ADAPTIVE DIALOGUES:
A UNIVERSITY'S RESPONSE TO COMPLEX ENVIRONMENTAL PROBLEMS

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ABSTRACT

The world faces a class of environmental problems that defy problem solving approaches based on the unilateral actions of government, industry, or any other stakeholding interest. Multiple stakeholders, a great deal of scientific uncertainty, and the necessary inclusion of non-technical considerations characterize this class of problems. Existing processes to aid governments in resolving technical issues and setting policy are not adequate in the face of this complexity. Despite evidence indicating some movement toward consensus-building activities, government policy generally results from an adversarial process that leaves one or more interests unhappy with the outcome, resulting in continued controversy and less-than-effective policy. Complex environmental problems require a policy making approach that enables government to overcome the obstacles of scientific uncertainty and divergent stakeholder interests while not presuming that uncertainty will be eliminated and that true consensus will result. Problem solvers can achieve their objectives only through the creation of focused, fair, and inclusive multistakeholder dialogues that can adapt, through a continuous learning process, to the evolving understanding of a complex problem. An ongoing effort at MIT to address the management of the future use of chlorine provides an opportunity to create such an "adaptive" dialogue. In this thesis, we describe five efforts (four previous and one ongoing) by MIT researchers to expand the university's role in the process of finding solutions to specific environmental problems through multistakeholder workshops and conferences. Our examination leads to the conclusion that while the university may be able to serve well in many capacities, including that of "neutral" or "objective" facilitator, its traditional role as educator is the key to a successful dialogue. In order to succeed in promoting an ongoing, educational, adaptive process, the university should make the design of post-conference dialogue mechanisms central to both the planning and execution of a multistakeholder gathering.

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John Weiss
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INTRODUCTION

In 1991, Greenpeace published a report entitled "The Product is the Poison" in which this environmental organization called for an across-the-board ban on the use of chlorine as an industrial feedstock. In a world in which an estimated 15,000 commercial compounds contain chlorine while numerous others rely on chlorine at some point in their manufacture, a call for such a ban, if acted upon, is no small matter. Chlorine plays a direct or indirect role in the daily life of nearly everyone on the planet, whether it be in the disinfection of drinking water, the production of plastics, the agricultural use of pesticides, or the manufacture of silicon computer chips.

The call for a chlorine ban grew out of the environmental consequences associated with a number of notorious chlorinated compounds, the so-called "bad actors" such as dichlorodiphenyltrichloroethane (DDT), dioxin, and polychlorinated biphenyls (PCBs). Each is well known for its actual or potential threat to human health and natural ecosystems, and has been accordingly regulated or banned. In the view of Greenpeace and other environmental activists the potential for the existence of additional, similarly dangerous chlorinated compounds is great simply because of the enormous number of candidates. Since it is not practical to test each compound to determine its toxicological effects, the only rational policy, it is argued, is to ban the use of chlorine altogether since it will presumably be too late once the next bad actor is identified. This is an example of what has become known as the "precautionary principle."

The Greenpeace movement gained momentum in 1992 when the International Joint Commission, a U.S.-Canadian government organization

responsible for overseeing the management of the Great Lakes region, recommended that these two nations begin the process of eliminating chlorine as an industrial feedstock. While Greenpeace may have a reputation as being far to the left on issues with which it is concerned, and therefore less likely to reach a mainstream audience, the echoing of their call by a less well-known but clearly a more centrist group helped to carry the possibility of a chlorine ban to the general public. In October 1993, a story describing the effort to ban chlorine was published in USA Today.

The chlorine industry has responded vigorously to those who question chlorine's value to society. Expressing their willingness to cease using chlorine in any instance in which strong scientific data supports such an action, the industry is quick to point out that those calling for a ban have yet to provide such data. The industry argues further that the consequences of a ban in economic terms do not justify the supposed benefits to be gained. A study commissioned by the chlorine industry found that the cumulative benefit to society of chlorine chemistry is at least $100 billion, including 1.4 million jobs in chlorine-related industries (Amato 1993, Kirschner 1993).

Most recently, the American Public Health Association issued a carefully worded statement based on a "rebuttable presumption that chlorine-containing organic chemicals pose a significant risk." The APHA called for industry to demonstrate, before using chlorine-based chemicals, that 1) for a particular compound, use, or process there is no significant risk, and 2) there are no available substitutes in the form of chemical or process changes that would result in a lower overall risk. The statement also included a specific call, based on the current availability of substitute technologies, for a "measurable and progressive reduction" of chlorine-based bleaching in the pulp and paper industry and of ozone-depleting chlorinated compounds

toward a goal of eliminating these uses entirely. In recognition of the complexity of the chlorine issue, the APHA statement included support for legislation that would assist workers displaced by any elimination or phase-out of chlorine use (APHA 1994).

To the layperson, calling for a ban on chlorine seems rather curious. Most people remember from high school chemistry that chlorine is an element on the periodic table and that table salt is otherwise known as sodium chloride. How then is it possible to justify a call for a ban on chlorine? It has been our experience that even within the academic community, those who are being introduced to the chlorine controversy for the first time often laugh at the notion of banning an element. In reality, of course, no one is calling for an alteration of the periodic table or the elimination of salt from the world's diet. Groups like Greenpeace are clear in their intention to ban chlorine as an industrial feedstock, the use that gives rise to undesirable environmental consequences. In fact, reports suggest that Greenpeace's approach to the issue will continue to be an incremental one, targeting classes of compounds or uses (e.g., bleaching in the pulp and paper industry or plastics manufacturing) one at a time and country by country rather than seeking an admittedly unrealistic complete and global ban (Amato 1993).

Yet when a complicated environmental issue such as this enters the public debate, as it has through the publication of stories in newspapers like USA Today, the presence of multiple stakeholding interests and a wide range of both technical and non-technical considerations makes the task of reconciling the competing interests both more pressing and more difficult to accomplish. Those who must make difficult environmental management decisions, be they government policy makers, industrial managers, or

environmental advocates, find that there is little if any consensus upon which to base their actions.

It was in this atmosphere of growing controversy that researchers in the MIT Technology, Business, and the Environment program (a unit of the Center for Technology, Policy, and Industrial Development) were approached in 1990 by a visiting scholar from Norway to initiate a study of the management of the future use of chlorine. The MIT/Norwegian Chlorine Policy Study received the support of the Norwegian Ministry of the Environment, Statoil (a Norwegian petroleum concern), Norsk Hydro (a major international producer of chlorine), and the Norwegian Smelters Association. One of the primary objectives of this work has been the engagement of the various chlorine stakeholders in a dialogue aimed at uncovering and working through the uncertainties that are impeding efficient and effective decision making.

Gathering people with a common interest to further the objectives of the group is an increasingly common practice. As issues become broader in scope, representation at the gatherings broadens to incorporate all of the perspectives deemed necessary to achieve the stated objectives. Groups of people with a common profession and a common perspective give way to groups of people with more varied backgrounds who still share a common perspective. At some point, an issue becomes sufficiently complicated that in order to find better solutions it seems necessary to gather people with varied backgrounds who do not share a common perspective. The natural endpoint for this kind of process is the gathering intended to include representation from every possible background and perspective so that there is an opportunity to reach consensus and resolve the issue.

The management of the future use of chlorine is an example of an issue that typifies the complexities of current environmental concerns. Problems such as this are now seen as part of an intricate web of global development concerns. The intricacy of these problems is evident in the fact that they are no longer simply questions of scientific or technological uncertainty but questions that require careful consideration of other, non-technical components. The political, economic, legal, and sometimes ethical implications of a problem are essential factors in the search for a lasting solution.

Our purpose in this thesis is to examine the role played by a research university like MIT in the formulation and execution of multistakeholder dialogues when technological solutions are sought for environmental problems that display this level of complexity. We will use the chlorine issue as the vehicle with which to promote a vision of a new form of dialogue. A key point will be that the complexities and uncertainties associated with these problems require a dialogue that is based on adaptability and flexibility. Seeking solutions must not be a static process but a dynamic one. By looking in some detail at specific examples of MIT efforts to bring stakeholders together to discuss technological issues, we hope to begin to develop an understanding of how far and with what degree of success the research university might go in establishing such a dialogue. We will propose that at least in the United States, with the continued and growing resistance to regulatory mandates and regulation's great expense, the federal government as well as industry and environmental groups should look to the university to help them find more efficient and effective policy making and decision making processes.

Chapter 1 characterizes the atmosphere in which environmental decision making and problem solving currently occurs. Also, in support of the university role we will propose, we will present evidence in the form of previous arguments for greater university activism as well as more recent, non-academic initiatives to move in the direction of meaningful dialogue. In Chapter 2, we will step back to examine the role of the research university in advancing the interests of society and to describe the resources that an institution like MIT has to offer to a complicated environmental debate. Chapter 3 presents descriptions and analyses of four previous efforts organized at MIT to foster a dialogue among stakeholders as a means of addressing environmental concerns. These efforts, with subject matter ranging from the specific (steel-making processes) to the more general (environmental ramifications of durable goods), have in common the goal of using the resources offered by MIT to accelerate and improve the process of finding solutions. Because of the range in scope of the efforts undertaken at MIT, it will be possible to come to some conclusions regarding the ability of the research university to tackle broader, more complex problems. Chapter 4 returns to the ongoing effort at MIT to address the chlorine problem. We will not only describe the direction in which this project is going, but also use the lessons learned from the other MIT efforts to outline, in Chapter 5, a new type of decision making, problem solving process designed especially for the increasingly complex world of environmental management. The final chapter offers some concluding thoughts about the global context in which technological solutions to environmental problems really exist.

CHAPTER 1 - CHANGING NEEDS FOR A CHANGING WORLD

1.0 An Opening Context

One can begin to understand the need for a new approach to the management of complex environmental issues simply by reading the popular press. On an increasingly frequent basis, newspapers and magazines publish stories describing government efforts to find solutions to problems deeply rooted in science and technology. Also on an increasingly frequent basis, we read about the less than scientifically rigorous manner in which government officials and others undertake these efforts.

In two consecutive weeks recently, The New York Times published stories in its Sunday magazine that illustrate this point. A cover story on the program to develop a permanent, underground repository for high-level nuclear wastes included some unsettling statements. The author quotes a Senate staff member as saying that a purely scientific basis for selecting the best site is less important than a "technically appropriate subsurface with a compliant governor on top." When Congress selected Yucca Mountain, a member of the House of Representatives is quoted as having said, "I am participating in a nonscientific process - sticking it to Nevada" (Erikson 1994).

The previous week, a story profiling Jim Anderson, a leading researcher in the field of stratospheric ozone chemistry, described an incident in which Anderson testified before a Senate subcommittee at the time when Congress was considering a ban on chlorofluorocarbons (CFCs). One Senator reduced the detailed presentation of scientific findings to the simple question of whether or not CFCs should be banned. Despite his misgivings about linking personal opinion with scientific data, especially since he was the only

person in the U.S. conducting this particular research, Anderson was pressed for an answer (Shell 1994).

These two cases alone do not prove that the government is not willing to make informed decisions on the basis of sound scientific evidence, nor is it our intention to make such an argument. They do, however, show that it is easy for the complexities of technical problems to be lost or overlooked in an arena that (appropriately) puts as much or more of an emphasis on non-scientific factors (e.g., politics, economics) as on scientific ones. Philip Boffey, in the preface to his book about the National Academy of Sciences, a primary source of technical expertise for the federal government, summed up the problem succinctly. He wrote,

> Ours is a society that believes in expertise, that constantly genuflects before the presumed wisdom of experts. . . . The public tends to assume that these expert advisers dispense some sort of objective truth, the 'right' answer to the problem under consideration. But such implicit trust is misplaced. There are relatively few public policy questions whose answers are purely technical (Boffey 1975).

1.1 From Divergence and Adversarial Standoffs . . .

Though there are signs of change, the atmosphere in which the United States addresses environmental problems continues to be an adversarial one. Competing interests, generally categorized as government, industry, and environmental organizations, are locked in a continuous struggle to advance their own agenda. Since the government and the environmental organizations share a basic goal, protecting the environment, it would be easy to assume that they would typically be affiliated in opposition to industry,

whose primary goals are economic. But as we know, this is not the case. The actions of governments are influenced by the shifting political winds, which carry with them variable attitudes about what constitutes environmental protection. More importantly, however, governments are likely to be caught in the middle between the competing claims of industry and environmental organizations, as both groups look to the government to sort through large amounts of scientific as well as non-scientific data and to issue policies favorable to their position.

The regulatory policy making process is characterized by what amounts to a competition among the various stakeholding interests to make the best case possible to those in policy making positions. Industry interests might use economic arguments as well as scientific data from their own research efforts to promote their views on the best course for environmental decision making. Environmental groups or other non-governmental organizations might also use the same kinds of arguments, only with markedly different data or differing interpretations of the same data. The regulatory process may involve any combination of government-sponsored hearings, studies, public comment periods, or direct negotiations with stakeholders, all in an effort to determine fact from fiction. When fact is not easily determined, the task becomes making the best decision given the available information. It is easy to see how this process can lead to a situation in which those with the best access to the decision makers might have the ability to influence the kind of dialogue that takes place and thereby influence the kinds of policies that are proposed or enacted. Government relies as best it can on the advice it receives from advisory boards, such as the EPA's Science Advisory Board or those formed by the National Academy of Sciences, but given the uncertain nature of the problems these bodies are asked to investigate, the same

problems of access will still have a significant bearing on decision making outcomes. Rather than viewing this situation as an indictment of government, we view it as illustrative of the difficulties government decision makers face in balancing purely rational policy making with the realities of the policy making process.

Recent events in the effort to reauthorize the Clean Water Act, particularly with regard to the issue of chlorine use, illustrate the kinds of outcomes that result from the present system. In August 1993, Congress received House Resolution 2898, the so-called "Chlorine Zero Discharge Act of 1993." Despite the continuing debate regarding the manner in which chlorine should be regulated (if at all), this bill was intended to put into law the position of only one side of the debate. Under the proposed law, within 18 months of enactment a report would be required outlining the manner in which zero discharge of organochlorine compounds could be achieved by the pulp and paper industry; within five years of enactment, the pulp and paper industry would be required to achieve zero discharge (U.S. Congress 1993). In President Clinton's "Clean Water Initiative," the Administration called for a policy that would give the EPA Administrator broad authority to "prohibit the discharge of a toxic pollutant" like chlorine. Policies such as these, which clearly favor the interests of some stakeholders over others, reflect the nature of politics. However, when an issue as complicated as chlorine use is the subject of those policies, there should be no doubt that these policies merely set the stage for legal challenges by dissatisfied interests and other adversarial roadblocks to successful policy making and policy implementation.

Kantrowitz (1976, 1977) and others have long been proponents of the institutionalization of the adversarial process through the creation of "science courts," arguing that this is the best way to ensure "the presumptive

validity of the scientific input on which democratic decision making can be based." Proponents of the science court state that the establishment of scientific fact requires the elimination of all non-scientific questions (i.e., questions concerning values or political considerations, for example), an outcome that is possible only in a judicial setting. Critics of these proposals counter with numerous arguments, including the near impossibility of achieving the separation of scientific questions from non-scientific questions; even before a science court had begun its deliberations, non-scientific considerations would have influenced the process through the selection of an appropriate controversy to adjudicate (Casper 1976).

The science court has never taken hold as a policy making tool in the United States, though Canada has used a formalized adversarial process in recent years, apparently with some success (Dowd 1988). However, the success of the science court is predicated on the ability to define explicit questions for the court to answer. Today's environmental issues require simultaneous consideration of many questions, not all of which are scientific in nature. The growing recognition of this fact has led to the increasing reliance of governments and others on non-adversarial, integrative problem solving systems.

Negotiated rulemaking (or "reg neg") is an example of one such system. The Environmental Protection Agency has adopted this form of rulemaking for selected environmental disputes, allowing competing interests to negotiate the wording of a proposed regulation so that the typically adversarial comment period can be avoided.

The protocol of negotiated rulemaking is as follows. The Agency first determines whether negotiation is appropriate, utilizing a neutral party to conduct a feasibility analysis. This analysis includes an identification of the

"materially affected" parties and assistance to those parties in determining if negotiation might promote their interests. A number of questions are asked in order to make this determination, including: Is the issue well enough understood to make sound decisions? Is the issue's resolution subject to a constraining deadline?; Is the outcome of the dispute really in doubt?; Do the competing interests value the factors in the dispute differently? (i.e., are mutually acceptable trades possible?); Are there a limited number of interests involved? (a group of no more than 15 - 20 is preferred) (Harter 1982, 1986).

If the Agency accepts the issue as a candidate for negotiation, the neutral party assumes the role of mediator and the parties begin a process to produce a consensus proposal. This proposal becomes the rule on which the Agency seeks public comment. The process then continues much as it would without the initial negotiation; comments are received, the Agency indicates its intention to form an advisory committee (pursuant to the Federal Advisory Committee Act) to negotiate any changes to the proposal, and a final Notice of Proposed Rulemaking is published in the Federal Register (Harter 1986).

However, as Wald (1985) and others have pointed out, consensus is never an easy goal to achieve and it is often difficult to ensure that all of the interests are adequately represented in the consensus-building process. The result is that "negotiation rarely *eliminates* court action altogether. [I]t only changes the *nature* of the subsequent judicial proceedings" (Wald 1985).

1.2 . . . Toward Convergence and Collaborative Solutions

Despite questions concerning its effectiveness, the negotiated rulemaking process exemplifies a new trend in environmental problem solving. We see

signs that there is continuing progress in the effort to minimize or eliminate the contentiousness that makes environmental policy making so difficult. Opposing interests see the value in pooling their resources and their data to resolve their differences in a way that accomplishes environmental protection without going so far as to drive interests from the process. The following examples illustrate the growing recognition within the federal government and among those who seek to influence policy making at this level of the need for more cooperative and integrative approaches to technical problem solving..

1.2.1 NIH Consensus Development Program

While consensus-building and multistakeholder problem solving seem to be a phenomenon that has only recently found its way into the mainstream, approaches of this sort are in fact not especially new to the federal infrastructure. Since 1978 the Consensus Development Program (CDP), administered by the Office of Medical Applications of Research (OMAR) at the National Institutes of Health (NIH), has provided a means to evaluate the safety and efficacy of existing or emerging medical technologies. At the heart of the CDP is the consensus conference, a gathering of representatives from the medical profession, the scientific community, the consuming public, and/or other interested stakeholders, in order to "improve the translation of the results of medical research pertinent to health care into information useful to the practicing community" (Perry and Kalberer 1980).

The NIH does not actively participate in the consensus conferences, serving only to bring the various parties to the table. Each conference is characterized by seven primary components: topic selection; planning

committee formation; selection of appropriate questions, a conference panel, and conference speakers; presentation of data; consensus development; preparation of consensus statements; and dissemination of conference outcomes (Institute of Medicine 1990, Lowe 1980).

The NIH selects topics for consensus conferences using criteria such as public health importance, the existence of a controversy that is based on data gaps, the feasibility of closing these gaps through a technical dialogue, and an adequate scientific foundation on which to construct a dialogue. The planning committee, comprising NIH staff and experts from outside the federal government, defines a set of very specific questions to serve as the conference focus. Generally, a conference is limited to four to six questions, each of which must be potentially answerable on objective, scientific grounds. The planning committee also nominates a conference panel, with the emphasis placed on finding individuals who represent a broad range of expertise (from researchers and health professionals to biostatisticians, lawyers, and economists) and who have not published any work related to the conference topic. During the two- to three-day conferences, the audience (which generally numbers in the hundreds) hears testimony from a series of experts. Panel members and the audience are invited to ask questions and offer additional information; for every hour of presentations there is typically one half hour of discussion. The panel adjourns to draft a consensus statement at the end of the first day and again midway through the second day, after the presentations are complete. On the third day, the panel chair presents a draft statement to the speakers and audience. Comments and suggestions for changes are then heard, and the panel adjourns to complete a final draft. Results are communicated to the press by the end of the third day.

The NIH also distributes the consensus statement extensively throughout the health care system (Institute of Medicine 1990, Perry and Kalberer 1980).

Two years into the program, the NIH offered an assessment that included the following observations:

- The detailed planning that goes into each consensus conference is essential to the conferences' success, including the identification of key issues and questions and the preparation of background materials to provide to conference participants.

- The success of each conference depends on the participation of a diverse audience. To this end, all conferences are free and open to the public.

- Fears that health professionals would view consensus development as inappropriate federal intervention in the medical practice have been unfounded.

- Fears that consensus development would inhibit technological innovation have also been unfounded. The inclusion in consensus statements of a recommendation for additional research , especially with regard to areas where the conference could not reach consensus, has promoted technological innovation (Perry and Kalberer 1980).

Because it has now been in existence for more than 15 years, the Consensus Development Program has already provided a number of lessons not only for those who would participate in the NIH program but also for those who would organize or participate in any kind of technology-based, consensus-building effort. As the authors of a recent evaluation of the NIH CDP pointed out, "Although written specifically for the NIH Consensus Development Program, the recommendations presented in this report

address many of the challenges of any group process intended to produce a consolidated, well-substantiated expert judgment for direct application to policy making" (Institute of Medicine 1990).

More than 80 consensus conferences took place between 1978 and the end of 1989 (Institute of Medicine 1990). Among the recommendations made to improve future conferences were:

- The scope of inquiry of the NIH CDP should be expanded. The program should seek to ensure that relevant economic, social, and ethical aspects of assessing biomedical technologies and management of clinical problems are appropriately addressed as part of the consensus process.

- OMAR should develop an explicit ongoing research effort to determine ways to improve the NIH CDP and to monitor the impact of the program.

- The planning committee should publicly solicit questions concerning a selected topic from a broad base of relevant organizations and individuals, including OMAR advisory council members (Institute of Medicine 1990).

It is also worth pointing out some of the thoughts that have been published regarding the objective of producing a statement of consensus. Writing in 1980, the acting Associate Director of OMAR noted that the CDP is a complement to, and not a replacement for, the publication of research findings in medical and other scientific journals. The CDP provides a means to convey the most current thinking on a particular topic in a comprehensive and ultimately useful way to those who would most benefit from that information. There is also an explicit recognition of the fact that the

information that comes out of a consensus conference, while the best available at that time, is likely to be modified as the technical understanding of the issue matures with time (Lowe 1980).

1.2.2 Carnegie Commission Reports

In 1988, the Carnegie Corporation formed the Carnegie Commission on Science, Technology, and Government for the purpose of "helping government institutions respond to the unprecedented advances in science and technology that are transforming the world" (Carnegie Commission 1991, 1993). Between 1988 and 1993, the Commission published 19 reports, including four that focused on environmental problem solving.[1] One of the last of these reports, Risk and the Environment: Improving Regulatory Decision Making, analyzes the way the federal government sets policy to deal with environmental issues and suggests a number of improvements in the existing system. At the heart of this report is the belief that "a more coherent, efficient, and flexible regulatory decision making infrastructure" is needed to tackle today's complex environmental issues (Carnegie Commission 1993).

1.2.3 National Institute for the Environment

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1 "E^3 : Organizing for Environment, Energy, and the Economy in the Executive Branch of the U.S. Government" (April 1990)

"International Environmental Research and Assessment: Proposals for Better Organization and Decision Making " (July 1992)

"Environmental Research and Development: Strengthening the Federal Infrastructure" (December 1992)

"Risk and the Environment: Improving Regulatory Decision Making" (June 1993)

In December 1989, recognizing the need to coordinate environmental research activities in the United States, a committee of scientists, educators, and the general public representing academia, government, industry, and environmental groups called for the creation of a National Institute for the Environment (NIE). The mission of the NIE would be "to improve the scientific basis for making decisions on environmental issues." As proposed, the NIE would do for the environment what the National Institutes of Health has done for human health: sponsor research, propose solutions to difficult problems, and ensure that decision makers have access to the best available information (Hubbell 1993).

The NIE would complement, rather than supplant, the existing federal agencies that conduct environmental research. Proponents cite two critical reasons why there is a pressing need for this integrative agency: the lack of a "coherent system for assessing, interpreting, and actively communicating knowledge about the environment" to those who would make environmentally critical decisions, and the lack of multidisciplinary focus that results from the fragmentation of current environmental research efforts among an array of federal agencies. The NIE would integrate research, assessment, information, and education and training functions, though the focus would be on research. The formation of three Directorates (Environmental Resources, Environmental Systems, and Environmental Sustainability) would allow the NIE to focus on problem-based rather than discipline-based research. This organizational principle is critical given the multidisciplinary nature of environmental problems and the great difficulty with which existing agencies are able to influence policy making through coordinated, scientific arguments (CNIE 1993).

Progress toward the creation of the NIE has been slow but steady. Within four months after the first formal articulation of the concept for the agency in 1989, House and Senate committees had held hearings on the merits of the proposal. In the following year, Congress appropriated $400,000 to the National Academy of Sciences to conduct a feasibility study under the sponsorship of the Environmental Protection Agency. The National Science Foundation, Department of Interior, and Department of Energy contributed an additional $200,000 to the study. The NAS assessment, released in June 1993, called the NIE concept "a credible and effective view of a means to organize environmental research." In August 1993, a bill (H.R. 2918) to officially establish a National Institute for the Environment made it to the House floor (CNIE 1993, Hubbell 1993).

More pressing domestic policy issues are likely to stall the progress of H.R. 2918, but the proposal received a boost in March 1994 when Dr. Richard Benedick assumed the presidency of the committee organizing the NIE effort. Benedick is known for his work drafting the Montreal Protocol, which is precisely the type of international, collaborative outcome that supporters believe the NIE can foster (Stevens 1994). A meeting held in Washington in late March 1994 is evidence that the concepts articulated by NIE supporters are being heard and taken seriously, though there is now some question as to whether the NIE will become a reality. The meeting involved the National Science and Technology Council's Committee on Environment and Natural Resources (NSTC/CENR) and focused on the future course of federal environmental research. [The NSTC is the newly-formed, Cabinet-level successor to the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET).] While encouraged by the fact that their ideas have gained the attention of the White House, NIE supporters are concerned that

the Administration appears to be proposing to coordinate federal environmental research and development programs through the NSTC/CENR rather than through an independent agency like the NIE (Thomas, Howe, and Geraghty 1994).

1.2.4 Office of Technology Assessment Report

In January 1994, the Office of Technology Assessment published a report entitled "Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities." This report, one of several OTA has published in recent years examining the technological ramifications of growing environmental concerns, focuses on the challenges faced by U.S. firms who are either providers of environmental technologies or who are manufacturers faced with the competing demands of environmental compliance and international competition. The second chapter of this report, "Issues and Options," includes the identification of several issue areas. One of these areas is "Regulatory Reform and Innovation." Among the options suggested to address this general issue is the following:

> Congress could fund an Institute for Environmental Cooperation to promote innovative cooperative efforts between industry, environmental groups, or other nongovernmental organizations, and government. The institute could be a forum for collaboration, bringing various parties together to explore new approaches and to craft new solutions. Moreover, the institute could study innovative cooperative efforts and disseminate lessons learned from these approaches (OTA 1994).

The OTA authors then go on to say, "Universities could also serve as forums for consensus building and collaboration." They cite as an example of this kind of effort the chlorine studies now ongoing at MIT and suggest that efforts like this could be supported by an Institute for Environmental Cooperation (OTA 1994).

The previous examples demonstrate that the desire for new problem solving approaches is real and exists at the highest levels of government. However, ideas, proposals, or plans that focus on improving environmental problem solving through government reorganization seem to miss the important point that the government is only one of many stakeholders. Adversarial situations are not likely to disappear if the problem solving process continues to require government in the leading role. The OTA report is evidence of the recognition that the university, though possibly a stakeholder itself, can play an important role in the evolution of more integrative problem solving systems that exist outside of the existing government structure. We turn now to a more detailed examination of that role.

CHAPTER 2 - EVALUATING THE UNIVERSITY'S SOCIAL ROLE

If our intention is to propose a new role for the research university in the pursuit of lasting solutions to complicated environmental problems, then it is necessary to discuss, briefly and generally, the ability of the academic institution to engage in activities that are designed to have an effect beyond the university's walls. Before doing so, however, we would like to define more specifically what we mean when we use the term "university."

This thesis examines the role the research university, and specifically MIT, has played and could continue to play in the environmental problem solving arena. MIT is a unique institution in that it commands respect throughout the world as a source of technical expertise in a variety of fields, but it is by no means the only institution of its kind that could take on this role. In fact, other research universities should be encouraged not only to participate in dialogues constructed at MIT, but also to construct other dialogues in which members of the MIT community would be able to participate. Other, non-technically oriented institutions of higher education will also contribute important players to these dialogues, since research universities by no means have a monopoly on expertise and input from the leading academic minds on an issue will be vital to the success of any of these efforts. However, our focus is on the research university because of the technical perspective from which we view environmental problem solving needs.

When it is proposed that a university lend its expertise to a difficult policy question, it is generally the case that the university as an institution is not being asked to enter a public debate, but rather some small segment of a much larger university community. This segment can be as simple as a

single researcher with a unique knowledge of or perspective on the problem at hand, who, acting as an academic "entrepreneur," might actively offer the university's resources as a tool for problem solving. Or, the segment could comprise a large group of people representing multiple disciplines and departments. And while the university administration must at least implicitly support the university representatives' efforts, the substance of the ensuing dialogue should not be assumed to represent a particular philosophy or set of opinions held by "the university."

In this context, an important question to address (if not answer) is whether a redefinition of the societal function of the research university is required if the university is to catalyze, organize, or otherwise lead the effort to find solutions to complex environmental problems. This question is one that both the university itself and those who interact with the university community (government, industry, the public) must address. Within the university, those who would commit to such an undertaking should ask whether it is possible for them to assume the roles of both educator and intervenor, and to be explicit about when each role is being played. Outside the university, interested parties should ask whether they are comfortable with the dual role offered by the university.

MIT as an institution is clear in its resolve not only to foster the highest levels of basic scientific research, but also to apply the scientific and technical knowledge that results. Whether the university should be an agent of societal change is a question that has been the subject of some debate. Nash writes of the three models of university service: the "ivory tower, " the "service station," and the "activist." An ivory tower university is one that engages in basic research but does not try to intervene in matters of public policy. A "service station" university conducts applied research and assists

both government and industry when called upon to provide "expert" advice. The "activist" university takes it upon itself to identify and seek solutions to societal problems (Nash 1988). As Nash describes, with its motto of *mens et manus* (mind and hand) MIT fits the description of a service station university.

The role we envision for MIT, that of the initiator of a policy or decision making dialogue among multiple stakeholders, might seem to be getting too far away from the primary objective of the Institute, which is conducting research. However, convening a group of people representing a number of interests in order to seek solutions is in fact a form of university research; it is a precursor to the formal research efforts that might take place in the laboratory or in the field. Before traditional applied research can be undertaken, it is necessary to pose the right questions and make sure that the ensuing effort is both useful and timely.

The concept of conducting process-oriented research, such as this, at a research university is not novel. In 1969, Erich Jantsch, a visiting research associate at MIT's Sloan School of Management, wrote a manuscript entitled "Integrative Planning for the 'Joint Systems' of Society and Technology -- The Emerging Role of the University." After defining what he saw as the three functions of a university (education of students, the enrichment of scientific knowledge through research, and service to the community), Jantsch expanded upon the research function. He saw a four step "enrichment of the dimensions of research," in which basic research and applied research gave way to "research in the organization of scientific and technological knowledge" (Jantsch 1969).

Many have also recognized the expanded role that the university could play in dealing with the problems faced by modern society. Wolfle (1972)

outlined three of the many reasons why "society needs to have the university conduct research": to educate students, to continue the education and maintain the competence of faculty, and to provide "informed and objective" social criticism. Wolfle goes on to state that "the most difficult policy questions are likely to center around the university's responsibility for multidisciplinary research on large problems of great social importance." In a commentary published in 1979, Robert Marshak, then president of the City College of New York, presented the thesis that:

> . . . the impact of science and technology on our post-industrial global society is so great that unless our universities are willing to accept much greater responsibility for applied multidisciplinary research on the larger societal problems, more and more of our social decision making will be based on the self-serving needs of government and industry, the blandishments of well-intentioned but uninformed citizens' groups and the pervasive emotionalism of the mass media. The present-day American university is the prime institution where intellectual discourse and research remain relatively free of political pressure and ideological expediency; one might therefore enquire whether these beneficent conditions that have been so conducive to outstanding American performance in pure science would also improve American performance in certain types of applied research (Marshak 1979).

Marshak also wrote of his belief that "a university or consortium of universities [is] the most appropriate mechanism for mounting an attack on those problems that transcend national boundaries . . . " and that "the burden of global challenges mandates that the American scientific-academic community attempt to balance the celebration of scientific creation with the application of scientific knowledge to societal needs . . ." (Marshak 1979).

Others are quick to contest an expanded university role, saying that the university is not equipped to address complex, multidisciplinary sociotechnological problems. Weinberg (1971) wrote "[t]he universities fall short because they are fragmented and disciplinary. It therefore seems to me that society will have to invent new institutions that can apply science to the broad socio-technological problems of the future." The idea of a university as a place where research is conducted "relatively free of political pressure and ideological expediency," as Marshak wrote, is also a contested one. Ashford (1983) and others point to the pressures faced by university researchers to direct their efforts toward those objectives that will help them secure funding, thereby detracting from the university's goal of seeking and transmitting "pure" knowledge. As we will discuss later, these external pressures may also stand in the way of a university operating as an "honest broker," or a "neutral facilitator," services which are typically those sought when academia enters into a public debate.

The arguments both for and against university intervention or participation in social decision making can be very persuasive. We feel that the resources of the university, in particular the research university, will be critical elements in any solution to complex environmental problems. Therefore, we propose that any discussion of the university's role focus solely on the one attribute that is shared by all universities and all institutions of higher learning: education. Above all, a university is dedicated to the acquisition and transmission of knowledge. The education of the university's students must always be the foremost priority, regardless of the framework within which this education is provided. Most students who earn undergraduate or advanced degrees, whether they attend an "ivory tower" or a "service station" or an "activist" university, will eventually leave the

academic community and apply the knowledge they have gained to societal objectives of their own choosing.

This process of taking in, educating, and returning is equally applicable to the interaction the university has with those who are not matriculated students but rather are representatives of government or industry or non-governmental organizations. When these people attend a conference or workshop at a university like MIT, the goal should be to provide a forum in which knowledge is shared. Each of the participants is potentially both a student and a teacher, a model that fits easily within the universally accepted role of the university as a place of education.

Finally, it is not our intention to propose an expanded university role designed to supplant existing systems of policy making. Rather, the service provided by a research university in the effort to find solutions to environmental problems is intended to complement these systems. Through the provision of a forum for interaction and education, we seek only to enhance the abilities of stakeholders to move toward their objectives in a manner that earns the respect and trust of all interested parties.

CHAPTER 3 - CONVENING STAKEHOLERS : FOUR MIT EXAMPLES

3.0 Introduction

This chapter contains descriptions of four efforts organized by MIT faculty and staff to create problem-focused dialogues among stakeholding interests. The MIT Workshop on Industrial Ecology and the Steel Industry (November 1993) provided an opportunity for steel manufacturers and others to explore possibilities for technological innovation in the face of the environmental demands confronting the industry. The Waste Incineration Conference (June 1988) put MIT in the role of neutral facilitator in an attempt to reconcile long-standing conflicts. The MIT International Conferences on the Next Generation of Nuclear Power Technology (October 1990 and October 1993) brought together representatives of numerous interests (of which MIT was one) to examine not only the technological needs and possibilities in the nuclear energy industry but also the problems associated with the loss of confidence among the U.S. public regarding nuclear energy. The conference entitled "Design and Disposal of Durable Products: What's the Best Route?" (March 1993) again saw MIT in the role of convener, though with far more stakeholders and a less clear cut framework in which to conduct a dialogue. The selection of these four projects is based on their timeliness (all occurred within the last five years) as well as for their differences with regard to the scope of each project's problem focus. The order in which we will present them (steel, incineration, nuclear energy, durables) shows a progression from a smaller number of stakeholders and a relative lack of uncertainty surrounding technology-oriented questions to a large number of potential

stakeholders and a great deal of uncertainty about the technological questions that need to be asked.

The description of each project is intended only to provide insight as to the role MIT played in defining and executing the dialogue. Therefore, the descriptions are relatively short. For the organizers of each project, the substance of the meeting was more important than the issues that we intend to explore, so there is not a large amount of data to evaluate. However, in speaking with the organizers and reviewing the available documentation (including feedback from participants in some cases), a picture of the university role and the way it can evolve begins to emerge. Each example consists of two parts. The first describes the purpose, organization, and execution of the meeting, including such topics as conceptualization, participant identification and invitation processes, and agenda structure and implementation. The second part is a discussion of the important factors associated with the meeting as they relate to MIT's ability to play a useful role in the dialogue.

3.1 Workshop on Industrial Ecology and the Steel Industry (November 1993)

3.1.1 Description

At the invitation of faculty in the MIT Materials Processing Center (a research group within the Department of Materials Science and Engineering), approximately 60 people representing the steel industry, the federal government, and the academic community convened at MIT in November 1993 to participate in a Workshop on Industrial Ecology and the Steel

Industry.[2] As stated in the letter of invitation to the participants, the workshop was intended to "identify technological issues that will be of concern to the steel industry in the year 2005" and to "determine to what extent academic research can address any of these issues." The conference had an environmental focus, with particular attention paid to the concept of industrial ecology.

The MIT faculty who initiated the workshop did so with two objectives in mind. First was the desire to employ the resources available at MIT (faculty, graduate students) to assist the industry in adapting technologically to the regulatory and environmental realities of the late 20th- and early 21st-century. A second and equally important objective was to reestablish MIT as a leading center of basic steel making process research.

The need for a steel industry workshop came strictly from the legislative and regulatory realities facing the steel producers. The Clean Air Act Amendments of 1990 and other existing statutes created a set of absolute guidelines that in a sense dictate the future of the industry. As a result, steel manufacturers find themselves in a position where technological innovation is a necessary means of protection against future liabilities.

For the MIT Department of Materials Science and Engineering, the workshop provided an opportunity to develop a list of potential research projects and to begin the process of gaining the support of the steel industry for the concept of a Center of Excellence for environmentally sensitive research. Such a Center, based at MIT or elsewhere, would allow the coordination of research efforts among universities nationwide.

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[2] Information for the following discussion was obtained through conversation with Professor Donald Sadoway, MIT Department of Materials Science and Engineering, as well as through documents provided by Professor Sadoway related to the Workshop. Professor Sadoway initiated the effort to put the Workshop together.

Attendance at the workshop was by invitation only, limited to representatives of the steel industry, academia, and government agencies who have a technical knowledge of steel making processes. The MIT organizers enlisted the support of the American Iron and Steel Institute (AISI) in advance of sending out formal invitations, primarily as a means of attracting the major industry interests. MIT organizers chose to deal directly with the technical community at AISI despite the existence of other interests within that organization (legal, lobbying) who are actively involved in the issues to be addressed at the workshop. In this way, the workshop focus could not be construed as anything other than a technology-oriented approach to finding solutions to difficult questions. A planning group of MIT and AISI representatives determined which stakeholding interests should be invited. MIT and AISI then collaborated in the creation of an invitation list; AISI made recommendations for industry representation, while MIT focused on academia. While they did not include every possible interest (environmental groups and certain foreign producers are examples of those who were not contacted), the organizers were satisfied that for their purposes the relevant stakeholders were invited. According to the workshop organizers, no invitations were declined for any reason other than scheduling conflicts, and in fact people who expressed interest in participating were turned away in order to keep the workshop relatively small (Sadoway 1994). Representatives of the federal government (EPA, DoE, Bureau of Mines, NIST) were encouraged to attend and were consulted during the planning process, though they were not given specific roles to play during the workshop.

In keeping with the stated intent of the workshop, there were four detailed technical sessions over the course of two days. The session topics dealt with recycling, waste disposal, waste treatment, and "clean"

technologies[3]. Each session began with an invited speaker followed by a discussion. The speaker was asked to provide a framework within which to discuss the technical issues in greater detail. An assigned discussion leader was joined in each session by three or four industry representatives who have an expertise in the area of the session's technical focus.

According to a workshop organizer, the individual sessions were planned so that the discussion time was at least as long as the time allotted for the initial presentation. Participants were thereby encouraged to participate and not to attend simply to listen to what others had to say about the future of the industry. Audience participation was facilitated through the use of comment sheets that asked for opinions on the session's key points, gaps in the discussion, relative priorities of the issues raised (or not raised), opportunities for university-based research to address any of these issues, and suggestions for additional follow-up work.

Of equal importance to the technical sessions were the scheduled informal breaks in the proceedings. Of the 11 hours allotted for the workshop, four were set aside as opportunities for informal, one-on-one discussions among participants or for more general group discussion. These breaks were especially helpful in fostering the exchange of ideas and concerns across interests (especially between industry and the government).

A report on the proceedings of the Steel Workshop is not yet available, and there was no public record of the proceedings in order to encourage an open and productive dialogue among the participants. A Blue Ribbon

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[3] The titles of the four technical sessions were:
"Dealing with Tramp Elements to Allow Recycling;"
"Efficient Disposal/Recycling of Slag, Dusts, and Sludges;"
"Application of High-Temperature Reactors to the Treatment of Industrial Waste;"and
"Clean Technologies"

commission is in the process of preparing a summary of the workshop findings.

3.1.2 Discussion

The Steel Workshop does not represent a gathering intended to address a set of highly complex questions posed by stakeholders from all of the major potential interest groups. The absence of non-governmental organizations (NGOs) or what might be generally categorized as representatives of the general public does not reflect an incompleteness in the dialogue. There are two reasons why this is true. First, many of the concerns that would be brought to the table by such groups, primarily the environmental consequences of steel making, have already been addressed through legislation and therefore may not be a current priority for those outside the industry or relevant government regulatory bodies. Had the workshop included non-technical factors, such as the effects of technological innovation on the steel industry workforce, then other stakeholding interests would have been appropriate for inclusion. However, since the focus on technology was well-defined in advance of the workshop, the interests represented were sufficiently inclusive. The second reason, related to the first, is that a goal of the workshop was to define a research agenda based on the perceived needs of the steel industry. Presumably, any issues that might arise as a result of ensuing technological developments could be addressed in another forum defined for that purpose.

The success of attracting major industry stakeholders to the workshop is evident in the fact that the chief executives of the two largest integrated steel mills and the two largest mini-mills agreed to speak at the workshop's

opening session. According to an MIT organizer, the high caliber of steel industry representation was the result of two factors: the reputation of MIT as a place where serious discussion of technological issues can occur and the explicit support of an important industry organization (the American Iron and Steel Institute). Another factor that influenced the ability of MIT organizers to attract the desired participants was that the workshop was clearly focused on processes rather than products. Few if any would argue that the problems associated with the steel industry require replacing steel with other materials. Steel manufacturers did not need to fear that they would find themselves defending their industry and fighting off calls for actions that might threaten their profits or even their economic viability. MIT organizers believe that federal government officials were drawn to the workshop by the caliber of representation from the steel industry, even though they had no formal role during the workshop sessions.

We have reviewed the comment sheets completed by the participants, and from them we can begin to see the potential for a university like MIT to actively participate in important, technology-based dialogues concerning the formulation of public policy. In particular, participants viewed the university as an institution that can facilitate policy making by assuming an intermediary role between government, industry, and the public (including environmental groups). The terms used to describe the university included "unbiased arbiter," "credible," "reasoned," "independent," and "honest broker;" participants described the role of the university as "education," "communication," and "translation." Workshop participants provided general visions of the kind of follow-up work that the university might undertake, revolving around the theme of developing a broader dialogue that includes not only different perspectives on steel technology but also

expertise on the non-technical factors that drive technology decisions (MPC 1993).

3.2 Waste Incineration Conference (June 1988)

3.2.1 Description

The Hazardous Substances Management Program in the Center for Technology, Policy, and Industrial Development at MIT was designed to provide a collaborative forum in which problems related to the introduction of hazardous chemicals into the environment can be addressed. One of the first efforts of the HSMP was to organize a conference around the problem of waste incineration. The Waste Incineration Conference took place on June 13 and 14, 1988, bringing together the primary stakeholders in an ongoing and often contentious debate concerning both regulatory policy and the siting of new incinerators.

MIT organizers were interested in promoting action through the use of the resources and expertise that a university can provide. Immediate solutions to the incineration problems were not expected, nor were they necessarily a goal of the conference. Rather, the HSMP organizers sought a focus on "taking steps which allow the parties involved to learn, to cooperate, and to create new possibilities." Furthermore, the intention of the organizers was to have MIT (that is, the HSMP) "act as a neutral convener" (Ehrenfeld et al 1988).

Prior to the conference, HSMP researchers prepared a comprehensive report that framed the issues in dispute. The report was circulated to the invited participants in order to ensure that all interests were portrayed fairly

and accurately. The purpose of this report was to provide something that "would allow the participants to converse with a shared understanding of each other's concerns" (Ehrenfeld et al 1988). The methods employed by HSMP in preparing the report included an extensive literature review of scientific papers, interest group position papers, testimony, articles, and other relevant materials; interviews with parties to a local incinerator siting dispute; and an analysis of the data in order to identify recurring themes that would help focus the dialogue at the conference. Participants were invited to comment on the position papers in advance of the conference.

The invitation to the conference specified four objectives:

- To bring together people who disagree about the need for incinerators, their safety, and the fairness of decisions.
- To clarify and understand the sources of the disagreements by holding up a mirror to everyone's views.
- To create a setting in which the participants, through an open dialogue, can explore options that will lead to action.
- To leave with a commitment to pursue the agreements which emerge from the conference.

The invitation further outlined that the "primary output" of the conference was to be "agreements and commitments," and that MIT intended "to provide an aegis for on-going dialogue" following the conference. Approximately 30 invitations were sent to representatives of government, industry, environmental and community groups, academia, and professional societies. In developing the invitation list, the primary objective of the MIT organizers was to include representation from all stakeholding interests. Of

the 22 participants who accepted the invitation and attended the conference, six represented environmental or community groups (at the local, state, and national levels), four came from professional groups or academia (not including the MIT organizers), five were state or federal government representatives, and seven came from industry. While MIT organizers were somewhat concerned that key participants in the debate had declined invitations, they were satisfied that the final group represented all of the perspectives that needed to be part of a dialogue. Participants were not generally aware of the original invitation list, but some, noting the absence of particular people, did seek reassurance that no one had been intentionally excluded. In most cases, organizers had in fact invited the people in question, leading the organizers to feel that the group was satisfied with the makeup of the group (Nash 1994a).

A set of groundrules were laid down at the beginning of the conference in order to promote an open dialogue rather than a positional debate. Participants were asked to stress the positive, to speak as individuals and not as organization representatives, to explain why they disagreed with a point or a position, and to seek consensus. The conference proceeded as a series of facilitated dialogues; facilitation was even included as part of the dinner on the first night as a means of setting the agenda for the second day, which had intentionally been left open to allow participants to decide which issues were the most important.

One month after the conference, each participant received a copy of an "Agenda for Action," which summarized the major points of discussion and the potential areas of agreement (see Appendix 1). The organizers asked for edits, additional suggestions, and opinions on the three most important issues to come out of the conference. In December 1988, the participants

received the revised Agenda for Action as well as a "Next Steps Opinion Survey." The survey asked the participants whether they would be willing to incorporate prescriptions from the conference into their organization's positions or actions, if they would support an effort to develop a public statement summarizing the conference's key ideas, if they would like to attend another conference to examine one particular issue (and what that issue should be), and if they had any suggestions for continuing the dialogue.

3.2.2 Discussion

The Waste Incineration Conference stands out as an explicit attempt by academia to step into a complicated, technical controversy as a neutral interest with the objective of facilitating consensus among the identified stakeholders. The reaction to the university's stated role and objectives both prior to and following the conference is worth noting. As they developed the invitation list, HSMP researchers encountered skepticism from numerous parties. Among those who hesitated or declined to accept invitations were environmental groups who felt that any agreement with industry was impossible, a local citizen group who stated that their opposition to incineration was "non-negotiable," and a government representative whose unfamiliarity with the HSMP resulted in skepticism about the program's motives (Ehrenfeld et al 1989). Even with these reservations, however, HSMP organizers were successful in convening a group that represented the diversity of stakeholding interests (Nash 1993a).

Immediately following the conference, some of the participants offered evaluations of the conference proceedings and results. While not everyone was polled, reaction was sought from each of the stakeholder groups. From

conversations with six participants (representing six different interests), two distinct themes emerged. The first concerned the stated goal of reaching some kind of consensus on the way to approach the incineration issue. Although consensus never emerged, one participant noted that "that's pretty much what we all expected anyway." Another participant said that it was "naive to think we could reach consensus," and a third left the conference skeptical that incineration is a resolvable dispute. The second theme, which may be related to the first, was a feeling that participants were holding back from really engaging in a debate. One participant felt that it was "too bad" that the conference was "structured to avoid direct negotiation," while another said that "people seemed tight." A third participant thought the agenda was "too polite" and that "everyone was walking on eggshells" (Nash 1988).

A second important characteristic of this conference was the amount of pre-conference research undertaken by the HSMP organizers. Recognizing that a complicated, multistakeholder issue could not be adequately addressed in two days without some initial focus, the positions of the interests were carefully documented by HSMP researchers. As a result, the conference was able to avoid posturing and the use of valuable time simply to reestablish the fact that there was disagreement among the stakeholders.

Finally, as it was a stated goal of the HSMP to "provide an aegis for the ongoing dialogue," it is useful to examine what happened when attempts were made to do so. The first opportunity to continue the dialogue came when the Agenda for Action was distributed for comments and revisions. Thirteen of the 22 participants responded, some noting specifically that there is a need for this group of interests to meet on more occasions and to keep the dialogue going. The Next Steps Opinion Survey brought 11 responses, all indicating a willingness or desire to attend another conference focused on a

particular issue. However, there did not appear to be any agreement on what that issue should be. Perhaps of equal significance to the apparent unanimity of the respondents in favor of continuing a dialogue is the fact that many of the participants chose not to respond at all.

3.3 International Conference on the Next Generation of Nuclear Power Technology (October 1993 and October 1994)

3.3.1 Description

In October 1993, the MIT Program in Advanced Nuclear Studies hosted its second International Conference on the Next Generation of Nuclear Power Technology.[4] Both this conference and the first, held in October 1990, offered an opportunity for representatives from many stakeholding groups to explore technological issues as well as social concerns regarding the use of nuclear power. A goal of both conferences was to foster "a common understanding" and "to assist the process of communication among various interest groups." The focus of the second conference was somewhat different from the first. As stated in the proceedings of the 1990 conference, its purpose "was to aid the process of reaching a greater consensus concerning acceptable technologies" for the next generation of nuclear reactors. By the time the second conference was held, it had become apparent that the technical questions regarding future technologies were no longer the most crucial. In their place were questions of public trust and the ability of the nuclear industry to define its role in the 21st century. In both cases, the conference focused on the

[4] Information for the following discussion was obtained through conversation with Professor Michael Golay and Sarah Abdel-Kader of the MIT Program in Advanced Nuclear Power Studies, as well as through documents provided by Professor Golay related to the Conference. Professor Golay initiated the effort to put the Conference together.

questions that organizers considered the most important at the time. The shift in focus is evident in the titles given to the individual conference sessions; the titles for the first conference were primarily titles of technical papers, whereas the titles for the second were a series of questions.[5] MIT organizers hoped that by bringing together all of the participants in the nuclear energy debate, the nuclear power industry would gain a much clearer picture of the realities that it faces.

A goal of the conference organizers was to have representation from as many perspectives as possible. The nuclear energy debate is fairly well established, so there was relatively little difficulty in ensuring that an interest group had not been left out. Some difficulty was encountered, however, in attracting all of the desired interests. Environmental NGOs were somewhat skeptical of the idea of having a meaningful dialogue with proponents of nuclear energy, but they were ultimately convinced to attend on the basis of the value their perspectives would bring to the conference. For both conferences, the invitation list was developed primarily by the organizers in the Program for Advanced Nuclear Studies based on their personal contacts and knowledge of the important players in the ongoing dialogue. An international perspective was ensured through the participation of

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[5] The eight technical sessions in 1990 were entitled: 1) Advanced nuclear power options: the driving forces and their results; 2) Modularization as an avenue to economic competitiveness; 3) Nuclear power public and utility acceptance issues in the United States; 4) Nuclear power public and utility acceptance in some other countries; 5) Audiences, rationales, and quantitative measures for demonstration of nuclear safety and licensing by tests; 6) Public preferences and risk perceptions; 7) Nuclear waste disposal; and
8) Use of fast-spectrum reactors for HLW burning.

Technical session titles in 1993 were: 1) What role should nuclear power play, and what would life be without it? 2) How long will the current nuclear power reactors operate? 3) Can nuclear power gain public acceptance? 4) What role should renewable energy technology play; what would life be like with them? 5) What to do about nuclear weapons proliferation, and do new reactors to consume plutonium make sense? 6) What will happen to our nuclear wastes? 7) What should our future nuclear energy strategy be?

stakeholders from Italy, Holland, Germany, Japan, and Korea. Participants were asked to enter into the dialogue on the basis of their own opinions and not as representatives of the organizations or interests from which they came (Abdel Kader 1994).

Each of the two conferences proceeded as a series of focused sessions with a presentation by an invited speaker followed by remarks from a respondant and a group discussion. The topics for each session were formulated by the MIT organizers and revised numerous times based on conversations with invited participants in advance of the conference. Organizers were able to establish general agreement on the questions in advance.

The Program for Advanced Nuclear Studies published a detailed summary of the proceedings, including reports from a rapporteur, following the first conference. As of this writing, organizers had not yet completed the summary of the proceedings of the second conference.

3.3.2 Discussion

The nuclear energy dialogue stands out as the only example of the four presented here that has been carried over to a second gathering of the stakeholders. Besides the significance of the MIT organizers' ability to sustain a dialogue, the two conferences illustrate how a dialogue changes as issues become more clearly defined, as old questions are answered, and as new questions arise. The first conference was intended to address, in a technical manner, the future of nuclear energy systems. However, as noted in the Proceedings from that conference, "[t]he most common theme throughout the Conference was the current lack of public acceptance and confidence in

the nuclear power program in the U.S. A great deal of discussion focused on probable causes and possible cures" (Golay 1990). In the three years prior to the second conference, it became clear to the major stakeholders that the technical issues paled in comparison to the more fundamental issue of public trust and whether there would ever be any need for advanced nuclear technologies. As a result, organizers designed the agenda for the second conference in a way that took into account the new realities of the issue, including framing each session in the form of a question.

As difficult as the questions concerning the future of nuclear energy are for participants to try to answer, they do have the advantage of a longer timeframe for their deliberations. Stakeholders recognize that if nuclear energy is to become a major part of U.S. energy production, it is not likely to do so until at least some time early in the next century. This reality stands in contrast to other environmental issues, including those discussed in this chapter, that are subject to more immediate concerns and a need to formulate policy relatively quickly. The longer time horizon is a double-edged sword, however, since the ability to have a more thoughtful and deliberate dialogue is tempered by the fact that those who have responsibility for making policy decisions today will have less to contribute (Golay 1994).

MIT's role in this dialogue differed in one important respect from the incineration and, as we will describe, the durables dialogues. While serving in the role of convener, the Program in Advanced Nuclear Power Studies, like the Materials Processing Center involved in the steel dialogue, had a very real interest in the future direction of nuclear energy policy. MIT organizers made sure, both before and during the workshops, that the participants understood the university's role as an active dialogue participant and not just as a facilitator. According to the principal organizer, participants were more

interested in a fair process than in an objective university role. The university's intention was to "shape an intellectual agenda" and not to serve as a "near-term change agent" (Golay 1994). At least some success toward this end was achieved, as noted by the rapporteur for the first conference when he wrote, ". . . we are opening a dialogue. The written positions of different interest groups look very harsh and inflexible. Now with dialogue developing, the potentially acceptable positions look more flexible. Openness in this process is the key to success" (Golay 1990).

Another significant characteristic of the nuclear energy dialogue was the level of international representation desired and achieved by the organizers. Through the creation of a multinational dialogue, U.S. participants had the opportunity to see that citizens of other countries view nuclear energy issues differently. As a result, U.S. stakeholders can now approach the issues in a broader context and can learn from the experiences of other nations. At the same time, participation in this conference gave international participants a new perspective on the ways to approach multistakeholder conflicts in their own countries, where it may not be as easy to involve stakeholders in a joint effort to supplement the policy making process.

3.4 Design and Disposal of Durable Products : What's the Best Route? (March 1993)

3.4.1 Description

On March 24 and 25, 1993, the Center for Technology, Policy, and Industrial Development (CTPID) at MIT sponsored a conference entitled

"Design and Disposal of Durable Products: What's the Best Route?" The impetus for this conference came from two issues that combine questions of both technology and policy, and therefore fit within the research of the Center. The first issue is the solid waste "crisis," namely the dwindling space available to dispose of waste material. Because of their size and the lack of existing recycling programs, durable goods (such as automobiles and refrigerators) are a significant part of the solid waste problem. The second issue that makes durables an appropriate focus for a CTPID conference is the amount of natural resources used in the manufacturing and especially in the use of these products. There is a growing belief that this resource use is not sustainable and that practices must be instituted in the near term to ensure adequate resource conservation.

The broad theme of the conference was "how to create an effective public policy framework to address [the environmental impacts of durable products]." Three objectives were outlined by CTPID in advance of the gathering:

- To assess, from the point of view of representatives of all the major stakeholding groups, the strengths and weaknesses of the different approaches to fostering "green" durable products.

- To produce a written statement of principles to guide those responsible for developing future U.S. public and private policy in this area.

- To design a process for continued environmental policy dialogue on durable products among all concerned interest groups (CTPID 1993).

The CTPID organizers decided that the dialogue would focus on the automobile and electronics industries. These industries already face the

challenge of complying with recycling initiatives in Europe, which has generated interest among industry leaders in the U.S. to begin looking at issues such "extended producer responsibility" and "green" products (Nash 1994b). The conference attracted 93 participants representing 14 electronics companies, 10 automobile companies, nine federal and state government agencies, seven non-governmental organizations, six suppliers, six universities, five consulting companies, four professional societies, two recycling companies, and one invited member of the press.

Organizers developed the invitation list in a variety of ways. Trade association rosters and a participation list from a previous EPA conference with a similar theme provided an initial set of names. Other names were added when organizers asked key players from environmental groups, the EPA, and the MIT International Motor Vehicle Program for their suggestions. The Business and Environment newsletter provided a forum in which to publicize the conference and attract still more participants. Finally, the initial mailing to invitees asked each for more suggestions, a process that generated approximately 50 more names. In sum, every effort was made to identify all who might be interested in attending the conference (Nash 1994b). As was pointed out to and later recognized by the conference organizers, the virgin materials industry was notable in its absence and the dismantling, reclamation, and recycling industries were underrepresented (Nash 1994a).

The conference agenda included a number of speakers followed by facilitated breakout sessions. The entire group reconvened at the end of the second day to present the points of agreement and disagreement. From these summaries, conference organizers drafted a summary report outlining the areas of agreement and disagreement among conference participants (see Appendix 1). The report was sent in draft form to each participant along with

a detailed Participant Evaluation form. Organizers also sent copies of the draft report to an array of non-participants, including EPA personnel and members of Congress.

3.4.2 Discussion

Unlike the steel conference, which focused on possible responses to existing regulations and economic realities, the durables conference aimed to blaze a trail for the creation of policies that are just now beginning to take shape or be discussed. The relatively infancy of the durable goods issues meant that this conference differed from the incineration and nuclear energy dialogues in that the stakeholding interests have not become polarized. Therefore, the opportunity to achieve the stated goals of the conference appeared to exist.

Forty-seven Participant Evaluation forms were returned to CTPID. In every case, respondents at a minimum expressed their satisfaction with the conference's value and in most cases, the answer to the question "Was the conference valuable?" was affirmative. Many specified that the value was primarily contained in the opportunity to exchange ideas with and learn more about the perspectives of the other stakeholders. There was somewhat less agreement in response to the survey's question regarding the conference's contribution to policy making. Those who felt a contribution was made saw the conference as the beginning of a policy making process rather than as direct policy input. One participant noted, however, that stakeholders are "just beginning to define the problem," making it difficult to reach firm agreements on possible policy options. Those who responded in the negative to the conference's policy making contribution had a variety of

reasons, including the need to engage in a more focused discussion, especially given the time constraints of a two day conference and the desire to reach agreements. There was at least one complaint that all of the stakeholders had not been represented. A truly inclusive dialogue, this person felt, would have included other industries, radical environmental advocacy groups, consumer groups, unions, and trade associations (Nash 1993).

At least one conference organizer has stated that the objectives of their effort were too ambitious. While succeeding in their goal to promote a better mutual understanding of the varying stakeholder perspectives, it proved to be much more difficult to draft a statement of principles and to design a process for a continued policy dialogue. This difficulty seems to have stemmed in part from the perhaps erroneous belief that this single objective would not be enough to consider the effort a success (Nash 1994b). Since, as many participants noted, this conference is only the beginning of a dialogue, it is difficult to pinpoint reasons why two of the three objectives were not met. No doubt it was due in part to the relative infancy of the debate and the need to reach a common level of understanding regarding the questions to be asked.

Until very recently there had been no MIT follow-up to the March 1993 conference. At this writing, the conference organizers are in the early stages of planning for a second gathering to discuss environmental issues surrounding durable products. The decision to plan a second gathering was due in part to the ideas and questions raised during the writing of this thesis. Other factors included participants' desire to see a continued role for MIT in the dialogue, the continued experience of European nations in this area, and recent steps taken by U.S. industry to address recycling issues. The initial thinking is that the second conference should focus on learning from others'

experiences and sharing information and strategies rather than on outlining directions for U.S. policy, as the first conference attempted to do.

Through our examination of past MIT efforts to engage stakeholders in constructive dialogues, we have observed that for all the careful planning that goes into a conference there is still a hurdle to overcome when sustained dialogue is the goal. This is especially true when the dialogue is based on an evolving set of issues. By looking at the dialogue now taking shape around the issue of chlorine use, we hope to provide a better understanding of this hurdle and to begin to propose a way to get past it.

CHAPTER 4 - MANAGING THE FUTURE USE OF CHLORINE

4.0 Introduction

An ongoing MIT project to study the management of the environmental impact of chlorine use provides an opportunity to expand the research university role in the effort to promote effective policy making when multiple stakeholding interests are involved and a great deal of uncertainty is present. This problem area centers on the question of whether chlorinated chemicals have undesirable environmental and health effects, and if so, what should be taken into account in establishing policies regarding their restriction or removal from the market. The following questions and issues, formulated as part of an MIT position paper for a New Initiative in Environmental Management, illustrate the topics a group like this might be expected to cover. Without systematic analysis, there is no way of knowing if the introduction of chlorine controls will have any overall beneficial effect. Can chlorine, as some groups demand, be totally phased out? If not, are there "good" chlorine uses and "bad" chlorine uses? What is the meaning of "good" and "bad" in the context of economic and social development versus health and environmental sustainability? How can industry make a transition from existing to new technologies? The effects of possible substitutes are poorly understood and may lead to other types of impacts on the economy and on the environment. There is a basic lack of knowledge about human health effects of chlorinated compounds on the environment. Can this knowledge arrive in a timely fashion based on highly targeted research efforts, or will there be pressure to decide before all the answers are known?

In this chapter, we will describe the efforts of MIT researchers in the last three years to try to answer, or find ways to answer, these kinds of questions. As will be evident, the chlorine study has been constantly evolving as the issues, the stakeholders and their positions, and the complexity of the problem have all come into greater focus. Having achieved this improved focus, we are able to outline the role envisioned for MIT in the evolving chlorine dialogue.

4.1 MIT/Norwegian Chlorine Policy Study, Phase 1

With funding from a group of Norwegian industry, non-governmental, and government organizations, MIT researchers in the Technology, Business, and the Environment program undertook an initial assessment of the issues associated with the growing international dialogue concerning chlorine use. A two-year effort by a group of faculty, staff, and graduate students led to the publication of the Phase 1 report, "Dimensions of Managing Chlorine in the Environment." The primary question that MIT researchers sought to answer in this initial study was the following:

> If chlorine chemicals have undesirable environmental and health effects, what are the salient considerations that should be taken into account in determining a course of action regarding their removal or restriction in the market? (TBE 1993)

The second important question of this study concerned the effects that a chlorine ban or restriction might have. As posited by the authors of the study,

> If the answers to the acceptability questions are in the affirmative, that is, that too much of some chlorine-containing chemicals are produced and consumed, what is the best way to proceed in order to avoid or mitigate the socially disruptive impacts of the action on the economy of the country, a group of countries, or the whole world, depending on the body that is undertaking such an action? (TBE 1993)

The Phase 1 report provides a context for the study of the chlorine issue. The report comprises five case studies, intended to illustrate the kinds of data needed to conduct a thorough policy analysis; an examination of the "industrial ecology" of chlorine and the methods available to use industrial ecology as a framework for policy analysis; and a summary of the study's findings and policy implications.

In reporting their findings, the MIT group focused on the extreme complexity of the worldwide chlorine "system" and the implications this has for any attempt to ban or otherwise control the use of chlorine. The diversity of uses, environmental impacts, and economic values associated with this chemical makes the definition of a single, broad-based regulatory policy difficult, if not impossible. For each instance in which a control on chlorine is sought, regulators must provide answers to questions concerning the scientific justification for their actions, the availability of alternatives to chlorine use (in terms of both products and processes), and the environmental and economic ramifications of a switch to a chlorine-free product or process. However, it is not enough to base a decision on an answer to only one of these question; simultaneous answers, each depending upon and influencing the others, are required. The report concludes that the existing policy making apparatus is insufficient for this degree of complexity and that we therefore must devise new methodologies designed specifically to accommodate multidimensional analysis (TBE 1993).

4.2 MIT/Norwegian Chlorine Policy Study, Phase 2 Prospectus

A few months after the publication of the Phase 1 report, MIT researchers prepared a prospectus for a second phase of the chlorine policy study, in which continuing research on chlorine-related questions would be "carried out within a policy-oriented dialogue framework" (Ehrenfeld and Marks 1993). By linking ongoing research efforts with a continuous process of communication between the major stakeholders in the chlorine debate, the dialogue necessary for effective chlorine policy making would be not only self-maintaining but self-improving. In the words of the Phase 2 prospectus authors, "The coupling of research and policy-making is critical to the success of this proposed project" (Ehrenfeld and Marks 1993).

The prospectus identified a wide range of potential research topics that fit within four broad categories:

- Analytic or procedural frameworks for the development of policy options;
- Environmental, technological, economic, and social analyses of classes or families of chlorine use;
- Analyses of potential policy approaches; and
- Clean technology research and development (Ehrenfeld and Marks 1993).

The authors noted that the research should be conducted collaboratively with other universities, as well as with government agencies, industry, and non-governmental organizations. More importantly, the research topics outlined in the prospectus were only those apparent from the Phase 1 research. As the

understanding of the issues matured, the ongoing dialogue process would assure and make necessary a fluid research agenda.

The concurrent dialogue process would be designed in recognition of the fact that research to establish "facts" by itself would be an insufficient means toward a policy making end. An open forum in which stakeholders could air their differences and share important information would be expected to help overcome the obstacles that are not amenable to arguments on scientific or technical grounds. For example, a technological change resulting from a restrictive chlorine policy would be expected to have a positive effect on the environment, but maybe only at the expense of a negative economic effect (e.g., a net job loss) on the industry faced with that change. Only through a direct give-and-take could stakeholders try to reach some level of agreement concerning the many trade-offs like this that would become apparent. The Phase 2 prospectus described a series of regional meetings for the purposes of maintaining a dialogue and providing the forum for the exchange of information and ideas, and, optimally, the building of trust and consensus.

MIT's specific role in this process would be as both overall coordinator and research participant. As coordinator, MIT would manage funds provided by other participants and foster the dialogue process. The MIT researchers hoped to enlist the support and participation of major stakeholding groups beyond the Norwegian concerns who had funded the first phase of the project and who were continuing to fund the development of the larger effort (as Phase 1.5). The initial focus was to be on governments, industrial organizations, and environmental NGOs, as well as other research institutions. A particular emphasis was placed on non-U.S. research institutions.

4.3 MIT/Norwegian Chlorine Policy Study, Phase 1.5 Activities

In the months following the completion of the Phase 1 report, including the time during which the Phase 2 prospectus took shape, MIT researchers learned a great deal about the difficulties associated with any attempt to address a complex and far-reaching environmental issue, especially when that attempt hopes to include all stakeholders. The following is a summary of activities that took place between May and October 1993, the result of which was a reassessment of MIT's goals. The original documentation of these activities came in the form of an October memorandum from the principal MIT researchers to a member of the Norwegian Steering Committee (Marks and Ehrenfeld 1993).

In May 1993, MIT researchers presented the findings of the Phase 1 report to a meeting of the International Group of Chlorine Chemistry Associations (IGCCA). In addition to the report findings, they presented some early thoughts regarding the next phase of work. However, they left the meeting with the impression that a more specific proposal had been expected.

In late June, one of the MIT researchers met in Oslo, Norway with the Steering Committee to discuss the evolving Phase 2 Prospectus. The Committee voiced some concerns, including a perceived bias against chlorine in the Prospectus introduction and a need to focus any continuing work on the provision of options to policy makers rather than on the creation of policy itself. Additional comments provided through correspondence after the June meeting emphasized that the project should "facilitate a continuous and constructive dialogue," and suggested an approach based on sectoral, regional, medium or other problem-specific concerns. The concept of a strategy

encompassing all conceivable chlorine issues was seen to be somewhat impractical. MIT researchers took note of these comments as they continued to revise the Prospectus.

MIT researchers again met with the Steering Committee in Norway during the August 1993 Environment North Seas conference. The Committee seemed supportive of the general organizational principles embodied in the revised Prospectus. Still, participants articulated a number of concerns, including: the ability of MIT to lead such a large project on its own; the need to recognize differences between European and US policy making; the apparent lack of detail concerning NGO participation; and the need to clearly define the conditions for stakeholder participation. Significantly, one commentor noted that "constructive dialogue would be valuable even if consensus were not reached."

In late September, MIT researchers traveled to Brussels where they met with the Director of Eurochlor, who was receptive to the effort taking shape. He too, however, discouraged an approach that sought to address all of the chlorine issues within a single framework, and also voiced his opinion that the consensus-building dialogue approach is more in the European style of problem solving, perhaps expressing some doubt that this can be successfully undertaken under U.S. leadership.

A subsequent meeting with the Chairman of the Paris and Oslo Commissions (the bodies formed by European convention to oversee environmental management in the North Sea) uncovered potential difficulties for the MIT project. While interest among European stakeholders to participate seemed to exist, the desired emphasis was on specific chlorine issues and there was little if any consensus on which issue(s) to address first. Furthermore, it was learned, a Dutch study of chlorine involving

government and industry representatives had recently lost the support of previously participating NGOs.

Upon their return to the U.S., the MIT researchers met with the chairman of the Chlorine Coordinating Council, a U.S. group sponsored by the Chemical Manufacturers Association to promote industry's positions in the chlorine dialogue. He expressed an interest in working with MIT, but also not in the way described in MIT's proposals. Instead, he saw industry contributing the "data crunching" while MIT focused on the policy analysis. In order for industry to participate, the process would need to be fair, inclusive of all stakeholders, based on scientific integrity, and cognizant of potential socio-economic consequences of any decision. Finally, industry reminded MIT that the university must not be perceived to be against chlorine or to assume that chlorine regulation is inevitable.

The result of this series of conversations with stakeholders was the realization that, as then formulated, the plan for continuing the chlorine policy study was too ambitious. Each interest group contacted had their own agenda and priorities, a situation that would preclude any collaborative effort based on a common vision of an overall strategy. Therefore, the MIT researchers presented two new options to the Norwegian Steering Committee for the continuation of the chlorine work.

The first option was the formation of a government-academia initiative to study very specific chlorine issues. The focus would shift to a process that excludes industry and NGOs from oversight positions because of the current lack of incentive for these groups to voluntarily commit to a consensus-building effort. The perception was that industry and environmental groups were, at this point in the debate, unlikely to see an advantage in contributing to a reduction in what was becoming a high degree

of polarization. MIT would offer "neutral and objective" facilitation to help governments focus on the risks and benefits of a particular chlorine use. The goal would be to provide governments with enough information to begin taking action, in effect forcing the polarized interests to choose between coming to the table or taking their chances with policies that might result without their input.

The government-academia initiative would begin with a two-day, issue-specific conference at MIT to which all stakeholders would be invited. Extensive advance work would clearly lay out the positions of each interest and the areas in which further work is needed. Participants would be asked to contribute to the dialogue through presentations, submission of data, and active involvement in conference discussions. In addition, MIT would initiate the creation of a database comprising the existing research data as well as descriptions of ongoing research efforts in the area of concern. This database would help to promote the continuation of a dialogue beyond the conference. MIT researchers would select a topic for this initial conference through consultation with industry and the Norwegian Steering Committee. However, industry input would be sought from chlorine end-users rather than solely from the chlorine producers, who had been the only industry stakeholders involved to this point.

The second option presented by MIT was an acknowledgment of the gulf growing between the various interests and to abandon the notion of a collaborative approach involving all of the stakeholders. NGOs are gaining momentum, especially through the mass media, in their advocacy of the "precautionary" approach, and governments are responding by taking initial actions to at least look at the possibilities of bans or other restriction. Industry, meanwhile, remains steadfast in its insistence on hard scientific

data to support any restrictive measure. If it were agreed that reconciliation between these two perspectives could not be achieved, then a more realistic approach for MIT and others might be to participate in the dialogue as individual institutions rather than as parts of a collaboration (Marks and Ehrenfeld 1993).

4.4 MIT Initiative in Environmental Leadership

Supported by a three-year grant from the V. Kann Rasmussen Foundation, MIT researchers moved forward and organized an Initiative in Environmental Leadership to continue the study of chlorine issues. This Initiative combines ongoing research in important technical and non-technical areas as well as a seminar series that seeks to tie together the research efforts, thereby fostering the interdisciplinary understanding needed to engage in the broader, international dialogue. The next step for the Initiative is to organize an on-campus workshop, at which MIT researchers will ask for the stakeholders' perspectives on the university's evolving role.

4.4.1 Research

Eight student/faculty teams are currently conducting chlorine-related research as part of "An Environmental Strategy for Future Chlorine Use" (PEEER 1994). The selection of research projects was based on the need to address as many of the relevant disciplines as possible. The research falls into four broad categories. The first concerns the movement of chlorinated compounds in the environment. One team is investigating groundwater contaminated with chlorinated solvents, with an eye toward quantifying

discharge and degradation and then using this information to seek better management practices for similar contamination problems. Two atmospheric chemistry teams are focusing on the contribution to urban air pollution of selected organochlorine compounds other than chlorofluorocarbons and hydrocarbons. While the latter have serious implications regarding ozone depletion and smog formation, an understanding is also needed of the movement in the atmosphere of compounds that are known or suspected human carcinogens.

The second issue area concerns the availability and implications of potential substitutes for chlorine chemistry. A research team is investigating the chemical synthesis of non-chlorinated pesticides. Two other teams are developing a system that will allow manufacturers of materials such as plastics to make more environmentally benign process synthesis decisions.

The economic and political aspects of the chlorine debate are the third area of concern. A research team is looking at the potential effects of bans or other restrictions on the use of chlorine in the context of differing international economies. A key question in this research is whether international regulations will diverge or if they will converge toward either a "least common denominator" or toward a higher, more restrictive standard.

The final issue area concerns the way in which policies develop given the multiple interests involved and the uncertainties associated with the risks of continued chlorine use. A research team is compiling information on the current state of scientific understanding concerning risk and specific environmental impacts associated with chlorine. This work can serve as a foundation for better, more informed policy making processes.

4.4.2 Seminar

A complement to the ongoing research is a seminar series entitled, "Management of the Future Use of Chlorine." In addition to presentations from the above research teams, speakers from the MIT community and beyond are invited to lend their perspective on some aspect of the chlorine debate. The seminar is organized around the idea that some middle ground must be found between the calls for a complete ban and those demanding scientific proof that such a ban would provide a net benefit to society. Six themes help to focus the seminar discussions. In the form of questions, they are:

- What criteria should be used to identify the most problematic chlorine-based chemicals and their uses?
- How can we identify the chemical "bad actors" on the basis of environmental and health impacts?
- Where are the "low-hanging fruits," the currently most viable major innovations modifying chlorine use?
- How should the social benefits of chlorine be measured?
- What political issues will shape or impede progress in reducing chlorine use?
- How can action in this area be stimulated? (PEEER 1994)

The seminar met on four occasions during the 1993 Fall semester. The first meeting served as an introduction and gave organizers a chance to outline the objectives of the seminar. Subsequent meetings included presentations by a visiting scholar from Norway who was instrumental in the creation of the original chlorine policy study, by professors of chemistry and chemical engineering who are examining the availability of chlorine

substitutes, and by the principal researcher studying groundwater contaminated with chlorinated solvents. Summaries of three of the four Fall seminars are included in Appendix 2.

During January 1994, speakers representing two sides of the chlorine debate came to MIT. On two consecutive days the seminar heard from a leading proponent of the "precautionary principle" who has spent considerable time studying the potential health effects of chlorine in the environment, and from the chairman of the Chlorine Coordinating Council, the leading U.S. industry voice in the chlorine dialogue. A summary of these presentations is included in Appendix 2.

The seminar was scheduled to meet on five occasions during the Spring semester. The first meeting focused on toxicological characteristics of organochlorine compounds and the difficulty associated with defining classes of compounds for the purpose of regulation (as an alternative to an across-the-board ban on organochlorines). The second Spring seminar addressed the application of risk assessment and risk management to the chlorine issue. Summaries of the first two meetings are included in Appendix 2. Subsequent meetings, held after the submission of this thesis, were to include a presentation by a guest participant from Drexel University on drinking water chlorination and the implications of calls for a chlorine ban, a presentation of results from the MIT research team exploring the effects of a chlorine ban in the context of differing international economies, and a report from representatives of a major pulp and paper concern on the potential impact of recently proposed effluent guidelines that would curtail the use of chlorine in bleaching processes.

4.4.3 Workshop

We are now beginning to plan for a workshop to be held on the MIT campus in November 1994. Working under the title "Shaping the Chlorine Agenda: A Roundtable for Sharing Knowledge and Perspectives," we seek to redefine, if necessary, the role a university like MIT plays in solving complex sociotechnological problems (Marks 1993). At the same time, the workshop is intended to help provide a better focus for the traditional research and education activities of the university. Although the emphasis will be on a particular environmental management issue, the articulation of a forward-looking university strategy for assisting in this type of process would serve as a model for similar efforts in a broader range of issue areas. A more specific description of our goals and the planning process for the workshop can be found in Section 5.4.

CHAPTER 5 - THE UNIVERSITY'S ROLE IN CREATING AN ADAPTIVE DIALOGUE

5.0 The Challenge of Environmental Problem Solving

KEY POINTS

- **Pursue focused, integrated, and interdisciplinary research programs.**
- **Overcome tendency to engage in adversarial policy making.**
- **Initiate and sustain communication between stakeholders.**

Perhaps the single greatest obstacle to finding a solution to any problem that involves science or technology is uncertainty. The difficulty encountered in establishing a universally accepted "fact" stands in sharp contrast to the ease with which doubts can be raised about that fact. Often, a public policy decision with widespread implications hangs in the balance. As a result, the public that expects
solutions sees only debate, litigation, and an apparent lack of progress.

Many current environmental problems are characterized by a great deal of complexity as well as a high degree of uncertainty. The global climate change issue is a good illustration of this dilemma. What began as a presentation of data predicting a potentially catastrophic rise in mean global temperatures is now a debate over varying interpretations of a growing set of data. Scientists are far from consensus on future climate trends or on the societal impact of a rise in temperature. If policy makers were to try to address in a comprehensive manner all of the non-natural factors influencing a possible change in global climate, they would be faced with a daunting array

of issues ranging from transportation to energy production to waste management. None of these issues can be considered in isolation if a true understanding of climate change is desired, yet the policy making process is not well-equipped to integrate the many disciplines needed to fully understand a problem of this magnitude. In fact, it is unreasonable to think that scientists or policy makers could unravel the complex web of interactions among the various issues in a manner that would allow the formulation of a comprehensive mitigating strategy. And yet, an understanding and appreciation of the fact that these interactions exist is vital to the success of future environmental management strategies.

Environmental problem solving efforts tend to utilize one or both of two basic approaches: consensus-building exercises that take into account numerous perspectives and multiple stakeholders and the use of "neutral" panels who are charged with sorting through existing data to uncover the "truths" that will make policy decisions both rational and easy. In theory, these approaches would eliminate adversarial relationships and lead to effective policy; in some cases, an argument could be made that the theory holds true (see Section 1.2.1 for a discussion of the NIH Consensus Development Program). The fundamental problem with either approach, however, is the implicit assumption that even in the context of the most complex environmental problems we can find answers that are satisfactory to all concerned. Having found the answer(s), the maintenance of relationships between the participating interests would no longer be necessary. We propose the explicit recognition of the inherent uncertainty and complexity of environmental problems as a starting point for future efforts. As Jasanoff writes:

> . . . agencies and experts alike should renounce the naive vision of neutral advisory bodies 'speaking truth to power,' for in regulatory science, more even than in research science, there can be no perfect, objectively verifiable truth. The most one can hope for is a serviceable truth: a state of knowledge that satisfies tests of scientific acceptability and supports reasoned decision making, but also assures those exposed to risk that their interests have not been sacrificed on the altar of an impossible scientific certainty (Jasanoff 1990).

In this chapter we return to previous efforts by the MIT community to use the university's resources as a means toward finding a "serviceable truth." We then develop the concept of the "adaptive dialogue," a new tool that learns from past experience and uses as its foundation the primary objective of the university, education, in order to continuously adapt to the changing needs of a problem solving effort. The goal of the adaptive dialogue is to foster effective policy decisions in the face of highly complex and uncertain problems without seeking to find "impossible scientific certainty."

5.1 An Approach to Environmental Problem Solving: MIT Stakeholder Conferences

KEY POINTS

- **Identification of important stakeholding groups.**
- **Identification of issue areas.**
- **Creation of a conference format based on a goal of consensus-building or finding common ground among the participating stakeholders.**
- **Statement of intent to pursue solutions through conference follow-up work.**

Since the adaptive dialogue will represent a natural progression from, rather than a replacement for, previous university experience with stakeholder conferences, it will be useful to review the main components of the efforts described in Chapter 3. [Although MIT gatherings have been billed as both "workshops" and "conferences," we will for convenience use the latter term only for the remainder of this thesis.] Having decided upon a theme for a conference, the first task for university organizers is the identification of stakeholders who might agree to participate. As we have noted, any effort to approach a problem in a more collaborative, integrative manner would ideally include as many stakeholders as possible. The free exchange of information between stakeholders would be expected to minimize or eliminate the adversarial relationships that can inhibit successful policy making.

The identification process is relatively straightforward, regardless of the issue. The main requirement is a prior familiarity with the issue and an initial group of representative contacts. Since MIT researchers organize conferences around topics related to their own research, it is not difficult to begin building an invitation list. The desire for completeness leads organizers to solicit the opinions of those who are to be invited in order to generate a more complete list and to try to ensure that they do not exclude important players.

The second component of conference organization is the development of a substantive focus. The selection of a conference theme is a necessary but not a sufficient part of the effort to develop this focus. In order to attract stakeholders to a conference and to stimulate discussion among those who do participate, it is necessary to select specific topics around which to structure the proceedings. Typically, potential topics are discussed with and solicited

from the stakeholders whom the university organizers contact during the planning process. Each conference is unique in this respect, though in every case the organizers seek to find the issues that are of most pressing concern to the stakeholders as well as those that afford the stakeholders the opportunity to anticipate future concerns. The organizers of the steel conference worked closely with an industry trade association to frame the issues, while the organizers of the incineration conference undertook an extensive pre-conference study as a means of determining an appropriate conference focus. The first nuclear energy conference drew on the research of leading stakeholder representatives to design a conference that would cover the wide range of issues associated with future use of nuclear power; the selection of discussion topics was easier prior to the second conference because of the evolution of the issues in the intervening years.

The third component is the design of the format in which the selected issues are to be discussed and the articulation of the purpose behind the announced format. In general, organizers structure the conferences with an emphasis on direct communication between the stakeholders for the purpose of reaching consensus or finding common ground. Organizers employ various means to pursue their objectives, though in three of the four cases we looked at the university's role was as a neutral or objective party.

The steel conference comprised four technical sessions at which speakers provided background to prompt the open discussion that followed. In this case MIT was advertised as the facilitator for these discussions and as a potential resource for the steel industry to use as it worked to answer technical questions. The incineration conference organizers were explicit in their definition of the university as the "neutral" party facilitating a dialogue among opposing interests. Recalling two of the stated objectives of the

conference, organizers hoped that the stakeholders would leave with an understanding of the sources of disagreement and with new relationships that could foster the common search for solutions. The mechanism for achieving these objectives was a series of formally facilitated dialogues. To make this process work, organizers asked the stakeholders to agree in advance to a set of groundrules.

The nuclear energy conferences were similar to the steel conference in that they were based on a series of technical presentations followed by discussion. In addition, a respondant spoke prior to the discussion. The stated goals of these conferences were to foster "a common understanding" among stakeholders. However, the university organizers clearly stated in advance of the gathering that they represented another stakeholding interest and were not acting as a neutral party. We will return to this important distinction later. One of the objectives of the durable goods conference was a written statement of principles to guide future policy making. The format for this conference included both plenary sessions with invited speakers and breakout sessions for facilitated small-group discussions.

The final major component, common to all four of the efforts we looked at, is the expression of the university's desire to maintain a dialogue after the conference has ended. What is significant about statements by the university about this objective is that they are made in very general terms. The planning process did not include any direct measures to promote a continuation of the dialogues started (or continued, as the case may be) at the conference. Perhaps this is reflected in the fact that the follow-up to these efforts has been somewhat less than hoped, at least at this point in time.

The continuing "dialogue" proposed at the steel conference by MIT organizers would take the form of renewed university-industry partnerships

to conduct environmentally-oriented basic research. In its invitation to the incineration conference participants, MIT organizers stated that they intended to continue lending their support to an ongoing dialogue after the conference was over. The nuclear energy conferences were intended to "assist the process of communication" among the stakeholders. One of the three objectives of the durable goods conference was to formulate a process that would promote a continued post-conference dialogue among participating stakeholders.

By identifying stakeholders and issues, designing conference formats that would facilitate an open give-and-take among the participants, and proposing that the university work to maintain the lines of communication created at these conferences, MIT organizers took the initial, and very important, steps toward the kind of problem solving that today's environmental problems demand. And yet it would appear that something more should be done if the university is to assume an important and lasting role in the problem solving process. Some might argue that the university's role should not extend beyond the academic exercise of convening stakeholders in an environment hospitable to the free exchange of ideas. We would disagree, and would instead propose that the university need only step back, evaluate what it can and can not do well, and assertively move toward the new problem solving paradigm that the adaptive dialogue represents. As a first step in this direction, we turn now to the lessons we have learned through our examination of the four MIT-organized conferences.

5.2 Lessons from MIT Experiences

KEY POINTS

- **Numerous factors make the maintenance of a dialogue more difficult than is originally anticipated.**
- **Objectivity or neutrality is not necessarily the most appropriate function for the university.**
- **A goal of consensus or reaching agreements of any kind is generally too ambitious for any single conference.**
- **Planning for a stakeholder conference must focus as much on the conference follow-up (i.e. the continuing dialogue) as on the conference itself.**

Perhaps the most important lesson we can take from previous MIT experiences with multistakeholder dialogue processes is that for all the good intentions of the university organizers, it is extremely difficult to maintain a dialogue after a conference has ended. Following the incineration conference organizers circulated two documents to the participants, first an "Agenda for Action" and then a survey asking for opinions on the appropriate steps to be taken in light of the dialogue achieved at the conference. Despite a response acknowledging the benefits of a continued dialogue, there has been no additional follow-up to date. The organizers of the first nuclear energy conference were able to organize a second conference three years after the first, but there are no immediate plans for a third and presumably any dialogue among the participants continues only on an informal, ad hoc basis. Until very recently, there were no plans to continue the durable goods dialogue; organizers are now in the very early stages of planning a second conference (tentatively scheduled for Fall 1994). This is not to say that the kind of dialogue envisioned will not or can not be achieved; it merely points to the fact that more attention should be paid to what can or should occur in the intervals between physical gatherings on a university campus.

If a university-sponsored conference is to foster an ongoing dialogue, we feel that a university's articulation of the conference focus should comprise not only a
definition of the important substantive issues, but also of the expectations the university has for its role and for the way the other participants view this role. Integral to this articulation is an emphasis on the long-term nature of the process and on the idea that stakeholders will not solve problems in a two- or three-day gathering but will only be laying a foundation for future problem solving.

Nash (1988) proposed the role of university as mediator, suggesting that given the current nature of issues faced by society this role is the appropriate synthesis of the ivory tower, service station, and activist university models. In the cases of the steel and incineration conferences at MIT, the perception of the university was very much along these lines. The organizers of the incineration conference even made it clear in their invitation to stakeholders that they intended to be the "neutral" party. However, one or more of the stakeholding groups may perceive an initial university bias, making claims of neutrality or objectivity suspect. Within the university there may be a hesitancy to assume an objective stance, especially if the university fits the description of an activist institution. We feel that the university does not need to sell its services as a neutral, a mediator, or a facilitator, unless the problem solving effort originates outside the university and the stakeholders specifically request this kind of service. The nuclear energy conferences were particularly successful because MIT organizers clearly defined the role of the university as convener and as a stakeholder itself and not as an objective facilitator. When the impetus for the problem solving effort comes from the university, the appropriate role is

educator (see our discussion in Chapter 2). The research university is committed to the education of its students, but today, especially given the growing emphasis on applied rather than basic research, it would seem reasonable to expand the definition of who the university's students are. Industry officials, government regulators, environmental activists, and any other person or group with an interest in the subject of a problem solving effort would in effect become students of the university should they choose to participate in the process. Furthermore, whenever research funding might result from the dialogue initiated at a conference (which would be one expected outcome), the university becomes a stakeholder and should identify itself as such. By identifying itself in this manner, the university participants would be indicating that they expect to join the other stakeholders in a continuous learning process.

Concentrating solely on their roles as educators, university organizers seeking to engage stakeholders in a dialogue would no longer feel the need to define an alternative role based on neutrality or facilitation. Instead, they could focus on a new organizing principle: fairness. The ability of the university to provide an open forum in which stakeholders can state their positions and associated rationales directly to other interested parties is at the heart of the university's role as educator. Participants in the nuclear energy conferences made particular reference to the fairness of the process created by MIT and cited the value of this characteristic in the promotion of reasoned and lasting solutions. Similarly, participants in the incineration and durable goods conferences noted the value of the opportunity to exchange ideas with and learn about the perspectives of the other stakeholders, in some cases for the first time. Fairness, characterized by the open and free exchange of ideas,

is a key element of the adaptive dialogue's foundation, for it will help to build the trust that will be needed to keep the dialogue going.

Because the university will emphasize its role as educator rather than as neutral, and because the university will define a conference as the beginning of a long-term process, we can also dispense with the objective of reaching a "consensus" during the initial gathering. Consensus is a common theme at gatherings that involve multiple interests, which is natural given that the purpose of bringing interests together is to find common ground and develop solutions to mutually shared problems. The incineration conference provides an example of an explicit attempt to reach consensus; in the aftermath of the conference, participants said that consensus was a "naive" goal and that in any case they did not expect to reach any consensus. And yet conference organizers were very serious about providing a consensus-building forum. The durable goods conference also had as an objective finding areas of agreement among stakeholders, but by the end of the conference it was clear that the issues were so far-ranging that the best the participants could have hoped for was to more accurately define the appropriate questions. We feel that a clear statement from the university that consensus does not need to be an explicit goal of a conference is an important step in setting the tone for what is likely to be a long-term process. Consensus is desired whenever possible, but given the complexity of environmental issues it will only arise as the result of more work than can be accomplished in a short conference, if at all. Consensus may never be achieved when the set of related issues is especially complex, but this should not preclude effective policy making.

We can derive one final lesson from the other lessons described thus far. Conference planning must proceed simultaneously on two tracks: the

first would provide the framework for a successful physical gathering, while the second would ensure that planning for the gathering would lay a foundation for the post-conference dialogue. Table 5.2 summarized the In the next section, we describe the important elements of the planning process and the proposed mechanism for maintaining an adaptive dialogue.

5.3 Form and Function of an Adaptive Dialogue

KEY POINTS

- **A CONTINUOUS, ADAPTIVE DIALOGUE SHOULD BE VIEWED AS AN EDUCATIONAL, NOT A CONFRONTATIONAL, PROCESS.**
- **The identification of stakeholders does not end when a conference begins.**
- **Similarly, the identification of issues can be expected to change over time.**
- **GOVERNMENT STAKEHOLDERS IN PARTICULAR WILL BENEFIT FROM THE GROWING BODY OF KNOWLEDGE AND SHARED UNDERSTANDING GENERATED BY AN ADAPTIVE DIALOGUE.**

As we described in the previous section, an adaptive dialogue should be viewed as a continuous educational process. Focusing on an educational basis for a problem solving effort establishes a university like MIT as the appropriate institution to organize a dialogue.

We recognize the importance of using a conference format to initiate a dialogue process. In the conference setting, stakeholders have the opportunity to establish relationships in a way that only personal interaction can provide. Presenting an argument before a live audience is far more powerful than any other means of communication. However, preparations

for a university conference and the conference itself are only the prelude to the real task of problem solving. The adaptive dialogue's success depends upon the ability of the stakeholders to tailor their discussion and their research to the changing needs of a problem area and to maintain a high level of communication after a conference is over. Ultimately, the way in which a particular adaptive dialogue operates will depend on the objectives, the resources, and even the initial degree of polarization that the stakeholders bring to the dialogue. Our proposal for the adaptive dialogue is guided in part by the concept of the "virtual organization," a corporate management tool that offers a set of principles that seem especially relevant in light of the complexity of environmental problems (see box on following page).

In order to create an adaptive dialogue, we must take a second look at stakeholder and issue identification. When a proposed dialogue topic is very broad and still in a developmental stage (that is, consensus does not exist on the appropriate questions for a dialogue), it is more difficult to identify and include all of the stakeholding interests. While organizers in three of the MIT cases reported relatively little difficulty identifying the relevant interests, either because of a relatively limited focus (steel) or a preexisting set of dialogue participants (incineration and nuclear energy), organizers of the durable goods conference found that participants noted the omission or under-representation of what were considered to be key interest groups. This occurred despite organizers explicit attempt to limit the dialogue to two sectors of what is clearly a very large universe of potential stakeholders. It would generally be the case that the identification of some stakeholders could occur only after the dialogue had begun and the issues came into better focus.

However, in creating an adaptive dialogue, ensuring complete coverage of the stakeholding groups does not need to be of the highest

Guiding Principles : The "Virtual Organization"

The concept characterized by the use of the term "virtual" has established a firm foothold in the late-twentieth century industrialized world and is growing rapidly. What began as "virtual memory" in the early years of the computer industry has been appropriated by the corporate world and renamed "virtual organization." Today we see the beginning of a new industry that promises a "virtual reality" in which we will enjoy entertainment, shopping, and other previously mobile experiences from the comfort of our favorite chair. In each case, however, the underlying premise remains the same; to generate utility through the use of tools or techniques that do not rely strictly on physical associations.

Virtual memory in a computer enhances the computer's functioning ability by making it act as if it has more memory than it really does. In doing so, the computer "perpetually adapts to the needs of the user" (Malone and Davidow 1992). In industry, a virtually organized corporation is also based on the principle of maximizing adaptability. In order to take advantage of a business opportunity that requires capabilities beyond those which it possesses, a company would form temporary alliances with other companies that can provide those capabilities. Each company would enter the alliance to extract some benefit from a market to which it would not otherwise have access. As summarized in a Business Week cover story, the virtual corporation includes the following attributes: Excellence - each contributor to the organization is a specialist in one particular area, making the joint effort one of unsurpassed quality; Opportunism - the organization can act quickly to take advantage of a situation and just as quickly dissolve when it is no longer beneficial to remain in alliance; Technology - a key component of the virtual organization, electronic networks will facilitate the cooperative efforts of entities who are physically separated; and Trust - with each participant dependent upon the others, new levels of openness will be required (Byrne 1993).

Virtual corporations may or may not become commonplace in the future; there are already skeptics who dismiss the concept. Andrew Grove, Chairman of the Intel Corporation calls the virtual corporation a "business buzz phrase that's meaningless. It's appetizing but you get nothing out of it" (Byrne 1993). Indeed, with the commercialization of virtual reality applications, the term "virtual" is likely to become even more of a buzzword, largely devoid of its original meaning. However, the principles underlying a "virtual" approach to a problem or opportunity are of enduring quality, especially in the context of environmental management. The uncertainty and complexity associated with environmental issues would seem to require an approach based on the ability to utilize the best human resources, to react quickly to changes in the understanding of a problem, to use technology to maintain open lines of communication, and to continuously build the level of trust among stakeholders.

priority. While the organizers' goal should be to attract representatives of as many groups as possible (given the size and resource constraints of a proposed conference), those who are not part of this initial gathering would have the opportunity to participate as the dialogue emerges from the conference and continues to develop. To this end, the initial list of potential participants should be made as large as possible even though it should be acknowledged in advance that this list will probably be incomplete.

Just as the identification of stakeholders should remain fluid, so too should the identification of appropriate issues to include in the dialogue. In previous MIT conferences we have observed considerable attention paid to the formulation of issues for discussion. We believe that this will continue to be a necessity especially as topics encompassing an ever broader range of potential issues become the focus of conferences. If specific questions or issues are not part of the initial conference, the effort will likely become bogged down in disagreements over the direction in which the dialogue should proceed. In an adaptive dialogue, the choice of initial topics is of lessened importance because of the recognition that as the issues evolve the dialogue will incorporate those with the most bearing on future policy needs. Therefore, conference organizers need only choose issues that will serve to stimulate a discussion. Extensive advance research (e.g., for the incineration conference) combined with consultation with participating and non-participating stakeholders (common to all four of the conferences we described) should allow organizers to accomplish this task.

Participants will leave the initial stakeholder conference not with agreements or answers, but with the momentum and the incentive to

continue talking. The organizing university would assume the initial responsibility for forming a communication network to facilitate the continuing dialogue. The primary means of communication would be electronic with provisions for those who do not have networking capabilities. The dialogue will focus initially on a limited subset of topics (to maintain focus and manageability), preferably a subset agreed upon by the stakeholders at the conference. Clearly this initial topic selection might mean that some of the original participants may have less of a need to be actively involved in the early post-conference discussion, but they would be asked to remain actively in the process as the dialogue would be expected to slowly expand back into their particular area of concern. All stakeholders would be encouraged to contribute whatever knowledge or perspective they might have regardless of the specific focus of the dialogue.

The substance of the dialogue would be limited only by the stakeholders themselves. An important component would be the reporting of research results as well as descriptions of ongoing and planned research efforts. If necessary, MIT would serve as a clearinghouse for information, compiling summaries or otherwise facilitating the transmission of information in a timely, concise manner. The university organizers would be responsible for the mechanics of the network and for publishing periodic summaries of the dialogue proceedings to distribute to the participants; for those not tied in to the network, these reports would serve as the primary link to the dialogue. The dialogue's success will depend heavily on the provision to <u>all</u> identified stakeholders of <u>complete</u> information; anything related to the dialogue issues that one participant brings to the dialogue would be made available to all participants.

A key to the dialogue would be the ability to add new participants and to adapt the substantive focus as the dialogue matures and evolves. Rather than simply curtailing the discussion of a topic or set of topics, the intention would be to expand the dialogue and tie new topics into those already in the network. This would serve to promote and reinforce the integrative needs of the overall dialogue. Participants may elect to leave the dialogue, citing anything from philosophical differences to a feeling of satisfaction that they have attained a desired outcome. The departure of a stakeholder would not represent a breakdown in the process, since they would remain a part of the network and could re-engage at any time.

Stakeholders at other universities would be significant contributors not only to the initial conference but to the dialogue, especially in terms of communicating information on research. At some point, it may be desirable to transfer the more administrative duties from the dialogue-initiating university to another participating university, or to set up a rotating schedule for the preparation of the periodic reports. The involvement of other universities would also be important in terms of identifying and initiating new research efforts; research should be collaborative whenever possible to reflect the nature of the dialogue.

It would be desirable to reconvene the current roster of participating stakeholders on a regular or semi-regular basis. As we have described, the opportunity to interact directly with other stakeholders is of great value and would help to re-focus and reinvigorate the dialogue. We envision yearly meetings as a start, but the schedule would depend again on the dialogue's needs as defined by the participants. A yearly meeting might best serve as a way to address in a more comprehensive manner a particular point that has caused some difficulty in the dialogue; this would create the advantage of

convening a very focused conference, where advance work would be built in to the ongoing process.

The way in which the adaptive dialogue becomes a policy making tool is straightforward. Any of the full-time or part-time dialogue participants as well as interested non-participants, faced with the need to make a decision related to the issues in the dialogue, could tap into the collected body of knowledge as if it were a database. If the topic of interest had been part of the dialogue, the decision-maker would have access to the most current scientific and technical information and would quickly be able to get a handle on the current perspectives of the stakeholders, the continuing points of disagreement, and the reasons why disagreement still exists. With this information in hand, the chances for effective policy are improved. In theory, opposition would be lessened because those who disagree with the policy decision would at least have been a part of or had access to the process from which the decision arose. If the dialogue is carefully managed and well-publicized and the major policy players are involved (as we hope they would be), then there should be a smooth interface between the dialogue and the policy making process. Policy making would be guided by the dialogue just as the dialogue would be guided by the needs of the policy makers.

5.4 Chlorine Revisited

As we have described, we will have an opportunity in November 1994 to create an adaptive dialogue for the purpose of addressing the management of the future use of chlorine. The workshop will be limited to approximately 100 representatives from government, industry, environmental groups, and the academic community. Our efforts to develop an invitation list for the

workshop began with the compilation of approximately 30 names representing each of the four main stakeholding groups: government, industry, non-governmental organizations, and academia. The next step will be to use our resources and those of the initially identified group to generate a mailing list of at least 500 people. The initial letters of invitation will include a description of MIT's vision for an adaptive process that stresses the university's role as a provider of a fair process in an educational framework.

It is crucial that the concept of adaptability be central to the planning process, including the development of the participant list and the creation of a suitable agenda. We believe that while it is important to attract representatives from the widest possible range of disciplines and perspectives, it will be more important to impress upon the participants that they are only the core of what will be an ever-expanding network of stakeholders. Even if the workshop were not limited in its size, it would be impossible to identify and attract representatives of "all" stakeholding groups because the chlorine debate has not matured sufficiently to know with confidence who all the stakeholders are. A major goal of the workshop should be to enlist the participants in the effort to identify more stakeholders. This and the creation of a database of stakeholders during the invitation process will facilitate the addition of new voices to the dialogue as it evolves.

Structuring an agenda is a more difficult task. The number of issues that could be discussed is very large and constantly growing. Our goal is to prevent the workshop from turning into a forum in which arguments already widely known throughout the stakeholder communities are repeated. On the other hand, since we hope that the workshop will be the first occasion for some of the stakeholders to interact directly, it will be useful to ensure that the group share a common understanding of what those arguments are. To

this end, it would be useful to generate a background document, similar to that prepared for the 1988 incineration conference, that highlights the key attributes of all known stakeholder positions. If such a foundation document can be prepared, with the cooperation of the participants, in advance of the workshop we will be able to build on this foundation when the stakeholders convene.

We have developed a tentative agenda that asks participants to look at the chlorine issue in a broad context. Industry, government, environmental advocate, and academic views would be heard regarding the following questions:

- What are the important problems associated with managing chlorine use?
- What are the important research needs?
- What are the important policy needs?
- What can the university do to promote cooperative multistakeholder problem solving?

These questions could promote dialogue on a variety of topics: What research is ongoing? What is the rationale for that research? Are chlorine substitutes on the horizon? What interventionist mechanisms can governments employ? What are the barriers as well as the incentives for innovation faced by industry? Can risks be prioritized? It is difficult to predict the directions in which workshop discussions might go, nor is it necessary to try to push participants toward one topic or another. During the planning stages, we will listen to participants' opinions on appropriate topics and try to structure the agenda around areas of common interest. However, we feel that at this stage

of the dialogue the specific substance of a two-day workshop is of secondary importance. If we are to articulate any objective for this workshop, it should be to define and begin planning the mechanism that will allow the workshop discussion to continue as part of an adaptive dialogue. We have learned from the experiences of others that it is not enough to articulate a goal of continued dialogue if concrete steps to promote that dialogue are included during the planning and execution of a stakeholder gathering. As a means of establishing an initial framework for the dialogue, substantive issues will be an important part of the workshop. But without considerable attention paid to the question of what will happen when the workshop ends we are unlikely to see the evolution of the university role that we believe is both useful and necessary.

Throughout the coming months, it will be interesting to observe the reaction of the stakeholders to our proposal. We are hopeful that they will recognize the opportunities of the adaptive dialogue and will engage in the process with enthusiasm and resolve.

CHAPTER 6 - CHALLENGES AND OPPORTUNITIES

The adaptive dialogue is not a complicated idea and it is not far removed from mainstream thinking about the need for more cooperation and integration in the search for solutions to environmental problems. Where it does differ from current thinking is in the way the adaptive dialogue recognizes and incorporates the nature of the problems it is designed to address.

We recognize that many issues would require resolution if the adaptive dialogue is to function as envisioned. An obvious question concerns sources of funding for a sustained problem solving effort. While the university responsible for coordination will require financial support, the amount should be kept to a minimum and should remain separate from funding provided for related research efforts. Funding mechanisms must be carefully constructed so as not to create the perception that the process is biased in favor of one or more interests over the others.

The university must also be prepared to address concerns that it will not be able to maintain the role we are proposing for it. Stakeholders might be concerned that the university researchers will lose interest in an issue like chlorine in favor of another issue that is gaining in prominence. They may also be concerned that the constant turnover in graduate students, who will provide assistance to the dialogue effort, will be an ongoing drain on the institutional memory needed to sustain a long-term effort. Our response to concerns like these is that the work will not be concentrated at one university, it will only begin at one university. Furthermore, the continuous expansion of a dialogue to encompass and integrate a variety of disciplines should ensure that there will always be interest in the academic community. Just as

other stakeholders can come and go depending on the needs of the dialogue, so too can academic representation and administrative responsibilities shift from one university or research group to another.

An equally important concern for organizers of multistakeholder gatherings is getting the desired participants to accept the university's invitation to a conference. In some cases, as we observed with the steel and nuclear energy conferences, the reputation of MIT has real drawing power. This would particularly be the case when the issue has a significant technological component, as is the case with most current environmental issues. However, reputation alone will not ensure a successful conference. The university must take into consideration the incentives each stakeholding group has to attend or not to attend a gathering of this kind. For example, a fundamental difference between the effort to address the future use of chlorine and the effort to address a specific topic like coke oven emissions at steel plants (one of the primary issues at the steel conference) is that the former is concerned with products while the latter is concerned with process. It should not be surprising that there would be some reluctance on the part of the chlorine industry to participate in a dialogue that has as one of its central themes the potential banning of chlorine products. On the other hand, the steel industry is very willing to participate in a dialogue that seeks to find solutions to the legislatively mandated coke oven emission regulations. The steel makers do not need to argue for their very survival, they only need to participate in the search for better ways to manufacture a product that all agree is a necessary component of the world economy.

The chlorine-producing industry has already expressed a willingness to participate in a process that does not begin with the presumption that chlorine will be banned or otherwise regulated. Their incentive to participate

increases with their belief that the process will be open to all policy options. Environmental organizations may be less inclined to participate because of their feeling that the trend in regulation favors their agenda and that to exchange ideas with industry might be seen as a willingness to accept compromise at a time when they should press their advantage. However, as the incineration and nuclear energy conferences indicate, environmental groups do not hesitate to take advantage of the opportunity to have an equal voice with industry in a problem solving setting. Government representatives are generally open to the idea of meeting with stakeholders and, as we have indicated, the trend seems to be toward a preference for this kind of approach. The challenge is to convince government agencies that a conference leading to a dialogue would be more than an academic exercise and in fact could be a valuable policy making tool. We feel the best approach for the university to take in providing each group with the incentive to participate is to be very clear about the goals of the conference and its aftermath and to be equally clear about the function the university will play in achieving those goals.

A significant general concern among participants might be that it is unrealistic to believe that governments will not only participate actively in an adaptive dialogue but will also rely on them to assist in the policy making process. We agree that it would not be appropriate or very realistic to propose a change in the actual policy making process that occurs in a federal government. The layers of bureaucracy that exist can not simply be replaced by a process that makes the government only one of many interested parties. We do not propose that the power held by the federal government to make policy should be in any way diminished. However, we do propose that the government would be well served to support and participate fully in this

process as a stakeholder. What a government needs to make more effective policy is access to the best information available and the broadest support possible from the interests with a stake in the final policy formulation. When the policy making necessarily requires some consideration of technical matters, the adaptive dialogue provides a way for the government to have access to the most current information and, more importantly, to the many perspectives of the interests involved. Armed with this knowledge, government is more likely to be able to avoid the problems that beset it during adversarial policy making. There would be no guarantee that everyone would come out of such a process feeling as if they had achieved the optimal outcome, but if the process works there will be less divergence among interests and less likelihood that final policy decisions leave one or more positions feeling left out, resentful, and poised to continue challenging government's efforts to move forward.

We close with a few words about what is ultimately the greatest challenge to this or any environmental problem solving effort. Our increasing understanding of the most complex environmental problems leads us inevitably to the conclusion that the best solutions will be international in scope. We have implicitly described "government" participation in the adaptive dialogue as the involvement of officials from the United States, but this stems only from our familiarity with the policy making arena in the U.S. and the likelihood that the focus of our efforts will be on issues affecting U.S. policy. We should always strive to include participants from other countries in these dialogues, so that as the dialogue grows it may become more useful on an international scale. We are encouraged by the successes of previous MIT efforts to bring international perspectives to their conferences; the nuclear energy dialogue stands out as an

example not only of this but of the positive effect that this added perspective can have on a dialogue. We are also encouraged by the Norwegian community's support of MIT's efforts to promote the chlorine dialogue. Creating a process that allows an adaptive dialogue to cross international political boundaries in support of global policy making may never be fully realized. We leave this task as an opportunity for continued research.

APPENDIX 1

MIT Conference Summaries

Waste Incineration Conference "Agenda for Action" (June 1988)

Design and Disposal of Durable Products (March 1993)

WASTE INCINERATION:
AN AGENDA FOR ACTION

OUTCOMES FROM A CONFERENCE AT MIT IN JUNE 1988

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Agenda for Action:
Suggestions From All Parties Involved in Waste Management

This report is the result of a June, 1988 meeting held at the Massachusetts Institute of Technology entitled Waste Incineration: Confronting the Sources of Disagreement. About 25 people from industry, government, environmental groups, citizens groups, and academia attended the meeting; its purpose was to clarify the sources of disagreements over incineration as a waste management technology, and search for areas of potential agreement. A participant list is included as an attachment to this report.

After the meeting, we drafted an Agenda for Action which recounted the ideas generated at the meeting. We sent this Agenda to the participants, and requested editorial comments, reactions and additional suggestions. This report derives from the returned surveys. Rather than reiterating each suggestion, we have reorganized and consolidated the most prevalent ideas. They fall into five categories which correspond to major stages or aspects of the waste management process (waste management planning, facility siting, facility operations and monitoring, regulation and permitting, and public education).

In response to a number of comments, we refocused this paper from the narrow concept of incineration as a technology for waste management, to waste management as a whole. (In this document, "waste management" is construed to include waste or source minimization, as well as the reuse, recycling, treatment and disposal of whatever remains.) This change addresses the concern that incineration cannot be considered apart from other waste management options, and that part of the problem with many incineration proposals is that they do, in fact, attempt to separate incineration from the broader concept of waste management. Because the conference did focus on waste incineration, this paper does not attempt to address in a complete way the larger issue of waste management; rather, we have changed the discussion of incineration to reflect its relation to these larger issues. For example, many of the most useful suggestions were directed specifically

toward incineration issues. We have incorporated these suggestions, but broadened their applicability whenever possible to all waste treatment technologies.

A related concept which pervaded the conference discussions and written suggestions was the need for waste management planning. Particular facility siting or permit proposals are difficult to accommodate (from the citizen/environmental perspectives) without some objective determination of the need for that facility, considering the current and projected future waste streams, front-end minimization, and alternative treatment options. For this reason, a particular facility siting or permitting effort will be facilitated by a prior planning effort. Therefore the bulk of the suggestions which follow address ways to improve waste management planning. However, as facilities will undoubtedly continue to be proposed in the absence of prior planning efforts, suggestions which are useful in these situations are also included.

Principles To Guide Waste Management Efforts

The following two principles pervade all of the suggestions which follow. Parties should use these principles to guide their waste management proposals and actions.

A) Waste management, including front-end minimization, is a social responsibility which must be shared by industry, government, public interest groups, and the citizens themselves. Any effort to change the status quo must explicitly recognize this shared responsibility. "Shared" in this context means that all parties must be willing to take steps towards improved waste management practices.

B) Any waste management strategy should reflect the following hierarchy of preferred options: a) reduce the amount of waste generated, b) reuse and recycle, c) treat, and d) use land disposal for any treatment residuals and remaining waste.

Suggestions To Improve Waste Management Planning

The following suggestions apply to any parties involved in waste management planning. As item A) makes clear, the preferred planning scenario is one in which all interested parties take part. However, these suggestions should be helpful to any waste management planning effort.

A) Developing plans and other documents which identify current and future waste management options will assist the management process. In addition, documents such as environmental impact and health risk assessments will assist any subsequent facility siting and permitting efforts. The following principles should guide the creation of these documents:

   1) The document preparation process should reflect the shared responsibility for waste management. Each stakeholder group should have a direct role in determining the plan's content. "Direct" in this context means a primary role, as opposed to a commenting-on-the-draft role.

   2) Each party to the planning process must acknowledge that the document may prescribe changes to the status quo in order to create options for future action; changes in current practices, norms, and comfort levels may be required of all parties.

3) Each party to the planning process must acknowledge the importance and legitimacy of both technical and non-technical concerns in waste management.

B) The following actions, prior to or as part of any specific planning effort, would improve the document's reception by all parties.

1) Develop a joint understanding of the limits of recycling and the limits of treatment technologies.

2) Develop broadly acceptable risk assessment protocols.

3) Develop credible data bases.

C) The following elements could improve the analytical frameworks for comparing waste management options. Parties devising waste management plans should consider their use.

1) Models which the general public can understand.

2) Multi-media analyses, which account for impacts to all compartments of the environment and all routes of human exposure.

3) Cost effectiveness analyses, including an assessment of the cost-effectiveness of not producing a particular waste.

4) An accounting of social costs and benefits of the alternatives, including the "no action" alternative.

5) An analysis of short-term benefits vs. long-term liabilities.

6) A discussion of the unquantifiable, intangible impacts a facility may have on a resident's way of life. The analytical framework should not discount such factors simply because they are not quantifiable.

7) Health risk analyses should not use cancer risk as the sole indicator of risk.

D) Waste management plans should examine a wide range of facility development possibilities to meet the area's needs. For example, the plan could examine:

1) Creating novel partnerships between the public and private sectors to build and operate waste treatment and disposal facilities.

E) In designing a waste management planning process, the government should consider the following techniques:

1) The use of specific representatives from all parties to provide consistency in the planning efforts.

2) The use of public meetings and workshops to scope concerns outside those raised by the parties preparing the plan; use forums other than the traditional "hearing" mechanism.

3) The use of independent consultants.

4) The use of public and private funds to assist those parties who wish to participate but do not have sufficient resources.

5) The use of a "generic" environmental impact statement or health risk assessment to describe waste management alternatives and their advantages and disadvantages.

6) The use of dispute resolution processes, such as facilitation and mediation, to help the participants agree on plans for action.

Suggestions to Garner Support for Waste Management Planning and Facility Siting Efforts

The following suggestions address ways to garner support for specific waste management planning and facility siting proposals. Like the suggestions above, they are useful for parties involved in waste management planning, but they are also useful for parties involved in facility siting and permitting. Although any siting effort would be aided by a previous or coincident planning effort, often facilities are proposed without a planning document in place. These suggestions should be helpful in either case.

A) Support for efforts to manage and control waste production and disposal may be expected to increase if:

1) All parties exhibit a willingness to explore a wide range of management options and/or facility sites.

2) All parties invest time and energy into understanding each other's points of view.

3) All parties make conscientious, visible efforts to build each other's trust and enhance their own credibility.

B) Support for waste management efforts may be expected to increase if the shared responsibility for waste management is made an explicit element of a plan's implementation or a facility's operation. Ideas toward incorporating this shared responsibility include the following:

1) All parties should aggressively enforce any new ordinances, policies, or facility permit conditions which arise from the plan. For citizens, this may mean encouraging friends and neighbors to participate in recycling efforts or household hazardous waste collections. For industry, implementing a self-monitoring system. For government, conducting inspections and pursuing penalties against violators.

2) The parties should continue their open exchanges of information through such forums as regular meetings, innovative communication networks (such as citizen concern hotlines), or third-party audit results distributed regularly to local residents.

C) Support among industry and the government for the public's demands concerning waste management proposals may be expected to increase if:

1) The public acknowledges that every individual is a waste generator, and every individual has helped create the waste disposal problem.

2) The public demonstrates a willingness to change its everyday actions and habits, (just as the public demands that industry redesign its processes and priorities), in order to create a more manageable waste stream.

3) Environmental and citizen leaders spearhead the efforts to communicate these needs to the rest of the public; these messages do not have the same credibility if communicated by industry or government representatives.

D) Support among the general public for waste treatment proposals may be expected to increase if:

1) Industry implements reasonable source reduction programs first, and then demonstrates that incineration is a necessary technology for managing a certain portion of the unavoidable wastes.

2) Operators agree to consistently provide the community with unbiased information regarding the facility's operations and impacts on the community. "Unbiased" in this context means that the information is provided in such a manner that the operator cannot alter or influence the data; real-time monitoring data accessible at community libraries is one example of unbiased information.

3) Industry and government establish enhanced information, education and outreach programs to inform the public about waste management efforts already underway.

Suggestions To Improve Waste Management Facility Operations

The following suggestions address changes to operational aspects of facility operation. Although all parties would benefit from these changes, they lie primarily within the authority of the facility owner/operators. By voluntarily incorporating these suggestions into a facility proposal (as opposed to agreeing to them at another party's insistence), operators could gain good will and enhanced credibility benefits in addition to the benefits inherent in the suggestions.

A) Training and certification of incinerator operators would benefit all parties. It would ensure a consistent minimum standard of operator performance, thus

1) Achieving the desired level of service and safety.

2) Enhancing the facility's credibility by assuring operator competence.

B) Monitoring programs which provide both the operators and other parties (local residents, environmental groups, and citizens) ready access to information about the facility are an important element of the shared responsibility for waste management. The following sorts of programs could benefit all parties:

1) Continuous monitoring of compliance-related parameters such as carbon monoxide, residence time, and temperature, transmitted to the other parties via computer, daily reports, or other means. The data should be in a form easily understandable by the intended audience.

2) Regular communication opportunities where the operators can keep the other parties current on the plant's operating status, future plans, problems and solutions, and where the other parties can ask questions and express concerns and suggestions.

Suggestions To Improve Waste Management Facility Permitting and Regulation

The following suggestions address regulatory changes which would ease the permitting of waste management facilities. They are particularly relevant to industry and government, but to other groups as well to the extent that they can influence the regulatory processes. These suggestions could be addressed immediately; they do not require a particular situation to be useful.

A) The following regulatory changes would improve the standard-setting and/or siting process for particular facilities.

1) As knowledge evolves, so should standards. In facilitating this evolution, however, parties must strike a balance between fixed (and soon-to-be-obsolete) standards, and too frequent changes which result in a moving target.

2) The process by which standards are promulgated and reviewed must be made more efficient.

3) Total emissions into all media should be monitored, including ash as a type of emission.

4) Environmental performance standards should be promulgated for recycling centers as well as for treatment facilities.

5) Standards should incorporate occupational health and safety concerns.

6) Regulations should encourage and make recycling more attractive (but not at the expense of lenient health-protection requirements).

Suggestions to Improve Public Education in Waste Management

The following suggestion addresses public education, which certainly could improve the waste management efforts. Implementing these suggestions is not necessarily within the authority of the conference participants. Nevertheless, to the extent any party can help bring them about, all parties could benefit.

A) Broad public education efforts are necessary to inform people about the importance of, and difficulties associated with, responsible waste management. Possible forums for such efforts include:

1) Grade school education in pollution prevention, including educating the teachers.

2) Educating community leaders through service club talks.

3) Widespread community awareness campaigns.

Design and Disposal of Durable Products: *What's the Best Route?*

Report from the Conference*

In March 1993 the Center for Technology, Policy and Industrial Development at the Massachusetts Institute of Technology sponsored a conference entitled "Design and Disposal of Durable Products: What's the Best Route?" The purpose of the conference, as stated by conference organizers in advance of the meeting, was three-fold:

- To assess, from the point of view of representatives of all the major stakeholding groups, the strengths and weaknesses of the different approaches to fostering "green" durable products.[1]
- To produce a written statement of principles to guide those responsible for developing future U.S. public and private policy in this area.
- To design a process for continued environmental policy dialogue on durable goods among all concerned interest groups.

This report summarizes the findings from the conference. It was prepared by conference organizers and represents their view of the major points of agreement and disagreement raised at the meeting. To place these findings in perspective, this report also discusses the roots of the durable products issue in the U.S., as well as the format and organization of the conference.

Emergence of durable products as an environmental concern

Public concern over the environmental impacts of durable products is awakening in the United States. This concern is rooted in two related environmental issues. The first is the problem of diminishing sites for municipal solid waste disposal. This problem emerged more than a decade ago as local disposal sites reached capacity and closed in many communities.

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* Nash, Jennifer. 1993. Design and Disposal of Durable Products: What's the Best Route? Report from the Conference.

[1] "Green" products are products whose manufacture, use, and disposal cause minimum damage to the environment. Durable products are consumer products that are intended to remain in use for at least three years.

Public opposition made the siting of new facilities nearly impossible, and disposal costs escalated.

Until recently, policy makers in the U.S. have focused upon modifying product packaging as a first attempt at solving the solid waste disposal problem. Local governments have initiated programs to recycle paper, metal, glass, and plastic containers. While costly, these programs have increased recycling rates for packaging in many communities. But packaging only accounts for approximately one-third to one-half (by weight) of the municipal solid waste stream. To achieve greater reductions, policy-makers have begun to look beyond packaging to focus upon products, particularly large durable products such as automobiles and electronics. Because of their size and the potentially toxic materials they often contain, disposal of these products can be especially difficult. Recycling is also problematic due to the complexity of both the ways products are designed and the materials used to make them.

The second issue at the root of emerging public interest in durable products is concern that current patterns of consumption of the earth's natural resources are not sustainable. While concerns over sustainability have been evident before (for example, during the 1970s Arab oil embargoes), the issue rose to prominence in 1992 during the Earth Summit in Rio de Janeiro, where sustainable development was the central theme. The Earth Summit prompted much discussion about the roles of government and business in husbanding and conserving the earth's resources for succeeding generations. As policy-makers have grappled with the idea of sustainability, durable products have emerged as a possible target for legislative action. Durable products require large quantities of natural resources in their manufacture and use.

In the U.S., new policy making at the federal level with respect to durable products is in a preliminary stage. Debate over reauthorization of the 1972 Resource Conservation and Recovery Act (RCRA) in 1991-92 included discussion of mandatory use of recycled materials in manufacture and "environmental" labeling that would tell consumers whether a product contains material that is recycled or recyclable. These initiatives are similar to proposals made with respect to packaging. At the time of the conference, neither of these proposals was under active discussion by lawmakers.

Policy making has progressed differently in Europe. An approach known as "extended producer responsibility" is being adopted in several

European countries, in various forms. "Extended producer responsibility" means that producers take responsibility for the environmental concerns generated through manufacture, use, and disposal of the products they make. The reasoning behind this approach is that producers are in the unique position of being able to redesign products and packages to make them more environmentally sound throughout their life-cycles. In Germany, government has issued a series of regulations requiring manufacturers to establish and finance systems to "take back" and recycle consumer and transport packaging. The German government has further proposed that manufacturers of automobiles and electronic and electric appliances institute "take back" programs for their products, and is currently negotiating with industry over how the programs will be implemented. The Netherlands and Sweden are also developing policies to extend producer responsibility.

The question conference planners urged the group to consider was not whether something should be done to reduce the environmental impacts of durable products but how to create an effective public policy framework to address this problem. Conference organizers asked participants: What policies should be used and who should be in charge? Should government establish the duties for those involved in the manufacture, use, and disposal of durable products? Should the task be left to those in business? How should responsibility be allocated among all the actors, including the consuming public?

Conference Participants and Organization

Conference planners decided to focus discussion upon two major industries -- automobiles and electronics. Autos and electronics are the targets of pending "take back" regulation in Germany. Planners invited leaders from most of the major stakeholding groups involved in shaping environmental policy for these products -- manufacturers and suppliers, state and federal government, and environmental advocacy groups. The conference was open to anyone representing an organization or business with an interest in this area. Ninety-three people participated. Participation included fourteen electronics companies, ten automobile companies, nine agencies of the federal and state government, seven non-governmental organizations, six suppliers, six universities, five consulting companies, four professional societies, two recycling companies, and one member of the press.

Notably absent from the conference were firms representing the virgin materials industry. Also, the dismantling, reclamation, and recycling industries were underrepresented.

At an opening session conference planners asked participants to agree to a rule: no one would attribute any of the comments made at the conference to an individual without his or her expressed consent. With no debate, everyone agreed, and discussion began. One of the objectives of conference planners was to initiate a dialogue among stakeholding groups before these groups developed inflexible positions regarding specific legislative proposals. Perhaps because of this timing, the tone of conference discussions was open and positive. People seemed to be listening to one another, and there were few sharp or angry responses.

Conference planners organized the conference into two major parts. The first part explored *public policy approaches* governments are using to encourage environmentally sensitive product design and disposal. The second part included discussions of *private sector initiatives*, in place now or planned for the future, to spur development of "green" products. Each part began with presentations from speakers. Speakers included representatives from the European and U.S. auto and electronics industries, an environmental advocacy group, and the staff member of the Senate committee responsible for environmental legislation. Following the presentations participants broke into three working groups of approximately 30 people each. Working groups were led by facilitators who helped the group develop its agenda, stay within time limits, and identify areas of agreement and disagreement. (A copy of the conference agenda is attached to this report.)

At the final conference session all participants came together to hear reports from the working groups. While each group's discussion was different, many themes were common to all three groups. While there was probably no area in which conference participants were in unanimous agreement, on many matters concerning the general direction of public and private policy *most* participants agreed. The remainder of this report attempts to capture the sense of conference discussions.

Findings from the conference

Points one through seven below represent the areas in which participants were largely in agreement. The explanatory paragraphs that follow each point draw out some of the places where participants saw things differently and disagreed. Together, these findings provide general guidance for policy-makers working to address the environmental concerns of durable products.

1. Conserving natural resources should be a primary objective of public policy concerning the manufacture, use, and disposal of durable products.

Facilitators began the first working group by asking participants to address the question "What are helpful public policy initiatives to foster recycling of durable products?" People in all three of the working groups were dissatisfied with this question and spent time initially to rephrase it. Nearly everyone felt that "recycling" was too narrow an objective.

After debate, all three working groups came to the conclusion that conserving natural resources should be the objective of public policy in the area of durable goods. Natural resources include clean air, water, and land, as well as energy and virgin materials. Conserving resources encompasses activities such as reducing use of hazardous substances, increasing the efficient use of raw materials, and conserving energy in manufacturing.

Not everyone who attended felt that public policy should be developed to address the environmental issues surrounding durable products. Many, in fact, felt that policy-making at this time would be premature. But most participants agreed -- given the premise that policy is forthcoming -- that the appropriate focus should be upon conserving resources. Support for this objective was strong and widespread.

2. Lack of understanding and information impedes action.

Conference participants cited lack of understanding as a major impediment to effective action -- on the part of governments, companies, and consumers. Representatives of the different groups, however, focused upon different areas where they felt understanding needed to improve. Many from industry focused upon the need to improve understanding of the environmental problems (if any) that durable products pose. They said that public policy

should not be developed without clearer articulation of these problems. Industry representatives also stressed the need for better knowledge of life-cycle assessment (LCA) techniques. Representatives from environmental advocacy groups said that industry should not use the need for understanding as a "delay tactic" and that decisions must be made with "imperfect information." They emphasized that environmental information that is already available is generally poorly organized and not easily accessible.

Participants agreed that consumers need to develop better understanding of the environmental impacts of their purchasing, use, and disposal decisions. Many conference participants felt strongly that education of consumers should be a top priority. But there was no consensus about who should educate consumers, and about what concerns.

To address the problems of inadequate information and understanding, many participants called upon the federal government to:

Support research to provide basic information on the environmental impacts of durable products manufacture, distribution, use, and disposal.

Research should:

- Document impacts of all stages of the product life cycle, especially the early stages in which raw materials are extracted;
- Be developed through the joint efforts of representatives of all the stakeholder groups;
- Be publicly accessible;
- Be integrated into other environmental databases.

Initiate at the federal level a process to achieve agreement and clarity on definitions and standards.

Much discussion occurred in all three working groups about the need for federal definitions of terms such as "virgin resource content," "recycled," and "recyclable." Nearly all participants, from a cross-section of stakeholding groups, agreed that clear and standardized definitions would benefit everyone. They concluded that the federal government should initiate a process in which representatives from all groups could take part in developing new definitions as well as standardizing the definitions used in existing regulations.

Most of the companies represented at the conference operate in many countries. Their products are manufactured, sold, and disposed of in a global marketplace. Conference participants urged policy-makers in the U.S. to work to harmonize U.S. standards and definitions with environmental initiatives world-wide.

3. Public policy should foster innovation and learning.

Conference participants called for the development of policies that would allow responsible actors -- government, producers, and consumers -- to experiment and learn about effective approaches to conserve natural resources. They offered two recommendations:

Institute voluntary initiatives modeled on the EPA "Energy Star" and "33/50" programs.

Conference participants said that the EPA programs "Energy Star" and "33/50" were models of programs that foster innovation and learning. One participant suggested that government initiate a program of voluntary resource conservation goals for companies. This suggestion was supported by others who noted that companies determined to become environmental leaders would move quickly to meet the goals, and that their learning could then be transferred to other firms. Several people said that such a program would be particularly helpful for companies that are just initiating recycling and conservation efforts. Participants explained that the objective of initial public policy efforts should simply be to "get things going." An additional benefit, according to representatives of environmental groups and some others at the conference, would be to make firms accountable for their environmental activities with respect to durable products. Several representatives from companies cautioned, however, that EPA should institute voluntary efforts selectively since firms cannot respond effectively to a multitude of programs.

Make government a "model customer" through changes in procurement policies.

Representatives from electronics firms spoke of what they called "antiquated" government procurement requirements that mandate the use of new (rather

than recycled) materials in government electronics purchases. Participants asked government to become a "model customer" by requiring features such as energy efficiency, recycled content, and design for disassembly in products it buys. These requirements would give firms incentives to innovate. This proposal received broad support.

4. Policy should remove distortion from the market to make recycled materials competitive.

Representatives from industry and environmental advocacy groups spoke of the need to allow markets to stimulate development of "green" durable products. Several participants said that the key public policy question is, "what can governments, industry, and suppliers do to enhance -- and not interfere with -- market action that is already progressing?" Representatives from environmental advocacy groups stressed the problems caused by the existing subsidies for virgin material exploration and extraction. While not agreeing on the magnitude of market distortions or the mechanisms that should be used to remove them, participants agreed that an important objective for public policy should be to "level the playing field" to internalize environmental costs and allow recycled materials to compete with virgin materials.

5. Policy should reflect the diversity of the durable products industry and the different opportunities and constraints producers confront.

Many participants voiced support for the general principle that "every manufacturer should recognize the impact of products beyond manufacturing and sale and devise strategies to reduce that impact." However, no agreement could be reached with respect to the types of strategies that would be appropriate. Participants felt strongly that what is appropriate would depend upon the product, industry, and market conditions. Representatives from the automobile and electronics industries stressed the different opportunities and constraints they face.

Auto industry participants reported that extensive recycling is already taking place now for cars in the U.S. and Europe. "The automobile is among the most highly recycled of all products, at 75 percent by weight," explained one auto executive. Auto recycling is done by the "economically viable" and "highly efficient" recycling industry. Companies that recycle cars operate independently from auto companies; both the recycling and auto industries want to maintain this independence. Several auto industry representatives pointed out that labor costs in the recycling industry are lower than in the auto industry, and that if the auto industry were to enter the recycling business, "labor rates would escalate, making recycling more costly and less economical."

Those from the auto industry also stated that cars manufactured today contain some 600 pounds (25 percent by weight) of non-metallic material -- plastic, rubber, glass, fluids, and fabric -- which, given today's technology, markets, and infrastructure, must generally be landfilled when cars reach the end of their lives. They said the auto industry is working to address these issues through the Vehicle Recycling Partnership of "Big 3" companies and collaboration with plastic suppliers (via the American Plastics Council) and dismantlers.

In contrast, recycling is a new activity for most firms in the electronics industry. A few large companies are experimenting with "take back" and recycling programs. But while an independent industry is well-established for recycling autos, businesses to recycle obsolete electronics are in start-up phases. Most used electronics are disposed directly in landfills, with no recycling. The electronics industry faces decisions about the role it will play in developing a recycling infrastructure for its products.

Conference participants stressed that the different needs of these industries should be reflected in policy.

6. Companies should strengthen internal management.

In addition to identifying actions that governments should take, conference participants said companies should also take steps to address the environmental concerns associated with durable products. Many of these steps are components of strong programs to address a broad array of environmental concerns, not just durable goods:

Commitment from the top of the company.

While participants agreed that top management support is necessary, they noted that motivation can come from managers and "move up" to the CEO or can be ordered "from the top down." Building support throughout the company is essential. One tool to build support is a company statement of policy with respect to environmental management. This statement should recognize that in the context of profit and growth the company must produce products and services that are environmentally sound.

Establish communication linkages.

Participants stressed the need for companies to develop new mechanisms for internal and external communication about environmental activities. One group focused upon the need for communication among design teams in different product areas. Another emphasized the role of marketing departments in tracing changing customer expectations, competitor initiatives, and prospective legislation for feedback to the design teams. Companies should build awareness among suppliers regarding changes to their products and manufacturing processes.

Measure waste generation and natural resource consumption.

Companies need to develop programs to measure and assess their environmental performance in terms of the amount of waste they generate (both manufacturing and post-consumer waste) and resources they consume. Several participants noted that accurate measuring is very complicated. Just defining what is to be measured can require much thought and analysis.

Develop partnerships with outside suppliers, government, and consumers.

Manufacturing firms should provide incentives to their suppliers to develop new, less costly technologies that use recycled inputs. Partnerships with government, such as the voluntary programs noted above, can help to strengthen the credibility of firms' environmental activities. Many also felt that companies have an important role to play informing consumers about the environmental impacts of their products.

7. Institute a process to continue discussions.

Conference participants spoke of the need to "continue" and "extend" communication initiated at the conference. Communication should include a cross section of industries, government, environmental advocacy groups, and universities. Participants noted that few opportunities exist for such communication geared toward development of policy recommendations. Several people noted that discussions would benefit from increased representation from dismantling and recycling industries and virgin materials suppliers. Many spoke of the usefulness of having a university serve as the "neutral convener" of such a dialogue.

Cross-industry conversation was particularly helpful to people from the auto and electronics firms because it helped them recognize important differences as well as some common links. Representatives from electronics firms said they felt they could learn from the auto industry's greater experience with metal recycling. One common link among all of the manufacturing firms represented at the conference was an interest in plastics recycling. These firms are confronting similar issues as they struggle to recycle plastic and felt they could benefit from working in some form of partnership.

Assessing the conference

Conference discussions revealed broad agreement regarding the basic norms that should guide environmental policy with respect to durable products. This policy, in the view of most participants, should be driven by the need to conserve natural resources. Conference discussions also pointed to broad-based support for several federal initiatives: development of informational databases to quantify resources depleted in all phases of the life-cycle of durable products, definition of terms such as "virgin materials content," "recycled," and "recyclable," and procurement policies that would favor "green" products. In the view of most participants, these initiatives should be developed through the joint efforts of representatives of all stakeholding groups.

There was less agreement about the public policy instruments that should be used to foster actions to conserve natural resources. Many voiced

support for federally-initiated voluntary programs and market-based incentives. Preference for these policy approaches may be a reflection of the fact that most conference participants represented private firms. Had a greater proportion come from environmental advocacy groups and government offices, the approaches favored might have been different.

Following the conference, organizers asked those who attended what, if anything, they had gained through participating.[2] In general, people valued the opportunity the conference offered to share perspectives with people from different stakeholding groups. Several people noted that few opportunities exist for this type of sharing. Usually interaction is contentious, with little chance for an open exchange of views. While saying that the conference had been helpful in initiating a dialogue, many noted, however, that it was "too early" for a rigorous discussion of the pros and cons of policy options. "We're just beginning to define the problem," said one participant.

These views point to the value and the difficulty in convening stakeholders to help set the direction for environmental policy. Participants' willingness to come and speak openly, their ability to find some common ground, and their interest in continuing a dialogue, are endorsements for consensus-building meetings such as the MIT conference. One of the objectives of conference organizers was to initiate this process of consensus-building before stakeholding groups had developed inflexible positions regarding specific policy options. But discussions of policy at this early stage were by necessity general in nature. Going beyond the general findings developed at the conference will require further discussions among all stakeholders, including several key parties that did not participate.

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[2] Organizers distributed a first draft of this report and a conference evaluation form to all 93 participants. Forty-seven people sent back comments on the report and the completed evaluation.

APPENDIX 2

MANAGEMENT OF THE FUTURE USE OF CHLORINE

A SEMINAR SERIES SPONSORED BY THE
KANN-RASMUSSEN FOUNDATION

Meeting: 22 October 1993

TITLE: **A First Look at the Key Issues**

The first meeting of the chlorine seminar provided the participants with an opportunity to hear from Dr. John Ehrenfeld, Senior Research Engineer, CTPID, and Lecturer, Dept. of Chemical Engineering. Dr. Ehrenfeld gave an overview of both the chlorine use. As an introduction to his presentation, he provided a response to a question that one participant had submitted in advance. The question concerned the number of chlorine compounds of the 15,00 in commerce that have actually been studied in enough detail to even attempt to quantify their environmental impacts. While the answer is in fact very few, the important point brought to the attention of the seminar was that the issue of chlorine and its uses is one characterized by an enormous amount of uncertainty. A great deal of research has been conducted, but little, if any, consensus has been reached. The current controversy surrounding chlorine is a direct result of this lack of consensus.

Dr. Ehrenfeld's presentation provided a summary of the ongoing program at MIT, supported by the Norwegian governments, as well as Norwegian industry and environmental groups, to study the implications of regulating chlorine or even going so far as to completely ban chlorine production. This overview included brief discussions of the key policy questions, the major research tasks as defined by the MIT researchers, and a history of previous ban and phase out efforts. In addition, Dr. Ehrenfeld made the following points: phase outs and bans are inherently political actions; there is available evidence of the feasibility of phase outs (both politically and technically); and that there are a number of complicating factors associated with a phase out, such as substitute chemicals or technologies have their own environmental implications.

As a means of converting this information to a policy analysis framework, Dr. Ehrenfeld presented a three dimensional trade-off between risk/cost and value-in-use of a particular material that contains or requires the use of chlorine. This led to a discussion among the participants regarding technological innovation and substitutability. Among the points to come out of this discussion were:

- that we need to consider in advance whether substitute might (or will) be available;
- that there is an important difference between examining these trade-offs in an academic setting and in the "real world", and that this difference must be recognized;
- that bans and phase outs shift the focus from the market to the design/innovation process; and
- that history has shown that regulation does bring on technological change, and that the more stringent the regulation, the greater is the substitution response.

Dr. Ehrenfeld's presentation continued with a discussion of process. For large, complicated issues like chlorine use, the normal process in which fact-finding leads to solutions is not enough. Issues such as politics and economics must be taken into account. Furthermore, the players are actively engaged in the process of finding answers, meaning that there simply is not enough time to study the problem in an academic manner. A discussion of the role of the academic community in the necessary dialogue followed. The key characteristics of this role were identified as 1) providing a forum in which the various parties can interact, 2) assisting in technology transfer through education, and 3) identifying opportunities for substitution research and development. Dr. Ehrenfeld concluded with the presentation of four points comprising the overall strategy of the MIT effort:

- Intermingle research and an ongoing policy dialogue;
- Involve all parties;
- Combine broad general analysis with specific cases; and
- Build a critical mass of participants and support.

A final discussion concerned the question of where to draw the line when the possibility of a complete chlorine ban is raised. Can we adequately distinguish between chlorine compounds that are of concern and those that are not? What are we to make of those who call for a ban on chlorine without distinguishing between chlorinated compounds and elemental chlorine? Theses are questions that seem to require answers if any kind of successful chlorine policy is to be formulated.

Research Opportunities

- Innovation and technology forcing.
- Institutional barriers to substitution.
- Quantification of chlorine's economic value.
- Toxicology of specific chlorinated compounds.

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Meeting: 5 November 1993

TITLE: **Risks of Chemicals in the Environment**

Jorn Siljeholm, a Visiting Research Scientist, graduate student in the Department of Chemistry at the University of Oslo and a former president of the Norwegian Friends of the Environment, gave a presentation on the risks of chemicals in the environment and whether those risks can be accurately ranked in any way. Siljeholm outline a number of strategies and approaches to dealing with chemicals in the environment, including: elimination strategies (through new technologies or new products) versus reduction strategies (end-of-pipe controls); the "good enemy" approach, defined as working against interests that are unable to defend themselves; a focus on primary production, in which appeals are made to governments and/or high-ranking individuals (e.g. CEOs); and a focus on tertiary production, in which appeals are made directly to the market and its consumers to force changes in the production, use, and disposal of chemicals. Siljeholm noted that the relevance and feasibility (technological, economic, political, institutional) of any approach are the most important factors to be considered.

Siljeholm continued by laying out some of the arguments and reasoning on which efforts to control or eliminate chlorine are based. A plot of octanol-water partition coefficients as a function of solubility for a number of chemicals led to a discussion of persistence and bioaccumulation/biomagnification. One argument is that these are the factors that are most important to consider if chemicals are to be ranked based on their relative risks. Siljeholm presented risk-ranking equations that take into account half-lives, partition coefficients, solubility, and vapor pressure, but do not take into account degrees of toxicity. The point was made that it is easier to design away from persistence problems than away from toxicity problems. A discussion of this approach followed, in which questions were asked regarding whether an emphasis on persistence and bioaccumulation is "widely recognized" as being sensible for risk assessment, and, if toxicity is considered, whether the focus should be on ecotoxicity or human toxicity.

A common theme throughout this discussion and the previous seminar concerns the lack of generally accepted science with which to tackle chlorine questions. The chlorine industry states that they are willing to make the necessary changes, but only after they have been shown the science that tells them who the "bad actors" are. This questions can not be answered until better agreement is reached not only on what science is important (e.g. toxicity v. persistence), but also how the science should be conducted.

Research Opportunities

- Market-based strategies for chemical elimination or reduction
- Fate and transport of chemicals as a measure of relative risks
- Ecotoxicity of chemicals as a measure of relative risks

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Meeting: December 10, 1993

TITLE: **Industrial Solvents in The Environment: Case Study of the Aberjona (Woburn, Mass) Watershed**

Professor Harold Hemond from the Department of Civil and Environmental Engineering gave a presentation on the characteristics of, and problems associated with, the release of chlorinated solvents into the environment. Professor Hemond is conducting research in this area, using the Aberjona Watershed (north of Boston) as a study area.

Industrial solvents (DCA, TCA, TCE, PCE) are produced and used in enormous quantities throughout the world. Twenty or thirty years ago, a substantial fraction of the solvents used were, for example, released directly to the environment through disposal in lagoons and drywells. Of 32 wells that have been sampled in the Aberjona Watershed, 27 have contained water contaminated with TCE. All but two of the solvents detected in these wells are chlorinated. Contamination in the area was initially discovered in Wells G and H (municipal supply for E. Woburn, MA) in 1979 after barrels were discovered in the Aberjona River at an upriver location. The correlation of this discovery with the previously identified clustering of leukemia cases in children whose water came from Wells G and H led to the designation of the area as a federal Superfund site and to the research efforts now ongoing. A study of heavy metals (arsenic, chromium) is among those being conducted in addition to the studies of chlorinated solvents.

Professor Hemond gave a general overview of the physical and chemical properties that make chlorinated solvents the environmental problem that they are. Due to their relatively high densities (> 1.0), these chemicals are categorized as dense non-aqueous phase liquids (DNAPLs) and sink through the saturated zone until they reach a relatively impermeable layer (an aquitard, e.g., clay or bedrock). This process is enhanced by the solvents relative insolubility; though their solubilities are just high enough to result in part per million concentrations in the ground water. As chlorinated solvents sink through the saturated zone, small, discontinuous parcels may be left behind so that in addition to a pool of chemicals at the aquitard, residual saturation may exist throughout the saturated zone. Finally, if the aquitard is bedrock, fractures in the bedrock surface are likely to result in the continued downward migration of the solvents. The problems associated with chlorinated solvent release is obvious: they are hard to find in the subsurface and have a low mobility once they get there. The latter fact means that trying to pump the solvent out of the ground may have only limited success.

Remediation efforts focus on both physical and chemical/biological methods. It is important to note that natural flushing (i.e. an essentially "no-action" response) is always available. The questions that need to be answered are whether it is better from an economic and risk standpoint to simply leave the contamination alone or whether remedial processes can be used to enhance the natural processes. The first rule of remediation is to remove as much of the pure solvent as possible. Because of the low solubility rates, even small pools of solvent can decades to dissolve into the ground water, resulting in what is, in effect, a continuous source of contamination. Drilling wells to recover solvent is problematic because drilling a little too far might mean creating a hole in the aquitard that acts as a drain for contaminants to move to lower subsurface layers. A solution to the problem of residual and dissolved contamination left after the pure liquid has been removed is to increase the flow of water flow to accelerate dissolution ("pump and treat"). Again, however, the low solubility means this process is likely to take a very long time. Also, the heterogeneity of the subsurface material (low conductivity regimes) might cause contamination to "reappear" after detectable concentrations reach zero and pumping has ceased.

A number of other remediation techniques are available. Hydraulic containment is the process of strategically placing wells to "capture" all of the ground water that might be contaminated. If the contaminated soil is near the surface, it can be excavated and treated/disposed at an off-site location. In-situ aerobic biodegradation is possible if organisms can be introduced that not only break down the contaminant but also use it as a nutrient in order to increase the organism population. Unfortunately, chlorinated solvents are not amenable to aerobic degradation through oxidation. Instead, they can be reduced through the process of reductive dehalogenation, in which chlorine

is replaced with hydrogen resulting in a compound that microorganisms can decompose.

Professor Hemond outlined the plan of research in the Aberjona watershed. The two major tasks are to identify and delineate the solvent contamination through systematic reconnaissance and prioritization, and to complete quantitative assessments of chemical fate. The ground water/surface water interface is an important area of research, since quantifying discharge rates will help to measure the natural flushing processes and since the combination of the reducing and oxidizing environments found in sediments and water, respectively, may hold promise for the degradation of chlorinated solvents. The question was raised whether this work will help to determine if alternatives to the chlorinated solvents are likely to be easier to deal with if they too are released to the environment. Professor Hemond answered that this work will provide the necessary framework within which to assess the physical and chemical characteristics of alternatives.

Professor Hemond concluded with a brief discussion of the instrumentation he is developing to measure volatile organic compounds in the subsurface. For a ground water setting, he is working on a driveable probe with a semi-permeable membrane that can be connected to a mass spectrometer. This type of instrument would be both portable and universal in its ability to detect subsurface contaminants. Obstacles that remain include developing the membrane so that it will not be damaged upon exposure and the physical chemistry problems associated with conveying a vapor through a membrane, through a probe, and into the mass spectrometer.

Professor Hemond made note of the ongoing remediation efforts at two of the Aberjona Watershed hazardous waste sites. After a year of pumping and treating the ground water, at an expense of millions of dollars, approximately 8 kilograms of solvent has been recovered. This inevitably leads to the question of whether the benefits justify the current costs of this type of remediation effort.

Research Opportunities

- Identification of and contaminant transport through bedrock fractures.
- Anaerobic biodegradation processes/effective microorganisms.
- Economic, risk-based tradeoffs associated with subsurface remediation.

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Two speakers were invited to MIT during the Independent Activities Period to continue the discussion of the management of the future use of chlorine. Dr. Theo Colborn and Brad Lienhart represent two of the many parties that need and desire to be present at the table as this important dialogue progresses. They each presented important perspectives, Dr. Colborn from the research community and Mr. Lienhart from the chlorine industry in particular and the chemical industry in general.

Meeting: 25 January 1994

TITLE: **Developmental Effects of Endocrine-Disrupting Chemicals**

Dr. Colborn spoke on the developmental effects of endocrine-disrupting chemicals in wildlife and humans (see Environmental Health Perspectives 101, October 1993). She began by describing the work that she has recently been involved with, such as the study of the Great Lakes (which led to the publication of her book, Great Lakes, Great Legacy?) and the Wingspread conference which brought together scientists from numerous disciplines to discuss the effects of chemicals on sexual development. Aside from the scientific knowledge that was gained during these efforts, Dr. Colborn noted that she also gained a better appreciation for the great gulf that exists between policy-makers and scientists and for the great need for these two groups to work much more closely if truly effective decision-making is to result.

Dr. Colborn described numerous studies that together are beginning to paint an alarming picture of the effects that chemicals have on the development of wildlife and humans. For example, it is now believed that a single dose during gestation is all that may be needed to result in a negative developmental effect, primarily by disrupting the normal mechanisms controlled by endocrinal systems. Dr. Colborn presented a long list of chemicals that are reported to have endocrine-disrupting effects, noting that many of these chemicals are chlorinated compounds.

Of particular concern is the fact that in addition to their toxicity, these chemicals are often persistent and bioaccumulative, and operate through a number of mechanisms including blocking cell-to-cell communication, disrupting enzyme activity, and behaving as endocrine disrupters. However, they are often not mutagenic and display equivocal human carcinogenicity. Therefore it may be concluded that traditional risk assessments to evaluate these chemicals are misdirected; in fact, the reproductive effects of the chemicals may be the area deserving of the most serious attention.

Dr. Colborn provided descriptions of the wildlife and human studies that together form a body of work that points to the breadth and seriousness of this issue. The fundamental problem in addressing the issue is the conflict

between asking science to demonstrate incontrovertible cause and effect relationships and the belief that if what the science seems to be showing is true, then there simply is not enough time to let science complete these demonstrations.

During a discussion period, the following questions and issues were raised. Dr. Colborn's responses are provided.

- What is the reason for the Japanese scientific community initiating developmental studies so much earlier than the rest of the world?

  The primary reason is that the Japanese diet is dependent upon species (such as whales) that are particularly affected by the relevant chemical releases. Dr. Colborn also noted the difficulty encountered in recent years to gain access to the important data gathered by Japanese scientists.

- How do the ongoing carcinogenicity studies fit in with the conclusions Dr. Colborn is suggesting?

  There are hypotheses that some chemicals display carcinogenic effects on second and third generations, but the link is not nearly as powerful as the endocrine-disrupting effects that are being observed.

- Who is denying the viability of these results?

  The tier above the scientific community (i.e. economists, lawyers) have the most difficulty with this issue because they generally seek to target specific chemicals for regulatory action. Their argument is that if broad categories of chemicals are regulated together (as the research may be suggesting is the only real solution), the ramifications of an erroneous decision are too great to make such action feasible.

- What is your view on the proposed phase out of chlorine?

  It is vital that we begin to conduct business differently. We must make sure that nothing new goes into the environment that can have similar negative effects and we must begin to search for substitutes, while recognizing the importance of chlorine in some products and processes.

- Is there a cutoff point below which chlorinated chemicals can be considered to be "o.k."?

  The problem in answering this question is that it is very difficult (or impossible) to obtain the materials from manufacturers to conduct testing and to obtain information gathered by industry.

- What is your opinion on chlorination for water disinfection?

  This is an example of a chlorine use for which alternatives do exist. Chlorine should only be used in closed, contained systems.

- Research should be conducted more strategically. That is, if a class of chemicals is tested by randomly selecting individual compounds, and negative effects are consistently demonstrated, then it should not be necessary to test all of the chemicals in the class. These results would provide enough justification to find alternatives.

- What would be the basis for clustering chemicals in order to undertake such random testing?

  It would be difficult, but it is something that needs to be done. One solution might be to start with the chemicals produced in the largest volumes (i.e. having the highest exposure potential).

- What if substitutes are not available?

  It is important not to prefer substitutes that allow for lower volumes at the expense of higher toxicity. It is more effective to take action such as reducing the acreage to which a chemical is applied. [Cuba, for example, has been successful in organically growing fruits and vegetables at a time when Cuban farmers cannot afford pesticides.]

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Meeting: 26 January 1994

TITLE: **Chlorine: Can We Live With It, Can We Live Without It?**

Mr. Lienhart began by affirming the commitment on the part of industry to participate in an ongoing dialogue and to share such information as they may have. He provided a broad overview of the current debate as perceived by the chlorine industry. Citing the recent Charles River Associates study, he noted that the value of chlorine chemistry, if replaced, is approximately $100 billion/year. By chlorine chemistry, industry is referring to the breadth of application of chlorine, including as an end-product, as a feedstock, facilitator, or catalyst in a process, or as a component of an end-product.

Mr. Lienhart noted the numerous "issue themes" (process emissions, incineration, toxic use reduction, pollution prevention, risk analysis, endangered species, to name just a few) that enter into the debate. He also noted that carcinogenicity is no longer the focus of concern, having been superseded by new "icitys" (immunotoxicity, teratogenicity, neurotoxicity, xeno estrogenicity). Furthermore, the problems associated with chlorine use are no longer limited to human health but extend to general environmental health as well. Mr. Lienhart also noted the large number of governmental and non-governmental groups involved in discussing these issues. Industry's view is that 90 percent of EPA's activities have some chlorine connection. Also, there are 16 regulatory standards passed within the last 20 years through which industry currently operates.

Mr. Lienhart suggested that the chlorine dialogue could be framed by the views of groups such as Greenpeace, who would ask "Can we live with it?," and the view of the chlorine industry, who would ask "Can we live without it?" He presented a number of issues within this framework, including:

- the call for a total ban on chlorine use versus the view that chlorine chemistry represents to wide a range of uses and applications to allow such broad categorization;

- the belief that chlorine chemistry is largely untested and is likely to include more "bad actors" like those previously identified versus the claim that products now undergo significant testing in order to ensure that no "bad actors" reach the market (a pesticide, for example, can go through 125 tests at an expense of $40 million and eight years of research);

  [The debate is open on the testing of industrial products, which must be addressed through a careful examination of the effectiveness of the Toxic Substances Control Act.]

- the assertion that chlorine chemistry processes are out of control versus the belief that industry needs only to do a better job of communicating the controls that are built in to the processes;

- application of the precautionary principle versus the need for more and better science; and

- the belief that chlorine chemistry is easily substituted for versus the need to look as carefully at the potential substitutes as we would the chlorine products.

Mr. Lienhart suggested that a set of four principles (published as "major principles on which scientific analyses must be based") should be examined for their relevancy in this dialogue. These principles are:

1) The fate and biological activity of a compound are determined by the chemical properties of the compound.

2) Compounds do not show adverse effects below certain threshold concentrations, and the magnitude of response is related to dose.

3) Inherent metabolic processes allow organisms to accommodate low doses of chlorinated organic chemicals.

4) Observations associated with the presence of a certain compound must be biologically plausible effects, based on the specificity of the compound's activity in experimental systems.

Mr. Lienhart stated that it is essential that we develop universally accepted systems that allow us to deal with situations where a chemical is found to be toxic, persistent, and bioaccumulative. He presented the types of decision trees that are being looked at to serve as appropriate tools. He also stressed the importance of rigorous analysis, including life cycle analyses, when substitutability is being considered. Mr. Lienhart noted that the chemical industry thrives on new science and technology and is not afraid of actively engaging in a dialogue to find acceptable substitutes or other solutions.

During a discussion period, the following questions and issues were raised. Mr. Lienhart's responses are provided.

- Do multinational companies follow the same principles outside the U.S. as they do when operating within the U.S.?

  The same standards would apply in any OECD country; however, the playing field is clearly different in the rest of the world. This is a challenge that needs to be addressed.

- Could you comment on efforts in the area of workplace health and safety?

  This area is not taken for granted by industry. We are working hard to better quantify exposures and to gather accurate epidemiological data.

- Given that so many chlorine compounds undergo transformations, breakdowns, etc., isn't it fair to say that the multinationals in fact have very little control over the bulk of exposures, but because the are the start point they bear the most responsibility?

Agreed, and therein lies the challenge. It's a question of effective leadership and stewardship.

- The focus on substitutability, risk analysis, and other rational trade-off systems is useful for industry, but off the point. Shouldn't the focus be on more fundamental questions? The real problem is that we are lacking a true mechanism to even join the debate.

- In addition to the scientific models used to analyze risk, toxicity, etc., what models are used for political and economic analyses, given that one of the major challenges is predicting future regulatory environments?

  The answer is to apply as much of the scientific model as possible and then control by assuming a much shorter life cycle than would previously have been the case, since future regulatory environments can not be accurately predicted.

- What is the perception in industry of the results presented by Dr. Colborn and others, and how is this influencing industry's thinking?

  Industry takes these results very seriously. The questions now being asked concern the significance of the results and what to do about it.

- What about the question of "ignorance," that is, not even being able to know what potential negative effects should be examined until a problem becomes evident?

  This is an important question and one that we must keep in mind as we look for new and better ways to find solutions.

- What efforts are being made to re-test existing products under new regulations, especially with regard to breakdown products, synergistic effects, etc.?

  Mechanisms are in place. When they are not being used on a consistent basis, that is more a problem of political will than anything else.

- Aren't the four principles you cited out of date and not applicable beyond the concerns regarding carcinogenicity on which they are based?

  Yes. These principles are cited because they are the principles embodied in current regulatory policy. The new "icitys" are challenging these principles.

- Are we ready to act in a regulatory way as we would as a parent? That is, are we ready to act on the basis of the precautionary principle?

  Efforts such as Responsible Care and product stewardship are moving us in that direction.

- Can you comment on inter-industry research and development efforts that might be ongoing?

  Little if any inter-industry collaboration exists for new product development. The study of health science issues is being done collaboratively because this is the only cost-effective way to do it. In the future, we may find that collaboration is also the only way to develop new products.

- Is the CMA looking ahead to other, non-chlorinated chemicals that may also be, for example, estrogenic?

  Industry is looking at many other chemicals. The debate is really about chemistry in general, but it is organized around chlorine chemistry because this represents such a large piece of the total chemical industry.

- Is it possible to have more general screens for chemicals rather than the very specific, chemical-by-chemical testing that is now undertaken, and would such screens counteract the problems of not knowing in advance what problems to look for?

  This is not only possible, but essential. The decision-tree types of analyses will hopefully allow us to move in that direction.

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Meeting: 5 April 1994

TITLE: **Toxicological Questions Associated with Organochlorine Compounds**

The first Spring semester meeting of the chlorine seminar after the joint series with 5.92 featured a presentation by Professors Rick Danheiser and Gerry Wogan of the Department of Chemistry on the toxicological questions associated with organochlorine compounds. They developed their presentation largely on the basis of questions submitted in advance by seminar participants. In particular, Profs. Danheiser and Wogan focused on

the following set of questions: Does it make sense to group organochlorine compounds into classes for the purpose of regulating those classes? What is the scientific basis, if any, for such groupings? How does the way in which toxicity is evaluated affect the reasonableness of this approach?

Professor Danheiser opened with a discussion of risk assessment. The three factors that generally lead to a definition of risk are persistence, bioaccumulation, and metabolic breakdown of any particular chemical compound. The focus of past seminar meetings has been on these factors. However, Prof. Danheiser noted, the characterization of a compound as persistent, bioaccumulative, and resistant to metabolic breakdown leads only to the potential for toxicity (defined here as capable of producing adverse human health effects). There is a need to focus more closely on toxicity in order to determine the most appropriate regulatory actions.

Two questions arose during the course of this discussion. First, how would one evaluate non-persistent, non-accumulative compounds that are still toxic? Prof. Danheiser explained that such compounds are not being considered in this discussion, since these are not characteristics generally associated with the chronic toxicity of organochlorine compounds. He did acknowledge that other situations, such as the non-biological transformation (dechlorination) of dioxins, are relevant to the overall chlorine debate. Second, is the focus only on human health? It was noted that ecological effects can be signals of potential human effects. Prof. Danheiser agreed that this is an important question, saying that there is an implicit assumption that a compound harmful to wildlife will be harmful to humans. The case of DDT, for example, makes such assumptions problematic; DDT, it could be argued, has saved more lives worldwide than possibly even penicillin through its ability to target disease-carrying insect populations.

Prof. Danheiser continued with a focus on the dose-response relationship. To paraphrase the 16th-century physician and medical pioneer Paracelsus, all things are poison if taken in sufficient quantity. In evaluating toxicity, we must always keep in mind the dose or level of exposure. It is well known that certain trace elements (e.g. selenium) which are toxic at sufficient concentrations are in fact essential to human health at very low concentrations.

The remainder of Prof. Danheiser's presentation was a critical analysis of a Greenpeace statement that organochlorine compounds should be treated as a single class because when chlorine is added to a hydrocarbon, the result is something that is always more stable, more resistant to breakdown, tends to be more bioaccumulative, and tends to have increased toxicity. With regard to any intrinsic stability of chlorinated compounds, Prof. Danheiser said that it is reasonable to argue that substituting chlorine for hydrogen usually increases the reactivity of the compound. He gave five specific examples,

noting that hundreds more would also show that the chlorinated compound would readily react with water to form inorganic chloride. When organochlorines are categorized as being extremely stable, it is because only a narrow slice of all compounds is being considered; a random sampling of all possible categories would show that stability decreases with chlorination. A seminar participant asked if a "family" of stable organochlorines could be identified. Prof. Danheiser answered that it would be very difficult because even a very stable compound can become unstable as the result of a very slight chemical transformation. Prof. Wogan added that it is not only the chemical structure that is important but also the availability of microorganisms to break down a compound.

Next, Prof. Danheiser demonstrated why it is difficult to say that all organo-chlorines are persistent and bioaccumulative. Some compounds that are considered toxic in part due to persistence and bioaccumulativity (DDT, kepone, chlordane, dioxin) are similar in that they are polychlorinated, have one or more rings, and are either aromatic or aliphatic compounds. However, there are even more chlorinated compounds (chloroform, ascochlorin, nitrogen mustard) in which the most significant functionality is unrelated to the chlorine component.

Prof. Danheiser also discussed the issue of "natural" vs. "unnatural" organo-chlorine compounds, the argument being that the introduction of synthetic chemicals into the environment is dwarfed by the compounds that are already there. More than 2,000 organochlorines present in nature have been characterized, a number that continues to increase as researchers focus on the chlorine-rich marine environment. Methylene chloride is generated by man at a rate of approximately 26,000 tons/year, whereas nature generates on the order of 5,000,000 tons/year through combustion and biological activity. In terms of average daily consumption of toxic compounds, only 0.09 mg are attributable to synthetic pesticide residues, whereas 1,500 mg are natural plant "pesticides" (natural plant defense mechanisms, which are a subject of the growing discipline of chemical ecology), and 2,000 mg result from cooking practices such as barbecuing. It is important that the existence of "natural" toxins be taken into account in risk assessments and as resources are allocated to promote human health.

Prof. Wogan continued the discussion, prefacing his remarks with the observation that the awareness of the attention paid to the potential human health effects of organochlorine compounds is comparable to where we were 30 or 40 years ago with respect to carcinogenicity and mutagenicity. Prof. Wogan began with a review of the basic components of risk assessment: Hazard Identification (determining if a cause-effect relationship exists), Dose-Response Assessment (constructing dose-incidence predictions for humans), and Risk Characterization (predicting incidence of disease in humans). He then discussed in more detail the first component, hazard identification, and

noted the need for more research in this area to improve our ability to determine what the real priority risks are. Animal bioassays are a common method to identify potential hazards (carcinogens), but the very rigid protocol for mouse and rat tests is both expensive ($2-3 million per compound) and time-consuming (3-4 years per compound). [In response to a question, Prof. Wogan explained that this protocol does not take into account mechanisms such as "promoters" which when present greatly increase cancer incidence in test subjects.] More than 600 compounds have been tested in this manner, but this is only a small fraction of the universe of compounds that could be evaluated. It is simply impractical to test and classify each one. Furthermore, bioassays were never intended for use in risk assessment, but since the protocol calls for three dose levels per test, it is possible to construct risk profiles. Finally, there is no comparable paradigm for other kinds of (non-carcinogenic) biological activity, so our ability to rigorously evaluate compounds of concern such as organo-chlorines is somewhat inhibited. Prof. Wogan described the Ames assay (which uses mutagenic activity as an indicator for carcinogenicity) and suggested that the development of novel assay techniques would go a long way toward determining which compounds pose the greatest risks.

Prof. Wogan then returned to the question of whether organochlorines can be usefully grouped into distinct classes. The characteristics that would allow classification must be measurable and quantifiable; possible classes might be based on chemical structure, toxicological effects (cancer endpoints or estrogen mimics, for example), or structure-activity relationships. However, to illustrate the difficulty involved in this kind of exercise, Prof. Wogan cited the work of the International Agency for Research on Cancer, which has published monographs on the carcinogenic risks of various compounds. Each compound is given a designation based on its suspected level of carcinogenicity: Group 1 compounds are considered carcinogenic to man; Group 2A compounds are probable carcinogens, while Group 2B compounds are possible carcinogens; Group 4 compounds are considered non-carcinogenic; and Group 3 includes everything that does not fit into one of the other categories. Of the compounds tested, 47 have been categorized as Group 1, though this includes types of exposure as well as individual chemicals.

A sampling of organochlorines illustrates the uncertainty associated with a compound-by-compound assessment. Two compounds (BCME and vinyl chloride) are in Group 1. PCBs are in Group 2A, while TCDD, DDT/DDE, and kepone are Group 2B. Dieldrin, dicofol, and methoxychlor are in Group 3. All of the Group 2 and 3 compounds cited are also suspected estrogen mimics, suggesting that there is no obvious correlation between carcinogenicity and this additional negative characteristic; this further complicates efforts to group organochlorines by class. An additional complicating factor is IARC's classification of certain estrogens (DES, estrogen

replacement therapy, and oral contraceptives) as Group 1 cancer risks. If we were to assume that organochlorines are estrogen mimics, what should we conclude about carcinogenicity?

Prof. Wogan provided a review of the way in which estrogens work in the human body so that seminar participants would have a better understanding of the risks posed by estrogen mimics. The mechanism by which estrogens (or mimics) bind to proteins, creating a complex that can recognize and activate certain DNA sequences, is key to the understanding of estrogen mimics in the environment. Traditional bioassays for estrogenic activity have been *in vivo*; new *in vitro* assays (analogous to the Ames assay for carcinogenicity) may offer greater insights and help to identify the risks associated with organochlorines. Prof. Wogan also described how the molecular structures of estrogenic chemicals vary widely, making it difficult to predict estrogen mimicry on the basis of structure-activity relationships. An important issue in the study of environmental estrogens is recognition of the fact that effects of estrogen mimics are seen very early in embryonic development whereas carcinogens manifest themselves in mature organisms.

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Meeting: 26 April 1994

TITLE: **Risk Assessment, Risk Management, and the Chlorine Controversy**

The second Spring meeting of the Chlorine Seminar featured a presentation by Edmond Toy, a first-year graduate student in the Technology and Policy Program, on the use of risk assessment and risk management in determining science-based policy. This issue is particularly important because of the central role that "risk" plays in the ongoing chlorine debate.

The presentation was based on two questions: what effect will existing risk assessment and risk management techniques have on the effort to resolve regulatory issues pertaining to chlorine use and what effect will the chlorine debate have on the development and institutionalization of risk assessment and risk management? The concept of "weight of evidence" was used as a vehicle for discussion.

Weight of evidence is a potentially confusing term whose definition varies from one interest group to another. In the chlorine debate, environmental advocates would contend that the weight of evidence

indicates potentially harmful effects from any use of chlorinated organic compounds, thereby justifying broad bans or restrictions on chlorine use. Industry groups, however, adhere to an interpretation based on the scientific method, which allows them to contend that the weight of evidence does not yet support the claim that chlorine is harmful to humans in all forms and uses. Mr. Toy presented the argument that neither can be considered the "correct" interpretation; rather, weight of evidence is simply one part, albeit a necessary one, of risk assessment. A brief discussion that followed pressed the point further, leading to the idea that weight of evidence is a framework within which evidence is of secondary importance to our decisions on how to use that evidence (i.e., what actions do we hope to promote through one "weighting" scheme or another).

A brief history of risk assessment at the federal level was presented. The 1983 National Research Council document entitled "Risk Assessment in the Federal Government: Managing the Process" (commonly referred to as the "Red Book") made the distinction between risk assessment and risk management, noting that the former is science-based where the latter includes political, economic, and social value considerations. In response to criticism that values can not possible be excluded from the scientific process, the proposed guidelines set up a system in which the selection of "inference options" (options based on reasonable scientific principles) would be consistent among researchers and from one assessment to the next. The NRC document also first put forth the four-step risk assessment process of hazard identification, dose-response assessment, exposure prediction, and risk characterization.

The presentation continued with a discussion of EPA's carcinogenic risk assessment guidelines. Compounds are classified on the basis of an examination of human epidemiology, long-term animal tests, and "supporting information" such as Ames tests and structure-activity relationships. The supporting information does not factor heavily in a cancer risk determination; classifications are based primarily on the quality of available human and animal data. However, this process is fluid. The weights given to different kinds of evidence have changed over time on the basis of political considerations as well as advances in scientific understanding of carcinogens. To demonstrate the difficulty associated with inference option choices, Mr. Toy showed three graphs illustrating dose-response curves for a particular chlorinated compound. In the first, the curves were based on assays of two tumor types and showed a positive correlation. The second, based on two different tumor types, showed a negative correlation between dose and response. The third graph combined the first two and, as expected, could only be described as inconclusive. This simple demonstration was especially significant because the compound for which the data were presented was dioxin.

Mr. Toy then presented EPA's guidelines for developmental toxicity risk assessment. As with carcinogenicity, these guidelines, first issued in 1986 and revised in 1991, are intended to provide a consistent scheme for the selection of inference options across chemicals. However, in a departure from the four-step process for cancer risk assessment, EPA combined hazard identification with dose-response data in order to take into account factors such as duration of exposure, time of exposure, and route of exposure. This change is in recognition of the different mechanisms by which developmental toxins act on organisms. Four assumptions are made in developmental toxicity risk assessment. The first is that observable effects in animals imply potential hazards to humans. Second, multiple developmental effects are considered, and the observation of any one implies some effect in humans though not necessarily the same effect. Third, as a default the most sensitive species is used for evaluative purposes, and fourth, a threshold is assumed to exist for developmental toxicity.

The weight of evidence scheme for developmental toxicity risk assessment differs from that for carcinogenicity. Evidence is considered either sufficient or insufficient (as opposed to the five possible classifications for carcinogenicity: sufficient, limited, inadequate, no data, and no evidence). A determination of sufficiency means that there is cause to proceed with the rest of the assessment process - exposure assessment and risk characterization. In this scheme, more evidence is required to judge a chemical as unlikely to be a hazard than it would be to determine that it is a hazard.

As an example of the use of weight of evidence schemes (and the associated difficulty), Mr. Toy presented the case of the determination of the carcinogenic risk of formaldehyde. This case is similar to the chlorine controversy in that there is a clear, non-trivial constituency that stood to be affected by any restriction on formaldehyde use. At the time formaldehyde was being evaluated (in the late 1970s), the Carter Administration's generic cancer policy stated that animal carcinogens should be considered to be human carcinogens. A study by the CIIT demonstrated a link between formaldehyde and cancer in animals. Since the Administration's policy had been included as part of an OSHA rule, it seemed that a request by the United Auto Workers for a determination on the hazards of formaldehyde in the workplace would be an open-and-shut case. However, OSHA ignored its own rule and refused to restrict formaldehyde use. This prompted judicial intervention to resolve the dispute. EPA does not have weight of evidence guidelines in formal rules, so it may be more difficult to ask for a court to intervene in a chlorine-based risk determination. However, it is worth asking if current guidelines are sufficient to avoid the type of controversy seen in the formaldehyde case.

The presentation continued with a discussion of the distinctions that are made between "regulatory " and "pure" science. Similar to the chlorine

debate, the Formaldehyde Institute preferred clear scientific evidence as the basis of regulatory decision making whereas the International Agency for Cancer Research stated that "for practical purposes" regulators should treat chemicals known to be animal carcinogens "as if they presented carcinogenic risk" in humans. IARC's statement reflects the belief that regulations can not be based on scientific certainties but must instead be pragmatic. The discussion that ensued, seminar participants cautioned against saying that there is a difference between regulatory and pure science. Rather, the important point is whether there is social agreement on the rules with which evidence is adopted to support one action over another. Another comment was that it is important to make the distinction between a preference for false positives or false negatives when evidence is being weighed.

To conclude the seminar and to initiate a discussion of where we should go in our research to overcome risk assessment obstacles, Mr. Toy presented the research of John Graham from the Harvard School of Public Health. Graham has developed a process of "scientific conflict mapping" which tries to determine if gaining more knowledge generally means a decrease in policy conflict. The results of Graham's research seem to demonstrate that more knowledge does not necessarily improve the policy making process. Though the ensuing discussion did not provide any answers, it was a useful in that it reinforced in the minds of all participants the great challenges ahead and the need to consider not only the specifics of a research effort but also the larger context in which the research is conducted.

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