Risk Assessment, Risk Communication and Legitimacy: An Introduction to the Symposium

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Widespread exposure to chemicals with latent health effects creates a dilemma. Although we know enough about the chemicals we use to realize that at least some of them are contributing to current cancer levels, we do not have enough information on most chemicals to determine which ones are harmful.[1] As a society, we are uncertain how to proceed.

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This symposium grew out of a conference which was sponsored by the Association of the Bar of the City of New York on February 4, 1988. *See* Committee on Environmental Law, Toxic Chemicals and Health Risk Assessments in Regulation and Litigation, The Record of the Association of the Bar of the City of New York, May 1989. Ross Lipman, Marla S. Rubin, David Freeman, Mark Manewitz, Daniel Riesel, and Robert Davis planned and prepared the conference. The Committee on Environmental Law is grateful to the Association and particularly to Alan Rothstein for supporting this project.

1. The term "chemicals" is used here in its generic sense, since health risks are posed by substances such as radon, as well as chemical by-products of industry, transportation and energy production. However, the focus of the symposium is on regulation of man-made chemicals and particularly on environmental pollution.

In 1984 the National Research Council of the National Academy of Sciences evaluated the nation's need for chemical exposure and health effects information. TOXICITY TESTING—STRATEGIES TO DETERMINE NEEDS AND PRIORITIES. The Council determined that for the great majority of chemicals, information essential for hazard assessment is lacking. Most striking was the Council's conclusion that for approximately 80% of the 48,000 chemicals in general commercial use there is no data available at all. While many chemicals need not be tested, because of their low potential for human exposure or toxic activity, the Council found that "thousands or even tens of thousands of chemicals are legitimate candidates for toxicity testing related to a variety of health effects." TOXICITY TESTING at 12-14. Because of the general scarcity of data, noncancer effects, such as neurological damage, and synergistic effects have been almost ignored.

Discussion of data availability in legal commentary has centered on the validity of different types of health data and the problem of how to regulate with limited data, rather than the causes of the data shortage itself. *But see* Lyndon, *Information Economics and Chemical Toxicity: Designing Laws to Produce and Use Information*, 87 MICH. L. REV. (1989); Schroeder & Shapiro, *Responses to Occupational Disease: The Role of Markets, Regulation, and Information*, 72 GEO. L. J. 1231 (1984); Latin, *Environmental Deregulation and Consumer Decisionmaking Under Uncertainty*, 6 HARV. ENVTL. L. REV. 187 (1982).

Risk analysis has evolved as a professional field which offers to order and simplify the choices that must be made about chemical exposure.[2] Quantitative risk assessment (risk assessment or QRA) is a methodology which combines calculations about exposure and health effects in order to characterize the costs of an activity involving toxic chemicals.[3] The final QRA product, the risk characterization, is generally expressed either in a numerical estimate of the maximum individual risk or as the number of cancers expected to result from the subject pollution.[4]

QRA is relatively new on the regulatory scene. Its widespread use is a phenomenon of the 1980's, but it is now a basic tool of policy planners and a common measure of acceptable pollution and exposure levels in regulatory proceedings. Recently it has also been used in expert testimony in toxic tort cases.[5] QRA is attractive to practitioners, because it provides an organizing framework for analysis of chemical effects. Yet the precise format

2. The emergence of risk analysis in chemical regulation seems to be a classic case of paradigm formation as described by Thomas S. Kuhn in THE STRUCTURE OF SCIENTIFIC REVOLUTIONS (1962). With "risk" as the organizing concept and risk assessment as the format for elaboration on it, risk analysis provides an "implicit body of intertwined theoretical and methodological belief that permits selection, evaluation, and criticism" in a field that was previously awash in facts of apparently equivalent importance. *Id.* at 15-17.

3. For discussions of risk assessment by scientists *see* NEW YORK ACADEMY OF SCIENCES, MANAGEMENT OF ASSESSED RISK FOR CARCINOGENS (1981); BANBURY REPORT 19: RISK QUANTIFICATION AND REGULATORY POLICY (1985); *Symposium on Risk Assessment*, 236 SCIENCE (April 17, 1987).

Legal commentary on recent developments include Latin, *Good Science, Bad Regulation, and Toxic Risk Assessment*, 5 YALE J. ON REG. 89 (1988); Baram, *Use of Comparative Risk Methods in Regulatory and Common Law*, 13 COLUM. J. ENVTL L. 1 (1987). *See also Symposium: Risk-Benefit Assessment in Governmental Decisionmaking*, 45 GEO. WASH. L. REV. 901 (1977); McGarity, *Substantive and Procedural Discretion in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA*, 67 GEO. L. J. 729 (1979); Baram, *Cost-Benefit Analysis: An Inadequate Basis for Health, Safety, and Environmental Regulatory Decisionmaking*, 8 ECOLOGY L. Q. 473 (1980); Latin, *The "Significance" of Toxic Health Risks: An Essay on Legal Decisionmaking Under Uncertainty*, 10 ECOLOGY L. Q. 339 (1982); Rodgers, Jr. *Benefits, Costs, and Risks: Oversight of Health and Environmental Decisionmaking*, 4 HARV. ENVTL L. REV. 191 (1980).

4. Cancer is used as a proxy for other health effects, because there is more documented research on cancer than on other diseases and cancer is a major health problem in the United States. In addition, according to the prevailing theory on carcinogenesis in the late 1970's and early 1980's, a single exposure to a carcinogenic agent could cause the development of a tumor. Regulators have reasoned that controlling for the cancer effects of a pollutant would establish a level of exposure that would be likely to control for other effects also. Today this understanding of the etiology of cancer is shifting and regulatory policy is likewise changing. *See* discussion *infra*, this volume, by Commoner, Paustenbach, Anderson, and Finkel.

5. *See* the cases discussed by Donald Stever and Vern Walker, *infra*, this volume.

and value of risk assessment in different legal contexts is still being worked out. Difficult conceptual and normative issues are inherent in it. Risk assessment's method of integrating multiple layers of information seems to solve some regulatory problems, but creates others.

The National Academy of Sciences (NAS) describes QRA as having four phases: hazard identification, dose-response assessment, exposure assessment and risk characterization.[6] Each phase contains many subparts, a number of which are full studies in their own right. The NAS has identified nearly fifty common QRA components with "inference options" which require that the risk assessor select among several plausible scientific judgments about uncertain data or theoretical connections.[7] Because the health sciences used in QRA are evolving at a rapid pace, there is a range of opinion among toxicologists, statisticians and molecular biologists about the scientific validity of different data and models of the etiology of cancer. Regulators and risk assessors must choose among these data and opinions to formulate a basis for regulatory decisions. In a real sense, risk assessment is an art.

I. An Overview of the Symposium

This volume presents a range of views on policy and practice problems in risk analysis. Most of the authors here are not lawyers. The predominance of scientists in part reflects the fact that the law is still reacting to the rather quick ascendence of risk assessment. Lawyers need to understand better the exact benefits

6. Hazard identification determines whether or not the particular chemical under study is causally related to particular health effects. Dose-response assessment estimates the relationship between the magnitude of exposure and the probability of occurrence of the health effect of concern. Exposure assessment, determines the extent of human exposure from the proposed project or product. Risk characterization, describes the nature and the magnitude of the human risk, and should also include the uncertainty factors in the estimate of magnitude. National Research Council, National Academy of Sciences, Risk Assessment in the Federal Government: Managing the Process 3 (1983).

7. *Id.* at 28-33. Examples of such inference options are: "What relative weights should be given to results of different types of epidemiologic studies, such as prospective studies, case-control studies and ecologic studies?" "Should evidence on different types of responses be weighted or combined (*e.g.*, data on different tumor sites and data on benign versus malignant tumors?) . . . How should findings of tissue damage or other toxic effects be used in the interpretation of tumor data? Should evidence that tumors have resulted from these effects be taken to mean that they would not be expected to occur at lower doses? . . . What factor should be used for interspecies conversion of dose from animals to humans? . . ." *Id.* at 29-31.

of QRA as a tool for analysis and how it fits within the existing framework of legal values and procedures.[8] The work in this volume may assist in the task of shaping a durable place for QRA in the law.

The symposium begins with an article by Lester Lave. Dr. Lave discusses the policy problems generated by the lack of health effects and exposure data. One of the chief difficulties is the task of establishing reasonable priorities for regulation. Lave stresses the need to communicate with the public about chemical risks and to hear from them what our policy priorities should be.

Christopher Daggett elaborates on these themes. Speaking from the perspective of a regulator, he describes the advantages of risk assessment in forming policy, particularly its use as a vehicle for cross-media examination of pollution control options. In his view, risk assessment provides a framework essential for environmental management. Daggett is also concerned with setting priorities and with communication between regulatory experts and the public.

How well does QRA translate from policy and planning to practice? Donald Stever describes the various contexts in which lawyers handle risk data. He points out that lawyers must "demystify" risk assessment in order for nonscientist decision makers, such as judges and juries, to apply the law. Stever finds that regulatory enforcement is the most problematic area for the use of risk data, in part because of the varied and incompatible QRA formats and guidelines used by agencies. Stever urges attention to designing a better fit between daily legal practice needs and risk analysis. But what is that fit to be?

Bernard Goldstein suggests that QRA cannot be all things to all practitioners. He points out that regulatory decisions require different levels of information; it would be inefficient to standardize risk assessment so as to require the same specifics for all deci-

8. In RECONSTRUCTING AMERICAN LAW, Bruce Ackerman cites Holmes' prediction that the future of the law belongs to [the master of statistics, no less than economics]. Holmes, *The Path of the Law*, 10 HARV. L. REV. 457, 461 (1897). ACKERMAN at 68 (1983). Risk assessment requires lawyers to understand biological and statistical sciences, critique their normative and political function and translate them into the values of the law and the political system. As Ackerman points out, lawyers have not been educated to this task and it is not an easy transition to make.

sions.[9] Goldstein describes the contrasting ways scientists and lawyers organize data; his insights illuminate some of the confusion in the regulatory discourse on risk and have important implications for risk communication.

Two authors examine the use of QRA by local governments in facility siting decisions. They agree that risk assessment may become a powerful political force, but they differ on its exact role. Alfred DelBello suggests that the availability and use of QRA creates new burdens on political leaders who must mediate and explain the long term negative effects of necessary public works, such as waste management facilities. He suggests that QRA is used by local opponents of projects to delay them, until they are economically unfeasible.

Barry Commoner maintains that, on the contrary, risk assessment is often used by officials to justify decisions after they are made. He argues that public participation in decision making about risk is essential, since the public asks questions and provides information which the official bureaucracy misses. He also points out that, in order for QRA to serve its purpose in policy making, assessments of competing technology options must be prepared simultaneously. Commoner notes that the merits of waste recycling relative to incineration have been largely ignored. Yet recent research on recycling suggests that it is, on the whole, less risky and cheaper than incineration.

Methodological questions continue to generate the greatest heat in the debate over QRA. Risk assessment is a complex series of factual characterizations and judgments. Where there is room for discretion, there is also room for philosophical differences. Four of the authors here discuss and disagree on new trends in the treatment of scientific data and models. The debate centers on recent changes in the risk assessment policy of the United States Environmental Protection Agency (EPA), incorporating guidelines which lead to "less conservative" risk estimates, and the EPA's reevaluation of dioxin risks. [10]

Dr. Commoner attributes the EPA's new "less conservative" QRA approach to an initiative by the Office of Management and

9. *See* discussion by Finkel, *infra*, this volume, of the factors which make each risk assessment unique and of the disadvantages of standardizing QRA components. *See also* HOEL, CONCLUDING REMARKS, BANBURY REPORT 19, *supra* note 3, at 345-46.

10. Latin, *supra* note 3, at 89, describes and critiques the EPA's changes in risk assessment policy.

Budget (OMB). Commoner explains why, in his view, certain aspects of the EPA's new guidelines and, in particular, its reassessment of dioxin risks are not good science or policy. He suggests that both changes ignore important scientific data in order to arrive at results which fit other regulatory agendas.

Dr. Dennis Paustenbach and Dr. Elizabeth Anderson defend the EPA move to "less conservatism." They argue that research is providing opportunities to improve the performance of regulation, since new data improves our understanding of chemical risks and provide a basis for revising earlier estimates downward. Given the economic costs of controlling chemical exposure, they maintain that we cannot afford to ignore information which will allow us to target regulatory attention more effectively. "Conservatism" started out as well-intentioned, but is no longer necessary and, in fact, may result in less safety, if we allocate scarce resources to controlling risks which have been overestimated and ignore other risks.

Dr. Adam Finkel disagrees with Paustenbach and Anderson on a number of issues raised by the new approaches to risk assessment. He suggests that, because of possible misperceptions about risk assessment, many instances of what would seem to be conservative treatment of the inference options in QRA turn out not to be so. In other instances, a cautious approach is consciously chosen to balance components where nonconservative treatments of data, or gaps in data, are necessary. Finkel suggests that certain terms, including "accuracy" and "real" or "actual risk," are semantic traps in the context of complex risks, which operate by different rules than more concrete phenomena that we can understand more intuitively. He recommends against a too hasty revision of QRA methods and suggests that, while "conservatism" expresses certain kinds of values, the alternatives to it are not less laden with judgment.

Risk assessment can be an important tool in the courtroom. Vern Walker charts the opportunities and pitfalls of the evidentiary use of QRA. Matching the complexities of risk estimation with the rules of evidence presents a major challenge for litigators. It is interesting to consider whether the uneasy fit between risk assessment and the rules of evidence tells more about QRA or about the law. Like Stever, Walker points to the need for lawyers to go beneath the surface of the scientific components in QRA and elucidate their origins and methodology. Walker

presents an organized approach to evaluating and attacking a risk assessment's viability as evidence.

The next three articles address a theme raised by almost every author in the symposium: the problems inherent in communication with and participation by the public in risk management strategies. Clearly, arranging for broader participation is an important next task for lawmakers, but what form should risk communication take?

Daniel Fiorino presents a thoughtful discussion of the current literature on public participation in science and environmental policy. In a democracy, major technological choices cannot be made by experts alone. Fiorino reviews and critiques the work of authors concerned with the problem of devising institutions and procedures which will generate legitimate decisions. He argues that we must reconsider our fundamental conceptions of citizen participation and devise new approaches to regulation, based on sounder theoretical and practical foundations. His explication of the issues is a significant step in that direction.

Paulette Stenzel suggests that there are some immediate actions that can be taken to improve the risk communication gap. She points out that risk data is accumulating, but that most people do not have access to it to help them make choices about chemical risks. She proposes that a clearinghouse be established to distribute the risk estimates we do develop. Such a clearinghouse would supplement other information strategies and help people interpret chemical toxicity data now available through right-to-know laws.

Dr. Joseph Highland notes that there are different kinds of uncertainty in regulation. Some is due to the state of development of scientific knowledge, but some is simpler and could be corrected with research that is technically accessible. Highland discusses several common concerns that people have about risk assessment, including the perception that revising a QRA's results to accommodate new data is "tinkering" to achieve a desired estimate. Another common concern is that a QRA has ignored significant exposures which are not the specific subject of the assessment or has considered only incremental risk and not taken background exposures into account. Highland points out that, unless synergisms are considered (and we do not yet have that capacity), these concerns cannot really be satisfied.

The authors who have contributed to the volume share basic concerns about policy, practice and democratic choice, but identify different immediate issues for risk management. Their insights and arguments together suggest that risk communication among experts is as important and perhaps as difficult as is interaction with the public. This is not surprising, given the interdisciplinary and integrative policy nature of risk assessment. The participants in the symposium have advanced an important process of dialogue.

II. SOME OBSERVATIONS ON LEGITIMACY AND RISK COMMUNICATION

The authors in the symposium write from a broad range of perspectives. It is clear from these articles that, while there is a consensus that risk analysis has a central role to play in regulation, the nature and extent of the role are still unsettled. Why is this true? And why is "risk communication" so problematic? Is the difficulty caused, as some authors suggest, by the fact that risk estimates themselves are rough tools with limited application? Or is it, as others indicate, that lawyers and the public have not yet been educated sufficiently to understand and use risk information? The rest of this essay explores some of the reasons why communications have been unsatisfactory, particularly in the context of environmental law.

Some of the difficulty in talking about risk assessment is certainly semantic: basic terms in the discussion have implications which are not explicitly recognized, though they are central to legal discourse. Lawyers tend to ask about QRA, is it "science?" It seems that if QRA information is accepted as science, then we will treat it as "a statement of fact" and therefore as a useful basis for decisionmaking. Scientists largely agree that QRA is science, though they disagree about whether certain judgments are good science. However, scientists are skeptical about the ways QRA is used, both by other scientists and by nonscientists, particularly lawyers. Dr. Commoner points out that it can be used by politicians to rationalize decisions which are chosen on nonscientific grounds. Dr. Highland suggests the law uses QRA for a purpose that does not even exist in science, but is perceived as necessary

in legal forums—the need for certainty.[11] Dr. Goldstein expresses the fancy that lawyers might be kept out of the area when actual risk analysis is being done, since consensus is necessary for that process and lawyers deal in contrast and confrontation.

It is true that lawyers are trained to deal in adversary terms, but this is largely because lawyers generally represent opposing interests. The legitimacy of risk assessment is in contention, because regulatory decisions distribute risks and benefits; lives, money, jobs and property values are at stake. Lawyers represent businesses, consumers, workers, towns, legislators, and regulators. These groups expect decisions to be made according to principles and procedures which have been worked out in the law, rather than in science. For lawyers then, QRA must fit within jurisprudential norms, rather than supplant them, and these norms should reflect the heterogeneous interests of our society.

In *Tragic Choices* Dean Calabresi and Professor Bobbitt suggest that societies must arrange to distribute scarce resources without jarring cultural expectations. Decisions about life-giving and life-destroying distributions are made with the greatest care, because if they cannot be made within the terms of values which the society holds precious, then the allocation process will stretch and tear the social fabric.[12]

According to Calabresi and Bobbitt, allocation decisions may be made in two steps.[13] The first step determines the amount of a good the society will produce; the second distributes it. The second step absorbs the attention of the applicants and puts forward standards to justify the allocation decisions. These standards must satisfy cultural expectations of what are appropriate bases for allocation and the process must also be seen as fair and honest. Second order decision processes tend to be unstable, be-

11. Lawyers are comfortable with certain kinds of uncertainty; it is always present at the moment of a legal decision, just as it is in medical decisions, which Dr. Goldstein points out here. Lawyers deal in the relative and are used to procedures designed to resolve disputes, in spite of lack of information and unequal access to it. Familiar common law rules designed to handle uncertainty, allocate a part of each decision to the judge and the jury; these include burdens of persuasion and proof, *res ipsa loquitur*, and the broad responsibility of the jury with its secret deliberations—the quintessential "black box" in the law. Administrative law provides for uncertainty through broad agency discretion and limited judicial review of administrative actions.

12. CALABRESI & BOBBITT, TRAGIC CHOICES 18-28 (1978).

13. An example of a first order allocation is the society's decision about how many kidney dialysis machines it will manufacture; the second order allocation is the process which decides which persons with kidney failure will be able to obtain a machine. *Id.* at 22-25.

cause of the stresses of scarcity and close observation. Calabresi and Bobbit suggest that the tension inherent in the allocation process may lead a society through a series of decisionmaking formats, in a cycle from centralized decisions by experts, to broadly decentralized choice, to mechanical selection devices.[14]

Risk assessment is a new format for allocation.[15] In this role it has several notable strengths. Risk assessment is scientific, in a society in which science is a powerful legitimizing force. Also, the notion of "risk" itself has considerable appeal of its own: risk is catchy, contemporary, macho, realistic, existentialist. Risk assessment is forthright: it proclaims a willingness to sacrifice a determined number of lives for a parallel economic benefit. It also produces information—a risk estimate number—which is easily communicated, an advantage in an age of data transmission and advertising. Risk assessment draws on values present in the culture and is relevant to our expectations about how decisions should be made.

Naturally, the appeal of risk is strongest in the abstract. The same is true of risk assessment. As long as QRA is conducted in the halls of administrative agencies, it is easily an instrument that builds consensus. It is understood and accepted by regulatory professionals as a necessary, though simplified, grid. But in permit and enforcement proceedings and in tort trials, QRA is subject to a different kind of scrutiny. Then it must convince affected individuals that it is fair and honest and that it incorporates values and distinctions that make sense. QRA has a hard time doing this.

14. Thus the variety in military service designation: draft, volunteer, lottery. *Id.* at 157-67. Risk assessment is inherently a highly centralized process. It is interesting to note that the increased use of QRA has coincided with the spread of hazard communication and right-to-know laws, which are decentralized control strategies.

15. Risk assessment is part of the second level allocation process. The first order allocation is implicit in the free enterprise system: the commons is assigned to producers on the market's terms, without respect to the environmental or human body burden of pollution. This primary arrangement is subject today to the second level allocation embodied in regulation. The regulatory allocation is framed as a determination of who will *not* be able to pollute, on the grounds that the chemicals impose costs on others. In the past twenty years, the exception has been swallowing the rule. Regulation is pervasive, at least on the books. But the conceptual origins of regulation as an exception to the rule and as a second order decision still affect it.

"Risk" is a slippery concept: it has no simple meaning, but varies in content according to circumstances.[16] Although numerical risk estimates provide a shorthand for comparing toxic chemicals, they only imperfectly describe the actual phenomena of exposure. In "real life" risks have more physical and social characteristics than mortality or morbidity numbers.[17] Danger, threat and risk have dimensions that are emotional, moral, political and economic.[18] Risk assessment does not provide the normative terms to resolve conflicts concerning who should bear the risks and who should benefit from any particular project involving toxics. It cannot resolve dilemmas beyond its own dimensions.[19]

16. Recent work by psychologists suggests that "lay" thinking about risk has characteristics not expressed in professional risk analysis. For instance, a lay person's response is likely to take into account emotional and moral factors and have a broader temporal perspective than the "number of cancers per million" that is the index of the professional risk analyst. Slovic, *Perception of Risk*, 236 SCIENCE 280 (1987); DOUGLAS & WILDAVSKY, RISK AND CULTURE (1982). Some important work has analyzed the mental strategies people use to make sense out of uncertainty; some of these lead to accurate perceptions and some to misjudgments. Experts appear to be prone to many of the same biases as the general public when they must rely on intuition instead of facts. Slovic, at 281. *See also* Kahneman and Tverksy, *On the Psychology of Prediction*, 80 PSYCHOLOGICAL REV. 237 (July 1973); Freudenberg, *Perceived Risk, Real Risk: Social Science and the Art of Probabilistic Risk Assessment*, 242 SCIENCE 44 (1988).

17. Nonexpert experience of risk contains information unavailable to experts, who are physically separated from the source of the risk. At the symposium, Dr. Commoner described the reaction of a Brooklyn Jewish community when a New York City official mentioned that the "mass burn" incinerator planned for their neighborhood would be of German design. The residents distrusted the City's risk estimates and pushed, perhaps harder than another community would have, to find out more about the technology. Their efforts led to a breakthrough in the understanding of dioxin formation in the incineration process. *See also* Village of Wilsonville v. SCA Chemical Services, 86 Ill. 2d 1, 426 N.E.2d 824 (1981).

18. DOUGLAS AND WILDAVSKY, *supra* note 16, at 73: "One salient difference between experts and the lay public is that the latter, when assessing risks, do not conceal their moral commitments but put them into the argument, explicitly and prominently.

It was a risk but I took it because:
I couldn't refuse her dying wish;
I had promised my child;
I know what her family would say if I didn't try;
He would have done as much for me.

[T]he ordinary individual admits that his loyalties and moral obligations are largely the matter at stake, but the risk expert claims to depoliticize an inherently political problem."

19. Risk managers sometimes talk of chemical risks in communal terms—we all share the risks of our common lifestyle. Lifestyle is not very satisfactory as a unifying value, since there are variations in income and opportunity and, in any event, most people will doubt that the particular risk they are confronted with is necessary to their whole lifestyle.

Risk has apparently supplanted safety, though numerous statutes still mandate safety-based standards. In the past few years the notion of safety has been considered naive, rigid, perhaps even agoraphobic, the opposite of a healthy acceptance of life's everyday

Even on its own terms, QRA suffers from a serious handicap. Beneath the frankness and simplicity of its final risk equation, QRA is inaccessible, at best, to outsiders. To the ordinary business person, worker or consumer, it appears to be an elaborate shell game or a byzantine maze. How does a citizen know that the number of lives placed at risk is even nearly correct, especially given uncertainty ranges which at times appear ludicrously large. Why should we not suspect that many facts are unaccounted for, especially if we are in the exposed population?

This unease is not due simply to lay ignorance of the subtleties and accomplishments of risk analysis. The many inference options in QRA do give the risk assessor substantial opportunity to affect the final result. While this is true in any application of technical knowledge, here it is not possible to test a prototype. The QRA product cannot effectively be checked, because there is no "real" risk to serve as an index of accuracy. Second opinions are costly; there is much data to review and underlying experiments cannot be repeated. The inclination to trust the community of scientists to reach an appropriate result is undermined by the fact that access to scientists is unequal. The costs of critical evaluation of QRA raise barriers to communication between experts and citizens and, indeed, among regulators themselves. As risk analysis becomes more central to the regulatory system, the economics of information production must become a greater concern of the law. The fact that risk estimates have economic uses exerts a strong influences decisions as to what data is produced, how and by whom it is produced and how it is communicated.[20] Though risk data is based on scientific knowledge and is developed according to an ethos quite different from data which is commer-

risks. Yet it need not be read literally as absolute security from physical harm. Safety could be a synonym for confidence and responsibility: a low risk, a particular stage in progress toward greater pollution control, or simply the community's consensus on what is an acceptable exposure.

20. Economists have developed a variety of models for observing the ways that availability and transfer of information affect the structure of a market and the behavior of its participants. Information may confer market power and, where the structure of the market and the type of product allow it, information manipulation and deception may result in inefficiency. This work helps place risk data in its economic context. For overviews *see* Simon, *Rational Decision Making in Business Organizations*, 69 AM. ECON. REV. 493 (1979); Joskow & Noll, *Regulation in Theory and Practice: An Overview*, in STUDIES IN PUBLIC REGULATION 1 (G. Fromm ed. 1981).

cial,[21] risk estimates are subject to market influences on information products.

For instance, absent regulation, the market tends not to produce toxicity or exposure information, in part because it is a negative product description, which will discourage sales and may result in tort liability. Since it is hard to prove that a product is free of adverse side effects or that pollution is harmless, the market prefers not to raise the topic at all. Indeed, until right-to-know laws, chemicals and chemical mixtures used in commerce were usually identified only by trade names. Chemicals have, in a sense, been invisible until recently.

The market does encourage production of information which reduces costs.[22] Health data which implicates a chemical as the cause of a disease may have value to those who are exposed; however, these people have been hard to identify, may be dispersed and usually are not organized to purchase complex data like toxicity information. On the other hand, health data which exonerates a chemical will reduce the costs of regulation to specific firms; these are already organized and have at least some financial resources to conduct testing. Since risk information is costly, it is not likely to be produced or released into the marketplace, unless it reduces the costs of the firm that produces it. The market therefore tends to drive private research and industry participation in the regulatory process in a definite direction, that is, toward information which indicates that there are little or no health effects from chemicals or at least that these are uncertain. Indeed, information exchange and manipulation are so much a part of contemporary commerce that it would be surprising if it were always easy for firms to draw a clear line between science and advertising.

21. Robert K. Merton, writes: "Four sets of institutional imperatives—universalism, communism, disinterestedness, organized skepticism—comprise the ethics of modern science. . . . 'Communism' in the non-technical sense of common ownership of goods, is a second integral element of scientific ethics. The substantive findings of science are a product of social collaboration and are assigned to the community. . . . The insitutional conception of science as part of the public domain is linked with the imperative for communication of findings. Secrecy is the antithesis of this norm; full and open communication its enactment." MERTON, SOCIAL THEORY AND SOCIAL STRUCTURE 607 (1968).

22. However, information is a problematic product; it is hard to hold for sale and difficult to set a price upon without revealing it. *See* Arrow, *Economic Welfare and the Allocation of Resources for Invention*, in THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609, 615 (R.R. Nelson ed. 1962).

To the extent that data is used to characterize chemicals as less costly than they actually are, it encourages inefficient choices.[23] George Akerlof suggested that the used car market is a model for the situation in which a complex product is known by its seller to have a defect, but product quality cannot be checked by the buyer.[24] In Akerlof's *Market for "Lemons"*, the information asymmetry between the seller and the buyer creates opportunities for deception and allows sellers to pass off lemons as good cars. Owners of good cars, aware that they cannot get full value for their cars, do not put them on the market. The quality of cars in the market deteriorates, as poor quality drives out the good.

The reason for the disfunction in the market for lemons is the asymmetry of access to information.[25] An analogous asymmetry exists in the chemicals market and the parallel is even more direct in the market for information about chemicals.[26] People who are exposed to chemicals—and therefore are faced with making basic economic choices with respect to them—cannot know the true cost of an exposure and their options to seek information and assistance are limited. These informational asymmetries are cor-

23. A. M. Spence, in MARKET SIGNALLING: INFORMATION TRANSFER IN HIRING AND RELATED SCREENING (1974), suggests that "signals" may occasion inefficiencies of two kinds. Signalers can invest in making a product appear to have characterstics which it does not have. To the extent that signals lead purchasers or other decisionmakers to selections based on inaccuracies, they are inefficient. Also, consumers, knowing of the seller's interest, will discount the seller's declarations. The seller then must present other activities of attributes which alter the beliefs or convey information to other individuals in the markets. *See, e.g.*, discussion by Beales, Craswell & Salop, *The Efficient Regulation of Consumer Information*, 24 J. OF L. AND ECON. 491, 506-07 (1981).

24. Akerlof, *The Market for "Lemons": Quality Uncertainty and the Market Mechanism*, 84 Q.J. ECON. 488 (1970).

25. Normal market responses to these dysfunctions include advertising and development of reliable trade names, pooling of buyer resources, and development of third-party information providers and product rating services. Stigler, *The Economics of Information*, J. POL. ECON. 213, 217 (1961); Akerlof, *supra* note 24, at 499-500; Salop, *Information and Monopolistic Competition*, 66 AM. ECON. REV. 240, 244 (1976). These cannot develop in the market for health effects information without general access to chemical identity and exposure information and reallocation of financial resources to purchase data.

26. *See* EPSTEIN, *Constraints in Decisionmaking*, in PUBLIC CONTROL OF ENVIRONMENTAL HEALTH HAZARDS 309-17 (E. Hammond & I. Selikoff eds. 1979), and Peto, *Distorting the Epidemiology of Cancer: The Need for a More Balanced Overview*, 284 NATURE 297-300 (Mar. 27, 1980). Richard Peto writes, "[s]o many examples of financially-motivated bias exist that the motives and work of industrial scientists and consultants are inevitably distrusted." *Id.* at 297. *See also* Portney, *Toxic Substance Policy and the Protection of Human Health*, in CURRENT ISSUES IN U. S. ENVIRONMENTAL POLICY 136 (1978); Shapiro, *Divorcing Profit Motivation from New Drug Research: A Consolidation of Proposals to Provide the FDA with Reliable Test Data*, 1978 DUKE L. J. 155, 161-68.

rected in part by government investment in research. However, the basic structure of the information supply system is influential. Scientists insist on independence, in industry as well as government, but the market exerts a powerful influence on information production.

Environmental and public health laws should be structured to minimize the pressures on regulated businesses. Lawmakers also need to account for existing limits on the supply of new health effects and exposure data. If legal rules rely on intensively data-dependent mechanisms, such as risk assessment, then the supply of data assumes added significance. A decision to require more information in order to control pollution may turn out to be, in effect, a decision to allow more pollution, unless a parallel decision is made to allocate more resources to information production. Also, the more data we decide to include in each risk assessment, the higher the cost of participation in decision making.[27] Risk assessment makes information a premium, but information is endless.[28] How do we decide at what point the detail is no longer worth its costs? What societal interests are served by each further investment for information? The need for consensus on chemical regulation may be met best by regulation strategies which are based on factors other than amount or specificity of data.

The value of risk estimates in consensus building would be higher if risk numbers could be linked to or accompanied by a measurable index.[29] In the environmental context, one factor that may be a useful correlating measure is pollution control. Risk estimates could be communicated with risk managers' corresponding goals for related pollution reduction. The use of risk assessment implies that reducing pollution is costly and that we should do so only when health costs are considered excessive. However, pollution itself is often costly, independent of health damage, and it may be more efficient not to pollute at all than to continue existing discharges. Pollution control strategies, which are central to regulatory policy for other reasons, contributed to the legitimacy of risk management. If exposures are reduced at the same time that estimated risk is reduced, the increase in pro-

27. *See* Latin, *supra* note 3.

28. *See* Albert, *Some Epistemological Aspects of Cost-Benefit Analysis*, 45 GEO. WASH. L. REV. 1025 (1977).

29. *See* Spence, *supra* note 23.

tection is more plausible to the observer. Where risks are considered acceptable, levels and means of exposure should be an expressed element of risk communication. Individuals can use this information; they can seek the assistance of third party services or take steps to reduce their own exposure.

As QRA moves out of the policy and planning context and more deeply into standard setting and enforcement, we also need to consider the long term effects of relying on it as a commonplace regulatory tool. Legal rules, and especially pervasive regulation, channel public and private investment. Is it possible that risk management strategies based on toxicology may not produce the greatest long-term value? Waste reduction, recycling, and traditional end-of-the-pipe controls may be encouraged with standards that stress pollution reduction, rather than risk reduction.[30] These benefits can be more easily measured than can information. Engineering and management data,[31] enforcement strategies[32] and economic research [33] may be cheaper and at least as productive in the long term as toxicology. In any event, their role

30. The "zero discharge" goals of the early environmental statutes, such as the Clean Water Act, have a renewed appeal after 1988's environmental crises. Risk-benefit analysis is a model of decisionmaking borrowed from economics, which concerns itself with marginal costs and gains in an open-ended system of social interactions. The ecosystem operates on a different dynamic and is not open-ended. *See* Jorling, *Risk Assessment: Dissent From a Former User*, GOVERNANCE (Spring 1984) at 14-18; Commoner, *The Environment*, THE NEW YORKER, 46-71 (June 15, 1987).

31. Section 313 of the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. § 1023 (Supp. V. 1987), directs EPA to conduct a national toxics inventory and mass balance study. The first results of the inventory are now being released. *See U.S. Calls Poisoning of Air Far Worse Than Expected and Threat to Public*, N. Y. Times, Mar. 23, 1989, at B.11. Industry representatives are responding to the information by claiming that they have already begun to cut back on emissions, because of the Bhopal disaster. Monsanto has announced that it will cut back 90% in the next four years. Since waste streams are rarely composed of one single toxic, such reductions in emissions may make it unnecessary to study some chemicals for carcinogenesis.

32. *See, e.g.*, Robbins, *Risk Assessment: Too Complex, Too Soon*, in MANAGEMENT OF ASSESSED RISK FOR CARCINOGENS 59 (1981). See Highland's suggestion, *infra*, this volume. For instance, he suggests that one way of handling uncertainties about exposure is to revisit them regularly; agencies can improve facility monitoring at individual sites, after the QRA is completed and the permit granted.

33. Adam Finkel points out in his article, *infra*, here that the economic costs of reducing risks are often as uncertain as the risks themselves. In an appendix to TOXICITY TESTING entitled *Costs of Misclassification*, the National Research Council presents an approach to the assignment of costs to errors in classification of chemicals as carcinogens or noncarcinogens. The model developed there suggests that the social cost of underregulating a chemical is much greater than that of overregulation. TOXICITY TESTING, *supra* note 1, at 378 (App. E). *See also* Hodgson, *Social and Economic Implications of Cancer in the United States*, in MANAGEMENT OF ASSESSED RISK FOR CARCINOGENS 189 (1981).

in risk management should receive as much attention as do the health sciences.

What is the place of risk management within environmental and public health management? It seems that the law's reliance on information-based regulation should continue to be somewhat cautious, unless the behavior of information in the market can be accounted for and levels of investment in research adjusted. Risk assessment is clearly a very useful methodology, as the discussions in this volume make clear. It organizes information and questions and provides necessary guidance for policymakers in establishing priorities. Yet we are all familiar with literary fantasies about information that overwhelms rather than assists.[34] Risk assessment gives the impression that it is capable of doing that, if it is not properly located in the legal framework.

Nor will risk communication be convincing, unless it is accompanied by recognizable reductions in human exposure to toxic chemicals. Today people are routinely confronted with mixed messages. An example is the following juxtaposition of two newspaper articles. On one page was the lead announcement, "U.S. Calls Poisoning of Air Far Worse Than Expected and Threat to Public," with the lower caption "A survey traces chemicals from industry and everyday use."[35] On the next page was a personal health column discussing "chemophobia," which was presented as a cause for concern, because it increases stress, ignores the benefits of chemicals and distracts from the ways health can be improved by controlling nutrition.[36] Yet, in light of the first article, it hardly seems that Americans are being neurotic when they show concern about chemical exposures or that giving this anxi-

34. In Charles Dickens' LITTLE DORRIT, at 145 (Penguin ed. 1967), Chapter 10 of Book I is entitled "Containing the Whole Science of Government" and begins: "The Circumlocution Office was (as everybody knows without being told) the most important Department under Government. No public business of any kind could possibly be done at any time without the acquiescence of the Circumlocution Office. Its finger was in the largest public pie, and in the smallest public tart. It was equally impossible to do the plainest right and to undo the plainest wrong without the express authority of the Circumlocution Office. If another Gunpowder Plot had been discovered half an hour before the lighting of the match, nobody would have been justified in saving the parliament until there had been a half a score of boards, half a bushel of minutes, several sacks of official memoranda, and a family-vault full of ungrammatical correspondence, on the part of the Circumlocution Office."

35. N. Y. Times, Mar. 23, 1989, at B.11. Also on the same page was the conclusion of a report on efforts to ban exports of hazardous waste.

36. Brody, *Personal Health—In search of perspective when fear of chemicals in foods begins to become a national phobia*, N.Y. Times, Mar. 23, 1989, at B.12.

ety a technical name will allay it. Quantified risk is only one dimension of the phenomenon of chemical use and one way of framing the issues about chemical side effects. People know this and appropriately want more than a number when they are making choices about their own exposure. As Lester Lave and other authors here point out, people want the society to implement a viable system to control pollution. Risk communication will be effective to the extent that risk assessment visibly helps us reduce human exposure to suspect chemicals.