

# Varieties of Risk Representations

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## 1. Social Holography

Since the late 1960s the concept of risk has become a focal point for a variety of critical issues bridging science, politics, technology, social theory, and the interpretation of culture: how we know about, value, and describe dangerous events and their consequences, how we reason under uncertainty, and how institutions, scientific paradigms, economic conditions, historical traditions, and political forces condition, direct, or define our interests and fears about pollution and other hazards.

Risks as diverse as global warming, AIDS, overconsumption of natural resources, hazardous waste, or the decline in biodiversity, are not *solely* health, technological, or environmental risks, but are also embedded in political or economic issues that preclude a neat segregation of the risk from larger ideologies of danger, knowledge, culture, and society. Making decisions associated with these risks will require substantially more than additional scientific research or public education campaigns aimed at "correcting" simplistic risk misperceptions. If anything, each one of these risks is pushing society to *different* limits. Collectively these risks are acting, or have the potential to act, as a powerful machine for social reflection, social criticism, and social change.

Through the concept of risk, issues in science, medicine, philosophy, social science, public policy, political economy, and communicative practices of all kinds are inextricably wedded in matters of direct public concern. To borrow a term from ecology, risk can be thought of as a kind of cultural and societal *holon*.<sup>1</sup> Ecological modeling necessarily moves hierarchically between various levels of biological systems and complexity, while for risk, the "systems" involve not just pollution as physical or biological processes, but involve also the human understanding of danger, and the place of both the danger and our knowledge of it within a dynamic social world. Understanding risk should mean the ability to "change the scale" or dimensions of risk so that it can be thought of simultaneously as a natural and a social object of knowledge and human interests. A single risk may lead to *a* whole, though perhaps not *the* whole, of society, and *a* risk can provide the conceptual and social machinery to systematize a range of problems and conflicts among health, the environment, technology, science, the economy, and politics. Risks are the poor man's dialectic, a panoptic window on society, a general tool for social policy and social change. *How is it*

*that the simple idea of risk provides such rich opportunities for scientific or social interrogation?*

This essay sketches an answer by developing a road map for some major categories of risk representation. But first, two additional illustrations prepare the way and make clear the pragmatic content of our problem in conceptual analysis.

## 2. Alar and AIDS

By 1985 the U.S. Environmental Protection Agency (EPA) had decided to ban the growth additive daminozide, sold as "Alar," which was used extensively and productively on apple orchards to prolong ripening time on the tree. EPA had identified daminozide as a possible human carcinogen, and calculated an additional cancer risk of just over their "de minimus" level of one in one million posed to individuals eating Alar-grown apples over a seventy-year lifetime. EPA agreed with the Alar manufacturer and apple growers to delay the ban for eighteen months, presumably to give growers time to "internalize" the regulation—i.e., eliminate Alar use without severely disrupting industry economics. This type of risk and benefit balancing for pesticides is governed by the federal Food, Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947, though just what risk and benefit "balancing" is supposed to mean is left open by the law. In contradiction with FIFRA, the infamous Delaney Clause, a 1958 amendment to the Food, Drug, and Cosmetic Act, allows *no* such balancing at all for carcinogens, and it is through these contradictory regulations, among others, that the Alar debate was played out.<sup>2</sup>

Enough has been stated already to identify some critical issues in social policy. First is the knowledge on which the calculation of Alar dietary risk is based. Imagine all the influences on your body and its health during your lifetime, all your exercise or lack of it, all the environments, good and bad, to which you are exposed, the care or lack of care you or society may provide for yourself—take that enormously complex process and consider someone telling you that the incremental chance that you will contract cancer is, to within an order of magnitude, 1/1,000,000. This value is calculated not from observed counts of consumers, apples, and cancers, but by dosing laboratory mice with large amounts of Alar/daminozide by-products for their body weight, watching for tumors, and then extrapolating by weight and the amount of Alar from animals to humans. The event, cancer from Alar, is so complex, and the model to calculate Alar risk so comparatively simple, that we must honestly ask whether the point is that the calculated value is right or wrong—especially since we can simply avoid the risk through the easy consumer choice of giving up Alar apples—but that such odd and esoteric knowledge has been brought to bear on the mundane act of eating an apple.

Of course apple growers are a major stakeholder group. So too are

chemical companies who manufacture pesticides and other chemicals used in the agricultural production process, and which have become as indispensable for some farmers as labor, land, water, and favorable weather. Enter also the Natural Resources Defense Council, who produced their own risk analysis of Alar use, following EPA methodology, but differentiating the consumption of apples by children from that of adults. On average, children consume more apples and fruit than do adults, and children are considerably smaller on average, by body weight, than adults, so the relative amount of a metabolite in children will be larger both in absolute and relative (by body weight) terms when compared to adults. And, as the dose makes the poison, if more toxin, then more risk: NRDC calculated a roughly 1 in 4,000 risk for Alar-eating children, comparable to the risk of childhood leukemia.<sup>3</sup> EPA claims to consider the “most sensitive population” in risk calculations, but they failed to do so here, regardless of the competing directives implied by FIFRA and the Delaney Clause. NRDC provided the missing calculation and, through the help of a public relations firm, made it public on the television “news magazine” *60 Minutes* on February 26, 1989. Following was a public outcry on many fronts, considerable media coverage, and a temporary consumer retreat from apple purchases. Uniroyal, the sole manufacturer of Alar, ended the controversy by halting production of Alar immediately, thus making NRDC’s and EPA’s argument over the risk numbers moot.

Alar has been cited as either societal “irrationalism,” cynical manipulation of the public by NRDC, shabby journalism by *60 Minutes*, or characteristic ineptness by EPA spokespersons. But the value of a debate on apples emerges from rescaling the risk to different sets of values and outcomes. First, NRDC for many years had as a key goal large-scale pesticide use reduction, so their use of Alar and children as a “sensitive population” had fundamental strategic value for their long-term objectives. There is also the strategic embarrassment to EPA brought about by NRDC’s following the letter and spirit of EPA’s approach to risk calculation. The threat to growers and chemical manufacturers was that *other* chemicals would be regulated on the basis of a new “most sensitive population,” thus putting at risk hundreds of millions of dollars of chemical and agricultural revenues, economically “optimized” with respect to the current regulatory regime. To help mobilize public concern, there could not be greater symbolic value risk than that this poison was part of the unprocessed, “natural,” food supply forming a major part of children’s diet. And beyond the strange role cast for science through risk assessment already mentioned, behind the scenes at EPA, the competing constructions for what the evidence “really meant”—provided by EPA, science advisers, and industry experts—only served literally to deconstruct the fragile foundation on which the risk assessment was built, and to turn the deployment of evidence into the capture of power.<sup>4</sup>

As it turns out, in 1993, NRDC’s criticism was at least partly vindicated by the appearance of a National Academy of Science report on children’s

overexposure to pesticides in the food chain and a plan by the Clinton administration for a massive overhaul of pesticide policy.<sup>5</sup> Skepticism about Alar and science was, and is, associated directly with what we value in agricultural and chemical production systems. Hence there is no simple story about Alar risk. Rather, there's a serious spectacle involving science and environmental policy, the relationship between positively ambiguous, super-flexible laws and the environment, about mass consumption and the agricultural and chemical industries, and about the way we inform ourselves about all this through the mass media.

Any residual doubts about the importance of Alar may be countered through the health impacts, risk perceptions, and social reactions making up the history of the HIV-diseases/AIDS (human immunodeficiency virus/acquired immune deficiency syndrome) pandemic. Here we see most clearly a horrible danger, with estimates of HIV infection in the year 2000 of up to 40 million people worldwide, and, given today's state of knowledge, and nearly a 100-percent mortality rate from any of several severely disabling, opportunistic diseases setting in five to ten years after infection. But what does *history* have to do with the contemporary risk of HIV infection and AIDS?

The emergence of the AIDS epidemic in the United States from the late 1970s to the late 1980s includes, first, that the largest populations initially infected by HIV were marginalized social groups, at least with respect to mainstream American culture: polysexual gay men, intravenous drug misusers and their sexual partners, and African heterosexuals. While outbreaks of esoteric pneumonias and skin cancers were being reported to the Centers for Disease Control (CDC), the principal federal organization responsible for monitoring disease in the United States, and though these unusual diseases were leading to premature death in the identifiably urban, gay men struck by them, CDC chose not to initiate standard interventions associated with warning signs of the emergence of an epidemic, namely detailed investigation of likely risk factors, and alerting the public, health officials, and the medical profession of the likelihood of a rapidly spreading disease.<sup>6</sup> The argument that a new epidemic "could not" be spreading among gay men was based, through ignorance of gay sexual practices, on the mistaken assumption that there was no means for a semen- or blood-borne disease to be carried from one infected partner to another. So, while epidemiologists pride themselves on their ability to ferret out, detective-like and in the spirit of high empiricism, the most obscure routes for mysterious disease outbreaks, the early years of the AIDS epidemic was given no such attention.

The national health agencies and the federal government, which for years failed to provide funding commensurate with an escalating death-rate and signs of the epidemic explosion, are not the only players in AIDS history. By 1983 several epidemiologists had conjectured that a virus was



being transmitted through blood or semen, and that infections and deaths seen in drug misusers could be further transmitted through blood banking. The pattern of denial and deferral seen in the CDC's response was repeated by most blood bank managers around the world. The chance of contracting AIDS from a transfusion in San Francisco was declared by some to be a de minimus risk of "one in a million,"<sup>7</sup> while odds correcting for demographics of blood donation calculated at Stanford University Hospital, one of the few institutions to begin testing their blood supply early on, were closer to a frightening one in five hundred. But even if risk estimates were uncertain, what was known were the increased costs of testing and the reduction in saleable blood product: by December 1983, one in fifty donations to Stanford's hospital was being rejected for immune irregularities, thus proportionately impacting the cost to them of each unit of blood, while many other blood banks absorbed no such costs. The aftermath includes, to mention just one case from 1993, the athlete Arthur Ashe's death of HIV-related diseases, contracted through a post-surgical transfusion a decade earlier, and today thousands of hemophiliacs worldwide are HIV-positive for similar reasons.

This is not to say that the history of AIDS is only one of the "bad" risk managers versus a "victimized" community of wretched intravenous drug misusers, unfortunate hemophiliacs, or disdained homosexuals. Many gay activists fought early in the epidemic not just for increased funding for AIDS research by CDC and the National Institutes of Health, but also within the highly charged worlds of gay politics to increase AIDS awareness and promote risk-reducing behavior. Yet these activists, far from being supported by the gay community, were vilified through a facile rhetoric of sexual liberty as "gay fascists" threatening to set back the advances made in gay freedom during the 1970s. For example, during the early 1980s bathhouses were a popular venue for multiple-partner sex trysts which became the vectors, in epidemiological parlance, for the new disease. Bathhouses were a prominent public and political symbol of gay liberation, and were also big money-makers. Owners in large cities contributed significantly to mainstream and gay political groups, wielded the same political power associated with any major commercial activity, and publicly fought or ridiculed gay activists promoting even the mildest "safe sex" risk communication campaigns. The cross-conditioning of uncertain knowledge and values follows no happy boundaries here.

AIDS is also remarkable for its combination of dire danger combined with simple hate, expressed most clearly in the scapegoating of AIDS sufferers and their families. In Florida in 1986, arsonists burned down the home of teenage hemophiliac Ricky Ray (who contracted AIDS through blood transfusion), after he attended school and in spite of widely communicated information that HIV was not contagious and was difficult to transmit. Ryan White, for whom a federal AIDS appropriation act is named, was also hounded from his Indiana school, while the Reverend Scott Allen

was asked to leave his Dallas ministry when his wife and children became HIV-positive through blood transfusions: and these are just some of the unrightly labeled “*unworthy*” victims.<sup>8</sup> Though attitudes are changing, AIDS has evidently been interpreted by many as a diseased condition implying moral transgression, and is fitting as a punishment. AIDS scapegoating has been made possible through the type of interpretation regularly given to cancer (or to Jews in the Black Death, or the *pharmakos* or scapegoat of ancient Athens), combined with a tacit or explicit public approval that this biomedical problem is also the expression of odious social character. So AIDS has not just a significant history of the spread of HIV, but a history of its own representations that contributed to that spread, and that history is still essential for designing useful social interventions to limit the disease in the future. AIDS is as much an epidemic of representations as of a virus.<sup>9</sup> The actions of the blood-bank managers, bathhouse owners, and venal neighbors show that AIDS was created, physically, through a manifestly social process of interpretation, personal perceptions, and political choice: *these are causes of AIDS.*

These truncated accounts of Alar and AIDS illustrate that risks are sites for complex negotiations over knowledge, benefits, danger, accountability, rights, and personal and social control. At the same time, no single characterization of danger, whether biomedical, environmental, economic, legal, historical, or political, dominates a risk debate or can lay claim to some fundamentally authoritative or privileged status. Let us see what we may infer from these sketches of Alar and AIDS risk with the aim of identifying some lessons that apply not to every risk, but to many.

### 3. Some Lessons

*First, problems about risk analysis and scientific knowledge.* EPA used its institutionalized modeling techniques for extrapolating from animal tests to humans to arrive at a worrisome, for EPA, estimate of about a one-in-a-million, or  $10^{-6}$ , chance of a cancer effect for an adult eating Alar apples over a seventy-year lifetime. Without detailing the problematic aspects of EPA’s modeling techniques, it is fair to say that though  $10^{-6}$  is the estimate provided by EPA, and a larger “corrected” value for children of about one-in-ten-thousand ( $10^{-4}$ ) was provided by NRDC using similar methods, *nobody believes these models or values are correct with a sense of accuracy or validity present in much scientific research.* For example, EPA risk standards have built into them so-called “safety factors” such that the risk estimate will, one hopes, always be much larger than the true value, which is to say that the value is not much of an estimate at all, but rather a confused proxy combining both science and policy-making at once. Not that anybody thinks that these values are exactly wrong, either, say as “conservative upper bounds.” But this “best” risk estimate, and many like it, is based on a raft of assumptions,<sup>10</sup> each of which is almost impossible to verify empirically but is neces-

sary to create a calculation at all. The approach is to assume as much as needed to come up with some answer, but outside the context of any broader scientific research program that provides substantive theoretical or empirical support.<sup>11</sup> Because of the complexity of many risks, risk models are often extremely simplified simulacra of the "true risk," which paradoxically has no independent characterization outside of the risk model itself. The possibility of empirically estimating the incidence of Alar-induced cancers, as in an epidemiological study, is essentially impossible because, with the small probabilities involved, cancer cases due to Alar could never be distinguished statistically from sheer data noise. Direct experimentation on humans instead of rodents is ruled out for ethical reasons. While in many cases, some model is better than none, insofar as there is no real research program in the case of Alar; no sustained theoretical or empirical progress; and no likely breakthrough to organize a confused field of knowledge—the limits of this applied science itself becomes all too clear to those involved.<sup>12</sup>

*Hence a skeptical lesson on risk analysis and science:* For many risks, we implicitly participate in a skeptical suspension of judgment associated with our best knowledge of a danger or pollution. The knowledge created to estimate the magnitude of danger is sometimes developed in a nether world of policy science, whether by the government, NRDC, consultants, or others, that incompletely and crudely captures all uncertainties through probability. But this is the "best" we can do, so implicit here is a recognition that science is not quite the help we'd like it to be, and science, in such cases, need not be recognized as the final, or even fundamental, arbiter on important environmental or health decisions.

AIDS, at least in the early 1990s, did not support the same risk-analytical skepticism illustrated by Alar, but instead leads to other problems associated with causality, explanation, and danger. While there are competing theories to the HIV orthodoxy, there is something closer to a science of AIDS containing substantive causal and epidemiological models, a surfeit of testable conjectures, and measures of progress between competing research programs. The progress is slow, but criteria for progress exist. At the same time, the absence of a magic bullet to control HIV as the biomedical cause of AIDS implied that the nonbiomedical causes of AIDS which contribute to HIV exposures, namely styles of sexual practices, the availability and use of functioning condoms, or practices of exchanging infected needles among drug misusers, are the means through which HIV and the spread of AIDS can be affected.

But these causes are unlike those associated with HIV as a biomedical risk. The possibilities for reducing HIV infections by changing sex habits or illicit drug practices are fundamentally social interventions such as behavior-modification campaigns, aggressive risk communication, or clean-needle programs, all of which are not only controversial, but whose role in mitigating AIDS leads immediately to problems of understanding AIDS in the deep

cultures of sex roles, vice, private rights, and public space. The risk analysis itself of AIDS shows, by simply asking how AIDS came to be, and how we are causally to control the spread of disease, that AIDS is "as much" a social, behavioral, communicative, and political risk as it "is" a biomedical risk, and thus neatly illustrates how risks contribute to the deconstruction of social reality. If anything, AIDS is "as much" a biomedical disease as it "is" a social disease. With AIDS, the pseudo-hierarchical distinction between social and physical causality is shown, if not fully recognized, as an artifact or explicit bias. Comparing AIDS to many environmental risks, we have a relatively strong analytical understanding of the danger, but we also know that to control the danger today we have to consider how human meaning-making and interpretation create danger, not just biological causality.<sup>13</sup> Paradoxically, we have astute intellectuals rightly inveighing against the moral interpretations which create AIDS stigmatization and its discourse of hate, but also an appeal to treat AIDS "just" as a disease, and for us to be good positivists for a change.<sup>14</sup> At the same time those who want to reduce AIDS risk must, in an anti-positivist spirit, understand the meanings of HIV and AIDS in the contexts of the sex industry, sexual recreation, and the cultures and business of drug use in order to create successful interventions. Useful AIDS interventions will not be generalizable like a Salk vaccine or follow from a behavioral cookbook, but rather will be exemplars of successful interpretive models that others can use as a guide.

*Hence another lesson on risk analysis and explanation.* For some risks, with AIDS as perhaps today's most instructive example, risk analysis shows that a causal model that best accounts for the risk or its control may necessarily incorporate deep social explanation, the interpretation of meaning, cultural symbols, and practices, as well as the understanding of social forces not traditionally dealt with in risk analytical terms. Different types of explanation are required for developing social interventions, and prediction and control take on different aspects altogether, in that certain interventions must be attempted experimentally which are not within the orbit of *predictable* success, nor straightforward confirmation.<sup>15</sup>

Now to another set of issues associated with both Alar and AIDS, having to do with *the individual's perception of risk*, meaning the battery of beliefs, however organized, that is brought to bear by a person in making judgments about a risk: how serious this risk is *for me*, what alternatives *I* should consider and select for action, the variety of outcomes *I* associate with the risk, and how *I* should judge and treat uncertainties.

To return to Alar, there is an often-cited list of "qualitative risk factors" that, some claim, accounts for much of how we, as individuals, condition judgments of danger and their relative importance.<sup>16</sup> For example, consider the following qualitative considerations on Alar risk: the risk affects children in disproportion to adults, and is therefore inequitably borne by a vulnerable group; the science associated with the risk is poorly understood; a relatively credible study by NRDC suggests a plausible modification to



children's exposure that makes children's exposure estimates increase their risk substantially—the study is provided outside of establishment channels and suggests a potential for lack of trust in official risk management; a carcinogen risk is dreaded, no matter who gets the cancer; the risk outcome is irreversible; the risk is man-made, while apples, the proximate source of the risk, are a conventional symbol of natural purity and goodness; the risk is largely controlled by growers and chemical manufacturers who benefit most directly from the use of Alar; anyone with young apple-consuming children may have a direct personal stake in the risk.

Clearly, there are ingredients here for a rich narrative or other risk representation, whether as cognitive mental model or articulated description of risk. Regardless of the absolute quantitative danger associated with Alar, there is much objective information here about the risk, oriented not favorably toward Alar, through which one may form and articulate a judgment. The lesson is that risk perceptions may originate in a variety of risk representations involving decision-making or risk-taking omitted from a risk analysis which refers to no social or personal decision-making contexts at all. Risk outside of all such contexts is no risk at all, since value is meaningful only in the context of choice, while the narrative calculus of qualitative risk allows us to navigate swiftly among bearers of danger, control, and benefit. In the cases of Alar and AIDS, the bearers of risk and benefit, and transfers of power between them, account for much in their respective histories.

For a different illustration of the role of risk perception, or the construction of individual judgments about risk, consider how the qualitative factors listed above "score" for the naturally occurring indoor gas radon, which may pose at least as great a total risk, even to children, as did Alar, but which is currently a small monument to public apathy.<sup>17</sup> No blame can be constructed for radon, and lack of concrete experience with the danger—its "visibility" so to speak—may contribute to lack of concern for homeowners who neither smell nor see radon, just as uninsured residents of flood plains may have never seen water near their homes, or some gay adolescents may have never knowingly met anyone with AIDS, or heard it seriously discussed among their peers. The moral is: too few, or no "negative," qualitative risk factors can mean judgments of no risk seriousness, while, according to the risk analysis, *some* homeowners should be paying considerably more attention to radon, the flood plain dwellers should buy insurance, and gay youth should be practicing safe sex. At least post-hoc, it may be possible to recognize how the mental model individuals hold of a risk may make possible types of important judgments, which may or may not be in their best interest.

Here then is another key aspect of risk perception, namely the combination of problematic belief and judgment as seen both from the point of view of the judgment-making individual and from the perspective of one who claims to know. But while it is possible, legitimate, and helpful, on a

risk-by-risk basis, to characterize and critique the constellations of judgments and actions made by individuals regarding risk decisions, there's no independent standard to decide who is "perceiving" and who is in the know, just as there are no similar criteria to decide who is a victim of political ideology and who is the bearer of political or economic truth. The notion of risk perception borders on self-contradiction insofar as it implies a claim to truth, and appropriate means of personal or social control, where it is exactly such claims, about danger or pollution, which are just at stake. The real problems of risk perception force us to recognize the skeptical absence of a fundamental distinction between actual and perceived risk which can demarcate "legitimate" knowledge claims about danger or pollutions from others. Rather, there are only individual claims and counter-claims to truths about dangers and pollution that are simultaneously negotiated as science, politics, and cognitive judgments. Stated positively, risk perception may stand for cognitive and social conditions making possible, through competing risk representations, debates and the social construction of risk for which no received standard for truth, no received canon of authority, no prior criterion of rationality, no fundamental organon of correct judgment is acceptable a priori.<sup>18</sup>

Consider, finally, how the qualitative risk factors cited above for Alar provide a source for reasoning about Alar risk, meaning giving accounts of what is to be done, and assigning accountability or blame. In analyzing a risk we usually don't discriminate in any significant way, say, between cancers that are natural and those made by humans, or those considered to violate an individual's right to a healthy environment and those that do not. It would likewise be unanalytical to make decisions based on "reading" AIDS, as many have, as moral transgression: disease is disease for the analyst, and not also a social text. Yet such interpretations do figure heavily in how we deal, for better or worse, with danger, yet they do not satisfy what logicians call "extensional reasoning," meaning that if I only redescribe the dangerous or polluting events my analysis—if not my interpretation—should remain unchanged. However, most legal codes, moral codes, and ethical claims over personal rights, justice, and equity all depend on how you describe people as consensus-forming citizens, responsible parties, blameworthy wretches, or undeserving victims. Only persons have rights, for example, and who counts as a person is not a natural fact, but a social and historical fact. So the risk perceptual perspective, at least via the narrative calculus of qualitative risk factors, forces us also to consider whether we can frame questions about risk solely in the instrumental terms of risk analysis, as helpful as they may be. *Which brings us to a final lesson on perception and language.* Attributions of blame, responsibility, voluntariness, and so on depend essentially for their expression on historical traditions, institutions, and forms of life which cannot be separated from the languages used within them. Take away their expressions or representations in language and the possibilities for such attributions disappear as well. Risk

“perception” ultimately fails as a metaphor for what is “left out” of risk analysis in that it obscures the fundamental role of language in making not just different perceptions of risk possible, but different interpretations having their life in language, meaning, and representation, not “perceptions” in any significant sense.<sup>19</sup> For those risks involving complex interpretations of accountability, rights, or blame, such as AIDS and moral transgression, or toxics and environmental racism, analysis and public policy naturally devolve into social and historical interpretation, as well as the “perceptions” of individual cognition and decision-making.

#### 4. Defining Risk and Risk Representation

The lessons of the earlier section were organized around three basic paradigms for understanding and theorizing about risk that may be called *risk analysis*, *risk perception*, and *risk interpretation*. It is time then to propose a definition of risk, toward understanding the rich economy of ideas at work in the notion of risk, and also to understand the “holographic” possibilities described in section 1.

So here is a working definition of risk, in no more than four words: *risk is adverse consequences under uncertainty*. This definition is to be taken in complete generality, meaning that no single interpretation for “adversity,” “consequence,” or “under uncertainty” has to be assumed a priori. Rather, *any* relation between a world in which something bad could happen, or does happen, and our uncertain knowledge of that world counts as risk. Uncertainty may be quantified or not; consequences may include any type of event in the world; adversity is any expression of value, implicit or explicit, codified in language or not, and profane, amoral, holy, strictly personal, strictly social, or deriving from any genealogy of morals; and the relation between a valued world and uncertain knowledge of it—telescoped within the preposition “under”—may likewise be assumed to take on a variety of conditions limiting knower and the known. There is no single narrower definition of risk which is without significant contradictions or limitations, including those implied by the three “paradigms” above.

The definition given is not that of a single thing or process, but of a relation, and immediately implies the necessity of analysis or breaking apart. In risk analysis this means, for example, to characterize a particular risk, one defines the risk’s sources, such as toxics, power plants creating gaseous carbon; exposure, or the conditions under which receptors, such as people, animals, or habitats are affected by the risk source; and finally the consequences of this interaction in the form of specific health, ecological, esthetic, or economic effects. Risk is defined through the system, process, or function consisting of all these interacting parts. That risk is relational is an old idea: *Dirt is matter out of place*.<sup>20</sup> Nothing is dangerous or polluting in itself, but only relative to a structured set of circumstances, *including* our knowledge and control of those circumstances. Because risk is relational, the

concept affords means for expressing, like an amphibious Nietzschean army of mobile metaphors, knowledge through value, or vice versa, and thus implicitly defines a powerful political-epistemological toolkit. Some of this power is revealed through categories associated with the terms of our relational definition: adverse, consequences, and under uncertainty, namely the categories of value, events, and knowledge, and the relations among them.

Adversity refers us to the category of value, or what is to be preferred, despised, or taken as indifferent. Value may be expressed in economic terms; in terms of human mortality or morbidity; in ecological terms, such as acres of wetlands lost or species sustainability; through categories of people such as adults and children, or the economically advantaged or disenfranchised; or through indicators of historical or cultural value; or as purely symbolic value, as some may see with either Alar or AIDS. Clearly, there is no single way of valuing all risks, and most risks are multiple-valued: few dangers entail only one value category or social impact associated with them. Attempts to respond to risks through only a single index of value—such as cancer cases avoided, or wetlands restored—or some such index and its costs, is almost always wrong.

Consequences refers us to the category of events, meaning physical, chemical, biological, or biomedical events such as exploding space shuttles, exploding pesticide factories, poisonings, degrading ecosystems, or drunkenness; or social and political events, such as consumption in Western cultures, the process of siting hazardous waste facilities, or the expansion of the world's electrical power grid; or psychological events such as the (mis) understanding of flood insurance, or the recollection in memory of disasters frequently presented through the mass media; or historical events such as the development of the nuclear weapons complex following the Manhattan Project, and the attendant neglect of toxic wastes. But no single type of event serves as a kind of ontological atom which we might use to anchor a risk-in-itself. We may, sometimes, argue that history is irrelevant, or that psychological perceptions are born of childish fear. But such arguments should be scrutinized carefully for what they serve to exclude. Risks help uncover connections between different types of experience and different ways of thinking about the world, and different accounts of a risk, such as biomedical versus social theories of the spread of HIV diseases, will turn on the types of entities or processes thought to provide the better causal account of a danger or pollution, and thereby influence the types of solutions required to reduce risk. Not that such accounts have to be exclusive; but that implies not one account of the kinds of things there are in the world, but many views: of diseased beings, species-beings, natural beings, historical beings, racial beings, or beings-in-communities.

Uncertainty refers us to the category of knowledge, and risk is remarkable for building into its foundation a skeptical and antifoundational stance about what we know. When we study, say, physics, one does not describe it



as “the properties of the physical world and our uncertain knowledge of them,” while for risk, such uncertainty is explicit from the start: one is skeptically expected to repudiate positivist assumptions about the potential finality of scientific knowledge in favor of an explicit acknowledgment of uncertainty. The standard procedure is to assume that uncertainty is best equated with mathematical probability. But successful science utilizes many techniques for dealing with uncertainty, typically not well quantified through probability, and some major risks such as global warming, or the safety of the proposed high-level nuclear waste repository in Nevada, fall into this category.<sup>21</sup> As of today, no universal demarcation rules exist for separating “rational” from “irrational” inference, and because uncertainty plays such a large role in many risk debates—uncertainty over causes, possible effects, or costs—one’s philosophy of uncertainty becomes associated with ideological claims of rationality, irrationality, or rules of scientific method, which is not surprising, given the skeptical assumptions built into risk itself.

“Under uncertainty” refers us also to what may be called reflection, meaning that we may step back and consider, reflectively, the relationship between value-laden events and our uncertain knowledge: this relation between knower and the known is part of risk also. The risk analyst hopes that this relation is captured by thinking about events as mathematical “sets” and uncertainty as probability; the cognitive psychologist turned risk researcher postulates the psychological expression of value judgments, and our “heuristics” and “biases” in thinking about risk; the ethnographer or social theorist finds relations among value, events, and knowledge to depend on, say, institutionalized languages of pollution and knowledge to be revealed through thick descriptions of social practice. The simple notion of risk invites us variously to be Galilean mathematizers of the world, or cognitive but asocial information processors, or self-conscious interpreters of human action and language whose understanding of the world is also part of it. At times, each of these assumptions makes sense and has its use, but the three options, of analysis, perception, and interpretation correspond to drastically different options for negotiating risk as a natural and human science. Risk debates thereby force upon us the question, at least implicitly, of selecting a reflective world-view of knowledge, action, and language, and so make a theory of knowledge critical to one’s ideology of danger or fear.

The world-views implicit in our three risk paradigms may be further analyzed in terms of how the categories of value, events, knowledge, and reflection are realized in practice, meaning how they create broad schemes for risk representation, being the building blocks for the languages of risk. Each paradigm tells something about what risk is, or should be, and provides heuristics for making that conception operational as science, public policy, politics, or social criticism: a *risk representation* therefore includes both (i) a *theory of risk* plus (ii) *heuristics* for putting the theory into use.

A theory of risk includes any account, research program, conjecture,

definition, regulation, formalization, working postulate, narrative, story, or myth, either implicit or explicit in risk discourse, of what either a particular risk or risk in general is. Heuristic includes any means for deducing, inducting, deploying, elaborating, supporting, suggesting, or otherwise creating a corpus of knowledge claims or advice about risk. A theory of risk provides criteria of truth, for claims about the nature of risk, or possibly any blame, shame, or responsibility associated with a risk, while heuristic, in this context, refers to the means used for producing such claims.<sup>22</sup> Such methods may be embedded in institutional practices of the Environmental Protection Agency or the Natural Resources Defense Council, or they may be formally codified in the abstract principles of decision analysis; in practice, most examples lie between these two poles, and partake of both institutions and abstractions in important ways. The purpose of separating out "theories of risk" is to cut across dichotomous classifications such as value-laden versus value-free theories, subjective versus objective judgments, quantitative versus qualitative risk characterizations, or perceived versus actual risk, none of which happen to demarcate risk analysis from other types of risk discourse. The definition acknowledges that all such considerations may be part of any theory of risk. The purpose of "heuristic" is to avoid distinct "modes of rationality," taken in any serious sense; there are only heuristics of different types, and there are no fundamentally "rational" or "irrational" styles of risk representation.<sup>23</sup> While the separation between a theory of risk and the heuristics used to put the theory into practice is not sharp, the different risk paradigms tend to make characteristic separations, and to marginalize issues which are central elsewhere. Each paradigm leaves open some fundamental issue about what risk is, how risk is represented, or how risk is interpreted. Because there is no obvious account of how one may consolidate or move between the insights of different risk or risk communication paradigms, the amphibious and skeptically uncommitted tool of risk representation is a useful, even necessary, means for navigating among them.

Examples of risk representations include: (a) a standard risk model of source, exposure, consequence, or any other causal framework for defining risk, plus scientific heuristics drawn from relevant physical, biological, or epidemiological theories, but without regard for regulatory or public health relevance; (b) a risk model as in (a), plus a restriction to quantitative probability (either subjective-Bayesian or a frequentist interpretation) to represent uncertainty; (c) a risk model as in (a) or (b) plus institutional guidelines aimed at using science to develop regulatory policy; (d) a standard model such as (a) plus the categories of qualitative risk provided by the "psychometric" paradigm of risk perception but without any specific heuristic for the extra categories; (e) (d) plus quantitative representations of qualitative categories collected through surveys; (f) (d) or (e) plus conjectures about how qualitative factors become operative in risk discourse, or advice found in risk communication handbooks;<sup>24</sup> (g) any formal or informal theory of

risk used by the lay public, media, politicians, or social activists, plus the means of deploying these theories through mass or informal communication channels; (h) ethnographies, histories, and other risk interpretive studies, combining risk representations drawn from the area of study plus the ethnographic or historiographic methods used for re-representing those criteria of risk.

Each example combines criteria of what risk is with heuristics used to make the theory of risk operational. (a)-(c) lead to accounts of the scientific basis of risk assessments, (d)-(f) lead to accounts characterized by their use of perception or "outrage" factors, (g) stands for the ubiquity of risk representations as they occur through dialogue, the press, public hearings, fiction, political debates, or any other communicative practice, and finally (h) stands for the reflective and interpretive accounts of (g) which themselves add to and modify the stock of risk representations.

The three risk paradigms of analysis, perception, and interpretation differ in terms of whether they are primarily a theory of risk or risk representation, and the relative direction taken influences their accounts of what risk is (especially through risk assessment), or how risk is represented and interpreted across varieties of risk discourse. Risk analysis intends to eliminate any vestige of decision-making, value, or interpretation from risk "as it is"; risk perception ambiguously situates risk between physical processes, cognitive categories, and decision-making; and risk interpretation opens risk to the gamut of interpretive strategies known to humankind without any specific criteria set for the validity or coherence of an interpretive practice. The three paradigms take us from a direct, "extensional" account of what risk is to an indirect account, or an account of the social construction of risk, via an increasing emphasis on the processes of risk discourse.

In a sense this dialectic from analysis, through perception, to interpretation, follows easily from the definition of risk as adverse consequences under uncertainty. "Under uncertainty" brings into the definition not just what is dangerous, but who knows about danger, and what the character of that knowing relation is—namely, its uncertainty. What that implies immediately is not "subjectivity," "mental models," or even "cognition" but the relation of knowing, which minimally involves a world and a language describing it, or interpretation. Make that world contain pollution or danger and you have risk interpretation.

## 5. Risk as Contemporary Skepticism

We are ready to return to the problem posed at the beginning of the essay, namely, to understand the "holographic" possibilities for risk and risk communication. Our answer is that the concept of risk is saturated through-and-through with skeptical assumptions about knowledge and value: the relational structure of risk entails no natural boundaries to causal or other explanation; presuppositions regarding uncertainty build in questions of

“perceptions” and antifoundational attitudes toward knowledge; the reflective dimension of adversity “under uncertainty” refers to contingent relations between knower and the known; and in all instances of risk, questions of value are integrated with problems of knowledge. These are the skeptical tropes intrinsic to the risk concept.

Let’s start again from the earlier definition of this essay: of risk as adverse consequences under uncertainty, or, for brevity, “relational risk.”

As mentioned, there are a number of standards relevant to the characterization of unquantified scientific uncertainty, in addition to the probabilistic methods used by risk analysts to quantify uncertainty. Some criteria for dealing with uncertainty may be accommodated as special cases of others, and some are of greater theoretical than practical importance, but the variety of epistemic standards occurring in contemporary risk discourse, even limiting ourselves to scientific uncertainty, shows that the general definition of risk as adverse consequences under uncertainty is conducive to epistemic pluralism: the recognition of multiple criteria of uncertainty with varying domains of applicability and importance. Quantified uncertainty is a special case which too may be elaborated in different ways: normative decision analysis, classical probability, subjective probability, and so on. It is also true that we collectively use all of these alternatives to solve problems and represent risks. Hence starting with the definition of relational risk, a first natural question to ask is the skeptical Question 1: What kind of uncertainty is relevant or at issue here? Question 1 may be asked equally well by philosophers, consultants, reporters, policy analysts, or politicians—all of whom have available representative replies as well.<sup>25</sup>

Epistemic pluralism is not identical to the cultural pluralism often associated with anthropological approaches to risk studies. Cultural pluralism (or relativism) reflects the value dimension of risk and generally means that there is no one best way to organize society, that different cultures have evolved different constellations of values and social mechanisms, and that cultural values must be evaluated in terms of their actual effects on social life, rather than by abstract criteria.<sup>26</sup> While the focus of this essay has not been on values, ethics, or the moral dimensions of risk, analogous to Question 1, and implied by the plurality of kinds of dangers covered by “adverse consequences,” is Question 2: What kind of danger or pollution is at issue here? The cultural pluralism implicit in Question 2 stands for the variety of dangers which may be selected to become risks, regardless of how they are deployed as part of a system of knowledge, though, in practice, there is often a close dependence between value judgments and types of uncertainty.<sup>27</sup> There is no reason to subordinate questions of value to questions of knowledge, but once one invites the general skepticism implied by epistemic pluralism, then there is no means, *in general*, of demarcating real dangers from illusory dangers, significant dangers from trivial dangers, or facts from fears, and the contestation of such issues may be found almost daily throughout the media. That is, skeptical problems about



value follow fairly readily from skepticism about standards of knowledge (though not obviously vice versa), and the particular values granted to (avoiding) cancer, AIDS, botulism, bee-stings, lawnmower accidents, suicide, and ozone depletion can be deployed with different heuristics for organizing our knowledge about these hazards. Consequently risk as adverse consequences under uncertainty entails a range of criteria for value choices as well as standards of knowledge. The relational conception of risk makes skeptical Questions 1 and 2 easy questions to ask together.

Taken jointly, epistemic pluralism and cultural relativism amount to a healthy abstract skepticism about both values and knowledge. But the abstract possibility of perpetual criticism should not be taken to mean that there are no standards of knowledge or value. That there are no absolute standards does not imply that absolutely there are no standards. We do, as a matter of fact, continually make value judgments and knowledge claims, but individual value judgments follow from adopting a standard with respect to an objective (e.g. valuing human over animal life with respect to the need to combat disease), and with respect to some provisionally accepted knowledge (current medical lore) to which the standard applies. But it does not then follow that there is a single standard applying to all types of danger a priori. As a matter of historical fact, societies like our own which concern themselves with risk-like notions, continually solve for themselves the problem of how the skeptic can live out her skepticism.<sup>28</sup> The epistemic pluralism implicit in relational risk does not entail unbridled moral chaos, the impossibility of scientific progress, the unfinality of all decisions, nor the equi-valuation of all risks. But the epistemic and cultural pluralism associated with relational risk makes such eventualities possible in principle, while in practice we always impose *some* bound, or *some* limit to the range of standards or dangers one may countenance in defining or selecting risks. Risk makes us radical skeptics in principle, and mitigated skeptics in life.<sup>29</sup> The third question therefore to ask from relational risk is Question 3: What limits are imposed to the variety of risks implied through answers to Question 1 and Question 2? Abstractly, anything goes; empirically this is far from the case.

It is therefore helpful to distinguish between abstract and empirical (or historical) standards. While abstractly there is no single characterization of uncertainty or danger setting the limits for conceptualizing risk, we successfully make choices via personal decision, political processes, historical traditions of many kinds, and generally any other means for defining different forms of life. In some cases choices for conceptualizing or valuing risk may be abstractly justified, as is done often in risk analysis. But in other cases the rationale emerges from historical criteria, and different historical traditions will support different means for interpreting dangers.<sup>30</sup> The abstract Questions 1 and 2 are answered via Question 3 sometimes abstractly, but also empirically or historically. As such, relational risk may make it apparent that basic issues of knowledge and value are matters of

historical process. Even the most formal aspects of quantitative risk assessment may be cast in this framework, as not only did our modern probability calculus not exist before the late seventeenth century, but the accompanying complex of notions on evidence, induction, and chance needed to support the “emergence of probability” did not exist as well.<sup>31</sup> We may prefer having this calculus available, but its usefulness depends critically not on an a priori selection of adverse consequences under quantified uncertainty as the natural representative of relational risk, but additionally on scores of ways of reasoning about evidence and justification now integrated into modern technological societies. Questions 1, 2, and 3 thus lead to Question 4: Through what combinatory mechanisms, practices, accidents, and institutions do the myriad choices for selecting and knowing dangers serve to constitute a risk, i.e., make it intersubjectively and objectively available as distinctive facts, events, or processes? The answer to Question 3 was: Abstract problems are solved via empirical solutions; Question 4 asks, How are these solutions realized? What, in other words, is the structure of the social and cognitive construction of risk? The answer assumes that at some level, contingent choices about both the form of rationality and the selection of values may play a prominent role in a how a risk is selected and defined. What is remarkable, and perhaps unique about risk, is that such choices easily become salient issues for public debate, rather than being buried under layers of ideology or historical artifact.

Questions 1-4 cross varieties of uncertainty and value with specific historical conditions as elements in the creation of particular risk portfolios. The final question to pose starting from the notion of relational risk is Question 5: From the plurality of risk representations that may be used to describe this risk and to reflect on social reality, which ones are used and why? We have now come full circle, as this essay suggests some answers to Question 5 for risk analysis, risk perception, and risk interpretation. As mentioned earlier, these paradigms give different weights to “risk as it is” and “risk as represented,” and these weights reflect fundamentally different, though related, approaches to the languages of risk, and the institutional or social forces conditioning them. One’s answer to Question 5 implies the most fundamental choice one may make in risk communication: Is language and representation intrinsic to notions of risk, or are language and discourse ancillary to the science or psychology of risk, or some other mechanistic paradigm?<sup>32</sup> Question 5 may alternately be posed as: Given that a main focus of contemporary social, historical, and anthropological analysis<sup>33</sup> is the extent to which discursive practices inform, and are informed by, social (and intellectual) structures and social action, to what extent is risk discourse an exemplary case, and for what reasons? The “ladder” of five questions just given, and this essay, provide a caricature of an answer, while a genuine answer could recapitulate a good bit of twentieth-century intellectual, technological, and social history, and still be left unresolved. Whether representations, psychology, science, or a mixture of all can be best used to

analyze risk and risk discourse admits of no short, evident, or single answer. Yet it is remarkable that risk should be such a fertile ground for abstractions ranging from probabilistic uncertainty to the social construction of risk, and equally remarkable that such abstractions should so come to life through the varieties of risk representations.

### Notes

- <sup>1</sup> F. H. Allen and Thomas Starr, *Hierarchy: Perspectives for Ecological Complexity* (Chicago: University of Chicago Press, 1982). The term "holon" is from Arthur Koestler.
- <sup>2</sup> For examples of how following the Delaney Clause can lead to increased risk levels, see National Research Council, *Regulating Pesticides in Food: The Delaney Paradox* (Washington: National Academy Press, 1987).
- <sup>3</sup> See Natural Resources Defense Council, *Intolerable Risk: Pesticides in Our Children's Food* (NRDC: Feb. 27, 1989). For comparison, childhood leukemia affects about one in every 14,000 children per year, or one in 1,100 per lifetime.
- <sup>4</sup> Sheila Jasanoff, "EPA's Regulation of Daminozide: Unscrambling the Messages of Risk," *Science, Technology, and Human Values*, 12, Summer/Fall 1987, pp.116-24.
- <sup>5</sup> See National Research Council, *Pesticides in the Diets of Infants and Children* (Washington DC: National Academy Press, 1993); "U.S. is Taking Aim at Farm Chemicals in the Food Supply," *New York Times*, June 27, 1993, on the alliance between FDA, USDA, and EPA to promote reduced use. Earlier in 1993, however, EPA had also announced that they would move to change the Delaney Clause, much to the disappointment of NRDC and other environmental groups. See "A Trace of Pesticide, an Acceptable Risk," *New York Times*, Feb. 7, 1993.
- <sup>6</sup> For much of the historical material that follows, see Randy Shilts, *And the Band Played On* (New York: Viking Penguin, 1988).
- <sup>7</sup> See Shilts, pp.361, 433.
- <sup>8</sup> "Ricky Ray, 15, Dies; Known for AIDS Case," *New York Times* obituaries, Dec. 14, 1992; "Minister's Ties to Church Are Sundered by AIDS," *New York Times*, Sept. 8, 1992. For a surprising example of the idea that some victims are more worthy than others, see the preface (p.x) in S. Graubard, ed., *Living With AIDS* (New York: MIT Press, 1990): "prostitutes and others who lead promiscuous sexual lives but also many who are innocent victims" (emphasis added).
- <sup>9</sup> Paula Treichler, "AIDS, Homophobia, and Biomedical Discourse: An Epidemic of Signification," in Douglas Crimp, ed., *AIDS: Cultural Analysis, Cultural Activism* (Cambridge: MIT Press, 1988), pp.31-70.
- <sup>10</sup> The assumptions include a 70-year lifetime for apple consumers; an average dietary intake over that lifetime; the residue of pesticide on apples; extrapolation of megadose experiments on small-bodied rodents to larger humans; and, for the EPA, the introduction of ad hoc "safety factors" to reduce statistical confidence intervals to single "acceptable risk" values. See John Graham et al., *In Search of Safety: Chemicals and Cancer Risk* (Cambridge: Harvard University Press, 1988). On the intermediate zone of risk assessment as a semi-science, see Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge: Harvard University Press, 1990).
- <sup>11</sup> For example, there are few real possibilities for theoretical argument, over, say, whether the slope parameter for a carcinogen's dose-response curve is greater (more risky) or less (less risky) than one: just what fact or argument may decide this almost metaphysical debate is unclear, and is reminiscent of what logical positivists like to deride as a "pseudoproblem."
- <sup>12</sup> See Jasanoff, "EPA's Regulation of Daminozide: Unscrambling the Messages of Risk," and *The Fifth Branch* for a detailed account of how EPA risk managers, industry representatives, and EPA's own Science Advisory Board miscommunicated and contended with one another through the Alar debate.

- <sup>13</sup> See National Research Council, *AIDS: The Second Decade* (Washington DC: National Academy Press, 1990), pp.440ff. for lip service on ethnographic issues.
- <sup>14</sup> See Susan Sontag, *AIDS and Its Metaphors* (New York: Farrar, Strauss, and Giroux, 1989).
- <sup>15</sup> For a classic account, see Charles Taylor, "Interpretation and the Sciences of Man," in Paul Rabinow and William Sullivan, *Interpretive Social Science: A Second Look* (Berkeley: University of California Press, 1987), pp.33-81. For arguments on the near impossibility of prediction in various communicative settings, see Jacques Ellul, *Propaganda: The Formation of Men's Attitudes* (New York: Vintage/Random House, 1965), Appendix I, "Effectiveness of Propaganda."
- <sup>16</sup> See, e.g., Paul Slovic, "Perception of Risk," *Science* 236, 17 April 1987; Paul Slovic et al., "Rating the Risks," in Theodore Glickman and Michael Gough, eds., *Readings in Risk* (Washington DC: Resources for the Future, 1990), pp. 61-75.
- <sup>17</sup> See Allan Mazur, "Putting Radon on the Public's Risk Agenda," *Science, Technology, and Human Values*, 12 Summer/Fall 1987, pp.86-93; for a critical view of EPA's radon risk assessments, see Leonard Cole, *Element of Risk: The Politics of Radon* (Washington DC: AAAS Press, 1993).
- <sup>18</sup> There is a powerful set of ideas in the literature on judgment and decision-making focusing on (their word) constructive aspects of preference and judgment. This work may serve as an important link between cognitivist and social-constructivist accounts of risk. See, e.g., Robin Gregory et al., "Valuing Environmental Resources: A Constructive Approach," *Journal of Risk and Uncertainty*, 7 1993, pp.177-93, and Baruch Fischhoff, "Value Elicitation: Is There Anything In There?" *American Psychologist* 45, August 1991, pp. 835-847.
- <sup>19</sup> The danger is to allow "perception" as a psychologistic metaphor act as a surrogate for theories of human behavior, action, thought, and truth. For insights about the diffusion of risk perception research see Baruch Fischhoff, "Psychology and Public Policy: Tool or Tool Maker?" *American Psychologist* 45, May 1990, pp.647-53.
- <sup>20</sup> See Mary Douglas, *Purity and Danger* (London: Penguin, 1966), p.48, who attributes the phrase to William James' *Varieties of Religious Experience*. An analytic version of "relational risk" is essentially contained in Vincent Covello and Miley Merkhofer, *Risk Assessment Methods* (New York: Plenum, 1994), p.2. Their definition is extensional, but broader than the National Academy of Sciences definition, in which uncertainty is assumed to be quantified through a probability distribution on adverse consequences. Douglas' most general definition allows for interpretive and symbolic dimensions as well.
- <sup>21</sup> For some of the important lessons of the philosophy and history of science over the last few decades relevant to uncertainty and rationality, see Ian Hacking, *Representing and Intervening* (New York: Cambridge University Press, 1983); Imre Lakatos and Alan Musgrave, eds., *Criticism and the Growth of Knowledge* (New York: Cambridge University Press, 1970); Paul Feyerabend, *Against Method* (London: NL B, 1975). On the high-level nuclear waste repository, see, e.g., K. S. Shrader-Frechette, *Burying Uncertainty* (Berkeley: University of California Press, 1993).
- <sup>22</sup> A formal analysis for some risk representations can be given, as for what is known as "prospect theory" in the cognitive study of judgments under uncertainty. See Daniel Kahneman and Amos Tversky, "Prospect Theory: An Analysis of Decision Under Risk," *Econometrica* 47, March 1979, pp.263-91. Heuristic may also have a "negative" interpretation, in the sense of deflecting certain types of arguments or criticism.
- <sup>23</sup> Even decision analysis or other formal methods must be implemented heuristically: there is always an informal translation from an informal risk representation to a formal calculus. On "technical" and "cultural" rationality see Sheldon Krinsky and Alonzo Plough, *Environmental Hazards: Communicating Risks as a Social Process* (Dover, MA: Auburn House, 1988).
- <sup>24</sup> For applications of risk perception ideas in risk communication, see Vincent Covello et al., eds., *Effective Risk Communication: The Role and Responsibility of Government and Non-government Organizations* (New York: Plenum, 1989), especially the risk communication manuals reproduced as appendices.



- <sup>25</sup> For a comparable social structure in which uncertainty claims played roles similar to those made possible today through risk, see Richard Popkin's account of the role of skepticism in post-Reformation Europe and the scientific revolution in *The History of Scepticism: From Erasmus to Spinoza* (Berkeley: University of California Press, 1979).
- <sup>26</sup> See George Marcus and Michael Fischer, *Anthropology as Cultural Critique: An Experimental Moment in the Human Sciences* (Chicago: University of Chicago Press, 1986), p.180, n2.
- <sup>27</sup> As shown, for example, by risk perception research correlating judgments of greater risk with greater scientific uncertainty. See, e.g., Slovic, "Perception of Risk."
- <sup>28</sup> See Myles Burnyeat, "Can the Skeptic Live His Skepticism?" in M. Burnyeat, ed., *The Skeptical Tradition* (Berkeley: University of California Press, 1983), pp.117-48.
- <sup>29</sup> For the positive role of constructive or mitigated skepticism in the scientific revolution, see *The History of Scepticism*, chap. 7.
- <sup>30</sup> A detailed account of historical and abstract traditions is provided by Paul Feyerabend, *Problems of Empiricism: Philosophical Papers II* (New York: Cambridge University Press, 1981), pp.5ff.
- <sup>31</sup> See Ian Hacking, *The Emergence of Probability* (New York: Cambridge University Press, 1975), and *The Taming of Chance* (New York: Cambridge University Press, 1990), the latter being an account of the introduction of statistical methods during the nineteenth century.
- <sup>32</sup> One rarely finds clear expressions on this issue, either one way or the other, perhaps because of the difficult interdisciplinary and practical problems possibly faced as a consequence of the answer.
- <sup>33</sup> See, e.g., *The Taming of Chance*, chap. 1.