall AB

Lars G. Josefsson holds a Master of Science degree in applied physics from Chalmers University of Technology and is a member of the AGS International Advisory Board. He suggested that the next two decades will see a dramatic rise in the intensity of electricity use even as energy intensity falls, because electricity is clean and versatile. "Electricity" he said "stands for quality of life."

The Vattenfall group of companies now sells heat and electricity not only to the Nordic countries but also to Germany and Poland. With total 2003 sales of 12.3 billion euros, Vattenfall provides 5% of Europe's electricity and produces about 2% of its CO_2 emissions. The aim of the company is to be "number one for the environment" (investing in new technologies including photovoltaics, renewables, and others), "number one for the customer," and "number one for the economy." He emphasized that economic development depends on industries that meet all three of these criteria.

Josefsson described three energy challenges that face Vattenfall and other energy companies in the EU. These include a new regulatory framework, the need to achieve security of supply, and climate change considerations. New rules for the future energy market include a timetable for a liberalized market for electricity and gas. According to Josefsson, by 2007 all electricity customers in the EU will be able to choose their own suppliers.

In response to this challenge, Josefsson is determined to lead his company in shaping how market rules can support the development of sustainable solutions. The question remains, how will this be achieved from the company's current position? He emphasized the role of well-designed, well-functioning markets to efficient energy use.

Security of supply is another important challenge. Josefsson observed that some analysts are concerned that the agreed-upon market mechanisms are not sufficient either to ensure security of supply or to support development toward this end. He broke down the notion of "security" into five elements: (1) susceptibility to short-term interruptions; (2) dependence on imported fuels; (3) investment in generation and transmission; (4) efficient use of energy; and (5) environmentally friendly solutions.

Vattenfall's response, he said, will be based on the belief that the existing framework for the internal energy market is sufficient to achieve security of supply. Josefsson believes that a well-functioning wholesale market is essential to such security. In his view, a credible price mechanism will be realized. He urged that the market

should be allowed to show that it will work and eliminate uncertainty in the regulatory framework. He said that, while market supervision is essential, it must be adapted to the specific needs of different parts of the value chain, and that national solutions will only complicate the creation of an internal market for energy in the EU.

Climate change represents the third great challenge to energy development in the EU, according to Josefsson. The most important element of any response, at this point, is to keep all options open while searching for long-term solutions. During the Kyoto period, emissions trading will function to stimulate new solutions by setting a price on emissions. Meanwhile, cost-effective measures must be developed. A sustainable energy system, he observed, will be built on four factors: renewable energy sources; increased efficiency in generation and utilization; cost-effective mitigation (e.g. emissions trading); and developing options for the future, such as fool-proof CO_2 capture and storage.

The most important factor, Josefsson emphasized, is the existence of well-designed market mechanisms. "Competition of options," he confirmed, "will bring the most efficient energy solutions at the lowest cost."

From Cowboy Economy to Spaceship Economy

Øystein Dahle Board Chairman,
Worldwatch Institute

In 1966 the well-known economist Kenneth Boulding published an important book with the title, *The Economics of the Coming Spaceship Earth*. That was probably the first attempt to describe the challenge of adjusting behavior and attitudes to the fact that we are living in a closed system. As a matter of fact, we who are living today are the first generations being permitted to see our planet from outside. The remarkable photos taken from space showing our small but beautiful planet against the vastness of the universe are visible proof of a paradigm shift of equal importance to the realization, some 500 years ago, that the Earth was not flat.

A development model gaining acceptance year by year is the process description "From Cowboy Economy to Spaceship Economy." This model describes the beginning of our civilization and where we are heading. We are starting our voyage through time and space with unlimited freedom to act. We are gradually recognizing that, due to the number of people on the planet and our increasingly demanding consumption patterns, our freedom to act will have to be limited. Our ecological footprints must be limited.

A few years ago, UNEP (United Nations Environment Program) published their Global Environmental Outlook report. In this report is a dramatic assessment of the challenges confronting us. According to UNEP, a responsible development—in those countries where a majority of the global population is living and where a majority of the majority is living at or below the subsistence line—will require that the industrialized countries over the next few decades reduce their resource consumption not *by* but *to* one-tenth of current levels. This is the magnitude of our challenge.

We need to introduce a Doctrine of Changed Circumstances. This will require:

- a new intellectual culture,
- a new consumption culture, and
- a new technological culture which will require what we should call ecological intelligence.

Albert Einstein warned us half a century ago by saying that the world we have created through our way of thinking has serious problems that cannot be solved by continuing to think as we always have been thinking. In 1987 Gro Harlem Brundtland, in her capacity as chair of the United Nations Commission on Development and Environment, said, when presenting the commission's conclusions, "A sustainable future will require a fundamental reordering of global priorities!" Seventeen years later we have not started that essential process.

There is no lack of understanding of the risks we are facing in an OECD report where we read, "We are facing

a policy challenge as urgent, difficult, and far-reaching in its implications as any in our history. All major global ecosystems are in decline." In 1992 a group of over 1600 prominent scientists, including over 100 Nobel laureates, signed a "Warning to Humanity" stating: "A great change in our stewardship of the Earth and the life on it is required if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated."

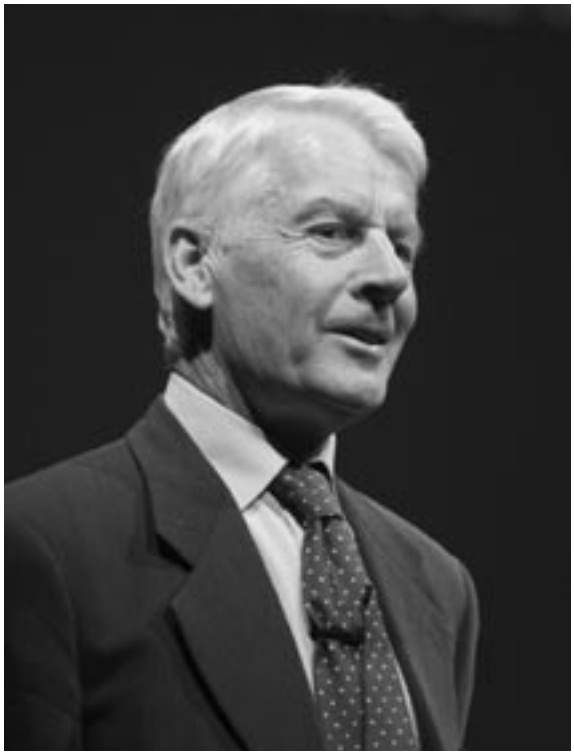
The challenge will require a new role for technology. The challenge will also require a complete redesign of the working relationship between the political system and the corporate sector. The objectives of the corporate sector, by exclusively looking after maximizing the return on shareholders' investments, are too narrow.

There is a long-term agenda which will require a new vision. The cornerstone of future strategies must be the ability to manage risks and manage change. Risk management is probably the closest we can expect to get to the precautionary principle.

On a bridge over the Potomac River in Washington, among other graffiti there are two thought-provoking statements: The first: GOOD PLANETS ARE HARD TO FIND; and the second: THE FUTURE IS CANCELLED DUE TO LACK OF INTEREST. We need to address the challenges with more engagement, with more enthusiasm, and with more determination.

We obviously have both the capability and the capacity to work on the problems if we decide to do so. It is a fascinating challenge, and I am optimistic that we can turn the tide.

Global But Small: How Volvo Cars Can Stay Competitive and Contribute to Sustainable Development at the Same Time



Hans-Olov Olsson President & CEO,
Volvo Car Corporation

A map of the automotive world is a complex, changing picture in which the larger players grow and the smaller, independent brands become fewer. Volvo is just a dot on this map, a small fish in a big pond—but a very colorful, attractive fish nevertheless. The Volvo name is well known: our brand is strong—much, much stronger than our size on the big map indicates. One reason, of course, is that we build good, attractive cars. But there is also another important factor helping to create our strong, global presence. We dare to be different, and it's all about being human. It has always been like that for us.

Our company has had a human-based philosophy from the very start. Our founders, Assar Gabrielsson and Gustaf Larsson, stated: "Cars are driven by people—the guiding principle behind everything we make at Volvo, therefore, is and must remain, safety." So the safety aspect has been with us from the start. The environmental awareness came later but with the same emphasis when we stated frankly in the early seventies, "Our products cause noise, pollution and waste." This was more than thirty years ago at the UN Conference for mobility. And we added, "Volvo alone can't solve the environmental problems associated with motor vehicles. The community carries the main responsibility for developing our transport systems. But Volvo is determined to make active contributions with solutions." Thirty years later this is truer than ever.

When it comes to cars and the environment, the development arrives usually in small steps and only rarely in big leaps. But it happens. In 1976, we contributed by introducing the catalytic converter, controlled by a Lambda Sonde. The technology soon became common practice in the car industry, cutting emissions of carbon monoxide, hydrocarbons, and nitrogen oxides by more than 90%. Today, all of you have a similar type of system in your car, so there is a little bit of Volvo in it no matter what you drive. So far, that invention has been our finest hour when it comes to environmental work.

We have done much more since then, cutting CFCs, building clean paint shops, installing allergy filters, and developing bi-fuel cars. Admittedly these are small steps, not giant leaps, simply because we can't take them on our own. We must listen to other actors. And we must work together: this is essential for our success in building sustainable societies.

To us it's also a matter of survival. Today, it is more clear than ever that the traditional capitalistic approach—being strong and profitable and creating shareholder value—has to be extended. We also need to add sustainability.

At Volvo, we firmly believe that sustainable development is a non-negotiable condition for achieving our business goals. Why? Because we know that people expect more from us than just a good, reliable car.

Today's customers—and, even more so, tomorrow's—want to demonstrate that they are responsible, intelligent people. Thus they want to buy their cars from a responsible company. These are hard facts. Results from worldwide surveys show that 40% of the world's population—and 70% in the United States—have considered refusing, or actually have refused, to buy products from companies not meeting their standards for social responsibility.

Our experience from developing cars for alternative fuels is that the emotional attraction is stronger than the willingness to pay extra for the technology. We have our bi-fuel cars running on natural gas or biogas parallel with petrol. We have developed these cars over time. They are mature, reliable cars, not concepts or try-outs. But unfortunately they are more expensive than traditional cars, and the access to the fuel is limited to a few countries and, in Sweden, only to certain regions.

I would love to stand here and say that our bi-fuel car is a hit that makes the world a better place and Ford's shareholders happier men and women. Instead, the bi-fuel project is an example of how the lack of coordinated action prevents a sound environmental idea from getting a real boost. But what if the politicians made natural gas cheap and the fuel companies decided to extend availability to more and more markets? That would be a different story.

It takes co-ordination and co-operation to tick the necessary boxes on the sustainability chart—technology, economy, and politics. Many people are crying for a revolution in the automotive industry; and they are calling for big, immediate changes. For them, the ecological system has to be saved no matter what the consequences or the costs may be. We can respect this, but we don't think it would create a sustainable society overnight: It might even cause more problems rather than solving them.

The real challenge for us is (1) to remain successful from a traditional perspective, creating attractive products and profitable, growth-creating jobs; and (2) to become successful in helping to creating a sustainable society. Participating in partnerships is one of the key elements to achieve this. And this is why we are here today. The Alliance for Global Sustainability has an exciting potential. Bringing together teams from four of the world's most distinguished universities is a great thing in itself.

Injecting collaboration with business leaders such as myself, government, policy-makers, and environmentalists makes it even more interesting. Volvo has enjoyed a long and fruitful relationship with Chalmers University of Technology. It has been a win-win co-operation. Chalmers has gained more muscle as an academic institution, and we at Volvo have gained knowledge and new ideas that have made us more competitive and profitable.

The AGS cooperation is another opportunity to join forces in the quest for a cleaner, better world—one of the greatest challenges for modern society. To me, this new partnership carries responsibility as well as the opportunity to emphasize our views on this crucial issue. There is no doubt that a company like Volvo must take responsibility for our role in it. We need to listen more, to be more transparent, and we must be able to

adapt to new demands. But, doing this, we also feel that we have the right to demand a fair playing field for our environmental initiatives.

I would like to see the AGS project promote a couple of things:

(1) A European, or even better an international, perspective on environmental regulations: Tougher regulations limited to Sweden will only make us weaker as a company and limit our possibilities to make contributions to a global sustainable development.
(2) Allowing companies to gain competitive advantages through strong environmental initiatives: This would create a positive wave within the industry in the shape of other companies following the lead and increased competition making the technology or initiative even stronger.

This thesis is part of the CARE [Competitive Advantage, Regulation, and the Environment] program within the AGS. CARE states (1) that it is desirable to increase the number of companies that succeed in integrating environmental performance in their business strategy, and (2) that this takes a new approach, not only for the companies themselves but also for those forming the regulations.

This is a highly important issue for us because we firmly believe that we have a lot to offer when it comes to developing environmental technologies (if we get the opportunity to make them successful) and profitable business ventures. So let us work together to meet these challenges at the local, regional, and global levels by daring to act and by learning from each other.

Our mission is to create a sustainable development by harmonizing technology, economy, and politics. Volvo has spent more than three quarters of a century proving that we want to contribute to a safer and more environmentally sound mobility. We think that we deserve to remain successful and profitable while continuing on that path.

There is a local saying that what's good for Volvo is good for Göteborg or even Sweden. Today I will be bold enough to say that what is good for Volvo could be good for the global community. Swimming small in the big pond for so long has made us tough enough to think that we are up for that challenge.

Some Thoughts on Research Partnerships

Måns Lönnroth MISTRA, Vice Chairman of the China Council for International Cooperation on Environment and Development

Mr. Lönnroth cited MIT's renowned historian of science, Elting Morrison, on the notion of a 'social immune system to new ideas' which might disrupt its current mode of functioning. He said that the mandate of MISTRA (the Foundation for Strategic Environmental Research) is the solution of environmental problems in ways that contribute to the Swedish economy. A major problem in effecting these solutions is establishing common goals for scientists working to develop technologies and for industrialists who will market them to users.

A common MISTRA metaphor, Lönnroth said, is the 'Death Valley' lying between these two groups, at the bottom of which lie the desiccated bones of many a great idea. What exacerbates the problem, he said, is the fact that both sides are becoming increasingly broken up into smaller and smaller niches on the user side, and more and more rarified and narrow disciplinary specialties in academia.

Fruitful technology research, Lönnroth said, must be trans-boundary in three senses: first, across academic disciplines; second, between the developers and users of an idea; and third, across national boundaries. Mr. Lönnroth described a 'watchicallit' graph, in which the x-axis represents scientific value and the y-axis represents user value. Each axis is divided in two, with the half closest to their intersection representing negative value and the half furthest from the intersection representing positive value.

The projects MISTRA is most likely to fund will appear in the upper right quadrant, characterized by high scientific and user value. The next most likely to be funded will fall into the lower right quadrant. Those with negative user value are of least interest.

The projects MISTRA funds are of three types. Commercially viable projects which may or may not represents technological breakthroughs, such as low-cost photovoltaics, represent the first type. Another category includes big issues of importance to Swedish leadership. The third type of project includes many stakeholders, e.g. ecosystem management. In selecting any of these projects, MISTRA looks for good communication strategies. These, in Lönnroth's view, are key to success.

Finally, he outlined four essential elements of a sustainable research agenda. These include:

1. studies of technology, including technology drivers, to help business move beyond compliance;

2. further development of multilateral institutions for dealing with transboundary issues—the network needs to be extended to address many more issues, and to be woven of finer mesh, i.e. to work with more precise scientific and policy instruments;
3. ecosystem engineering—active management and the development of the perspective on the Earth as an engineering problem, with the recognition that no place on the planet has escaped human intervention: Social engineering must be included; and
4. a scientific platform for altruism.

Main Challenges of Sustainable Urban Development in Fast Growing Cities of the South

Professor Kwesi Andam

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Abstract

Sustainable development is development that meets the needs of the present whilst not compromising the ability of future generations to meet their needs (Brundtland Report, *Our Common Future*, 1987). It is a process that has the potential to lead to the creation of wealth and the eradication of poverty.

On one hand, the trend of globalizing sustainable development knowledge has aided in the spreading of certain ideas and information. On the other hand, it can also overlook or even suppress local knowledge and research capacity, favor inappropriate standardized solutions, and constrain real commitment and implementation. Thus, universal analyses and standard solutions for sustainable development will rarely be applicable.

Africa faces significant challenges and opportunities in the area of sustainable urban development. The African people and institutions have significant human and knowledge resources that should be the principle resources in planning and managing sustainable development. Sadly, these human and knowledge resources have not been adequately mobilized, and most countries, since their post independence years, have experienced persistent and severe economic, environmental, political, and social disorders.

In the face of these problems, there is hope in the tenacity and strength of the people of Africa to overcome problems of increasing magnitude within the context of sustainable urban development. This presentation seeks to examine the challenges that are encountered in sustainable urban development in Africa.

Introduction

Sustainable development is seen by many people as a tool and a potential solution to balancing economic development, social assets, and environmental protection for current and future generations. The United Nations-sponsored Brundtland Report has a less well-known passage that further explains the meaning of sustainable development: The Earth is one but the world is not. We all depend on one biosphere for sustaining our lives. Yet each community, each country, strives for survival and prosperity with little regard for its impact on others. Some consume the Earth's resources at a rate that would leave little for future generations. Others, many more in number, consume far too little and live with the prospect of hunger, squalor, disease, and early death.

The challenge of sustainable development is to harmonize economic, social, and environment objectives. For development to be sustainable it must address the aims and aspirations of today while passing resilient environmental and socioeconomic systems to future generations. Africa is more than ever at a crossroads. Although richly endowed with natural resources, the continent is afflicted by unprecedented poverty, aggravated by inadequate use of the valuable products derived from its soil, subsoil, and shores. With respect to sustainable development, Africa faces challenges that are interconnected in various ways such that the existence of one challenge may either directly or indirectly influence the intensity of others.

In this presentation, the challenges that Africa faces towards sustainable urban development will be examined under the following sub-divisions:

1) Health
2) Education
3) Governance
4) Demography
5) Economy
6) Infrastructural Development
7) Agriculture
8) Environmental Issues
9) Policies and Organizations
10) Others

Health

Health and development are intimately interconnected. Both insufficient development leading to poverty and inappropriate development resulting in overconsumption, coupled with an expanding world population, can result in severe environmental health problems in both developed and developing countries. Health of the human stock is the most critical factor in the sustainable development of any African country. Without healthy workers no country can even function in the long term. Epidemics like HIV, wars, superstitions, lack of adequate medical facilities, overpopulation, and lack of awareness about health issues have caused great damage to the working populace in urban cities of African countries.

Education

Education in all its forms is essential to sustainable development, because it provides the scientific and technical skills required and the necessary motivation, justification, and social support for pursuing and applying them. It increases the capacities of people to transform their visions of society into operational realities. It is for this reason that education is one of the primary agents for sustainable development. The main impediment to Africa's development stems from its high level of illiteracy, which arises from (a) insufficient primary and higher education facilities, schools, teachers, universities, lecturers, etc., (b) lack of vision or awareness, (c) lack of policies and funding, and (d) the high cost of good education. Most African cities lose the services of their well-educated graduates to the developed countries in the process that is commonly referred to as brain drain. This is the situation where highly qualified local doctors, nurses, and engineers choose to relocate to countries, usually countries of the North, where there are better remuneration packages and better standards of living.

Governance

Governance and human development are indivisible. Human development cannot be sustained without good governance. Governance cannot be sound unless it sustains human development. Africa as a whole has begun to make significant economic and political progress in recent years, but in many parts of the continent progress remains threatened or impeded by conflict. Since 1970, more than 30 wars have been fought in Africa, the vast majority of them intra-state in origin. In 1996 alone, 14 of the 53 countries of Africa were afflicted by armed conflicts, accounting for more than half of all war-related deaths worldwide and resulting in more than 8 million refugees, returnees, and displaced persons. The consequences of those conflicts have seriously undermined Africa's efforts to ensure long-term stability, prosperity, and peace for its peoples.

The nature of political power in many African states is a key source of conflict across the continent. It is frequently the case that political victory assumes a winner takes all form with respect to wealth and resources, patronage, and the prestige and prerogatives of office. While African peacekeeping and mediation efforts have become more prominent in recent years, the role that African governments play in supporting, sometimes even instigating, conflicts in neighboring countries must be candidly acknowledged.

Demography

A central concern today and in the future is how to meet the needs of the rapidly growing population while maintaining the natural resource base on which livelihoods in the region depend. Populations in Africa have been growing rapidly over the past decades compared to the world average. As the regional population has grown, it has also become more urbanized. There has also been a general migration in the region that is driven in part by the greater economic opportunities in these countries especially in the cities, by population growth, and also by the climatic conditions in areas which are prone to desertification and are less suitable for agriculture. These migration patterns are placing increasing stress on resources, ecosystems, and human infrastructure, particularly in cities and coastal areas.

Economy

The average income of most African countries is smaller than the average of Africa as a whole and considerably below the world average. In countries such as Benin, Burkina Faso, Mali, Côte d'Ivoire, Senegal, and Ghana, agricultural products are the most important exports while mineral ores are the most important exports in countries like Niger and Togo. This reliance on a limited range of food and basic commodity exports makes most countries vulnerable to price fluctuations in international commodity exports. For most African countries, the value of aggregate exports exceeds imports, implying that they rely on imports rather than on their own resources to meet domestic demands. In addition, the debt burdens carried by most countries are extremely alarming. Thus, though there is net income from trade, it is currently used to service the regions debt payments, constraining investment and development in the region.

Infrastructural Development ICT (Information and Communication Technology)

It is essential for African countries to strive to catch up with the developed countries in order to improve the standard of living of their citizens. Most existing internal communication in the South goes through the North, resulting in great variations depending on the media. Some of the countries of the South have one postal and Telecommunication Corporation, usually government monopolies, which barely facilitate information, exchange.

However, changes are occurring such as the privatization of some government corporations. Some existing communication mechanisms in the South are radio, television, press and newsletters, and electronic communications (internet, conference calls etc.).

The process of information and communication exchange in Africa is hampered by many activities and occurrences, including the following:

1) In many cases, there are no appropriate information dissemination and exchange mechanisms.
2) In many African countries, locating a source of information that is needed is very difficult; in certain cases, there is delay, which is sometimes serious enough to render information irrelevant, inconsistent, or incomplete.
3) Media do not often provide opportunities for willing partners in information exchange and dissemination for sustainable development.
4) Information from grassroots is not being communicated to the national level and NGOs because they are unavailable in print or any other media.
5) Language is a serious barrier to communication: for example, environment and development conventions are conducted in languages that most local people cannot fully understand.
6) There is reluctance by donors to fund information dissemination and exchange for local communities and their needs in Africa.
7) There is frequently no provision for continuous learning or exchange of information with facilitators or project managers. There is also a lack of awareness about existing programs.
8) There is a concern as to how to take advantage of the North's information capabilities to benefit Africa.

Agriculture

Agriculture plays a crucial role in addressing the needs of a growing global population and is inextricably linked to poverty eradication, especially in developing countries. Chapter 14 of Agenda 21, on sustainable agriculture and rural development, notes that, by the year 2025, 83 percent of the expected global population of 8.5 billion will be living in developing countries. Yet the capacity of available resources and technologies to satisfy the demands of this growing population for food and other agricultural commodities remains uncertain. Agriculture in Africa remains predominantly a subsistence activity, although it is becoming progressively more market-oriented. It has a slow development process due to the following reasons: a) The risky nature of agricultural production makes farmers less willing to spend their limited resources on new approaches; b) few farmers apply fertilizer or adopt practices to improve conservation of soil moisture; c) allocation of resources is probably limited by the perceived higher benefits from investments in areas other than land conservation; and d) most agricultural production sites are located in the rural areas of the countries which are rarely easily accessible from the urban cities, where a greater proportion of the population resides.

Environmental Issues

Drought and desertification threaten the livelihood of over 1 billion people in more than 110 countries around the world. Kofi Annan

Water

The availability of water in Africa is highly variable both in space and in time. Precipitation over the continent

varies from practically zero over the Horn of Africa and the Namibian Desert to more than 4,000 millimeters a year in the western equatorial region. A large proportion of the continent is semi-arid, receiving between 200 and 800 millimeters a year of variable rainfall. The impact of variable rainfall and drought has been heightened by land degradation and deforestation. These have led to more soil erosion, and hence increased sediment transport, which adversely affects water quality, reservoir volumes, and hydroelectric dams. Ground water quality is deteriorating in most growing cities due to lack of proper assessment and management. All countries in continental sub-Saharan Africa share one or more river basins. There are at least 54 rivers or water bodies that cross or form international boundaries in Africa (e.g. The Nile, Zambezi, Volta, and Niger). However, few are effectively managed jointly. Water resources management is a sector that needs to be radically addressed in the growing urban cities of the South.

Desertification and Deforestation

The African continent contains the world's largest expanse of drylands, covering about 2 billion hectares or 65 percent of Africa's total land area. One third of this area is hyper-arid deserts, while the remaining two-thirds consist of arid, semi-arid, and dry sub-humid areas, which are home to about 400 million Africans. Recurrent droughts are a permanent feature of drylands of Africa. Severe droughts have seriously affected both agriculture and wildlife and have caused deaths and severe malnutrition. Desertification increases with each drought cycle. Currently, 36 countries in Africa are affected by some degree of desertification.

Land degradation, which includes degradation of vegetation cover and soil degradation, is a major ecological problem in Africa. Land degradation is exacerbating the existing natural constraints on agricultural production, including poor soil quality, variable climatic conditions, and reliance on rain-fed agriculture. Deforestation is a major problem throughout Africa, although its causes and magnitude vary by region. The major cause is related to forest clearance for agriculture and the harvesting of fuelwood. What remains of the forests in humid West Africa are disappearing at the alarming rate of about 2 percent a year, and exceeding 5 percent in the extreme case of Côte d'Ivoire.

Pollution

Water bodies that are present or flow through urban cities of the South are under constant threat of pollution. For major cities, such as Accra, there is a pressing problem with the effective management and disposal of waste. Thus most of the generated waste contributes to the pollution of existing water bodies, groundwater, and air quality and plays a prominent role in the deterioration of air quality and sanitary conditions in the cities.

With the increase in population in the urban cities and a growing need for transportation facilities, there has been a corresponding increase in the import and use of vehicles for transportation needs. For most countries, the primary mode of transportation is by road. Thus there are more vehicles present in the urban cities, which in turn results in more carbon emissions into the atmosphere causing a reduction in air quality.

There are occurrences of indoor air pollution from the burning of biomass fuels. The burning of these fuels is associated with a range of health impacts including respiratory infections in young children, low birth weights of babies, adverse pregnancy outcomes etc. It is imperative that urban cities move away from traditional use of biomass fuels in households and towards electricity and cleaner-burning fuels.

Policies and Organizations

Some of the challenges that Africa faces towards sustainable urban development with respect to policies and organizations are as follows:

- Policies do not allow grass root participation.
- Policies are formulated in languages that local people do not fully understand.
- Policies for existing and potential NGOs tend to slow performance rates of these organizations.
- Some organizations are formed for selfish individual profits and benefits.
- Some international organizations do not make provision for maintenance and sustenance of projects such as the provision of trained local managers and operators for successful ongoing projects.

Other considerations

Sustainable urban development in Africa is also hampered by the non-inclusion of women in the process. Women form a greater percentage of the population, yet they are not very involved in the various sectors of development. However, some countries have put in place systems that encourage the education of the girl-child and project initiatives that are manned and operated by women.

In recent years, Africa has seen a lot of climatic changes. For instance in Ghana this year, the dry season (also called the Harmattan), which usually occurs in late December and January, is still occurring intermittently. There is also an increase in the global temperature of the region and a shortening of the rainfall season. This also results in a decrease in the agricultural output of countries that depend mainly on rainfall for irrigation.

Research is an avenue of sustainable development that is not being effectively utilized in the African cities. The major impediments in the area of research are the non-availability of funds and facilities and the non-utilization of research results to the relevant areas.

Summary of Challenges

Among the barriers to implementation of sustainable urban development in the South are the following:

- The health of the working populace of the cities is threatened due to lack of facilities and cost of health care.
- Poverty, illiteracy, and lack of awareness on the part of the majority of the population create problems in the development and implementation of programs to achieve sustainable development.
- There is an increasing gap between population growth and national economic output.
- Favorable conditions do not exist for foreign investors, usually because of political governance.
- There is a lack of national consultation prior to signing international agreements and the proliferation of those agreements, which results in signing conventions without full knowledge of the implications to the countries and without having the capacity to translate these agreements into action.
- There is inadequate coordination between government, NGOs and the private sector.
- There is a lack of vision and commitment by leaders to implement sustainable development.
- Climatic changes are occurring across the region.
- There is marginalization of women in the national development process.

Response Initiatives

Although Africa faces the greatest development challenges in the world, positive changes are laying new foundations for peace and prosperity throughout the continent. Major initiatives in response to environment and development needs in African cities include the existence of national initiatives such as National Environmental Action Plans (NEAPS), National Conservation Strategies (NCSs), and National Plans of Action to Combat Desertification (NPACD). At present, about 80 percent of the countries in sub-Sahara Africa are involved in the NEAP process, and there is preparation for involvement by other countries.

Important changes are also being made to the national constitutions of African countries to incorporate the basic principles of environmental management. These include the right of the citizen to a clean and healthy environment and the responsibility of the state to protect and conserve environmental and natural resources for present and future generations. For example, the new constitutions of Ghana, Ethiopia, Mali, and Uganda, among others, are explicit on these themes.

The role of the media and the active participation of grassroots groups in environmental management are being promoted. The Gambia, Senegal, and Ghana, among others, have introduced environmental studies into the curricula of their school systems. A number of regional response mechanisms have been put in place. Sub regional institutions involved in this endeavor include the Arab Magreb Union (AMU); the Economic Community of Central African States (ECCAS); the Economic Community of West African States (ECOWAS); and the Southern African Development Community (SADC). Most African countries have signed the related UN Conventions (Biodiversity, Climate Change, and Drought and Desertification), although ratification has been slow.

General Conclusion and Recommendations

The present trend of development in Africa can be reversed through the following:

- Stronger policy interventions backed by genuine national consensus;
- Strong and sustained political will to implement policy reforms; introduction of innovative management systems, coupled with the widespread application of better and appropriate technologies;
- Integration of environment and ecological issues into decision-making at all levels, and given equal priority with economic and social concerns;
- African countries must themselves understand the environment and ecosystem idea and interpret it in relation to African peoples daily needs and the need for economic growth;
- Development of human resources and institution building;
- Establishment of new kinds of effective partnerships between national governments and their own citizens, and with the international community.

National planning processes presently adopted in African countries provide the policy and institutional framework for development, and, as such, they provide the critical and necessary tools for mainstreaming some concerns in the development process. The ultimate goal should be planning for sustainable development in which the environmental, ecological, social and economic dimensions of development are harmonized and optimized in all policies and programs.

Ethics, Profits and Sustainability

Peter H. Grassmann Former President and CEO of Carl Zeiss

Profit is the traditional motivator of industry. Strong profits are a sign of health and achievement, and they reconfirm success. Pressure to achieve profit is high. A few percent vanish easily, creating the pressure for compensation and profit increase.

Only some companies today see ethics—and as part of it, sustainability—as an equally strong motivator, a must just as important as profits. And only some admit that their role is primarily to serve society and not profit-creation alone. In fact, the different stakeholders have different expectations, if it comes to ethics and sustainability:

- Customers want quality of products and services first,
- Shareholders want profits, growth and stability first,
- Employees want job-security and good pay first, and
- Our society wants ethics and sustainability.

But they all like a positive image of a company that may well involve environmental and other sustainability efforts. The fact is, however, that the motivation for sustainability efforts is too small. It has to grow to the same level as the motivation for profits. I will try to develop further a few scenarios to achieve that goal, to achieve it with the help and motivation of all stakeholders.

Governance of good Citizenship

It is the task of governance to secure a behavior that is in line with the expectations of all stakeholders and of society in general. Therefore a motivation for sustainability has to start with the attitude and the instruments of governance. We have seen that product quality, environmental requirements, and other compliances have been implemented successfully through management and company boards without reducing either profits and growth on the one hand or the attractiveness to the shareholder on the other.

Just remember how product and process quality are today a cornerstone of business success. Boards have created internal pressure, but, in many countries, conserving resources and preserving the environment have also become a must for good business practices. Many companies want to be "a good citizen," and they know that it already helps their business success today. How, then, can we widen the motivation for real sustainability, which includes many global development responsibilities? Our governance structure does not reflect that yet—but it can.

Structure and Rules

The governance structure of most of the larger companies already goes considerably beyond the traditional understanding of governance. Many special boards exist, some implemented by the management and some by the governing board. For example, boards exist for quality, for compliance (in particular in FDA-regulated industries), for environment, for human resource policy, for financial ethics, etc. Sustainability, particularly in its global context, is not yet sufficiently part of such an internal board structure, but I suggest that it will become an important part of governance. It can start with the creation of a *sustainability board* in each major company by the supervisory board or the management.

I suggest that the overall scheme of governance in the future will be to govern the overall compliance with the demands of "good citizenship." This includes governance to include the viewpoint of all stakeholders. It means to take up governance responsibilities not only for the sake of the shareholders but also for the expectations as a customer, as an employee, and of society overall—i.e., the complete viewpoint of good citizenship.

Board and management can set an internal network of an audit and board structure which supervises the company`s behavior in all aspects of good citizenship. Of course, some of these boards need a good mixture of outsiders and company members in order to secure balanced and business-related goal-setting and judgement. Issues to watch can include balanced marketing behavior, environmental and energy conserving programs, as well as manufacturing and product programs designed specifically for developing countries.

However, I do not mean that the company will slide away into a not-for-profit attitude. Good profits can be combined with good citizenship, as shown by many companies, but other priorities of a demanding society must also be given enough attention. Goal-setting, delegation, and some control are often enough to trigger socially outstanding activities of a company in the industrial countries and, in particular, in the developing world. All companies that are engaged in the AGS have shown promising or already successful examples of this.

But I do not deny that these activities will create cost at the onset and will not help short-term profit achievement. However, already today many stakeholders respect such a broader attitude of good citizenship, because it contributes to the positive image of a company. There can be more. All stakeholders have to understand how important the citizenship attitude of a company will be for the future of society. Such an attitude should not be hidden; but rather it should be marketed as an example and a strong image contribution. This will not come by itself; it needs promotion and it needs transparency.

The Role of the AGS

This is where the AGS should come in. First of all, it is not trivial to create rules and goals that reflect an exemplary attitude of good citizenship, including sustainability requirements. Without some standardization, not enough appreciation will develop. We have already seen such initiatives as the UN Global Reporting Initiative (GRI). These are a start, but they are not specific enough. The AGS is optimally suited to create a codex for an exemplary industrial attitude of good citizenship and sustainability. All of the AGS member universities have very close ties with industry, all have business schools, and all are respected as being well-informed and realistic. The AGS, therefore, is ideally suited to create a "Code for Sustainability and Good Citizenship." Such a code will have to consist of generally applicable recommendations such as energy conservation, environmental and

resource guidelines, etc., and segment-specific guidelines for the different manufacturing industries, trade and supply companies, banks, and even organizations such as universities.

I will be happy to discuss examples for individual segments, but I am sure that each and every one of you knows several demands that should be reflected in a "Good Citizen Code of Conduct." As a side remark, such code recommendations might be combined with a consensus publication of the AGS member universities on the potential of new technologies, again as a guideline for policy and strategy decisions of industry and research funding.

What about profits?

I have said that profits need to continue as one of the priorities but not as the only and most dominant one. However, profit is the simplest motivator in the long run. Therefore, some responsibility falls back to customers and investors as the most direct stakeholders. If they have an easy possibility to judge the degree of performance in regard to good citizenship, it will influence their decisions. They can, with their decisions, best contribute to profit and the growth of companies that perform well as good corporate citizens both on a local and on a global scale.

That will need a measure, a degree of performance that is derived from the judgement of the different dedicated boards and the overall supervisory board with a strong vote of its outside members. But what does not get measured does not get done. As we have today a rating for financial sustainability (for instance Moody), an overall sustainability rating can develop and become a guiding factor in buying and investment decisions and a prerequisite for strong business success. Investment funds such as pension funds and consumer-related NGOs can play an important early role in its implementation, and they do already.

It goes without saying that it will take years to develop accepted measures and board structures and to achieve global acceptance. But without such measures the motivation of our business environment is too small for a full commitment to sustainability and good citizenship. It is easy to predict that the next generation will—in light of the foreseeable consequences of today`s limited efforts—ask us one day: "What did you know and what have you done?" The AGS is one of the answers, and it should further sharpen its voice. It has the power and the knowledge.

Research Partnerships and the Future

Lawrence Susskind Massachusetts Institute of Technology

Let us step back and ask what we now know about effective research partnerships that advance the cause of sustainability.

The partnerships we tend to value most are those that (1) help a specific set of decision makers (clients) solve a clearly defined problem; (2) build on-going relationships between "problem havers" and problem solvers; and (3) embed problem-solving within the broader university educational mission.

What have we learned about the organization of such partnerships?

- They are self-organizing (voluntary) and transdisciplinary;
- Participants realize they must rely on each other to reach their goals;
- They serve the strategic interests of all the parties involved;
- They are oriented toward problem solving and knowledge production;
- They are multisectoral (public, private, civil society).

What, then, are the major obstacles to making research partnerships work?

- They often provide insufficient attention to internal capacity building;
- There may be a lack of methodological transparency;
- They have often failed to engage knowledge consumers early and often;
- There may be a lack of timeliness in their knowledge production;
- They often display insufficiently accessible format and findings.

There are a number of strategies that can be used to overcome these obstacles. First, knowledge producers and knowledge consumers need to meet face-to-face to frame and review proposed research objectives, research design, and preliminary findings. They then need to incorporate policy-relevant input from the social and management sciences. Next, they need to demonstrate sensitivity to differences in time constraints facing knowledge producers and knowledge consumers. And finally, they need to employ multiple formats to communicate the products of their research in an accessible form to multiple audiences.

To conclude, I propose an "AGS Checklist" to ask ourselves about the effectiveness of research partnerships. Do ongoing and new research partnerships have:

- Clear problem statements produced jointly by knowledge producers and knowledge consumers?

- Written understandings regarding roles and responsibilities of knowledge producers and knowledge consumers?
- Provisions for building and enhancing the problem solving capacity of the partners and the partnership?
- A strategy for ensuring timeliness and accessibility of the products of the research?

Panel of Presidents

From left to right: Kwesi Andam (Vice-Chancellor, Kwame Nkrumah University), Hiroshi Komiyama (Vice President, University of Tokyo), Jan-Eric Sundgren (President, Chalmers University), Charles Vest (President, Massachusetts Institute of Technology), Hans Weder (President, University of Zurich)

Hans Weder *President, University of Zürich, Switzerland*

In Zürich we have set up a center for corporate responsibility and sustainability where there is cooperation between academics and private companies. During the set-up of this center we discovered that there are some large private firms in Zürich that have already put considerable personal resources as well as money into sustainability research. There is already quite a large competency there, and it is very interesting to see how their approaches combine with academic approaches. It's a very good opportunity for academics to cooperate with people from the private sector and vice versa.

For the first three years we focus, as you would expect in Zürich, on financial services and banking. In this sector there is a need for sustainable behavior. This will be expanded into different areas of research, of course. Also we try to implement an inter-disciplinary approach where science, economics, social science, and humanities are cooperating in the same field, concentrating on solving the same problems. Our goal is to find multi-dimensional solutions, including cultural and behavioral aspects.

It is very interesting that private companies are interested in this multi-dimensional, approach which, moreover, includes humanities and cultural studies. They are operating all over the world and have a need, first, to get to know other cultures, and second, to learn to act in a way that is appropriate to their customers and partners. That is the reason why these firms strongly stress a multi-dimensional approach. Of course, in academia we like that because, as a full-scale university, it is in our interest to try to produce this kind of added value to the whole discussion of sustainability. But we are fully aware that technological solutions are very, very valuable and must not be ignored. It is just this sort of coming together with other dimensions I am speaking of that is so important.

Kwesi Andam *Vice-Chancellor,*
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

In the third world, research is very expensive from the academic point of view. In Ghana, we allow industry to influence the kind of research that takes place. However, it is very expensive for industry itself to find money to carry out any meaningful research.

Our research takes place at two levels (as I expect is the case in most universities), first, at the post-graduate level, and second, at the level of research institutions. In Ghana there are six main colleges, each of which has a research institution. There are post graduate studies at the masters level and at the doctoral level. The student first registers as a masters candidate and then carries on and completes the doctorate studies in three to four years.

Each of the six colleges has a dedicated research institution. For instance, in the medical health sciences, comprising the school of medical sciences and faculty of pharmacy, we have what we call the College for Collaborative Research. Research in this particular organization takes place at a very high level at which researchers are working on WHO-funded projects such as malaria, tuberculosis, and related tropical diseases.

Our real strengths are in engineering. In all six faculties, research takes place in civil engineering, mechanical engineering, electrical and electronic engineering, computer engineering, telecommunications engineering, chemical engineering, agricultural engineering, and materials engineering. In all these areas we have research being carried out by our graduate students. In addition, in the social sciences we have an institution called the BIRD, Bureau of Integrated Rural Development. In this particular institution research takes place in micro systems to deal with rural areas through very small packaged programs meant to help with rural problems in general. In most of the social related research, we get funding from donor agencies including the World Bank. Also I would say we have a very good rapport with industry.

At any particular time my university is helping with research and teaching in south universities such as the National University of Rwanda in Butare and other universities in Africa that are less well funded than KNUST. My professors at KNUST jointly carry out research with other universities, because they are younger universities and KNUST has better resources than they do.

Charles M. Vest *President, Massachusetts Institute of Technology, USA*

The development of an academically oriented enterprise such as the Alliance for Global Sustainability follows a natural progression. The first stage is taking what we are already doing, changing the name a bit, and hoping that the modified program will be a good match with the goals of the funding organization. Next is for the partners to begin a number of modest-scale, innovative projects together as a way of exploring and defining the mission more fully.

There then comes a natural point when we can consolidate our focus and work on some larger-scale projects, because we have developed a strong organizing principle or vision. I suspect we are going to see more of that as the AGS moves forward.

Why do we do this? We do it because we want to make a difference. We want to have an impact. Given the kinds of things that the AGS is concerned about, I believe that impact will be maximized and, indeed, made possible only through serious partnerships with governments, with industry, and perhaps with other NGOs. But I want to focus a little bit on industry partnerships because it is something that I've had a fair amount of experience developing in our own institution, MIT. I will review a few of the lessons I think we have learned. They are very simple, but I'm going to state them nonetheless.

First of all, in my experience, you cannot expect new activities or those that cut across disciplines to work in a university unless they come from the bottom up. You can talk about it top down, you can enable it top down, but the intellectual driving force, the desire to collaborate, has got to come from the bottom up.

So how do you correlate that with trying to put together larger scale partnerships with industry? In my experience, it is best if you work with the presidents, deans, or other academic leaders who can plow the ground, so to speak, by getting broad agreement with the leaders of the company with which you want to partner. That way, if the right kinds of ideas are put together, they will want to sponsor it.
Then you do the hard work of (1) putting together the appropriate team of faculty leaders from the academic institution and the scientific/technical leaders from the company, and, if you will, (2) locking them in a room and saying, "Come out when you have achieved a potential working agenda that fits the mission of both organizations and that can add more value than either organization alone."

That implies a number of things. First of all, you have to recognize up front, as Hans Weder has already pointed out, that you are working with different cultures and different bureaucracies. It takes a while to develop the core of understanding that allows you to come together to do the work really well. You begin to run into things such as different views on intellectual property. That always has to be worked out up front before you begin the work, and that's usually the hardest part of the negotiation between an academic institution and a company. But it is very, very important to clearly understand each other and come to a common agreement on that at the very outset.

Next comes what I call the timeframe. There are natural cycles or timeframes for serious academic research that are largely associated with the normal time required, say, for a graduate student to do his or her thesis or

dissertation work. That is usually very different from the timeframe to which industry partners are accustomed. This, too, is an issue that has to be addressed upfront, and it usually takes a lot of discussion to come to a common understanding of the timeframe under which the work is going to be accomplished.

Next, you'll never put a good university-industry partnership together unless you agree on some milestones and some metrics to chart your progress toward your goal. Here again, you will come across a cultural difference—although we're getting more and more used to it in the university world—which you have to approach with a seriousness as well as an open mind.

A few years ago, after we had forged four or five rather large-scale and long-lived corporate partnerships at MIT, we polled the faculty with a questionnaire asking, "What did you learn? What is the most important thing that we're going to have to know when we put such a partnership together in the future?" The responses were very interesting. All the things I've talked about were there. But the number one answer was, *trust.* What made a partnership work was the establishment not only of mutual respect but also of *trust* between people working at the intellectual level in the two organizations.

The final point I would like to make, again, based only on my own experience and observation, is that there has to be a clear, individual champion for the partnership in each organization. If responsibility for the partnership is diffused throughout a large company, it is likely to decay: You won't stay on the path and you won't accomplish what you set out to do. You really have to identify up front, who is going to be the champion in the AGS or in the university and who is going to be the champion in the company—i.e., the individuals who will have the passion and zeal to make all of this work.

In closing, I return to the point I began with—why do we want to consider major partnerships? In my view it's primarily because AGS wants to have an impact. We will maximize that impact if we work with industry or government or with other partners who are able to implement the things that we develop in our universities.

Hiroshi Komiyama *Vice President, University of Tokyo, Japan*

I would like to make two comments. One is concerned with the target of research partnerships in AGS, and the second is concerned with the causes of difficulty in doing research and outreach.

First, I feel we should place more focus on Asia—and, in particular, China—because sustainability issues have regional characteristics as well as global characteristics. In Asia, for example, cities are often huge, with more than ten million people living in concentrated, densely populated states. And many Asian cities are situated in the monsoon climate. This is very different from cities in European, North American, and even African countries. So I feel we should focus more on Asia, where economic growth is huge, and we should initiate new research partnerships in that regard.

I feel that the essential difficulties of research partnerships are twofold: one is the subdivision of academia and

the other is the complexity of sustainability issues. Human knowledge has increased tremendously in the 20th century. And the knowledge creation process of human beings is composed of not only domain definition but also finding the governing rules in a given domain.

You can understand this by considering the process by which Sir Isaac Newton discovered the laws of movement. He first defined a domain of movement of mass. Then he found the rule of mass and momentum. He defined a domain and found a governing rule. This is the knowledge creation process.

And so very naturally, with increasing amounts of knowledge, academia has been divided and subdivided into pieces. This has narrowed the field that any single individual could cover and has consequently left our knowledge scattered about in subdivided academic fields. On the other hand, the issues to be solved in the 21st century are complicated, as we all know. These two factors, the sub-division of academia and the complexity of the issues, have made it difficult for some researchers to solve their respective issues.

Thus, we need research partnerships in the AGS. However, it is not easy to collaborate among partners of different backgrounds. We need a more efficient knowledge infrastructure. I believe structuring the knowledge concerned with sustainability is an important role played by the AGS. You may recall the work named the Tokyo Half Project. Looking ahead to the next AGS technical meeting, I hope that my colleagues and I will demonstrate the fruitful example of this knowledge structuring tool, which has been created through partnership with the AGS.

Jan-Eric Sundgren *President, Chalmers University of Technology, Sweden*

I have a few comments to make on research partnerships. From being in a small university in a small country, I see partnerships as a necessity. If I and my colleagues are to compete in the international arena, it is crucial that we join forces with others. I like to quote John Lennon and Paul McCartney, who sang "I get by with a little help from my friends." I think that is the essence of partnerships.

In Sweden over the years there have been many forces from the outside that have stimulated partnerships. There are excellent examples of how people in industry and academia can work together to produce good outcomes. Ten years ago, based on what has happened in the UK and particularly in the United States, one of our funding agencies wanted to form competency centers. The criterion by which the competency centers were to be formed was to have input one-third from industry, one-third from the funding agency, and one-third from academia.

At that time in Sweden there was a major discussion in academia about whether or not such competency centers would go against basic science and result in poor research. Furthermore, industry argued that academia cannot keep time schedules. But if we look at the situation today, although there have been some failures in a general way, many of the competency centers that were started almost ten years ago have become highly successful.

We are now running six of these competency centers at Chalmers, two of which are very relevant to sustainability—i.e. bonding catalysis and NO_X reduction. It's a rather narrow focus, but I think they have succeeded in bringing together research groups with industry in ways that are competing with some of the best groups in the world. It has taken time, and it has taken some effort to build mutual respect and trust, be they between one university and another or between a university and an industry. As President Vest said, trust is extremely important.

Also, personal chemistry is important when you have people working together. We can see this in the workshops that have been conducted by the AGS, which show that when people get to know each other, the interaction—even across the globe—can be very successful. However, as has been learned in the competency centers that have been operating in Sweden, it is necessary to settle boundary conditions up front from day one, including issues of intellectual property, milestones, and how one should evaluate the results.

Evaluating a project is extremely important in order to know where you stand and where you are heading. However, not everything is working perfectly. We know that. In Europe there has been another force that has played an important role and will play an important role in shaping research in Europe. We heard Margot Wallström yesterday talking about the Lisbon goals, namely to put Europe in the forefront of knowledge society by the year 2010.

In the European Union, we conduct research through so-called "framework problems." These have been rather complicated in terms of application procedures. But there are some excellent examples of where the European Union has successfully put research groups together from academia and industry and where the results have really made a difference.

But another question arises, namely the question of size. How many partners can you have? In the Sixth Framework Program, which is a program the European Union is currently working under, large integrated projects were created with large sums of money available between academia and industry and addressing problems relevant to both industry and society.

The average number of partners in these integrated projects funded so far is around 31. But can you really have a meaningful partnership with so many partners? There are even programs that have as many as 1,800 partners. In my opinion, you probably won't get value out of the money you put into such large programs. So I think one needs to limit the scope of research partnerships in order to fulfill the criteria, gain respect, and get know one another.

AGS is a partnership that, at least if I look at what it has done internally at Chalmers over the years we have been participating in AGS, has really made a difference in our internal way of working. And I also think that the themes and strategic plan that we now have for AGS have the potential to make a real difference.

Workshop 1

Carbon Capture and Storage

Chairman: Prof. Filip Johnsson

This workshop focused on the AGS research partnership, "Bridges to Sustainable Energy Futures—An international Research Partnership on Carbon Capture and Storage." The overall goals of this research partnership are (1) to identify, study, and address non-technical barriers for the introduction of carbon capture and storage from fossil fuelled energy production, (2) to study social and political aspects of carbon capture and storage technologies, and (3) to provide guidance to decision-makers.

Amid the dire warning of severe weather perturbation and rising global temperature, scientists, engineers, policy makers, and others are searching for ways to mitigate the growing threat of climate change, and more, to move towards a more sustainable energy system. The development of carbon capture and storage technologies, which has accelerated greatly in the last decade, may be instrumental in building a bridge from a carbon-based to a carbon-free energy system.

Carbon capture and storage (CCS) offers the possibility of a significant and relatively quick response to climate change at reasonable cost. In order for this technology to reach widespread commercialization, it is crucial to establish large scale demonstration projects, achieve further reductions in capture cost, build infrastructure for transportation of captured CO_2, establish a legal framework, and reach acceptance by the public.

The aim of the workshop was to discuss:

- How CCS fits into a portfolio of technologies and measures along paths towards a sustainable energy system;
- How to establish the regulatory and policy framework required for storage of CO_2;
- What requirements for CCS are needed to achieve acceptance from the public and other major actors including industry, non-governmental organizations, and governments.

Session 1

Session 1 commenced with a prepared presentation by Lennart Billfalk—Executive Vice President of Vattenfall AB, a leading European energy company—in the form of key challenges from an industrial perspective. Over the past few years, Vattenfall has grown considerably with core business concentrated in Finland, Germany, Poland, and Sweden. Vattenfall operates in all segments of the electric value chain, including generation, trading on financial and physical markets, and distribution and sales (both business-to-business and to household customers). Vattenfall also generates and sells district heating and energy solutions as well as maintenance services and consulting services. Vattenfall is involved in R&D on CCS and is leading an integrated research project on CCS within the 6th framework of the European research program.

Session 2

The Climate Action Network (CAN) is a worldwide network of over 365 NGOs working to promote government, private sector, and individual actions to limit human-induced climate change to ecologically sustainable levels. The European node of CAN, CANEurope, is a non-profit organization operating as a coordination office since 1989 for environmental groups in Western Europe (European Union, Iceland, Norway, Switzerland) working on climate change issues.

In Session 2, Jason Anderson, a policy analyst at Climate Action Network Europe (CANEurope), addressed the role of CCS from an NGO perspective. Anderson leads CANEurope's research on technological responses to climate change, covering carbon capture and storage, hydrogen production, fuel cells, and alternatives to fluorinated greenhouse gases. In addition, he coordinates European NGO actions on the Clean Development Mechanism at the UN negotiations on climate change and follows environmental issues arising from energy market liberalization in Europe.

Anderson observed that environmental NGOs see a problem of credibility and vision: renewable energy and efficiency are far underutilized, and now we are being told, surprisingly, that we will solve climate change using more fossil fuels. On the other hand, many NGOs see the opportunities to engage policy laggards like the US, growing fossil-fuel-intensive economies like China and India, and global corporations with vested interests.

Anderson noted that CCS is already being sold as a "zero-emissions technology," but capture of around 90% CO_2 (plus the impact of the energy penalty) isn't 'zero.' Leakage rates from storage are not yet established. Selling 'green' aspects of CCS while causing environmental concern in the same project for other reasons diminishes credibility.

Basically all NGOs are strongly against ocean disposal of CO_2, said Anderson. Different stakeholder groups are generally addressing local and global hazards. Local CO_2 danger is largely viewed as a manageable risk, but opportunities away from populations are best studied first. Any incident can change perception very fast and attract much wider attention. But in the engagement with stakeholders, people's opinions are not *risks* to be *managed*: The public is a participant in the process, which demands flexibility and willingness to change.

Increases in research funding, legislative support and corporate effort toward renewables and efficiency are a top priority, said Anderson. To be credible, CCS must be seen as slotting into strategies that meet the goal of avoiding dangerous anthropogenic climate change. The jury is definitely still out on CCS, said Anderson: Credibility, cooperation, and the internalization of important environmental values are key to success.

Session 3: Findings and Conclusions

One of the key outcomes of the workshop was the recognition of a public lack of quantitative knowledge about the problem of global warming and a public lack of knowledge on limitations for the options—in terms of technologies and measures—which are available to solve the problem. CCS is meant to be one part of a larger portfolio to tackle the problem.

The presenters stressed that it is necessary to focus on pathways towards sustainability by starting to invest now. The challenge is how best to design the portfolio. Ongoing work in this regard includes a survey of opinion leaders (NGOs, industry) designed to

- understand how these actors assess the state of the CCS technology;
- compare CCS with other options;
- perceive the risks involved;
- perceive the attitudes or likely attitudes of the public; and
- espond to new information on CCS.

Another strategy is to perform near-term (10 to 20 years) pathway analysis including "energy-infrastructure" constraints. In order for the portfolio to be successful, there is a need for consensus among academia, industry, NGOs, and the public.

The CO_2 mitigation paths portfolio embraces the following objectives:

- Reduced energy consumption/production
- Increased efficiency
- Fuel switch (coal to gas)
- Increased use of renewables
- Increased use of nuclear power
- CO_2 capture and storage

It is necessary to consider all paths.

Looking to the road ahead, can we move from "targets of opportunity" to widespread implementation? Technical challenges are (1) to lower costs primarily associated with the capture process, and (2) to develop storage res-

Workshop 2

Competitive Advantage, Regulation, and the Environment (CARE) —Public Environmental Interest and Private Business Risk

Rapporteur	Christine Ng
Chairman	Flemming Norrgren Chalmers University, FENIX Program

The two-day CARE workshop featured speaker presentations and discussion addressing firm-level strategies to derive competitive economic benefits from superior environmental performance. The first day focused on the automotive and fuel sectors, and the second day covered the pulp and paper, pharmaceutical, and insurance industries.

Session 1: Theme – Automotive & Fuels

Introduction

Kenneth Oye of MIT opened the workshop by introducing the main problem. Most of the literature on competitive advantage from environmental performance is based on conventional demand- and supply-side strategies such as efficiency gains, voluntary compliance, and green labeling. However, there are limited benefits to

companies from these "win-win" strategies. In the absence of regulation, the financial rewards accrued to the companies for superior environmental performance rarely offset the costs to the companies.

Moreover, traditional sources of competitive advantage are eroding. If environmental pioneers do not capture the value of their innovations, firms have less incentive to invest in environmental innovation. Information technology has reduced market segmentation through information asymmetries and local biases. Not only do competitive regulatory strategies provide public environmental benefit but also they can differentiate products and resist commodification.

Charlotta Källbäck Strategy, President's Office, Volvo Car Corporation

Charlotta Källbäck discussed Volvo Car's strategies for competing based on environmental performance as well as the challenges to extracting economic benefit from those strategies. She drew a parallel between safety concerns and environmental awareness. When safety first became a key part of the dialogue about cars, acknowledging the reality that cars could kill people was very controversial. Likewise, despite the initial hesitancy to acknowledge cars' contribution to environmental harm, there is now a growing acceptance of the problem.

Källbäck gave an overview of Volvo as a company. In 1999, the acquisition of Volvo Car by Ford Motor Company shifted Volvo Car's customer focus. It was no longer part of a company dealing mostly with trucks, buses, engines, and construction equipment. Safety has long been a core value at Volvo, and environmental care has also been a core value since 1972. Quality, which includes durability, is another core value. Volvo Car has manufacturing facilities in Sweden and Belgium and assembly operations in Malaysia, Thailand, and South Africa. Its sales are strongest in Europe and North America. Even though Volvo represents only 1.5% of the global market share in cars, its actions do affect the rest of the industry.
The life cycle of Volvo's products is approximately six to seven years, which is much shorter than in the past, when products could stay on the market for as long as ten years. Volvo launches a new car at the rate of one or two per year. Since Volvo is in the premium car segment, customers are willing to pay for features beyond basic transportation or mobility. However, customers do not give environmental characteristics a high priority. According to a 2002 Roper Global Study, environmental friendliness ranks eighth on a list of top automobile characteristics. Safety, design, and economy (value) are the top reasons customers give for purchasing Volvos; meanwhile, fuel consumption and environmental efficiency rank very low.

While Volvo has been able to charge a premium for safety, it has been increasingly harder to sustain that price premium, because customer expectation of safety is now higher. Given its customers' low prioritization of the environment, a major question is whether Volvo should be influencing its existing customer base's preferences or redirecting its resources to other market segments. Volvo would like to strengthen the reinforcing effect of the "virtuous circle" of premium brands, where a strong brand yields strong resale values, high brand loyalty, and limited competition—all of which further strengthen the brand reputation.

Since the 1970s, Volvo has had some leading and innovative environmental features. Recently, the 1998 launch of the PremAir "ozone-eater" in vehicles garnered significant media attention, a success from a communications point of view. Communicating environmental features to potential customers is not easy. Volvo Car sells cars

through independent dealerships, which means that the company relies on dealers to communicate environmental solutions and technologies to consumers. Since dealers only have a few minutes to talk to customers, the challenge is determining how to convey multiple issues to consumers in such a limited amount of time.

Volvo has recently begun to offer a bi-fuel vehicle, which can run on either natural gas or gasoline. Although the engine costs more, customers benefit from reduced fuel consumption, tax incentives, free parking in city centers, access to public transport lanes, access to restricted city areas, and permission to drive on restricted car days. Nevertheless, the bi-fuel vehicles have not been selling well. Many of the 6,000 cars sold are Volvo company cars. Customer hesitancy has been frustrating, especially when the fueling infrastructure and customer benefits are widely available in southern Sweden. It is difficult to make a business case for a model that only sells 500 to 1000 cars per year.

Källbäck concluded by reiterating (1) the main challenges, i.e. technology and infrastructure availability, customer behavior, business benefits, and business models, and (2) demands of key stakeholders, i.e. investors, auto industry, regulators, consumers, and NGOs.

Kenneth Oye MIT

Kenneth Oye highlighted five case examples where companies had proprietary technologies with superior environmental performance characteristics.

(1) *Montreal Protocol*
Dupont and ICI, the largest producers of ozone-depleting CFCs, initially resisted the Montreal Protocol, which called for a CFC phase-out. In the meantime, they had developed and patented costly CFC substitutes. Competition from low-cost CFC producers was cutting into their market share. As the scientific evidence on ozone depletion grew, Dupont and ICI changed their initial positions. Dupont voluntarily phased out CFCs ahead of deadlines. The phase-out hurt Dupont's sales in the short-term, but it increased the value of their proprietary technology.

(2) *Xerox and PM emissions in the 1980s*
Fine particles from photocopiers are a major health concern because of their ability to penetrate deep within the lungs. In the 1980s, Xerox asked its research group to set a goal to exceed existing regulatory standards on particles by a factor of 10. Their success in narrowing the size distribution of toner particles reduced the number of the more harmful tiny particles. Rather than secure tighter regulations benefiting Xerox over its competitors, Xerox went along with the rest of its trade association. It did not treat regulations as a component of corporate strategy, perhaps missing the opportunity to accelerate more stringent standards.

(3) *Air conditioning seasonal energy efficiency ratio (SEER)*
Carrier and Trane have superior proprietary technologies in air conditioning, but they are being buffeted by low-cost competitors. In January 2000, the Clinton administration increased US energy efficiency standards by 30% for 2006. Later, the Bush administration withdrew the regulation and recommended a 20% increase, a reduction supported by the industry association ARI (Air-Conditioning and Refrigeration Institute). Carrier and Trane belong to ARI as well as the American Council for an Energy-Efficient Economy (ACEEE). Supporting the

higher 30% standard, Carrier and Trane worked quietly to reverse the position of ARI. Eventually the federal courts intervened and restored the tighter 30% standard. When it became apparent that the higher standard was going to win, ARI reversed its decision to support the 20% standard. Carrier and Trane stand to benefit from the tighter regulation.

(4) *EU diesel*
European countries have set extremely high fuel taxes to penalize less fuel-efficient passenger cars, and they have created a price differential favoring diesel fuel. As a result, there is a large incentive to buy diesel cars in Europe, compared to the US or Japan. Standards on nitrogen oxides (NO_x) and particulates (PM) are less stringent in Europe than in the US. Meeting the tighter US standards requires expensive technologies, which would add considerably to the overall cost of the vehicle. The popularity of diesels in Europe benefits European manufacturers, whose diesel technology is ahead of the Japanese, the leaders in hybrid technology.

(5) *Food safety*
In the US, the public policies regarding HACCP (Hazard Analysis and Critical Control Points) improved food safety while favoring larger firms. Initially, the large producers resisted HACCP, but they eventually assented and benefited from the stricter food safety regulations. Costs of HACCP compliance were relatively light for large and technologically proficient firms across the beef, pork, and poultry industries. There is indication that the beef and pork industries have become more concentrated.

In summary, Oye pointed out that firms typically have trouble recognizing opportunities to use competitive regulatory policy. It is not customary for firms to see regulation as part of their corporate strategy to contain risk; instead, firms do not view regulations as something to be manipulated to their advantage.

Subunits involved in technology/product development are not well integrated with those handling regulatory affairs, further limiting communication about regulatory strategies. Key areas of opportunities for environmental strategies are frequently overlooked. For example, changes in administrative rules, test procedures, model specifications, and enforcement procedures often escape public notice. It can also be difficult for academics to investigate these areas, because they need to understand multiple areas of expertise. While there are cases where companies have used regulatory strategies to their benefit with no actual public environmental or health benefits, most regulatory and legal systems are able to "filter out" these cases of rent-seeking.

Discussion

There was considerable discussion about responding to customer demand. Customers are not prepared to pay for environmental benefit. Part of this research group's agenda was to determine the constraints to garnering benefits from environmental technologies.

In the case of Volvo's bi-fuel cars, many customers see diesels as a more attractive option. Those who do buy bi-fuel cars may be looking at their decision from a purely economic point of view, but most customers are not concerned with fuel savings alone. Diesels have higher performance and less infrastructure concerns. Consumers do not tolerate inconvenience and performance loss. Even though bi-fuel cars are intended for private

consumers, not fleet owners, it is risky for a private individual to spend extra money for a vehicle if he or she is uncertain of its residual value. Car owners want to be able to refuel outside southern Sweden, where natural gas fueling infrastructure does not exist. In the meantime, Volvo is still investing in their diesel technology. It is not feasible to expect companies to supply multiple alternative fuels and their accompanying infrastructures. At this point, it is easier to sell to fleet owners because they are more concerned about fuel economy.

Although fuel prices are high in Japan as in Europe, diesels are less popular in Japan than in Europe. The Japanese government is concerned about diesels' generation of particles, and the public has a negative view of diesels. The Tokyo metropolitan government has recently imposed stricter regulations on diesel trucks.

One participant observed that Volvo's brand is associated primarily with safety, and questioned whether Volvo can use the environment as a characteristic for product differentiation, especially with an SUV in its portfolio. Källbäck explained that Volvo seeks to improve its product characteristics in every segment for which it has a model. For instance, Volvo had struggled with its decision to introduce a convertible, since it is well known that convertibles are less safe than regular sedans. However, the company decided that it would aim to make their convertible the safest in its segment. Likewise, the company aims to make its vehicles, including its SUV model, the most fuel-efficient in its segment.

Urban Wass, a representative from Volvo Truck, commented on the need for customer or regulatory pressure for action. The advances in truck engine technologies have coincided with customer demand for fuel efficiency. It is easier to sell fuel efficiency as a desirable characteristic because heavy-duty truck customers are more concerned about fuel consumption. Volvo supports stricter regulations, but it is wary of those with loopholes for cheating.

Wass' comment led into a brief presentation by Christine Ng of MIT, who explained the unintended outcomes of the 1998 consent decree between the US EPA and the heavy-duty diesel engine manufacturers. US regulators found that all the major manufacturers had used illegal software, or "defeat devices," to bypass NO_x emission controls during steady-state on-highway driving. As part of their settlement with EPA, the engine manufacturers agreed to meet the 2004 NO_x and PM emission standards early, by October 2002. The standards' stringency and shortened timeline reinforced a trend of increasing market concentration and vertical integration.

Concerned about the new EGR technology's reliability and 3-5% fuel penalty, truck fleet owners chose to order engines before the October 2002 deadline to avoid buying the post-October 2002 engines. This led to a massive pre-buy and production fluctuations that significantly reduced the market for the new engines and the associated environmental benefits. Moreover, the regulations inadvertently penalized companies that met the October 2002 deadline because customers preferred paying for the higher-priced noncompliant engines (due to noncompliance fines) than the compliant but less fuel-efficient engines. While this appeared to be a disadvantage to manufacturers of compliant engines, their decreased market share may be temporary as customers gain confidence in the new technology and all manufacturers must ultimately meet the higher standards.

Another prerequisite for the spread of new emission control technologies is the availability of low sulfur diesel fuels. In the US, sulfur levels are comparatively high, which creates a barrier for diesel cars equipped with sulfur-

sensitive aftertreatment technologies. Even within the US, some geographic regions will be exempt from the new sulfur standards, which will create fueling problems for interstate trucking and disadvantages for some refineries over others.

In his presentation, Mats Williander of Chalmers University and Volvo Car used a framework of "competitive rationality" to explain how taxing "eco-malign" activities could drive the market towards eco-benign choices. Instead of relying on emission regulations, this would focus on generating economic incentives for improved performance. By including the cost of emitting pollution to the "commons" in the cost of car ownership, customers may not choose a more polluting, heavily taxed car because it is more expensive.

Williander described a French proposal where vehicles emitting above average would be taxed according to their deviation from the average, and vehicles emitting below average would confer some benefits (e.g. saleable credits) to their manufacturers. This will give companies the incentive to produce lower-emitting cars, subsequently driving down the average level of emissions.

One participant brought up the difficulty of weighing and then aggregating the various types of emissions to come up with an average level. For example, how is carbon dioxide weighed against nitrogen oxides or hydrocarbons? There could be a lot of contentious fights caused by heterogeneity in local emission levels, which prompts some populations to emphasize one pollutant over another.

Another participant pointed out that a tax-incentive balancing scheme would present a dilemma for a company with a portfolio of products, with varying emission levels. A company with a mix of low-polluting and high-polluting products may be pitted against itself in terms of deciding how to respond to such a scheme. Williander suggested that this could be remedied by using weight classes. Since companies compete on other product characteristics besides the environment, the tax incentive scheme would be a way to embed the economic value of using the "common" into the purchase decision.

There was some discussion about the extent to which different business units within large firms have the same interests or feel constrained by the parent company. For example, one of Novartis' business segments was investing in biotechnology in food while the parent company was banning GMO foods. In the case of Volvo Car as a Ford brand, Volvo must reach emission levels on its own rather than relying on the parent company to "rescue " them if it falls short of its goals. The different premium brands under the Ford family are different enough from each other that they do not compete against each other. In terms of lobbying, they do consider what is best for the whole company.

Auto companies have recently been trying to communicate their environmental leadership to their customers, but this may be difficult given that most do not have a deep history in "environmental" research and most of that research has been driven by regulatory compliance. However, some of the most important "environmental" work has not been labeled as such. For example, there are many researchers in the auto industry working on enhancing efficiency and performance who are not labeled as "environmental" researchers.

The relationship between firm size and environmental performance plays an important role in industry consolida-

tion. Ideally, cleaner companies would buy up dirtier companies, but this is not always the case. One participant introduced the example of a large, relatively dirty energy company buying up small, relatively clean oil refineries in the southern US. Although the closure of dirtier plants may indicate an improvement in environmental quality, there is concern that companies are merely conducting their dirtier operations in pollution havens elsewhere. Also, the disastrous outcomes of some mergers and acquisitions (M&A) indicate that firms not do recognize the environmental risk that they have acquired through M&A activity.

In the final wrap-up of this first-day session, James Foster of MIT suggested that in order to keep firms involved in probing these research questions, it is important to engage them on a specific issue. Many questions were generated by the discussion, such as:

- Does business really see the opportunities?
- What are the incentives and benefits of improved environmental performance?
- Are firms aware of the opportunities of improved environmental performance?
- What are the regulatory constraints on "beyond-compliance" performance?
- What are the true risks associated with poor environmental performance?

Foster used a 3-by-3 matrix to explain the research areas of interest. On one dimension was cost to companies, categorized as small, equal, or large. On the second dimension were the outcomes, categorized as win-win, win-lose, or lose-lose. Most literature has focused on win-win strategies where the costs at stake were relatively small. Preference for a particular technology would fall into the category of equal cost / win-lose. CARE research will definitely focus on competitive advantage involving win-lose outcomes with large costs. In the large cost / win-win category, some companies may still have a financial advantage, such that their benefits are larger than their competitors' benefits. Of great interest to the CARE team are large cost / lose-lose strategies where compliance is costly for everyone, but the relative costs vary considerably and place some companies at an advantage.

Session 2: Theme – Pharmaceuticals, Pulp & Paper, and Insurance

Introduction

Kenneth Oye opened the second day's session by reiterating some themes from the previous day. He also noted that the morning's plenary session speakers had mentioned voluntary codes of conduct and separate sustainability indices. CARE will be considering alternatives to these measures. Combinations of regulation and corporate strategy can ensure that sustainability translates to profitability, which are still measurable by traditional profitability indices.

In the production and use of pharmaceuticals, there is a classic tension between solving externalities problems and creating innovation incentives through intellectual property rights. In the pulp and paper sector, the regulation of inputs, processes, and products affects the terms of competition among firms. Environmental liability and insurance are a crosscutting issue because many sectors face potentially substantial and uncertain damages.

"The Challenge of Sustainable Development"

Peter Hellsberg — Head of Safety, Health, and Environment (SHE)
AstraZeneca Sweden

Assessment of safety, health, and environmental (SHE) issues is built into the drug approval process. It begins at the time a candidate drug is nominated, and progresses through a SHE "tree" process until each step is completed. While the technology for green manufacturing is available and feasible for new products, processes for existing products are fixed according to pharmaceutical registration and regulatory demands. A change takes four to five years. Although the complexity of the work deters changing the process, some changes have occurred. For example, AstraZeneca now uses water as a solvent, whereas ethanol and even methyl chloride were used in the past.

The goal of sustainable development is at odds with the goal of low-priced medicine. Medical agencies and insurers require customers to use the cheapest product regardless of environmental considerations. There is little incentive for sustainable practices that cost more because customers, or their doctors, will select the cheapest product. After patent expiration, generic manufacturers can produce an even lower-priced product.

Hellsberg described how a "leading edge" research-driven company might become a "bleeding edge" company. Environmental friendliness is not a priority for the medical authorities. The late adopter learns from the often-expensive mistakes of the innovator. Even if a company must conduct costly studies on environmental effects, it is not taken into consideration by the medical authorities. Speed to market is very important to the pharmaceutical industry. There is no business advantage from working in the environmental area today. The tools for risk assessments are too blunt: they mostly measure acute toxic effects and do not account for long-term, low-dose effects.

It is important to have the environmental and medical authorities working together. At this point we do not even know if we are measuring the right impacts. Once we decide the important endpoints, we have to develop sharper tools to measure them. Medicines are a unique group of chemicals because they are designed specifically to improve health by affecting the human body, so those benefits must be considered. When it comes to the pharmaceutical industry, authorities are focused on the effects of drugs on the human body, not on the environment. In Sweden, the government prefers lower-cost generics rather than new products. Even if AstroZeneca could develop new but more costly products with less environmental impact, people would still buy the older, less expensive products.

Europe's new REACH (Registration, Evaluation, and Authorization of Chemicals) legislation requires that the pharmaceutical industry register all intermediate chemicals, even those that never leave the factory. Other countries do not have that policy, placing European drug manufacturers at a cost disadvantage.

Discussion

Currently, consumer awareness about safety, health, and environmental issues is very low; unfortunately, only

a major scandal may make low-level chemical exposure a top concern. Given the barriers to understanding and internalizing environment impacts, the working group discussed ways to offer incentives (1) to manufacturers, to develop less environmentally harmful products and (2) to customers, to purchase them. One idea is to use a labeling system to designate the environmental impact of products. Another was to price the product higher, but customers are not generally the ones who select the products; it is doctors who make the decisions and often the health care provider (government or insurance company) who pays the bill.

If an industry association that includes generics firms were to adopt a voluntary code of conduct, Hellsberg expected that the lowest common denominator would prevail. Unless all companies are required to meet mandatory environmental regulations, companies will not voluntarily reduce environmental impacts, because doing so raises their costs in a market where everyone is competing on cost.

The group also addressed the difficulty of aligning the interests of the medical and environmental regulatory authorities. Despite a recent stakeholder dialogue that brought the authorities in Sweden together, they are each bound to their different roles and objectives. There needs to be stronger leadership from the top, i.e. from the politicians.

In response to a question about examples of over-compliance and its drivers, Hellsberg mentioned AstroZeneca's state-of-the-art process wastewater treatment plant. It was developed in the 1990s because the municipal wastewater treatment plant could not take care of the high volumes. Concerns from the public and investors motivated AstroZeneca to show that the company is taking care of wastewater in the most efficient way possible. Absent this new technology, the company would have been in violation of today's regulations. However, there was no regulation requiring that level of performance at the time of adoption.

The long time horizons and slow processes that characterize low-level exposure stand in contrast to the acute, sharp signals needed to draw attention to these problems. As with the issue of climate change, this may require application of the precautionary principle. By grouping these problems together, it may be easier to articulate an approach. Even though more research studies are needed, there is no consensus on a cohesive plan or direction.

While all new products go through the SHE process, the old products are not evaluated retrospectively. A chemical company may be hesitant to push new types of regulations forward because it may risk stirring up public opposition from consumers worried about rising health care costs. The EU has already come under fire for their eagerness to invoke the precautionary principle.

The interest in regulating the environmental effects of pharmaceuticals has already begun. AstroZeneca realizes that its position at the leading edge of this issue means that it has to show concern. Ultimately, there need to be both regulatory and economic incentives for change.

"Regulation, Technological Innovations and Environmental Performance of the Pulp and Paper Industry: The Past, the Present, and the Future"

Per Mickwitz The Finnish Environment Institute (SYKE)

Prior to the 1970s, the pulp and paper industry was by far the dirtiest of industries in Finland. Since the 1970s, production and emissions have decoupled: Production has increased threefold while emissions have dropped dramatically. New technologies have reduced water discharges and air emissions. Innovations have partly taken place due to anticipation of tightening requirements. The permit systems have sped up diffusion. Customer pressures and cost savings are other drivers.

The industry is currently working on the integration of the permit system based on the EU IPPC directive. It is the only area where industry supports more bureaucrats, because the integration can improve their business operations. The concept of integrated permits sounds very reasonable because of the danger of shifting the risks to different media or locations. However, there is also the danger of the innovators being wrong about the technologies needed in ten to fifteen years' time. In light of the difficulty of getting huge Nordic mills to try new technologies, smaller-scale pilot projects can be useful.

The Finnish pulp and paper industry abolished the Nordic Swan label and started to use EMAS, an environmental management system. There have been a lot of improvements in the regulatory system, but handling risks is still a major issue. Accidental releases can cause a huge liability problem. The industry has shifted from small national to large international companies, such that there are no longer any purely Finnish companies. Today's international markets for capital, timber, electricity, and technology create a very different environment from the 1970s. The effects on biodiversity in Brazil may instantly become an issue in Europe.

Any action to curb climate change will have a major impact on the electricity-intensive pulp and paper industry. We should encourage "ordinary" technologies that are not explicitly "environmental" technologies but have positive environmental side effects. Meanwhile, there should be penalties for technologies with detrimental effects.

According to Mickwitz, the hype of environmental taxes, voluntary agreements, labels, etc. has gone, and "Traditional regulation is in." More attention needs to be paid to the interaction between instruments and to the potential for over control or lack of control.

Discussion

One participant asked about how the difference in environmental regulations among countries affects plant mill location decisions. Mickwitz explained that, instead of mills' closing down, some have changed their operations. For example, there have been shifts to different types of paper. Mills are relocating to larger end-markets because of recycled paper requirements. Because of the rising electricity costs, the pulp and paper industry has been talking to regulators about the high costs of inputs.

James Foster gave his perspective on the situation in the US. There is wide variation in the efficiency and environmental performance of plants, even those owned by the same company. Jobs are a top priority, and states will promote the continued operation of poorly performing paper mills just to keep the jobs in the state. Technologies exist to improve the plants, but companies do not adopt them because regulations are not adequately enforced. Because of grandfather clauses exempting older plants from compliance, companies do not have the incentive to upgrade their old plants.

Although Finland has very high paper recycling rates, it is the smallest EU country with recycling. This means that its recycled paper products must be exported and must compete with other exporters such as Brazil, where prices are low. Transporting collected paper long distances for use in recycled and cardboard products can get very expensive, so locating local sources is preferred. In addition to the constraints posed by access to local markets for recovered paper and transportation costs, Finland's capacity is constrained by its inability to use more trees.

Some participants discussed whether EU expansion will lead the EU to resemble the US in its regulatory variation. According to one participant, the stronger social safety net in Europe implies that the fear of job losses from more stringent regulation and plant closings would not be as strong in the EU.

"Environmental Liability, Insurance, and Corporate Environmental Performance"

Thomas Bernauer Swiss Federal Institute of Technology Zürich

Insurance is currently not serving as an effective alternative to environmental regulation because of the uncertainty about risks. Insurers have always faced the supply-side problems of adverse selection, moral hazard, and insurance pricing, but these may be worse for environmental issues. The weakness of liability laws in practice also creates a demand-side problem. In order to facilitate risk management through insurance, tougher environmental liability laws—such as a mandatory insurance requirement—could be used in combination with transparent and verifiable corporate environmental performance standards. These changes would encourage the insurance industry to show stronger support for public environmental regulation.

There is an emerging literature on insurance as an alternative to regulation. One study by Minoli and Bell (2003) found that two leading UK insurance companies were doing a poor job of handling pollution claims. Insurance companies do not usually price environmental risk separately, yet insurance has the potential to serve as a risk manager or even a risk reducer.

Bernauer explained the purposes and the weaknesses of the recently adopted EU Environmental Liability Directive. It applies the "polluter pays principle" even though the concept has existed in the EU since 1987. The directive not only covers conventional media-based damage but also covers species and ecosystems, whose effects are harder to measure. It excludes nuclear accidents, damage caused by ships, and GMOs. National governments have leeway to determine whether companies are responsible for environmental damage.

There is no compulsory insurance for environmental damage except for high-risk sectors such as the nuclear power industry. Scientific uncertainty and lack of data on damage and treatment cost were used as the reasons for not imposing a mandatory requirement. Since there is no systematic application of the "polluter pays principle," taxpayers are still expected to continue paying for environmental damage. As a result of these deficiencies, the Environmental Liability Directive is a weak incentive for the insurance industry to offer environmental insurance and for industries to buy insurance.

The insurance industry always faces an information problem. ISO 14001 certification or EMAS registration can help the industry with underwriting assessments and insurance pricing, because they serve as indicators of a company's environmental performance. EMAS stands for Eco-Management Audit Scheme. Although it is a larger achievement to get the more demanding EU-specific EMAS registration, ISO 14001 is more popular because it is perceived as the preferred global standard. Germany accounts for most EMAS facilities. The level of EMAS registrations has reached a plateau, and industry EMAS registrations are going down since governments and universities can also get EMAS certified. Regulatory agencies may give preferential treatment to EMAS certified facilities. There are still many remaining questions about the stringency of environmental liability rules and the role of EMAS or ISO 14001 in providing insurers with signals of good environmental performance.

Discussion

Trade patterns may account for the differences between the UK and Germany's adoption of EMAS vs. ISO 14001. Companies that do more trade within EU may adopt EMAS, whereas countries that trade outside EU would rather adopt ISO 14001. EMAS is likely to evolve towards mandatory open reporting so that the public has access to documents.

US firms may be concerned about risks that they know little about, yet these risks can result in substantial liability because of the tort system. If firms have "deep pockets," they would presumably shift production and divest their most dangerous activities overseas or to domestic units with "no pockets." The insurance market does not handle liability risks well because they are difficult to characterize. Meanwhile, strengthening the tort system gives more incentive to shift the problem from companies with "deep pockets" to those with "no pockets."

Larger companies may choose to self-insure. They may know their own risks well enough so that the cost to self-insure is less than purchasing insurance. A company sometimes creates its own subsidiaries that offer the company insurance. This can lead to an adverse selection problem because the large, self-aware companies opt out of the insurance market, leaving smaller, and possibly more risky, firms. A company may be able to insure against long-term, gradual changes, but they may have trouble reacting to unexpected abrupt changes. It would be very costly to insure against such changes. Even if mandatory insurance were required, only the large firms would be able to afford it.

One participant posed the idea of insurance specifically for small and medium-sized enterprises (SMEs). In most countries, it is the large firms that face discrimination because SMEs are given exemptions. Government can opt to do more command-and-control regulation or hand off some of its risk management authority to industry,

which may have a greater incentive to monitor behavior than the government. Another option may be to require industry to contribute to a shared fund.

The work group discussed the difficulty of managing large, infrequent risks. Small, frequent risks such as product liability or misuse are statistically manageable. Environmental risks occur less frequently but tend to be larger and less well understood. Insurance companies do not have the data for estimating this kind of risk. Some have even proposed canceling all property insurance because of the possibility of abrupt climate change associated with a Gulf Stream slowdown.

We need to evaluate the full range of options for a company. So far, we have considered divestment, self-insurance, environmental performance, and product improvements. Insurers need to assess risks to rate premiums and value environmental liabilities in merger and acquisition activity. Some problems are characterized with uncertainty, which cannot be measured. In some cases, the government operates as an "insurer of last resort," and bears the costs for environmental harm.

If higher performing firms are "rewarded" with more insurance options or lower insurance costs, insurance may serve as a market mechanism to improve environmental performance. In discussing whether EMAS is an appropriate performance signal to insurance companies, one participant noted that EMAS is better for providing information about an individual site rather than the whole company. Therefore, it is more relevant to liability risk than total performance.

It may be helpful to consider the nuclear industry, where insurance is required so all companies share the risk. There is a cap to the insurance coverage, which means that the government also shares in the risk in the event that coverage is inadequate.

The group discussed the dilemma of insuring against very large uncertainties as opposed to risks with known probability distributions. Perhaps insurers are suited to deal with risks while governments should deal with uncertainties. Insurers may have an interest in working with regulators to delineate risk from uncertainty. For example, they may seek regulation that limits their vulnerability to insuring against large unknowns.

In deciding whether public policy should move towards regulatory laxity, stringency, or diversity, decision-makers face tradeoffs across several issues, i.e. environmental impacts, trade impacts, jobs, and costs of public goods. For example, regulatory diversity could be used to favor domestic jobs, but it could be detrimental to the public good and to the environment. It may be also be used as a disguised trade barrier. It is challenging to trade off long-term, uncertain environmental effects with short-term considerations like jobs. In the pharmaceutical case, the demand for affordable, effective health care has to be considered alongside environmental protection.

Future Research Directions

The group ended the session with a discussion of possible future research directions.

- *Integrated regulations:* Integrated regulations arose as an area to explore further because they can help

promote sustainable solutions in different areas rather than focusing on one area to the detriment of another. Some applications include consideration of both pharmacological and environmental effects of drugs, and the use of "cluster rules" in the US paper industry. A major challenge to integrated regulations is the decline of regulatory predictability, which might pose a threat to industry groups or discourage investment in innovative activity.

- *Workshops:* A subject-specific workshop—perhaps on long-term environmental effects of drug use or insurance for environmental risks—could bring together a small 30- to 40-person group of regulators, technologists, NGOs, and companies to identify key areas of uncertainties and ways to generate information. A workshop would help to form a backdrop for forming coalitions to improve knowledge generation and decision-making.

- *Public communication:* Developing a better understanding of customer and voter demands could be valuable for regulators and politicians. This knowledge could offer some fresh, innovative ideas on how to generate demand for higher environmental performance. It would clarify whether company investments are based on regulatory incentives or real company demand. Although companies do market research and economists conduct willingness-to-pay surveys, there is room for researchers to study actual consumer behavior based on their purchasing decisions. Academic researchers can communicate to the public the value of environmental performance, inform government handling of trade-offs, and educate business on the benefits of "being green." One participant hoped to see academia as a "credible, unbiased voice" that illuminates the public policy process and highlights the corporate areas of risk that may not have been properly considered.

- *Insurance/liability:* The group agreed that it would be worthwhile to probe the insurance/liability area further. One participant suggested looking at investment banks, financial options, and derivatives to examine how markets currently handle risks. Research on insurance is only viable if insurance companies are interested in partaking in a partnership, partly because a lot of information is proprietary. Rather than focus on a specific environmental issue, it may be preferable to bundle the appraisal of long-term environmental risks as a topic.

Workshop 3

Sustainable Materials

Chairpersons: Session 1: Prof. Anne-Marie Tillman, Chalmers;
Session 2: Prof. Randolph Kirchain, MIT;
Session 3: Dr. Rainer Züst, ETH

The objective of the workshop, organized by the AGS research partnership on sustainable materials, was to develop methods to assess emerging material technologies from a sustainability perspective, including economic, environmental, and social aspects.

The first session, featuring speakers from the polymers and electronics industries, set out to explore the challenges posed by the need for sustainable development, as seen from an industrial perspective. Discussants considered (1) how research may help meet those challenges and (2) in what ways the AGS research partnership might contribute. Researchers presented some of the tools utilized in the project as well as preliminary findings from case studies. The final session set out to identify opportunities for, and barriers to, knowledge transfer relating to sustainability. Industry-academia interaction in the innovation of new tools, methodologies, and technologies was discussed.

Session 1: Sustainable Material Systems – Industrial Challenges

In this session, speakers from the polymers and electronics industries gave short presentations on how their industries view sustainability issues. An overview of the project of the research partnership was presented, along with the roles of the collaborators at MIT, Chalmers, ETH, and UT.

After presentations from all speakers, a panel discussion was held to address synergistic issues. In particular, discussants were interested in understanding

1) How does the industry see itself dealing with issues of sustainability?
2) What are the most important research issues?
3) What are the prerequisites to overcoming any barriers and allowing implementation of more sustainable material technology?

Session 2: Methodological Approaches for Assessing Sustainability

In this session, researchers presented some of the tools utilized in the project and preliminary findings from case studies related to the project. Presentations addressed the use of life cycle assessment, process-based cost modeling, sustainability metrics, environmental assessment, and technical change. The issue of social responsibility and what it means for a company to declare dedication to sustainability was raised. A panel discussion followed in which relevant types of assessments and metrics as well as commonly collected industry data were discussed.

Session 3: Knowledge Transfer

The third session of the workshop addressed issues related to the transfer of newly developed tools, methodologies, and technologies. Opportunities to knowledge transfer for achieving sustainability were considered as were the identification of barriers. Role models for industry-academia collaborations were presented in order to learn lessons for the research partnership. A discussion followed on issues of knowledge transfer, whether related to the adoption of sustainability assessment methodologies or to the adoption of new, more sustainable technology.

University-Industry Collaboration for New Material Innovation:
The Case of Titanium Dioxide Photocatalyst in Japan

Yarime Masaru and Baba Yasunori, Research Center for Advanced Economic Engineering, University of Tokyo (Presented by Yarime Masaru)

According to David Mowery and Richard Nelson (1999), in order to excel in technological innovation in science-intensive fields, it is of critical importance to maintain conditions and environments that would support close interactions between science and technology communities in the framework of national innovation systems.

However, Fumio Kodama and Lewis Branscomb (1999) argue that the Japanese system has not been generally successful in coupling advanced scientific seeds and economic and social needs effectively, although there have been traditions of informal collaboration which cross institutional lines, representing a certain degree of exchange of information and knowledge between academia and industry.

An important exception is innovations in the field of new materials, where highly sophisticated materials have recently been developed and have begun to be applied for commercial use. Based on the findings of the state-of-the-art scientific fields such as nanotechnology, new materials embody functions that had not been realized before.

Titanium dioxide (TiO_2) photocatalyst, in particular, incorporates novel functions of decomposition of organic substances and high hydrophilicity only with the use of solar light and has been successful in its utilization for various applications ranging from self-cleaning building materials to anti-bacterial ceramic tiles and anti-fogging window glasses. That has led to the creation of new markets that did not exist ten years ago. The current size of commercial products embodying photocatalysts was estimated to be $300 million US in 2002.

The case of TiO_2 photocatalyst has turned out to be unique in that, while the Japanese performance on scientific research is comparable to that of the United States or Europe, patent and commercialization activities in Japan surpass significantly those in these two regions. In this study we investigate how and why the commercialization of TiO_2 photocatalyst has been successfully achieved in Japan through collaboration between university and industry in the context of the Japanese innovation system.

We study how basic research and product development activities are conducted and interact with each other, leading to the successful creation of new markets in a way that is particularly conducive to new materials innovation. To examine in detail the process and mechanism of the evolving university-industry collaboration, a qualitative analysis at the micro level is conducted through interviews with researchers in universities and industry.

Our research shows that the success in the case of TiO_2 photocatalyst could be attributed to the fact that communities of practice on joint research were born and have been growing between the university scientists who have been proactive in industrializing their scientific findings and the firms that seek to work with the star scientists. These scientists excel in scientific research and industrialization in the field of photocatalysis.

Our analysis is focused on the activities of two prominent professors, namely, Professor Akira Fujishima and Professor Kazuhito Hashimoto of the University of Tokyo, who have made crucial contributions to the development and commercialization of TiO_2 photocatalyst in Japan. They discovered fundamental phenomena concerning TiO_2 photocatalyst, published scientific papers extensively, and acquired numerous patents, including those of critical importance to the development and commercialization of TiO_2 photocatalyst. In this connection, Fujishima and Hashimoto have functioned effectively as the key hub in the science and technology communities, promoting information exchange and communication among diverse actors.

An intensive analysis has been conducted to examine how the two professors have formed communities with what kinds of industrial partners in producing one of the most successful cases of university-industry collabo-

ration in Japan. We have found that historically there have been different forms of communities of practice involving the star scientists, in which different modes of university-industry collaboration have functioned. The most important one is the community consisting of several core firms, which published papers as well as applied for patents jointly with Professors Fujishima and Hashimoto. The market potential of the products proposed by these core firms has been regarded highly.

This fact suggests that, only when firms themselves are engaged in serious research activities jointly with academia and their products that satisfy user needs are supported by solid scientific understanding, their market potential could be realized. The communities involving organizations in the public sector have also made a significant contribution to promoting the growth of university-industry collaboration in the photocatalyst field. That has been implemented by broadening research activities to incorporate diverse areas such as environmental protection and societal purposes, which could not be readily supported by companies in the private sector.

Our analysis primarily considers the activities of Japanese firms in the context of the Japanese innovation system. To address the research questions in a broader framework, we are also conducting an analysis of the cases of the United States and Europe by applying the same methodologies. Further, we intend to investigate the structure and evolution of their university-industry collaboration. It seems that the communities of practice in the United States or Europe are much smaller, without the existence of any hub comparable to that of Fujishima and Hashimoto in the science and technology communities.

For further reading:

Hullmann, Angela and Martin Meyer (2003). "Publications and patents in nanotechnology: An overview of previous studies and the state of the art," *Scientometrics*, 58 (3), 507-527.

Kodama, Fumio and Lewis M. Branscomb (1999). "University Research as an Engine for Growth: How Realistic Is the Vision?" in L. M. Branscomb, F. Kodama, and R. Florida, eds. *Industrializing Knowledge: University-Industry Linkages in Japan and the United States*. Cambridge, Massachusetts: MIT Press.

Mowery, David C. and Richard R. Nelson, eds. (1999). *Sources of Industrial Leadership: Studies of Seven Industries.* Cambridge, UK: Cambridge University Press.

Workshop 4

Sustainability and Urbanization

Rapporteurs	Lara Greden (Session 1 and 2) and Derlie Babiano (Session 3); Other contributors: Jann-Henrik Kain, Pål Castell
Chairman	Prof. Björn Malbert, Chalmers University of Technology

Prof. Malbert articulated the cumulative goal of the three sessions, i.e. to define research objectives and potential partnerships for sustainable urban development.

The first session started with presentations by Professor Kwesi Andam and Professor Colin Fudge on the challenges facing cities in both the developing and developed areas of the world, and participants followed with small group discussions on possible areas of AGS research.

The second session began with two presentations on partnerships: Mr. Bo Antoni presented a partnership between Göteborg, Sweden and Port Elizabeth, South Africa on waste management, and Mr. Axel Wenblad presented a corporate viewpoint on partnerships based on his experience as Vice President of Sustainability at Skanska, Inc., a major multinational construction company. Participants then reflected on potential research partnerships.

The third session was mainly used to reflect on learned experiences from earlier projects on urban development carried out by the AGS.

First Session: Primary problems

Professor Kwesi Andam, of the Kwame Nkrumah University of Science and Technology Kumasi (KNUST) in Ghana, discussed the challenges of sustainable urban development in fast growing cities of the South. Prof. Andam drew many examples from Ghana in supporting several key points. First, the trend towards expanding urban populations is a primary problem. Professor Andam said that people migrate to the city in part because basic amenities, including electricity and water supply, cannot be found in the rural areas. Waste collection is a major challenge in expanding cities, as Mr. Antoni discussed in more detail in the second session.

Another problem for developing countries is the loss of highly educated people to the first world, a phenomenon known as 'brain drain.' To combat this problem, efforts are being made to maintain contacts with the students who go overseas so that they may conduct research projects that may also benefit their home country.

Although Ghana receives much funding from the World Bank, it is not to be spent on higher education. This is an example of decision-making that does not take into account local participation. Prof. Andam stressed that policies and organizations need to encompass the local needs and people.

The question of gender balance in urbanization is a key factor that needs to be addressed in Ghana. Women form a greater percentage of the population but are not very involved in the various sectors of development. Ghana now has a ministry of women and children, which has enabled the country to spend more money to support the needs of women in the urban areas. Andam also emphasized that, to a large extent, it is women who perform the daily activities and basic services in the urban system.

During the question-and-answer period, one discussion focused on advances in communication technology in Ghana. According to Prof. Andam, there are five public and ten private developers in information and communication technologies. He also stated that Ghana's policy is to provide for easy outsourcing of contracts, exemplified by the initiation of a telecommunications center in Ghana.

A second major discussion focused on the need for integrated responses to urban problems. Andam noted that if waste management and housing supply are approached in isolation, nothing would be solved. Rather, the related system problems need to be addressed. For example, improving education in rural areas will help halt the migration to the city. A current area of university research is access to computers for children in rural areas.

Professor Colin Fudge, of the University of West England, discussed the problems of cities in the more economically developed parts of the world. Prof. Fudge's insight into the interdisciplinary issues and relationships between research and practice comes from a variety of positions he has held, including Deputy Head of Environmental Affairs in Australia, involvement in urban planning in London, and a position as head of the city

government in Bath, UK. Prof. Fudge is the chairman of the EU expert group on the urban environment, which advises the plenary keynote speaker, Margot Wallström, member of the European Commission responsible for the environment.

According to Prof. Fudge, one of the most pressing issues for cities is to build sustainable development into land use planning. Cities are addressing integrated, sustainable transport planning but are struggling to find workable solutions. Urban regeneration has too often done without sustainability goals, but such concepts could be readily included. Cities are already concerned with maintaining a sustainable economic agenda and need to add environmental and social aspects. Local support, including the existence of green business clubs, demonstrates interest in economic development coupled with sustainability goals.

New ways of using technology are being pursued. The EU has directives to improve noise, health, and congestion in urban areas. Climate change and air quality are also on the agenda. Attempts to move towards energy efficient buildings are strong. New ways of dealing with waste and continued use of recycling are also policy priorities. Finally, water management is a key area of policy at the city and/or urban level.

Recently, however, urbanism has actually fallen out of the EU research agenda, just when there is going to be a push for urban environment policy and strategy. Three areas are not getting enough policy attention at the city level: demographic change, climate change adaptation, and urban-rural integration within regional constructs as opposed to cities and rural areas as separate, disconnected entities.

Over the next 20 years, the aging population will create a dependency ratio (elderly vs. young) that is very different from the current model. The taxable base of workers will be reduced. A recent report called *London Warming* suggests that London, as a very low-lying city, needs to address flooding possibilities. The notion of regionalism has existed for years but waxes and wanes with political leadership. For example, current policies are very discouraging for local/regional food production.

Prof. Fudge also discussed the need to overcome barriers to bringing new technology to the mainstream. He cited the example of zero-heating energy homes just outside of Göteborg. Thick insulation, tight construction, air-to-air heat exchangers, and heat recovery of used water result in a home that needs no additional heating furnace to maintain comfort year round. Another key feature of the homes is that they do not visually stand out as sustainable homes, thereby reducing problems of public skepticism about the underlying technical change.

Research is needed on public perception and market acceptance of change for sustainability. Incentives and regulation in relation to implementing sustainable innovations also need research. Experiments in crosscutting partnerships for governance are happening in many places. Bristol, for example, has 22 relationships with NGOs and the private sector on a range of issues. The long-term existence of such partnerships often reaches a level of fatigue, as it involves much time, and enthusiasm often wanes.

Discussion

The workshop participants then broke into four groups, each with a facilitator, to discuss how AGS partnerships

might contribute to the body of knowledge focusing on urban issues. The following is a sample of brainstormed discussion topics in one of the groups.

First, how can we reach people and convince them to make decisions for sustainable buildings? For example, the zero-heating homes are in their third year of successful operation, but they have not yet been adopted anywhere else in Sweden. A second suggested topic was what Middle Eastern and Southeast Asian cities could be addressed? Third, how can information technologies aid planners and decision-makers? The fourth topic was about setting up learning exchanges between developed and developing countries and understanding how to reduce barriers to knowledge exchange.

The participants discussed the idea of identifying best practice case studies and learning how to appropriately translate them to apply in other cities and countries. Leap-frogging and support of local innovation in technical, regulatory, and implementation areas were discussed. The group noted that the international and interdisciplinary nature of the necessary research is why the AGS should address these issues.

During the large group discussion, the following key points were reported from each of the four groups. The first group discussed a need to have lessons from ongoing and past AGS projects. They agreed that education, training, and capacity-building need to be a major part of AGS research. They suggested the idea of a management research model consisting of teams to improve technical understanding, to conduct education and training, and to reflect on research progress and findings.

Discussion in the second group centered around learning and knowledge transfer (including barriers to change), understanding the issue, best practices, translating examples for local use, and implementation and adoption. The issue of local innovation was raised together with the recognition that many practices in the developed world are not desirable for replication in the developing world. Rather, local knowledge and technology may need to be developed to arrive at appropriate, sustainable solutions in the developing world.

There were comments that the AGS plays an important role in sustainability research because it is international, interdisciplinary, and has a track record in this type of research. Concrete research suggestions were proposed:

- Conducting comparative case studies on the translation to best practice;
- Developing local innovation; and
- Deciding on paths of development.

In the third group the multicultural, interdisciplinary nature of research on sustainable urbanism was emphasized. It was agreed that key components of AGS research should be knowledge exchange, communication, action, and reflection. Discussants noted that potential problems to address are abundant, with relevant problems identifiable in almost every city and at many scales. Research partnerships should include local agents who can collaborate and take action with the research findings. The strength of AGS sponsored research is the ability to compare findings and learn from such comparative assessments.

In the fourth group the idea that AGS research is characterized by partnerships between universities, business, and government was raised. Discussants felt that the most challenging urban problems are in the developing world. They highlighted the possibility for two-way exchange, not just mono-directional transfer. The suggestion was made that the role of AGS research should be to help local universities replicate the model of action-oriented research that includes cooperation with local governments. One participant said that the main role of the AGS is as an external agent that helps to bring legitimacy to the research in partnering with the local sectors. Another participant asked how students or other young researchers might make proposals to receive funding for AGS sponsored research. The group expressed the belief that the AGS should look at small but rapidly growing cities.

Second Session: Research partnerships

Bo Antoni, the senior advisor of the city of Göteborg, presented the city's partnership efforts with the city of Port Elizabeth, South Africa in developing an integrated waste management plan (IWMP). Mr. Antoni oversees Göteborg's Recycling Board, which has the overall responsibility for the city's waste handling, water, and sewage. The Board has plans to introduce greater ecological considerations into their operations.

The cooperation between the cities of Göteborg and Port Elizabeth began with the SKF factory in Uitenhage, the neighboring city of Port Elizabeth. Since the 1990s there has been a desire on the part of Port Elizabeth to cooperate with a city from every continent. Göteborg was chosen, partly because of the past historical relationship between the two cities and partly because of the similarities between the two cities, including major functions as port cities.

The partnership guidelines from Port Elizabeth's side are as follows:

1. Support local development in a broad sense;
2. Transfer knowledge and experience;
3. Maintain a long-term partnership;
4. Promote economic and other forms of cooperation of mutual benefit.

The partnership covers municipal and urban development, business, sports, tertiary sectors, arts and culture, and tourism. In particular, the tourism sector has been successful. Many charter flights connect Sweden and Port Elizabeth. The partnership organization consists of a steering committee, a management committee, and champions for each sector. The IWMP was not one of the original sectors but arose as a contract between the Recycling Board and the Swedish International Development Agency.

Port Elizabeth is experiencing rapid economic development, including heavy investment in infrastructure, tourism, and real estate. They are still plagued by problems of high unemployment, segregation between class areas, HIV/AIDS, and a growing gap between the poorest people and the other classes. The waste management sector in Port Elizabeth has 250 employees, and some twenty persons die each year from AIDS.

Göteborg is also experiencing growth in both its economy and its population. Heavy investment in transport

infrastructure and growth in real estate prices are the two major trends. Segregation, particularly between ethnic groups, is also a problem in Göteborg.

The environmental services division of Port Elizabeth is responsible for waste management. 200,000 tons of domestic waste are produced per year. One percent is recycled, whereas 90% could potentially be recycled. Producer responsibility does not exist. At the landfill, "unofficial sorting" takes place by local people rummaging through the trash. There is a compulsory monthly refuse tariff, which covers forty to fifty-percent of the costs. Local planning staff carries out the implementation of the IWMP.

Mr. Antoni stressed the importance of local leadership in development of the IMWP, stating that externally imposed plans are not enacted. Study tours and short courses for the African planners and officials were conducted in Sweden. Advisory groups in Sweden supported the Port Elizabeth team in developing their plan. The IWMP is almost finished, and the public participation process is ongoing. However, the board has undergone reorganization, as key persons have left. Capacity-building was partly reduced, with the result that the current level of devotion to the IWMP is low. Moving forward, they are continuing a partnership effort for the IWMP with three goals:

1. Fulfillment of the plan;
2. Capacity-building in the organizational structure, including study visits and a Swedish visiting consultant;
3. Extension to environmental management projects, particularly for air pollution.

In conclusion, Mr. Antoni noted that it is important that the citizens see changes from the start of a project; thus, implementation in parallel to planning is key. The owner of the problem must provide the solution. Capacity-building is important and can experience setbacks when key players leave the project. To address the risk of loss of built capacity, it is important to include as many people as possible in the knowledge-building efforts. Finally, the chance for public officials to experience common problems in a foreign setting is a highly motivating activity. Action-oriented research is needed to support the planning and implementation processes.

Mr. Axel Wenblad**,** Vice President of Sustainability at Skanska Construction Company, addressed the group on the viewpoints of partnerships from a large corporation perspective. Mr. Wenblad has a background in freshwater ecology, the area in which he worked for thirty years before joining the construction industry. Skanska is a construction company which was started in Sweden in the late 1800s and which now has 70,000 employees worldwide. Its operations in the US account for 45% of its revenue.

Skanska is the lead construction company for the new Stata Center building at MIT, a rather untypical example of the commercial and office building sector in which most of their work is concentrated. Incentives and disincentives to join research partnerships in Skanska's areas of sustainability priority include (1) chemicals used in construction processes, (2) the energy performance of their buildings, and (3) avoidance of the use of pristine land and forests for the protection of biodiversity.

For example, Skanska learned that some chemicals they were using to seal a railway tunnel in Sweden mixed in a way that caused a herd of cattle to become sick and damaged the groundwater. It was seen as a scandal

in the country, and Skanska learned that they needed to take the responsibility to have full knowledge in all the chemicals that they use. Trusting the supplier was not enough.

Buildings account for some 40% of overall energy use in the EU. Thus, Skanska sees that reducing building energy consumption is a primary goal for addressing climate change. Buildings are complicated systems and, although much technical knowledge is available, barriers to implementation persist. Skanska has started a line of research addressing sustainable buildings in cooperation with Chalmers University, the Royal Institute of Technology in Stockholm, and others. Using a case study approach, they are looking at twenty different buildings with the objective of supporting business development in the area of sustainability.

In Sweden, there are four key actors in building projects. First is the municipality, which is often the client in Swedish building projects. Second are the designers, architects, and engineers. Third are the suppliers of materials. The fourth set of actors consists of the contractors whom Skanska employs. Addressing the interactions among these groups is necessary to understanding the opportunities for sustainability.

Skanska also has a business model of build-operate-transfer (BOT). A few examples of BOT projects include a 60-kilometer roadway in Santiago, Chile and several hospitals in the UK. When approaching the possibility of a partnership, research, or business, Mr. Wenblad said the first step is to understand the objectives and capabilities of potential partners. Next, incentives and risks for each partner need to be identified and understood. Third, the set of partners must have the competence to communicate on the research topic. Trust is necessary to glue the partnership and should be explicitly addressed. Financing models must be worked out, and a long timeframe needs to be embraced.

In conclusion, Mr. Wenblad provided a viewpoint on two particular challenges. First, some cities do not have resources to support urbanization. Second, the aging building population, particularly the post-war structures, needs to be addressed in the upcoming decades. Doing so presents a great potential for reducing energy consumption.

Discussion

Following Mr. Antoni's and Mr. Wenblad's presentations, the workshop participants discussed how AGS partnerships could make a real difference in addressing urban issues involving sustainability. The discussion began with a few lingering questions for the presenters. Mr. Antoni added a comment on the need to understand poor practices to avoid repeating problems and the importance of local judgment in defining the key issues. Mr. Wenblad added that there is a need to combine technological education and research with business understanding as a way to better grasp and communicate the risk management aspects of sustainability.

Moisture and mold in buildings is an example of a risk that has not been managed well. It is a health risk for those using the buildings and a financial risk for the contractors and building owners. Technical solutions exist, but implementation remains elusive.

Competitive edge is a selling feature for Skanska regarding the implementation of sustainable development. Clients are aware of the possibility of sustainable buildings and are asking for them. How to measure the extent of sustainability remains a bit ambiguous, although labeling systems are beginning to address that issue.

Discussion then turned to the importance of a long, multi-year timeframe for AGS research partnerships. The impact on the number and type of projects that can be done is an important issue. Another issue is the balance between immediate and on-going deliverables.

Mr. Antoni discussed the nature of delay in government or aid organization work as a normal part of the process, and he added that sanctions would not be an effective way to address such delays. He also noted that although the partnership needs to have a critical length of cooperative time, there must be a point at which the work can continue effectively in local hands. However, because a relationship has been built up, it is common that new studies are proposed and carried out. For example, the sister-city project now has a proposal to carry out benchmarking of development in other sectors.

In one participant's view, the problem of sustainability lies in the gap between the rich and poor areas of the world. Thus, the strength of the AGS lies in the network and the possibilities for younger researchers to have international experiences, such as doing visiting research or working in a multi-national firm.

Mr. Wenblad discussed a program at Skanska for young managers where they are sent to a workshop on sustainability issues. They exit the workshop not only with an understanding of the issues but also with a network of thirty other colleagues in leadership tracts.

It was suggested that the AGS should look at problems that especially require local government involvement, since local governments are often weak in their institutional capacity. Once the partnership is started, it may be wise to continue building on the relationship, continually addressing new problems as previous ones are solved.

As urbanism involves growth, it is important to address areas of the world where high rates of growth are underway. For example, China is building 10 million residential units per year. Help should continue to be pursued to develop appropriate technical solutions so that they do not follow the poor examples of developed countries.

One participant commented that, since the role of the AGS is not only to conduct research but also to help policy-makers, two-year funding cycles are too short to achieve results. The participant suggested that working with local developers and city planners is a fruitful area for research results. Another participant suggested that the workshop should include reflection on current AGS projects.

Leon Glicksman, one of the principal investigators of the "Sustainable Residential Buildings in China" project, described how their AGS partnership worked with a local university that had a lot of technical expertise but little experience working with developers. Part of the AGS team's role was to help the local university develop the skill of working with local developers.

Participants discussed the need to have a system to facilitate shared knowledge among AGS research projects. Another suggestion was made to expand AGS research efforts in addressing air quality. It was also suggested that ecology, economy, and social aspects should be a part of all AGS research projects.

Research on sustainable strategies for small townships was mentioned. Another point that was raised was that, to address sustainable development, a broad and integrative approach must be used. The scope of the research should not be too narrow. It was also noted that the definitions of sustainability differ from place to place.

Third Session: Summary

Rapporteur: Derlie Babiano

Mr. Wenblad, speaker in the second session of the workshop, facilitated the third session. The first question was about the six bullet points given in the morning session to reflect the key issues in partnerships. The following additional points were brought up in a general discussion:

- Understand your partners;
- There should be clear incentives for all partners;
- The partners must have sufficient competence;
- The relationship must be built on mutual trust;
- There must be a clear financing model;
- There must be clear timeframes;
- There should be a common vision of the outcome of the project;
- Transparency and open communication are needed;
- The exchange should be mutual—especially in regard to South/North disparities (a common bias is that knowledge is only transferred in one direction);
- There must be clear management and organization models;
- The local actors, those who own the problems, should identify the problems.

The main part of the session was then used for a reflection on previous initiatives being done by the AGS in the field of urbanization. Discussion focused on three projects:

- Mexico City project (air quality);
- Guangzhou project (transportation, waste treatment, housing and cultural heritage);
- DIMSUD (design, implementing, and measuring sustainable development).

Mr. Wenblad suggested that those involved in the aforesaid projects would provide a brief background on the projects and conduct a simplified SWOT analysis (i.e., strengths, weaknesses, opportunities, and threats).

The MEXICO CITY project

Prof. Johan Mellqvist described the Mexico City Project briefly:

- it involves air quality and remote sensing in Chalmers;
- it is headed by MIT;

- it is funded by the Mexican government;
- it is something AGS can do, thus a typically good AGS project;
- it is a 3-4 year project (but, for the AGS, it is a 2-year project);
- it is not inter-disciplinary, but involves nature scientists.

The objectives of the project are to understand the driving force of the air pollution in Mexico City and find out what would be the most cost-effective countermeasures to improve the situation. The focus of pollutants was on NO_x (from cars) and volatile hydrocarbons (from cars and other types of combustion).

Mellqvist then made a SWOT [strengths, weaknesses, opportunities, threats] analysis of the project, as follows.

Strengths:

- There is good pre-understanding of the problem and strong scientific knowledge in the issues involved;
- There is direct connection to politicians and the local community and broad involvement of stakeholders.

Weaknesses:

- A communication gap and cultural differences exist between scientists from the North and the local scientists;
- All questions are by no means answered—some scientific questions remain open.

Opportunities:

- The interest in the result from local actors presents the Mexico City project with the opportunity to have a significant impact if the answers it provides are straightforward;
- Mario Molina, a Nobel prize winner, is heading the project and his prestige attracts much support;
- The broad network for this project could be a good base for other AGS projects;
- The potential exists for generic conclusions.

Threats:

- If science does not give straightforward answers, there will be a loss of trust and poor impact;
- Scientists from the North tend to focus more on publications than on the impact and local results of their work;
- There is a risk that scientists' publications will be difficult to access by local actors due to language differences as well as the cost of North American scientific magazines.

The Guangzhou project

There have been three sub-projects in the Guangzhou area of China. One is focused on transportation and infrastructure of the city headed by Prof. Moavenzadeh, MIT; one on sustainable water management headed by Prof. Hanaki, UT; and one on housing and development in a set of nearby villages headed by Dr. Hugentobler, ETH.

- This is a six-year collaboration among a social scientist from ETH and two engineers from MIT and UT. It is now in the second phase.
- As with many other projects, it started with personal contacts.
- Students have been involved in the project.
- The transport issues:
    - How to control the demand for transport;
    - How to reduce the pressure the city is facing with regards to the supply side;
    - How to build an extended railway system and a new airport;
    - Whether and how to use a pricing system;
    - How to use new communication technologies.
- The water issue: finding a sustainable water management system, using scenario simulations.
- The village issue: improvements of the residential environment, to find models for urban renewal.

SWOT analysis

Strengths:

- Interdisciplinary;
- Earlier collaborations in the same team;
- Good contacts with the local actors in the city;
- Starting from locally defined problems and concerns;
- Highly qualified people are already there;
- Mutual sharing of experiences: local partners were invited to Tokyo and Boston, so that all knew the realities of each other—better understanding.

Weaknesses:

- No solid institutional structure to enforce and implement the project outcomes;
- Highly qualified technical people at the middle level who have no way of communicating their ideas to higher levels of management (in the local governments);
- Some actors were replaced with others during the process, due to institutional changes;
- Unclear roles for some of the actors and sometimes poor project organization;
- The local universities had low status among decision-makers;
- There was not enough interaction in terms of the researchers' opportunity in speaking with the people;
- The language and cultural barriers were a big issue;
- There had been no opportunities for student exchange.

Opportunities:

- The contacts remains for future projects—to follow up this research could be a good starting point for future collaboration;
- The rapid growth in the region brings an openness for rapid changes in policy;
- New contacts could be created between the city and the villages.

Threats:

- There is a risk of exploitation in the villages that threatens traditional local community life.

The DIMSUD project

Presented by Prof. Björn Malbert (Chalmers), the DIMSUD (design, implementing, and measuring sustainable development) project is a three-year comparative study of Santiago, Johannesburg, and Gaborone (the capital of Botswana). It consists of cooperation between three AGS universities and three local universities. Four themes are being addressed in this study:

- What are the challenges and options involved?
- What are the strategies and policy instruments in use?
- What kind of monitoring tools are used in the cities?
- What kind of sustainability indicators are to be discussed?

SWOT analysis

Strengths:

- Working with students as an eye opener and linking academia with practice;
- Integrating all issues of sustainable urban development;
- Active involvement of local authorities.

Weaknesses:

- Lack of long-term strategies for approaching local authorities;
- Different expectations from different universities and difficulties in collaboration;
- All partners did not previously know each other.

Opportunities:

- The established network between universities in north and south is a good base for new projects.

Threats:

- The difficulty in communicating over distance with new contacts has threatened to delay the finalization of the project and reduce the academic quality of the publications it generates.

Closing discussion

Mr. Wenblad saw good opportunities in continuing all the three projects, even though he questioned the broad scope of the DIMSUD project. Some participants replied that the question of realizing an overall sustainable development is very complex. There is a need not only for thematically focused projects but also for attempts to bring together and to elaborate upon different issues concerning the institutional challenge of integrative sustainable urban development.

Mr. Wenblad continued by noting that, to balance all the studies carried out in the South, there should also be a project in the North. His proposal was to work with reconstruction of dense, high-rise residential areas in former communist states of Eastern Europe.

Prof. Nazli Chourci (MIT) commented that an often forgotten region is North Africa/Middle East, which is an extremely important and interesting field for sustainable urban development research.

Prof. Fudge raised another issue critical for urban development in Europe, namely the aging demographic structure. How should we handle a situation where an increasing part of the population are pensioners and thus outside the production? One participant commented that the obvious solution would be to see a huge migration from the "young" populations of poorer countries with pyramidal demographic diagrams to balance the more "mushroom-like" demographic diagrams of early industrialized countries.

Another participant commented that the voices of students in the AGS research projects should be strengthened.

Workshop 5

Sustainable Water Management

Chairman: Dr. Per Sander, Chalmers University

The workshop on sustainable water management presented for consideration and discussion several issues and challenges within water resource management, water distribution, and wastewater handling as well as legislation and law enforcement. Approximately 30 people participated, representing the academic community, waterworks representatives, and experts from municipality and regional planning offices.

The workshop theme is a very broad topic and constitutes one of the most critical environmental and developmental issues of the 21st century. Two-thirds of the world's population lives in areas where quantity or quality of drinking water is or will be a serious threat over the next twenty years. Presenters and discussants identified key areas in water management where international collaboration between academic institutions, authorities, industry, the public, and others parts of society can lead to the development of research projects that serve to alleviate water-related development problems. Workshop participants agreed that the involvement of stakeholders from all parts of society is vital to the success of applied research projects and should be encouraged.

The objectives of the workshop discussions were to identify critical areas for research in sustainable water management (SWM) and to assist in developing an AGS research profile in SWM. During brainstorming

sessions following the introductory presentations, all members of the workshop group were encouraged to actively contribute with ideas on critical areas for research or to share other experiences that are valuable in the development of AGS research.

Four presentations were given during the workshop as input for brainstorming and discussions. The presentations were:

1. *Critical water resource management: Challenges in South Africa*
   by Kevin Pietersen
2. *Towards integrated catchment management: The paradigm lock in the HELP initiative*
   by Lars O. Eriksson
3. *Safe water management: what is the problem?*
   by Thomas Hellström
4. *How sustainable is it being sick?*
   by Olof Bergstedt

Discussion Summary

Why focus on water?
Water is an integral part of the ecosystem, a finite natural resource, and a social and economic good. Hence, issues of water availability, access, and quality are of fundamental importance to development, poverty reduction, and ecosystem sustainability.

What is the problem?
Many of the problems within SWM concern how to create sustainable access to water (for drinking water supply, sanitation, agriculture, and food security) and how to provide safe drinking water to communities while ensuring that water for ecosystems and biodiversity is adequate in quantity and quality. In short, it is about protecting humans and the environment from "water risk." Water risk concerns the quality, supply and distribution, efficiency, sustainability, and affordability of the resource. While dealing with these problems there is a need for communication with stakeholders, which involves creating access to relevant knowledge through the development of appropriate tools, e.g. management options, decision support tools, etc.

Suggested research areas
The following research areas were identified as the most important fields of studies for SWM:

1) Integrated management of water resources (both surface and ground water);
2) Inter-linkages of the hydrological cycle;
3) Water scarcity (management and technologies to support water conservation);
4) Protection measures for water resources;
5) Appropriate technologies for water treatment for potable water and environmental releases;
6) Water requirements for ecosystems;
7) Re-use of wastewater and use of storm water.

Scientific focus vs. policy/legal focus is of great importance in order to study inter-linkages. The research areas can preferably be linked to other areas such as contaminated land, sustainability, and urbanization. Of major importance is continuous capacity building through education and training. The "blue revolution" has already happened but is the AGS responding to the challenges? Participants agreed that water is of fundamental importance to a sustainable future and needs to be emphasized in the AGS agenda._

Workshop 6

Contaminated Areas

Chairman: Dr Lars Rosén, Chalmers University

Rapporteurs: Dr Yvonne Andersson-Sköld, Nazmul Haque

Introduction

Contaminated areas pose a problem for global sustainability. Due to large numbers of contaminated areas and high costs for remediation of those contaminants, it was suggested that in the next decade there will be an increase in investment in the remediation of contaminated areas. In this workshop, research ideas and research methodologies were discussed for remediation and how the cooperation and knowledge exchange between the developed countries and developing countries can be effective for global sustainability.

The main issues of the workshop were understanding uncertainties, risks, and decision-making regarding remediation of contaminated areas; improved methods for cost-effective remediation technologies; and reducing legal and regulatory obstacles to sustainable development.

Sessions and Main Points

The first session of the workshop focused on three main points:

- The nature of the contaminant areas;
- When remediation of contaminated soil and sediments will be the best option; and
- How best to spend money on the contaminated areas.

In Sweden 38,000 potentially contaminated areas are identified and in all Europe the number is approximately 750,000. But no data is available for the total number of contaminated areas across the globe. This is because risk assessment thus far is costly and time-consuming. Moreover there are no tools for measuring the background level of contaminants.

The question arises, "How clean is a clean soil?" After the industrial revolution a huge amount of toxic chemicals were disposed into various sites from various anthropogenic activities including industry, transportation,

settlement, etc., and those chemicals were carried by ground water as well as surface water from one place to another, posing risks to human health and ecosystem health.

Two important steps in remediation of contaminated areas are

- Identification of the hazards of contaminated areas, and
- Response and allocation of resources.

For cost reduction, estimated remediation cost per site is 2-4 million Euros in Sweden. Dig-and-dump and land filling are two common processes of remediation. But what is considered clean today may be seen as contaminated tomorrow. Thus cost-effective risk assessment and remediation methods are crucial issues for the present time, and for that purpose the following points should be taken into consideration:

- Remediation measures should be integrated into the planning process;
- Risk assessment should consider combined risk;
- Risk communication and implementation are needed.

The second session of the workshop focused on environmental analysis and risk investigation and soil treatment. In the UK over sixty laboratories are undertaking analyses of contaminated soils. But results of proficiency testing show a very wide variation. This is due to the variety of methods in use, the lack of parameter definition, the lack of performance, and economic pressures.

The results of analysis can be considered as "the reduction of uncertainty" for a given contaminated soil. For proper sampling, the following measures should be taken into consideration: (1) appropriate sample containers, (2) correctly taken and stored samples, and (3) avoidance of contamination.

Some recommendations are as follows:

- New analysis methods should be developed for precise results of environmental analysis;
- Low-cost QC reference materials must be used for QC purposes;
- Compulsory regulatory environmental method validation protocol is necessary;
- Improved quality of sampling and targeted analysis is needed.

The Forum for Risk Investigation and Soil Treatment (FRIST) is a recently established competence center for the investigation and treatment of contaminated sites. The aims of FRIST are

- To develop cost effective strategies for investigation and treatment of contaminated areas;
- To have a holistic research perspective; and
- To establish Göteborg as a leading area in the treatment of contaminated sites.

The development of treatment techniques include contaminant mobility and treatment technique efficiency, studies of both organic and inorganic pollutants, and development of on-site and in-situ treatment.

Conclusion

Contaminant behavior, exposure conditions, effects from climate change, and local and global economic changes

are the key criteria for risk assessment and remediation of contaminated areas. Developing countries are distant from these activities due to lack of technological support and financial resources. Thus far, global sustainability is concentrated on site-specific sustainability. Developed countries are reducing the exposure of contaminants day by day, and they are taking steps toward the remediation of contaminated areas.

However, the scenario is completely the opposite in the developing countries. Consequently, co-operation and knowledge transfer between developed countries and developing countries is needed for the remediation of contaminated areas around the globe. To that end, the following factors are essential:

- Prioritization tools,
- Sampling uncertainty and design,
- Site-specific assessment and action levels,
- Risk evaluation,
- Cost-effective selection of remediation strategies,
- Increased treatment efficiencies, and
- Increased efficiency of permission procedures.

Workshop 7

Learning for Sustainable Development

Rapporteurs Kerstin Ludvig and Are Wallin

Chairpersons Prof. Jeffrey Steinfeld, MIT, Prof. Gustavo Perrusquía, Chalmers University

Overview

Environmental issues have appeared on the political agenda for over thirty years. From being a problem denied—as many statements from the time show—environmental issues have grown in importance among political leaders, academics, and others. Catastrophes have occurred which have forced a change in this awareness—for example, the Minamoto disease and other disasters in Japan.

The Stockholm conference in 1972 set the tone for several conferences that have followed. Issues arose and were explored on the subjects of poverty, population, and women's and children's rights. The world was seen as being divided into two parts, the industrialized countries and the developing countries. Although there were tremendous challenges, the opportunities for positive change were never greater.

And there are some positive trends over the past thirty years. Worldwide, the proportion of extremely poor is 50% less, infant mortality has gone down by 50%, and average life expectancy is higher than 60 years. However, there are undesirable trends such as climate change, a world that exceeds its ecological capacity, and the fact that 15% of the richest people represent 56% of the world's consumption. Further, more than one billion people lack fresh water, and more than two billion people lack electricity. Further, there are HIV and malaria epidemics in the south and diabetes in the north.

The UN summits following the Stockholm conference have shown progress. The Millennium Declaration set up some measurable targets for the year 2015 to integrate sustainable development into all policy areas, including substantially reducing the proportion of people living on less then 1 USD per day.

Problems still exist, although the global system has been somewhat more robust than people had thought. The protocols that have been signed by countries during all these years have not implied an enormous change. Terms like the "Decade of Education for Sustainable Development," or DESD, might, to some degree, serve as a slogan, as they lend more legitimacy to the idea of sustainable development.

Questions and Answers

Jeffrey Steinfeld (MIT) posed the following questions: What happens during the DESD? What are the opportunities of having a DESD? What can one expect from it? And how can we take advantage of it?

Manne Wängborg replied by saying the importance of legitimacy cannot be overestimated. We could set up sub-goals or ten annual sub-themes in relation to education for sustainable development. Otherwise there is an obvious risk of losing the momentum initialized by having DESD. Wängborg also said DESD can legitimize cooperation between groups to achieve common goals.

Izumi Tanaka (Swedish Embassy in Japan) asked what are the expectations for the May conference in Göteborg?

Manne Wängborg replied that a national committee has been formed to come up with recommendations for the coming years to be published in the autumn of 2004. The Office for Sustainable Development was created in Sweden to assure that sustainable development suffuses all areas of the government.

Challenge	presented by Manne Wängborg
Chairperson	Jeffrey Steinfeld, MIT

The challenger, Manne Wängborg noted three conceptually related world summits. The focus in the 1972 Stockholm summit was the human environment. By 1992 the focus in the Rio summit had widened to the relationship between poverty, social issues, child mortality, etc. By 2002, in Johannesburg, the concept of sustainable development was fully developed with emphasis on three dimensions—economic, social, and

environmental, although this paradigm is far from perfect. Wängborg said that, if one looks at all this positively, there has been a learning process from the Stockholm conference to the Johannesburg conference.

Open Discussion

Michael Toribio (University of Tokyo, UT) said the UN makes many declarations on different issues, but do we have the infrastructure to fulfill them, especially the DESD? Are leaders and teachers ready, and do they have something to teach? What should they teach? What learning should be spread during this decade? The developed world and the developing world focus on different aspects of sustainable development. The developing world focuses on economic and social aspects whereas the developed world focuses on technology.

Manne Wängborg said it is clear that there are many factors in the developing world that work much better than they do in the developed world. We have to look at each society separately to determine what is best for each.

David Wallace (MIT) said there are communities in Mali where the inhabitants work during the day and go to school during the night. At school, they have to use flashlights to see the board, but they persist in their efforts nonetheless. Students come up with solutions in various projects. Sustainability, Wallace said, depends on what you value in terms of a broad sense of consequences. He advised putting problems in a social context and encouraging students to think in a wider perspective.

Beth Conlin (MIT) pointed to the need for integration of sustainable development in all situations. In reply, Manne Wängborg noted that sustainable development is not a subject, but rather, it is an approach to life. This is one of the principles that will be presented to the Swedish Government, he said.

Ellen Kabat Lensch (ATEEC) has been working in the K12 system (Kindergarten to 12th grade) in the US. The ATEEC has developed a curriculum and instructions for teachers in an effort to get cutting-edge research into suitable formats. Together with MIT, the ATEEC has developed workable models that teachers can use in all kinds of already existing courses. Earlier, they focused on higher classes, but now they also turn to lower classes (13 years and younger). The idea is to plant seeds, she said, so that the children will learn to make the right choices as they grow older. [More information can be found on www.ateec.org or from ekabatlensch@eicc.edu.]

Gustavo Perrusquía (Chalmers) said he came to Sweden from Mexico twenty years ago. The hundred million people of Mexico want to have a better life with the same standards as the developed world. How can we convince the developing countries to raise their standard slowly while telling the developed countries to lower their living standards?

Naoyuki Mikami (UT) said that social justice in a broad sense should be a part of the discussion. In Japan, many people are skeptical of sustainable education. Traditionally, there has been a clear separation in Japan between the environment and development. That distinction is smaller now with the emergence of the concept of sustainable development. NGOs are becoming more aware of education in sustainable development because it

involves them directly. On the other hand, applying principles of sustainability may conceal conflicts between businesses, minority groups, etc.

Inger Björneloo (Göteborg University) noted that conflicting messages are given to pupils at all levels. In school, they are taught to save paper and electricity, adults tell children not to waste, and so on. But when they leave school, they get peppered with the opposite message: buy, consume, use, and dispose.

Wrap up for Session 1

Jeffrey Steinfeld said the main findings from the brainstorming in Session 1 were as follows: There is no time to waste; we much share knowledge effectively with diverse audiences; integration across educational levels and disciplines is essential, as is the need to integrate academics with the community (including industry, government, and the people); and we need to identify core knowledge and core values.

Session 2

Challenge: From reliable knowledge to socially robust knowledge

Challenge Roger Svensson, STINT Foundation

Roger Svensson: Today I will try to give a picture of the tremendous success of science and scientific knowledge production and the consequences it has on the role of science and scientific institutions. In doing so, I will rely heavily on two book projects I have been involved in: *The New Production of Knowledge,* edited by Michael Gibbons, and *Re-thinking Science*, edited by Helga Nowotny.

In 1998 the American Association for the Advancement of Science [AAAS], in their immensely influential *Science* magazine, ran an essay by the French sociologist, Bruno Latour. Latour wrote about the transition from the culture of "science" to the culture of "research." The essay coincided with the AAAS celebrating its 150th anniversary. Latour's message is as follows: "Science is certainty; research is uncertainty. Science is supposed to be cold, straight and detached; research is warm, involving, and risky. Science puts an end to the vagaries of human disputes; research creates controversies. Science produces objectivity by escaping as much as possible from the shackles of ideology, passions, and emotions; research feeds on all those to render objects of enquiry familiar."

Latour goes on to argue that science and society cannot be separated; they depend on the same foundation. That is the view of a French sociologist going back 150 years. I believe that the post-World War II success in the history of science, coupled with the emergence of mass higher education cannot be overestimated when it comes to the consequences for the knowledge production system.

Sophisticated knowledge production today permeates society at large, directly in the developed world, and indirectly in the developing world. As with so many civic phenomena, it has a truly military background. During the First World War the British could not dye their khaki uniforms because the Germans alone had the chemistry knowledge. The Second World War gave the impetus for developing radar, operations analysis, and, finally, the atomic bomb.

But it was not only the hard sciences: Keynes had scientific theories for solving the world economic crises in the same way that von Hayek had the theoretical underpinning for deregulating markets. Later on, anthropology and linguistics became involved in the Cold War efforts to understand and ultimately control far-away countries. The lessons drawn from these experiences and examples were too obvious and too compelling not to have a much further impact. Leaders in society, whether political or industrial, realized that there were direct benefits to be derived from science.

The scientists, in the same vein, understood that there was a much larger playing field, and funding possibilities existed that had no limits. The "slack-funding" of the extended military-industrial complex was a dream come true, not only for the rocket scientists but for a whole host of academically defined disciplines. Other prestige projects, like Apollo, had a similar impact. Today, we have the emphasis on wealth creation in science policy, and research is part and parcel of environmental issues, whichever side you take.

Parallel with this development, mass higher education has arrived. With it, an ever-growing portion of the population, again in the industrialized world, has an education more or less based on science. The claims of the scientists to be supreme problem-solvers, the spending of taxpayers' money on science, and, finally, the distributed expertise resulting from higher education have made research high profile in the political and societal arenas. Science matters, and, not surprisingly, the scientists are no longer left alone in their activity. The perceived possibilities and threats of modern biotechnology are just the latest additions to a long list of research-related bones of contention.

So, what does all this mean for the development of science and its relationship with society at large? The first point to note is that changes that are taking place in knowledge institutions are not simply the result of exogenous changes imposed on science from the outside, from society either directly or via government policy. The proliferation of research practices, the increasing collaboration with users, the explosion in multidisciplinary research, etc. cannot be explained in terms of government policies or a decline in research funding alone. On the contrary, these changes could not have come about unless the sorts of institutional loosening up—increasing permeability and social experimentation—were also going forward, making it more likely that these new patterns of behavior would survive long enough to be effective.

The parallel changes in both society and its knowledge institutions should be described in terms of a process of co-evolution. The developments are related not mechanically but, as the evolutionary model implies, by an experimental process of trial-and-error where some developments survive while others fail. Policies aimed at promoting university-industry interactions, for example, have promoted a great deal of experimentation and contributed to creating a situation in which the ethos of a university and that of industrial laboratories have become virtually identical.

If there are differences between these two types of institutions, they are not in the ways that they carry out research. More professors now hold joint appointments with industry, just as more industrial scientists hold honorary fellowships in university departments. Each institution has borrowed research practices, methodologies, equipment, and modes of organization from the other, with the result that a useful distinction between the two is more and more difficult to make.

A second point to note is that this process of co-evolution implies that the boundaries which kept society and science relatively separated have now been transgressed. In other words, there is more two-way communication between the various knowledge-producing institutions both among themselves and between them and society more generally. This is creating the conditions in which it is possible for society to "speak back" to science and in many different ways.

In the previous mode of social organization, where stronger institutional boundaries prevailed, society spoke back to science, mainly along institutional lines and through institutional representatives. Much of national science policy, for example, was constructed in this way. Social needs were derived by government, transformed into policy objectives, and implemented through the bureaucratic apparatus of government departments in a process in which the institutional representatives of science played an important part. This was necessary in a regime in which government was the prime sponsor of scientific research, whether in its own research laboratories, in industry, or in universities.

By contrast, in today's society the role of government is much changed. The markets have transgressed the state: Governments have become more facilitators than core sponsors of scientific research. As a consequence, the role of government in policy-making is different. Now organizations of every type—industrial laboratories, charities, and organizations in the voluntary sector—can mobilize resources around research aimed at meeting their objectives. Their policies and funding strategies reflect their interests, and, though national and regional governments continue to be involved, they are likely to be only one partner among several.

Indeed, it is now possible for groups with the lightest of organizational back-up to mount significant research activities in which their perspectives have a constitutive involvement. Think of the roles played by individuals and small organizations in developing the HIV/AIDS research agendas. Put briefly, there are many more sites not only where research can be carried out but also where science or research policies can be formulated. This is one aspect of the increasing density of communication between society and science.

As with other knowledge-related activities, policy formulation, too, has burst out of its dependence on governmental support that was prevalent in an earlier time. A third point to note is that the more open structure, which allows this reverse communication between society and science to take place, has not left science unchanged. The reason is that both scientists and members of society have perspectives on what research might be able to do. A much less hierarchical society makes the identification of sympathetic "others" easier.

Also, communication between society and science has a reflexive element. That is, the exploration of research possibilities demands that researchers not only think differently about the questions they address but also act differently in relation to the techniques that they use in their investigations and the ways in which their results

will be evaluated and used. This reflexivity is a key element in the transition from reliable to socially robust knowledge. More importantly, attention should be given to this reflexive element; that is, to shifts in the attitudes or belief systems of researchers as to what is worthwhile doing and how and with whom to do it.

There is a strong experimental element in all this. Not every set of perspectives will necessarily form the basis of a research program. Some will emerge and others will fail. This process cannot be forced by centrally-driven, means-end policy initiatives. Reflexivity is about how interaction in the many trading zones of the agora produces changes in attitudes and beliefs. These interactions involve negotiation and consensus and cannot be imposed. Neither can they expect to leave the participants in the negotiation unchanged.

This brings me to a fourth point, and it is the crux of the matter. Universities are primary knowledge-producing institutions in most societies because they alone have responsibility for carrying out research and for training future generations of researchers. In other words, universities have both social and scientific roles, and I would argue that these roles are converging. To be active in research, universities will need to enter the agora and play their role in developing the agenda. Equally, such involvement will, through reflexivity, bring about changes in the attitudes and beliefs of faculty about what it is worthwhile doing and, in due course, about what will be taught.

The current debate about whether some universities should be research institutions while others remain teaching institutions is in danger of missing the point altogether. The challenge for the universities is to bring this ethos of reflexivity into the heart of the institution—to support it, to reward, and, through teaching, to diffuse it. Perhaps, in a later day, universities will be ranked not in terms of teaching quality or research excellence but in terms of their ability to link reflexively to society in the execution of distinct, locally-based research or teaching agendas.

Universities are the crucial institutions to carry forward the intellectual task of re-thinking science. The image with which we currently work is still based upon a scientific community in which truth, objectivity, or reliability could only be had by distancing science from the hurly-burly of the market place. In this view, science has been able to communicate with society, but, so far, it has been reluctant to accept much in the way of reverse communication. Science has been willing to communicate freely its discoveries to society, but it has been less willing to involve society in the genesis of these discoveries.

The image that keeps science and society in largely separate compartments is no longer appropriate to, nor is it effective in, the new context of modern society. By saying that science needs to be re-thought, I am contending that new structures are needed which allow science and society to meet in the agora and then to reflexively articulate a research agenda.

There are a few main elements that I believe need to be taken into account in re-thinking science:

- The presence of a pervasive uncertainty;
- Contextualization of knowledge caused by reverse communication between society and science;
- The idea of socially robust knowledge, which replaces merely reliable knowledge;
- The notion of the distributed nature of expertise.

Uncertainty is meant to describe one of the most pervasive features of the society we live in and which we do not expect to diminish. Uncertainty is driving much of the social experimentation, which we currently observe not only in science but also more widely. Contextualization describes the processes through which science is becoming more open to receiving reverse communications from society. It is a process in which attitudes, beliefs, and perceptions change and, through this influence, which is thought to be worthwhile doing.

Socially robust knowledge pushes beyond merely reliable knowledge produced in laboratories into the agora where research agendas are reflexively elaborated between scientific and social perspectives and are less likely to be contested. Distributed expertise highlights the difficulties that, in a knowledge rich environment, experts have in responding to questions that do not arise within the frame of reference of their particular expertise. It is a difficulty that faces every expert and confronts every society with further uncertainty—hence, the need for developing narratives which are able to display disparate, sometimes contradictory, information about particular issues in ways that are less likely to be socially contested.

But, "How will this be done and who will do it?" are things that we need to discuss. If society and science are co-evolving, then one might expect to see a convergence of social and scientific roles in the universities. If this convergence is to be robust, then universities will need to take the lead in the production of contextualized knowledge. They need to put the same effort into promoting socially robust knowledge that in an earlier era they put into establishing the reliable knowledge of the disciplinary structure.

But they cannot do this alone or remain structured as they are at present. The production of socially robust knowledge requires a reflexivity that, so far, is very nearly excluded by the scientific and technical norms of each discipline. How can universities stand Plato on his head and develop sciences in which active involvement in the agora, rather than detachment from it, becomes established as the way, if not to the truth, then to knowledge that is reliable outside the laboratory and not socially contested?

This has occurred in other contexts. Thomas Hughes, for example, has analyzed the shift in philosophy among engineers working on large projects from designs that are driven entirely by technical criteria to those which include greater involvement of people. Engineers, he concludes, have developed a new ethos in which they agree that involving people in the design process actually produces better designs.

Is there any *a priori* reason why reflexive articulation of perspectives in the agora cannot also produce "better" science? At the moment, the incentives and the institutional structures that would allow this kind of science to flourish are only faintly visible. But, were such a program to be embraced, you might be able to see what is meant when I refer to the transformation of the institutions of knowledge production. In brief, the contextualization of knowledge needs to be internalized in universities.

Discussion

Jeffrey Steinfeld: There is a fundamental error in Latour´s statement. Science is not certainty. Many times the scientific facts are proven to be not only not right but even totally wrong. The question is how to make choices

among the uncertainties? There are many examples in the US that science is subservient to ideology.

Roger Svensson: Most scientists realize that what they produce is just provisional truth. The problem is how the media report it. The detached scientist is probably only fully detached in front of his fire with bourbon at night.

Manne Wängborg: Science is not certainty. Nils Bohr said: "How does truth replace errors in science? Old men die." There is no absolute truth in science. Research is passion, but also science is passion. Science cannot remove itself from ideology.

Roger Svensson: Research is science contextualized. What you do in your lab has wide consequences. Researchers on mathematics or physics need the context as well, not just researchers on sustainable development. When we get down to detail, the context often disappears.

Jens Soth (ETH): Scientists tend to proclaim their provisional truth a little bit louder, just to be heard. There is a risk for marginalized science.

*Greg Morrison***:** We have to consider the narrative dimension. Sustainable development is not an exact science. The only way to discuss sustainable development is through narratives. Universities need to learn how to embrace it.

Roger Svensson: You have to create the narratives; otherwise somebody else will do it. They will do it because they have their own agenda. But creating narratives will not make you professors any faster.

Jeffrey Steinfeld: The culture today is that once the article is published, your job (as a scientist) is done. The information is out there. But that is only the first and easiest part. The second part is to pass on the knowledge to the people who need to know it, i.e. to make it accessible to the public.

Ellen Kabat Lensch: How do you get the scientific reports in the hands of the public? Most people, teachers and students included, do not understand scientific reports. You have to put them in a context that they can understand.

Roger Svensson: Scientists are like preachers. Contextualized science is more than that, not only translated into layman's English but also expressed more broadly.

*Carl Lindberg (Swedish Ministry of Education)***:** On the business cards of foreign ministers of education, we sometimes see: "Education and Research" and sometimes "Education and Science." In Sweden, universities work with "the third task," to cooperate and communicate with society, to inform and create a debate. My wish from this conference is to find out how to stimulate scientists to always have the sustainable development perspective in their work, whatever field they are in.

Stina Holm Moberg (Göteborg University): Younger as well as older scientists need basic pedagogical education so they will learn how to communicate their message.

Jeffrey Steinfeld: The career of a scientist consists of research, publications, recommendation letters, peer reviews, etc. There is no reward structure in the academic system. Something is starting to change. Presidents of universities are here taking an active part in the AGS meeting. We have to find partners, people who have special skills and can communicate this message.

Roger Baud (ETH): The public at large is not interested in the research. If the public should be interested, presentations must be done differently. Though interesting, National Geographic on TV has few viewers. First we need a societal change to get people interested. My proposal is to add a few hours every week when employees are given education while on full salary. That would get them interested in research and sustainable development. It would bring scientific knowledge to the public. It would also bring debates, but some people do not always want that.

Ellen Kabat Lensch: Information must be presented on a personal level, so that people can see the impact on them personally.

Roger Svensson: The public is often more interested than we think. According to surveys, universities and professors are trusted by society.

Manne Wängborg: There is an international agreement on destroying all chemical weapons. People are more interested in particular topics that concern them and when these topics are fashionable. Science is a part of society. Academics are also private persons.

Bo Samuelsson (GU): The university system is based on organizational knowledge, on disciplinary subjects being classified and organized. There are few incentives to change.

Carl Lindberg: Swedish people are now more interested in history since a researcher published books on history with a familiar tone a few years ago. It is possible to do the same for sustainable development. There are increasing numbers of people attending institutions of higher education. There is a great opportunity for change in society if we can teach them sustainable development. If the university looks at sustainable development as a key issue, professors will have the sustainable development perspective in their teaching. This change is up to the scientists themselves, but politicians can make things happen through funding.

Jeff Steinfeld: Science has to be embedded in society. There is a link between daily action and sustainable development problems. How can we make this link clear? That is a challenge!

Third Session: Cooperation and networking

Chairperson Gustavo Perrusquía, Chalmers

Structured Agreement, Third Session (Summary)

Introduction

Sharing knowledge with a diverse audience (i.e. community, university) and making it available are vital objectives. Universities must cooperate *with* society and be integrated *in* society, not just in a formal academic context such as a 3-year course, but through continuing education in people's lives. Such cooperation and integration will lead to moving our educational system into sustainable literacy among the general population. However, the academic system does not have a reward system—there are no incentives for researchers to cooperate with society. Funding organizations need to provide the resources for cooperation to take place.

Forums and world summits on sustainability may come and go on forever, but 'the ship is approaching the iceberg.' Students must realize that it is their future that is at stake. They will have to live with the consequences of what we do today. If we are wrong, their lives and careers will be in jeopardy. Therefore, student participation is vital for the success of sustainable development as a way of life, not simply as a nice slogan.

Swedish Students Reflection Team Christer Flood (Electrical Engineering)
Johanna Liljedahl (Engineering Physics)

Christer Flood
Sustainable development is a well-known phrase for those interested in the environment, but it has not been thoroughly adopted by the public at large. The present workshop was mainly about how to create a general conscience and build an understanding for slogans such as sustainable development.

The UN has declared that the decade from 2005 to 2015 will be a "Decade on Education for Sustainable Development," but how can this help the environmental situation we are in at the moment? After all, sustainable development connotes a way of life. It is difficult to change the lifestyles of our world in just ten years. However, the Decade on Education for Sustainable Development may provide us with a beginning. But learning for sustainable development cannot be the same throughout the world, for developing countries have different needs from those of developed countries.

Various types of cooperation were mentioned in the workshop, e.g. between scientists of different disciplines or between different organizations. These kinds of cooperation are vital to sustainable development as understood in its three dimensions—social, economic and environmental. In order to achieve goals in these dimensions, society must cooperate and share knowledge.

Universities may play an important role, partly to make future business leaders aware of the sustainable

development concept and to engage researchers and scientists in making their reports understandable by, and available to, the public. Even so, the public must have a broad interest in life-long learning.

However, in this workshop I felt that there was a lot of talking but no action. I wondered if there was any evidence of things being affected by the words spoken at the workshop. At least I do not have any doubt in committing myself to these issues. I am looking forward to the Decade on Learning for Sustainable Development, and I hope that something will come of it as a result. However, it will require great skills in pedagogy and a lot of will from many people.

Concerning the Annual Meeting in general I am very satisfied, and the reception at *Universeum* was exceptional. Perhaps smaller seminars could be held with groups even smaller than the workshops. These groups could have sizes around 6-7 people and work as a complement to the brainstorming in the workshops. I hope the workshop on learning for sustainable development really made a difference and that the upcoming meeting on the same subject in Göteborg will result in positive outcomes.

Johanna Liljedahl

I was initially disappointed when I learned that I was assigned to attend the workshop on learning for sustainable development. The subject seemed too large to comprehend: I was much more interested in learning about more specific issues such as carbon storage or water management in developing countries. However this workshop turned out to be more than interesting, even if it was at times confusing. What did we learn or agree on that was new?

The workshop group consisted of about 20 people from different countries and with different professional backgrounds, although all of them were somehow related to education. In the first session the challenger presented his case to us. I had problems understanding exactly what the challenge was, but I think it had to do with diplomatic tools for communicating development and research and the imperfect diplomatic management of the concept.

The discussion that followed touched upon issues such as what sustainability really means: Certainly it means different things in developing countries than it does in developed countries. Can we trust that our teachers' knowledge is up-to-date, and what do we do when the message outside the academic world is the opposite of what we have learned?

A concrete solution that came up was the case of Iowa Community College, which has put together teaching materials about subjects concerning sustainability such as environmental ethics. A thought that immediately came to mind was "Are meetings like the one in Johannesburg 2002 too big for people to agree on anything that really makes a difference, and do too many compromises make the decisions insufficient?"

In the second session the challenger presented his case concerning the gap between society, universities, and researchers. The major issues were how to get the public interested and how scientists can communicate with the public in ways that get people interested. Can we bring science and environmental issues back into fashion

again? I think we need to make people more aware, but the problem is that research is done in areas that do not apply to the average person. Also, much is said, very little is done. There is need for action!

International Students Reflection Team Chan Ting On (China), Isaac Keke Cumber (Cameroon), guests, and audience discussed problems in education of sustainable development, and then some of them shared their experiences of various sustainable development learning schemes. In the first section of the workshop, discussion focused on the general problems encountered on sustainable development. Participants agreed that sustainable development education should integrate with different educational levels and disciplines as well as with different sectors in society. I agree with this because I was not an environmental student before, and therefore I could not receive any information on sustainable development. I think addressing this problem is important, because at the present time environmental studies are just a minority in society, whereas sustainable development is something vitally important that everyone should learn about.

Furthermore, the participants agreed that the core value of sustainable development should be identified. In the second section of the workshop, they tried to discuss sustainable development on a deeper level by starting from defining the principle of science, to pointing out that sustainable development is actually not an exact science but, instead, is rather narrative in nature. Therefore, some of them claimed that scientists failed to transfer their research outcomes to the general public, thanks to focusing only on publishing academic papers. I think this is true.

For example, scientists may claim that the number of fish in the Atlantic Ocean decreased according to ten years data to suit a statistical model but they may fail to tell the public about what impact this will bring to us or our next generation. They may not put emphasis on how this would be sustainable for humans. However, even if they can do this, they may fail to consider the economic, social, and political factors, all of which are related to sustainable development. All participants in the workshop agreed with this problem, and they extended the discussion on how science should interact reflectively with societies and how universities should cooperate more with other sectors.

Also, people should keep learning about sustainable development throughout their life, not only in the confines of schools. I think this principle is good but just a bit too idealistic a belief. To strengthen sustainable development education is not an easy job. A huge amount of human effort and motivation is needed. I hope more scientists will realize the importance of sustainable development and, at the same time, that the private sector and governments will provide resources on it.

In the last section of the workshop, guests from different institutions or organizations shared their experiences on teaching of sustainable development. There are short courses organized by different organizations together and also web-based courses for people from different parts of the world. Actually, the AGS is one of the successful joint forces to advocate sustainable development. I hope more and more world-class institutions will join the AGS to strengthen such meaningful education.

Isaac Keke Cumber

Sustainable development (as defined by the World Commission on Environment and Development, called the Brundtland Commission in 1987) is "meeting the needs of the present without compromising the ability of future generations to meet their own needs"—in other words, the use and exploitation of today's resources in such a manner that these resources will be available for use by future generations. Sustainable development demands that we seek ways of living, working, and being that enable all people of the world to lead healthy, fulfilling, and economically secure lives without destroying the environment and without endangering the future welfare of people and the planet.

Sustainable development relates equally to the three domains of economy, environment, and society with the goal of making the world a better place, though there are still millions of people who go hungry, who are without pure water, who have no access to electricity, and who are ill, unemployed, and with low levels of welfare. However, political reshuffling can solve these problems.

The concept of sustainable development has emerged by a slow but gradual process, enhancing changes over time. For example, average life expectancy has risen to about 60 years since the 1970s, the proportion of children with meaningful education has increased, the population of poor people has been reduced by half in the developing countries during the past 30 years, and health problems have been reduced (in spite of the appearance of HIV and AIDS) together with increasing development indicators.

Awareness is the first step towards change or sustainable development. Sustainability depends on what we value: Thus, by creating awareness through sharing knowledge effectively with diverse audiences, we will be turning the minority into a majority. Also, because there is no time to waste, we could be challenged to start as an individual, two people, and two more people and so on gradually, until everyone identifies sustainable development with their core knowledge and values.

Also, there will be integration across education levels and disciplines, likewise integrating academics with the community, thus making it possible for communication to flow. However, there are no sustainability standards though there are environmental standards. There have been basic discussions on the human environment, from the Stockholm conference to the Johannesburg summit: The environment, economics, and social aspects are part of the concepts for sustainable development.

Science is not a certainty: Thus scientists must look at the surrounding society. Scientific knowledge must be brought to the public at large, and ordinary people must be reached with what researchers have found. There is a need for real life-long learning processes, and information should be put on a more personal level for the public to be interested. Restructuring of knowledge for the better understanding of sustainable development together with scientists having the perspective of sustainable development in their teaching will have a great impact on society leading to sustainable literacy all over the world.

Participant's own impression of the workshop

Naoyuki Mikami PhD Student of Sociology, University of Tokyo

In the AGS Annual Meeting 2004 at Chalmers, we had seven workshops running in parallel, each of which consisted of three sessions of 7.5 hours in total. The program seemed to me excellent because we could have enough time to discuss and work together on a variety of topics. I had been looking forward to the workshop sessions prior to the beginning of this annual meeting.

Though all the workshop topics seemed attractive to me, I decided to join the learning workshop. Just before the AGS annual meeting, I attended the Annual Meeting of World Student Community for Sustainable Development (WSC-SD) at Chalmers. In the WSC-SD Annual Meeting, about 60 students from the AGS partner universities and other institutions discussed intensively the issues relevant to international and trans-disciplinary research partnerships, such as the gap between North and South, the problems of ethnic conflict, language and cultural barriers, and so on.

During the WSC-SD Annual Meeting, I strongly felt that we, especially the students from Japan, should be more competent at international communication and more familiar with the theories and methodologies of participatory learning. I was eager to acquire some clues to the challenge during the rest of my stay at Chalmers, and so I chose the learning workshop without hesitation. Frankly, I feel my choice was right, because I found I could learn a lot in the workshop and rediscover the theme of "Learning for Sustainable Development" in the context of my own research.

I am majoring in environmental sociology and currently focusing on citizen participation in urban environmental policymaking. It is true that I had been interested in learning/education for sustainability before I attended the workshop, but I had thought the theme didn't have a direct connection with my research topic, which is citizen participation in environmental policy-making and participatory democracy.

However, especially through the report by Manne Wängborg and the discussion after it, I belatedly realized that the theme of learning is an essential element when discussing participatory democracy. I had been somehow obsessed with the idea that learning/education comprises merely one of the subfields of the academic endeavors for sustainability or sustainable development. In other words, I thought that some specific fields such as pedagogy or psychology should have charge in learning/education and that it could not be a key component for the sociology of environmental policy or participatory democracy. But I now understand that the scope of "learning for sustainable development" is much broader, including school and academic institutes as well as voluntary organizations, governments, businesses, and society at large.

Manne Wängborg put forward the phrase "learning to change our world," which is also the title of the conference he is going to host next in May in Göteborg. As a student of sociology, I had long thought that something "to change our world" is social movement, not learning. But at the same time, I had felt the limitations of the concept of social movements as I studied environmental movements in Japan. For example, many existing

voluntary organizations in Japan have limited active members and are not successful in involving a wide array of citizens. When we observe these organizations only from the viewpoint of movement or mobilization, they seem too weak to change society.

In this regard, it is often argued by researchers that environmental movements have to be stronger as organizations (NPOs/NGOs) in order to compete with other stakeholders in society such as businesses and government. But such strategy of beefing up voluntary organizations often leads to sectionalism with more limited participation of 'elite' citizens. So I had been looking for an alternative concept to movements or NPOs/NGOs in order to work out my strategy to change society toward sustainability, but I could not find a clue to the question.

When encountering the phrase "learning to change our world" and participating in the discussion on it, I thought I finally found the clue. When we observe what is happening in Japanese civil society from the viewpoint of learning instead of movements, everything seems to me very clear. Though most voluntary activities for environmental protection in Japan are less organized and rather weak as social movements, nonetheless participants in such activities are always learning a lot about society, technology, nature, and the environment. I am not yet ready to give a full-length sociological description of my idea, but I realized by intuition that the practice of lifelong learning by the participants in such activities has greater potential to change our world than social movements in a narrow sense.

As a matter of fact, what gave me such a perspective was a casual comment made by Manne Wängborg during the discussion after his report. He said that he was uncomfortable to hear terms such as NPOs or NGOs used to describe voluntary organizations or grass-roots organizations. His point was that 'non-governmental' or 'non-profit' is just a negative expression and fails to identify the positive characteristics of these organizations.

In line with his remark, the same viewpoint is common in Sweden, but the comment had a great impact on me. I found that I had observed voluntary organizations just as replaceable parts or functions by using the negative terms, NPOs and NGOs. I had never intended to take such a stance; by contrast, I had thought I was standing by civil society in my research. But I realized that I needed more effort to identify what the people gathering in such organizations were aiming at and to find right sociological categories to clearly define their activities rather than using "non-" words. When trying to do so, it seemed to me, the concept of learning is crucial. Social movement is still one of the important categories when observing social change through civic participation, but we have to add the concept of learning in a broad sense at the top of the glossary.

In some sense, the outcome of the workshop itself seemed quite broad and general, and I heard some participants express their dissatisfaction with it after the sessions. But I had a different impression. Naturally, it is difficult to come up with some specific solutions to a certain problem through such a workshop with participants from various backgrounds.

I suppose that the fascinating aspect of such an interdisciplinary and international workshop lies in another place. In such a workshop, if we try to bring up the ideas or topics related to our own research, we need to locate them in broader contexts so that other participants can understand them. Such an effort—which is not necessary when we attend academic conferences in traditional fields of science—is an interesting and thrilling

challenge. Through this challenge, we can know where our own individual research is located on a larger map and have an opportunity to relocate it by getting new ideas.

In this sense, I fully enjoyed the workshop on learning for sustainable development, and I am very grateful to all contributors and participants, especially to the organizers for giving me such a great opportunity.