Taming Prometheus: Talk About Safety and Culture

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Abstract

Talk of safety culture has emerged as a common trope in contemporary scholarship and popular media as an explanation for accidents and as a recipe for improvement in complex sociotechnical systems. Three conceptions of culture appear in talk about safety: culture as causal attitude, culture as engineered organization, and culture as emergent and indeterminate. If we understand culture as sociologists and anthropologists theorize as an indissoluble dialectic of system and practice, as both the product and context of social action, the first two perspectives deploying standard causal logics fail to provide persuasive accounts. Displaying affinities with individualist and reductionist epistemologies, safety culture is frequently operationalized in terms of the attitudes and behaviors of individual actors, often the lowest-level actors, with the least authority, in the organizational hierarchy. Sociological critiques claim that culture is emergent and indeterminate and cannot be instrumentalized to prevent technological accidents. Research should explore the features of complex systems that have been elided in the talk of safety culture: normative heterogeneity and conflict, inequalities in power and authority, and competing sets of legitimate interests within organizations.

> "...the darkest and most treacherous of all the countries... lie in the tropic between intentions and actions...."
>
> —Chabon (2008, p. 29)

Rescuing Prometheus, by the venerable historian of technology Thomas Hughes (1998), describes how four large post–World War II projects revolutionized the aerospace, computing, and communication industries by transforming bureaucratic organizations into postmodern technological systems. In place of centralized hierarchies of tightly coupled homogeneous units typical of traditional corporate and military organizations, Hughes describes the invention of loosely coupled networks of heterogeneously distributed and often collegially connected communities of diverse participants. By the 1980s and 1990s, new modes of management and design—public participation coupled with commitments to environmental repair and protection—overcame what had been intensifying resistance to large-scale, often government sponsored, technologies. "Prometheus the creator," Hughes (1998, p. 14) writes, "once restrained by defense projects sharply focused upon technical and economic problems, is now free to embrace the messy environmental, political, and social complexity of the postindustrial world."

If the engineering accomplishments of the past 40 years signify a resuscitated capacity to mobilize natural and human resources to produce, distribute, and accumulate on historically unprecedented scales, proliferating interest in safety culture may signal renewed efforts to tame Prometheus. In the past 20 years, a new way of talking about the consequences of complex organizations and sociotechnical systems[1] has developed. Although culture is a common sociological subject, those talking about safety culture often invoke the iconic concept with little of the theoretical edifice sociologists and anthropologists have built for cultural analysis. Decades after the social sciences reconceptualized culture as "the medium of lived experience" (Jacobs & Hanrahan 2005, p. 1), a normatively plural system of symbols and meanings that both enables and constrains social practice and action (Sewell 2005, pp. 152–75; Silbey 2001; 2005a, p. 343), the cultural turn has taken root in the military and engineering professions, and for similar reasons: human action and culture getting in the way of technological efficiency. However, unlike the military's embrace of culture where critique confronts its every move (Gusterson 2007), efforts to propagate safety culture in complex technological systems proceed with scant attention to its ideological implications. Despite the appropriation of the term culture, many advocates and scholars of technological innovation and management deploy distinctly instrumental and reductionist epistemologies antithetical to cultural analysis. We can be protected from the consequences of our very effective instrumental rationalist logics and safety can be achieved, they seem to suggest, by attending to what advocates of safety culture treat as an ephemeral yet manageable residue of human intercourse—something akin to noise in the system. How are we to understand this unexpected and unusual appropriation of the central term of the soft sciences by the experts of the hard, engineering sciences?

This article reviews popular talk and scholarship about safety culture. Since the 1990s, identifying broken or otherwise damaged safety culture has become a familiar explanation for organizational and technological failures. Although the term safety culture has been deployed across institutional sites and scholarly fields, it is largely absent from sociological scholarship. Sociologists studying accidents and disasters provide a more critical and skeptical view of safety culture, if they address it at all (e.g., Beamish 2002; Clarke 1989, 1999, 2006; Gieryn & Figert 1990; Hilgartner 1992; Perin 2005; Perrow 1999 [1984], 2007; Vaughan 1996). However, in engineering and

[1] "The notion of a sociotechnical system stresses the close interdependence of both the technological artifacts and behavioral resources (individual, group, and organizational) necessary for the operation of any large-scale technology" (Pidgeon 1991, p. 131).

management scholarship, the term safety culture is invoked with increasing frequency and seems to refer to a commonly shared, stable set of practices in which all members of an organization learn from errors to minimize risk and maximize safety in the performance of organizational tasks and the achievement of production goals.

In this review, I argue that the endorsement of safety culture can be usefully understood as a way of encouraging and allocating responsibility (Shamir 2008)—one response to the dangers of technological systems. Invoking culture as both the explanation and remedy for technological disasters obscures the different interests and power relations enacted in complex organizations. Although it need not, talk about culture often focuses attention primarily on the low-level workers who become responsible, in the last instance, for organizational consequences, including safety. Rather than forgoing particularly dangerous technologies or doing less in order to reduce vulnerabilities to natural, industrial, or terrorist catastrophes, talk about safety culture reinforces investments in complex, hard to control systems as necessary and manageable, as well as highly profitable (for a few), although unavoidably and unfortunately dangerous (for many) (Perrow 2007). At the same time, talk of safety culture suggests that the risks associated with increased efficiency and profitability can be responsibly managed and contained. The literature on safety culture traces its provenance to the copious work on risk assessment and systems analysis, system dynamics, and systems engineering that became so prevalent over the past 30 years.[2] At the outset, paying attention to culture seems an important and valuable modification to what can be overly abstract and asocial theories of work and organization. Despite this important correction, research on safety culture usually ignores the historical-political context, the structural relationships, and the interdependencies that are essential to cultural and organizational performances and analyses.

This review first provides a historical framing for talk about safety culture because that perspective is most clearly missing in much of the research. I suggest that talk about safety culture emerges alongside market discourse that successfully challenged the previous centuries' mechanisms for distributing and mitigating technological risks. In the second section, I describe the more than fourfold increase in references to safety culture that appeared in popular and academic literature between 2000 and 2007. Organizing the work in terms of three commonly deployed conceptions, I then describe culture as causal attitude, as engineered organization, and as emergent. Relying on a conception of culture as an indissoluble dialectic of system and practice, both a product and context of social action, I argue that the first two perspectives not only fail to provide persuasive accounts, but reproduce individualist and reductionist epistemologies that are unable to reliably explain social or system performance. Although invocation of safety culture seems to recognize and acknowledge systemic processes and effects, it is often conceptualized to be measurable and malleable in terms of the attitudes and behaviors of individual actors, often the lowest-level actors, with least authority, in the organizational hierarchy. The third category of culture as emergent and indeterminate critiques claims that safety culture can be confidently instrumentalized to prevent catastrophic outcomes from complex technologies. This section suggests that future research on safety in complex systems should explore just those features of complex systems that are elided in the talk of safety culture: normative heterogeneity and cultural conflict, competing sets of interests within organizations, and inequalities in power and authority. Rather than imagine complex yet homogeneous local cultures, research should explore how struggles among competing interests are part of the processes of cultural production and how normative heterogeneity, structured competition, and countervailing

[2] Risk and systems analysis pervades contemporary organizations from manufacturing, transportation, and communications to finance, health, and education.

centers of power can contribute to, rather than undermine, safer technologies.

HISTORICAL SHIFTS: CONSTRUCTING AND DECONSTRUCTING SAFETY NETS

Why has attention to safety culture arisen at this historical moment?

Any answer must begin by acknowledging the technological catastrophes of the past 40 years: Three Mile Island, Bhopal, Chernobyl, the *Challenger* and *Columbia* accidents at NASA, the *Exxon Valdez* oil spill, oil rig accidents, Buffalo Creek, contaminated blood transfusions, and a host of less spectacular disasters (Ballard 1988; Davidson 1990; Erikson 1978; Fortun 2001; Jasanoff 1994; Keeble 1991; Kurzman 1987; Medvedev 1992; Petryna 2002; Rees 1994; Setbon 1993; Stephens 1980; Stern 1976/2008; Vaughan 1996, 2003, 2006; Walker 2004).

In each instance, the accident was usually explained as just that, an accident—not a system or design failure, but the result of some extraneous mistake or mismanagement of a basically well-conceived technology. Because the systems in which the accidents occurred are omnipresent, the recurring accidents undermine confidence that catastrophes can be avoided. Alongside concerns about genetically modified foods, the toxicity of commonly used household products, the migration of various synthetic compounds from plants through animals into the human body, the rapid spread of disease and contamination through porous and swift global transportation routes, and human-produced environmental degradation, technological accidents feed a deepening mistrust of science (Jasanoff 2005). If, as Hughes (1998) suggests, the invention of postmodern systems rescued Prometheus from the technological disillusionment of the 1960s and 1970s, perhaps the promotion of safety culture responds to a renewed technological skepticism in the twenty-first century.

However, accidents alone cannot be driving the recent attention to safety culture. Technological accidents are not new phenomena, and safety has been a lively concern since the middle of the nineteenth century, if not earlier. Indeed, in some accounts, much of the regulatory apparatus of the modern state was institutionalized to protect against the injurious consequences of industrial production by setting minimally safe conditions of work, establishing private actions at law, and spreading the risks (of what could not be prevented) through fair trade practices, workmen's compensation, and pension systems, as well as labor unions, private mutual help, and insurance. Safety was one of several objectives promoted by the system of instruments regulating relations between capital and labor (cf. Baker 2002, Ewald 2002, Friedman 1967, Orren 1991, Welke 2001, Witt 2004).

In a sense, the invention of risk,[3] and with it widespread insurance and regulation of workplaces, products, and markets, created the basis of a new social contract. Responsibility was transferred from the person to the situation—the job, the firm, the union, or the collective nation—forgoing reliance on any individual's behavior, whether worker or boss. Eschewing interest in specific causality, and thus individual liability, this collectivized regime acknowledged a general source of insecurity in technology and responded with a set of generalized responses, albeit after extended and sometimes tragic struggle. Where responsibility had previously rested on the idea of proximate cause and a selective distribution of costs based on liability as a consequence of imprudence, the late nineteenth and early twentieth century industrial and business regulation redistributed costs to collectivities, offering compensation and reparation, if not safety and security. Responsibility was "no longer the attribute of a subject, but rather a consequence of a social

[3] Accounts vary as to the moment when probabilistic calculation about hazardous events became a recognized practice (see Hacking 1990, 2003).

fact" (Ewald 2002, p. 279). One was no longer "responsible because one is free by nature and could therefore have acted differently, but because society judges it 'fair'" to place responsibility in a particular social location, that is, to cause a particular person or collectivity to bear the financial costs of the injury. In short, the costs of technological consequences were dispersed, "the source and foundation of responsibility . . . displaced from the individual onto society" (p. 279).

Talk about safety culture offers a new twist, or possible reversion, in the allocation of responsibility for technological failures, a return to the nineteenth century and earlier regimes of individual responsibility, but in a context of more hazardous and global technologies. After several decades of sustained attack by advocates seeking supposedly more efficient and just allocations of goods through unregulated markets, the regime of collective responsibility has been dismantled, replaced by one of institutional flexibility. Rather than attempting to mitigate and distribute risk, contemporary policies and practices embrace risk (Baker & Simon 2002, p. 1). Embracing risk means to "conceive and address social problems in terms of risk"—calculated probability of hazard (Heimer 1988, Simon 1988). Human life, including the prospects of human autonomy and agency, is now conceived in very much the same way and analyzed with the same tools we employ to understand and manipulate physical matter: ordered in all its important aspects by instrumental and probabilistic calculation and mechanical regulation (Bittner 1983).

Unfortunately, risk analysis and discourse narrow consideration of legitimate alternatives while nonetheless sustaining the appearance of broad pluralism (cf. Habermas 1975). Because of the assumption that realism resides exclusively in science, reflexive observation and critique as well as unmeasured variables are excluded from official risk discourses. As a consequence, allegedly empirical analyses become solipsistic, focusing exclusively on the methods and epistemologies that are internal to technological instrumentalism (Deutch & Lester 2004; Lash & Wynne 1992, p. 4). Heimer (1985) identified the illusory nature of this supposed realism in her prescient analysis of the reactive nature of risk, demonstrating how risk (probabilities of threats to safety and security) would necessarily elude our grasp because each effort to control risk transformed its probabilities in an ever-escalating spiral.

Embracing risk also refers to the specific policies and techniques instituted over the past several decades to undo the system of collective security. "Across a wide range of institutions, officials are now as concerned about the perverse effects of . . . risk shifting [i.e., risk sharing], as they are about the risks [probabilities of hazard] being shifted" (Baker & Simon 2002, p. 4). In place of the regime of risk containment, proponents of flexibility argue that safety and security can be achieved more effectively by embracing and privatizing risk.

Although pro-privatization market policies that attempt to "make people more individually accountable for risk" (Baker & Simon 2002, p. 1) are often justified as natural and efficient, there is nothing natural about them (Klein 2007, Mackenzie 2006). Just as risk-spreading was achieved through the efforts of financial and moral entrepreneurs to transform common, often religious, conceptions of morality, responsibility, and money (Becker 1963; Zelizer 1979, 1997), contemporary risk-embracing policies are also the outcome of ideological struggles. If in the nineteenth century marketing life insurance required a modification in what it meant to protect one's family by providing materially for them after death rather than seeming to earn a profit from death, so too risk-embracing policies in the twentieth and twenty-first centuries require a similar redefinition in what it means to be responsible, productive citizens. Contemporary moral entrepreneurs energetically promote risk taking rather than risk sharing as morally desirable; the individual more effectively provides for family security, it is claimed, by participating in a competitive, expanding, market economy than by relying on government-constructed safety nets.

This moral entrepreneurship directs our attention to safety culture because the concept arises as a means of managing technological risk, just as the previous security regime has been successfully dismantled. This is not to say that the nineteenth to twentieth century regulatory system was perfect, nor as good as it might have been, nor that it prevented or repaired all or most technological damage. It was, however, a means of distributing, if not preventing, the costs of injuries. Yet, for most of the twentieth century, risk analysts themselves expended a good part of their energy attacking this system, legitimating the risks undertaken, reassuring the public that they were nonetheless being protected, and second-guessing the regulatory "agencies' attempts to do a very difficult job" (Perrow 1999 [1984], p. 307). Paradoxically, many risk analysts regularly assessed the risks of regulation more negatively than the risks of the hazards themselves (e.g., Deutch & Lester 2004).

With a commitment to the idea of efficient markets, critics of regulation produced accounts of government regulation as publicly sanctioned coercion sought by private firms to consolidate market power, inhibit price competition, and limit entry. As a result, critics argued, the system produced inefficiencies, a lack of price competition, higher costs, and overcapitalization (Joskow & Noll 1977, Joskow & Rose 1989; cf. Schneiberg & Bartley 2008). Interestingly, these challenges to government regulation rarely valued as highly consumer service, product quality, and environmental protection that were also promoted by regulation. The accounts of corporate capture undermining regulatory effectiveness (Bernstein 1955; Derthick & Quirk 1985; Peltzman et al. 1989; Vogel 1981, 1986) also ignored the new social regulation in safety, consumer protection, and civil rights. Perhaps the focus on market control, and a latent hostility to the struggles between labor and capital and between manufacturers and consumers that became ideologically entwined with the struggles against regulation, blinded scholars to non-economic variables such as safety that had also been part of the regulatory regime. For whatever reasons, ideological or coincidental, the focus on market competition as the central guarantor of productivity and efficiency overlooked constituent structural features of the regime of government regulation, insurance, and liability that mitigated risk by promoting countervailing interests in safety and responsibility.

Notably, the nineteenth to twentieth century solidarity regime was "not only a paradigm of compensation but also one of prevention" (Ewald 2002, p. 281). Bottom-line profit taking required diligent efforts not simply to estimate costs and prices but also to prevent losses, that is, accidents and disasters. A host of institutional practices and organizations promoted responsibility by enacting prevention, in this way reducing costs and increasing profit. For example,

> the great life insurance companies were pioneers in epidemiology and public health. The fire insurance industry formed Underwriter's Laboratories, which tests and certifies the safety of household appliances and other electrical equipment. Insurance companies seeking to cut their fire losses formed the first fire departments. More recently, health insurance companies have been behind many efforts to compare, test, and measure the effectiveness of medical procedures (Baker & Simon 2002, p. 8; cf. Knowles 2007a,b).

Under the solidarity regime, industries, individual firms, and labor unions collectively promoted forms of social control, workplace discipline, and self-governance that were expected to reduce injuries and thus costs for the various organizations (Ericson et al. 2003). Minimally, they identified the worst offenders.

Insurance companies have traditionally also taken precautions to mitigate financial losses not only through safer practices but through investment of premiums and reinsurance. The post-1929 American banking and financial industry regulations purposively segregated different financial functions and markets to prevent excessive losses in one activity from contaminating related industries and parallel silos in the financial markets. However, since

the systematic deconstruction of this regulatory regime began in the 1980s, insurance firms, like many corporations, have become ever more financialized, earning profit more directly from investments in global financial markets than from selling insurance. With the invention of derivatives and similar instruments, a wider array of firms have been transformed into financial rather than productive entities. Financialization means that capital and business risks are disaggregated, recombined in heterogeneous assets that are bought and sold globally, and distributed among myriad other firms, shareholders, and markets. Losses in these assets are supposedly protected through insurance swaps. There is an indirect but substantial consequence for safety in this financialized system because there is less interest in the reliability of the specific products manufactured or services offered. Less financial risk means reduced attention to the associated practices that encourage risk prevention and enhance safety.[4]

Finally, we cannot ignore the role of civil litigation as part of the twentieth century solidarity regime and its twenty-first century demise. The expansion of rights and remedies that began slowly with the New Deal but grew rapidly post–World War II came with "a great a burst of legalization." While "regulation proliferated, extending to aspects of life previously unsupervised by the state" (Galanter 2006, p. 4), civil litigation independently generated rights. Although some commentators describe this as a litigation explosion (Friedman 1985, Kagan 2003, Lieberman 1981), it is actually a shift: from contract litigation dominating in the nineteenth century to tort litigation predominating in the twentieth century (Galanter 1983). Although strict liability is not the generously absurd protector of irresponsibility that critics claim it to be (Burke 2004, Holtom & McCann 2004), there is no doubt that the twentieth century produced, "by any measure, a great deal more law" (Galanter 2006, p. 5). The legal profession exploded from 1 lawyer for every 627 Americans in 1960 to 1 lawyer for every 264 in 2006. Spending on law increased, as did celebration of lawyers and legal work in popular media and film (J. Silbey 2001, 2004, 2005, 2007a,b).

In canonical Newtonian fashion, the expansion of law caused an energetic backlash. The early and mid-twentieth century cries that the legal system "failed to provide justice to the weak—gave way to a responsive critique that the nation was afflicted by 'too much law'" (Galanter 2006, p. 5, citing Galanter 1994). One alleged legal crisis followed another, from product liability to overcrowded courts to medical malpractice (Baker 2005). Calls for tort reform and informal dispute resolution as alternatives to litigation became common, the centerpiece of organized professional and political campaigns (Burke 2004, Silbey & Sarat 1988). With Ronald Reagan's election to the U.S. presidency in 1980 and subsequent Republican presidents, nominees to the federal courts were systematically screened for their ideological conformity with a less law, less rights agenda. By September 2008, 60% of active federal judges with this agenda had been appointed, and, as a consequence, the federal courts have joined the movement to embrace risk, becoming another voice promoting individual, rather than shared, assumption of risk (Scherer 2005).

Thus, from the middle nineteenth through the late twentieth centuries, industrial and insurance firms, individual families, the civil litigation system, governmental regulatory agencies, and labor unions built and sustained a safety net of collective responsibility; they reinforced each other within a tapestry of organizations and institutions whose interests competed, yet coalesced to support relatively safer practices. The demise of those structural components is precisely what underwrites the

[4]The financial downturn that escalated to a worldwide crisis in 2008 can be attributed in part to just these practices. In the financial markets, not only was the safety of the produced material goods less salient, but the safety or security of the financial assets was of less concern because of default swaps, hedging, and insurance on bets that finally unraveled. Rather than encouraging responsibility, the layered system of disaggregation and recombination buttressed by hedges and insurance undermined critical or responsible decision making.

contemporary focus on safety culture as a means of managing technological hazards. If we do not have empowered regulatory agencies, judicial support for tort litigation, organized labor, and insurance companies with a financial interest in the safety and longevity of their customers, we have lost a good part of what made the previous paradigm work to the extent it did for as long as it did.

Talk of safety culture flourishes at the very moment when advocates extend the logic of individual choice, self-governance, and rational action from the market to all social domains. Just as historic liberalism was "concerned with setting limits on the exercise of political or public authority, viewing unwarranted interventions in the market as harmful," contemporary neoliberalism[5] promotes markets "as a principle not only for limiting government but also for rationalizing authority and social relations in general" (Shamir 2006, p. 1). Through a process of so-called responsibilization, "predisposing social actors to assume responsibility for their actions" (Shamir 2008, p. 10), these policies simultaneously empower individuals to discipline themselves while distributing, as in the nineteenth century prudential regime, to each the costs of that discipline and the consequences for the lack thereof (Rose 1989, 1999). As a concept, responsibilization names efforts to both cultivate and trust the moral agency of rational actors as the foundation of individual and collective well-being (Shamir 2008, p. 11).

Because the propagation and inculcation of safety culture is only one approach to enhancing the reliability and safety of complex technologies, it is not unreasonable to wonder whether safety culture, focused on individual participants' self-determined contributions to the system as a whole, might not be described as an expression of responsibilization, this neoliberal technique of governance. Without necessarily intending to promote policies of deregulation and privatization, the celebration of safety culture as a means of managing the hazardous consequences of complex systems expresses what Weber described as an elective affinity, phenomena that do not necessarily cause one another but nonetheless vary together. In the next section, I explore calls for and accounts of safety culture to extract from this diverse literature the purported meanings and relationships of safety and responsibility.

TALK ABOUT SAFETY CULTURE

Between 2000 and 2007, academic literature and popular media exploded with references to safety culture. Over 2250 articles in newspapers, magazines, scholarly journals, and law reviews in an eight-year period included references to safety culture, whereas only 570 references were found in the prior decade. Before 1980, I could find no references in popular or academic literature.[6] Although the unprecedented appearance and the rapidly escalating use of the concept seem to support my hypothesis of ideological affinities between talk about safety culture and the dismantling of the regulatory state, we should look more closely at what people say to interpret what they mean when they speak about safety culture.

The earliest uses of safety culture in newspapers and popular media invoke the term primarily in discussions of nuclear power, energy generation, and weapons production to describe within organizations an "ingrained philosophy that safety comes first" (Diamond 1986). One non-nuclear reference to a British railroad accident is illustrative because, even in this less common venue, a deteriorating safety culture was offered as the explanation for what went

[5]The term neoliberalism is conventionally used to refer to the policies advocating deregulation, privatization, and reliance on markets for both distribution and coordination, but also includes a set of fiscal, tax, and trade liberalization policies that is sometimes referred to as the Washington Consensus because of support by the International Monetary Fund and the World Bank.

[6]I searched LexisNexis, JSTOR, and the Engineering Village databases for the years between 1945 and 2008, using the phrases safety culture, safety (and) culture, and culture of safety within two words of each other.

wrong and should be improved to prevent future accidents.[7] Mechanical error compounded by lax management processes was named as the cause of the accident. Nonetheless, the judge heading the accident inquiry focused his recommendations for improving the safety culture not on the management of the system or the communications processes within the railroad hierarchy, but on the laborers, calling for "radical improvements in recruiting and training and an end to excessive overtime" (Diamond 1986).

Although talk about safety culture emerged during the 1980s when major accidents at Three Mile Island, Bhopal, and Chernobyl weakened public confidence in complex technologies, only well into the 1990s did talk about safety culture become a common phenomenon. Although thousands of newspaper articles were written about the March 28, 1979, partial meltdown of Unit 2 at the Three Mile Island nuclear power plant in Dauphin County, Pennsylvania, none spoke about the plant's safety culture. We first see accounts of lax safety culture following the December 3, 1984, explosion of a Union Carbide plant synthesizing and packaging the pesticide methyl isocyanate in Bhopal in the Indian state of Madhya Pradesh.

In these early references, the phrase is invoked primarily to denote culture in its more colloquially circulating meaning: to suggest that nations vary in their respect for safety. Because the Indian partners in the Union Carbide plant did not share the American culture (which implicitly valued safety), they were, by inference, responsible for the accident. John Holtzman, spokesman for the Chemical Manufacturers Association in Washington, DC, pointed to "the differences in 'safety culture' between the US and other countries. . . . We have a certain sense of safety. You see it in campaigns like 'buckle up.' It's not necessarily the same elsewhere. It's difficult to enforce our culture on another country," Holtzman said, "especially when the other country seems willing to take risks in exchange for speedy technological advance" (Kiefer 1984).

This use of safety culture to name variations in national cultures, reminiscent of historic justifications for colonial rule, did not stick. Very quickly, it became apparent that the preexisting safety problems in the Bhopal plant were not peculiar to Bhopal, or to India. Although Union Carbide had insisted that the conditions in Bhopal were unique, one of its sister plants in Institute, West Virginia, produced a similar accident just eight months later (Perrow 1999 [1984], p. 358). Although an Occupational Safety and Health Administration (OSHA) inspection had previously declared the West Virginia plant in good working order, the OSHA inspection following the explosion declared that this was "an accident waiting to happen," citing hundreds of longstanding, "constant, willful, violations" (quoted in Perrow 1999 [1984], p. 359). Clearly, the different national cultures of India and the United States could not explain these accidents, which seemed to have had some other source. No one mentioned the role of lax inspections as part of the safety culture. With the exception of one story about how E.I. DuPont de Nemours & Co is "recognized within industry for its [exemplary] safety" practices (Brooks et al. 1986), the early references in popular media to safety culture do little more than invoke the term. They provide little specification of what activities, responsibilities, or symbolic representations contribute to a safety culture.

In professional and scholarly literature, the phrase safety culture first appears in a 1986 report of the International Atomic Energy Agency (IAEA) on the Chernobyl accident. Three years later, a second reference by the U.S. Nuclear Regulatory Commission (1989) states that plant management "has a duty and obligation to foster the development of a 'safety culture' at each facility and throughout the facility, that assures safe operations." After five years in common usage, an IAEA report defined

[7] During the morning rush hours of December 12, 1988, 35 people were killed and another 100 injured when "one commuter train rammed the rear of a stopped commuter train, outside busy Clapham Junction in south London. The wreckage was then struck by a freight train" (Associated Press 1989).

safety culture as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear power safety issues receive attention warranted by their significance" (IAEA 1991, p. 8; 1992). As Perin (2005) comments in her detailed study of four nuclear power plants, "Determining that significance in particular contexts is . . . the crux of the quandary" (p. 14).

For the past two decades, researchers have been actively engaged in analyses of safety culture, with the vast majority of work produced in engineering, management, and psychology, and a smattering of mostly critical work produced in sociology and political science. If we look across these fields, we find variation in the ways in which safety culture is invoked, although there is a great deal of conceptual importation from the social sciences to what we may think of as applied social science in engineering and management.

The General Concept of Culture

Culture is an actively contested concept; its importation into organizational and engineering analyses is equally contentious. Confusion derives in part from intermingling two meanings of culture: a concrete world of beliefs and practices associated with a particular group and an analytic tool of social analysis referring to a system of symbols and meanings and their associated social practices, both the product and context of social action. The analytic concept is invoked (*a*) to recognize signs, performances, actions, transactions, and meanings as inseparable, yet (*b*) "to disentangle, for the purpose of analysis [only], the semiotic influences on action from the other sorts of influences—demographic, geographical, biological, technological, economic, and so on—that they are necessarily mixed with in any concrete sequence of behavior" (Sewell 2005, p. 160). Thus, organizational culture and safety culture are terms used to emphasize that organizational and system performances are not confined to formally specified components, nor to language alone. Although formal organizational attributes and human interactions share symbolic and cognitive resources, many cultural resources are discrete, local, and intended for specific purposes. Nonetheless, it is possible (*c*) to observe general patterns so that we are able to speak of a culture, or cultural system, at specified scales and levels of social organization. "System and practice are complementary concepts: each presupposes the other" (Sewell 2005, p. 164),[8] although the constituent practices are neither uniform, logical, static, nor autonomous. As a collection of semiotic resources deployed in interactions (Swidler 1986), "culture is not a power, something to which social events, behaviors, institutions, or processes can be causally attributed; it is a context, something within which [events, behaviors, institutions, and processes] can be intelligibly—that is, thickly—described" (Geertz 1973, p. 14). (*d*) Variation and conflict concerning the meaning and use of these symbols and resources is likely and expected because at its core, culture "is an intricate system of claims about how to understand the world and act in it" (Perin 2005, p. xii; cf. Helmreich 2001).

Culture as Causal Attitude

For some authors, safety culture is understood as a measurable, instrumental source composed of individual attitudes and organizational behavior, or conversely as a measurable product of values, attitudes, competencies, and behaviors that are themselves the cause of other actions (Cox & Cox 1991, Geller 1994, Glennon 1982, Lee 1996, Ostrom et al. 1993). In both uses, culture "determine[s] the commitment to, and the style and proficiency of, an organization's health and safety programs"

[8] "The employment of a symbol," Sewell (2005, p. 164) writes, "can be expected to accomplish a particular goal only because symbols have more or less determinate meanings—meanings specified by their systematically structured relations to other symbols. But it is equally true that the system has no existence apart from the succession of practices that instantiate, reproduce, or—most interestingly—transform it. Hence, a system implies practice. System and practice constitute an indissoluble duality or dialectic."

(Reason 1997, p. 194, citing Booth, UK Health and Safety Commission 1993). Whether the first mover or an intermediate mechanism, "an ideal safety culture is the engine that continues to propel the system toward the goal of maximum safety health, regardless of the leadership's personality or current commercial concerns" (Reason 1997, p. 195). Culture as the ultimate, intermediate, or proximate cause often leaves unspecified the particular mechanism that shapes the safe or unsafe outcomes of the organization or technology (but see Glennon 1982, Zohar 1980), with much of the management and engineering literatures debating exactly this: how to operationalize and measure both the mechanism and the outcome. Clearly, this conception of safety culture belies exactly that thick description of practice and system that cultural analysis entails (Fischer 2006, Geertz 1973, Silbey 2005b).

A persistent muddle in this usage derives, in part, from the aggregation over time and across professional communities of concepts developed to name the emergent properties of social interactions not captured by the specification of components, stakeholders, objectives, functions, and resources of formal organizations. There seems to be a recurring cycle in which heretofore unnamed or unperceived phenomena are recognized as playing a role in organized action. A construct is created to name what appear to be stable, multidimensional, shared features of organized practices that had not yet been captured by existing categories and measures. All this is fine and congruent with the best sociology. However, once the phenomena are named, some researchers attempt to specify and measure them more concretely; disparate results generate continuing debate about different conceptualizations and measurement tools (Cooper 2000, Guldenmund 2000). As empirical results outpace the purportedly descriptive models, new constructs are offered to name the persistent, yet elusive effluent of unpredicted events, now hypothesized as intangible cultural causes, fueling additional debate. Thus, talk of safety culture emerged as a subset from prior talk about organizational culture (Beamish 2002; Bourrier 1996; Carroll 1998a,b; Cooper 2000; Schein 1992), and both organizational and safety culture developed alongside concepts of organizational climate and safety climate, generating a bewildering mix of concepts and measures. Numerous efforts have attempted to parse these terms, with negligible theoretical advance (Denison 1996, Zhang et al. 2002).

To some extent, the conceptual puzzle is energized by occupational and professional competitions, different disciplinary communities pushing in one direction or another, using preferred concepts and tools to authorize expert advice about how to design systems, assess performance, and manage them on the basis of this information (Abbott 1988). Although organizational and safety culture can and should be normatively neutral, the terms have usually been deployed to emphasize a positive aspect of organizations, one that leads to increased safety by fostering, with minimal surveillance, an efficient and reliable workforce sensitized to safety issues. The framing generates ellipses that invite further conceptual elaboration to account for what has been excluded in the particular normative tilt of the concept. Although some authors view culture as something that can be changed—managed to improve organizational performance—and seek to develop models to generate more effective safety culture (Carroll 1998b, Cooper 2000), others adopt more disinterested formulations (Beamish 2002, O'Reilly & Chatman 1996).

Guldenmund's systematic review of the literature through 2000 describes organizational and safety culture as general frames determining organizational and safety climates.

> The term organizational climate was coined to refer to a global, integrating concept underlying most organizational events and processes. Nowadays, this concept is referred to by the term organizational culture whereas organizational climate has come to mean more and more the overt manifestation of culture within an organization. Therefore, climate follows naturally from culture, or, put another way,

> organizational culture expresses itself through organizational climate (Guldenmund 2000, p. 221).

Summarizing across dozens of uses, Zhang et al. (2002, p. 8) suggest that safety culture be understood as

> the enduring value and priority placed on worker and public safety by everyone in every group at every level of an organization. It refers to the extent to which individuals and groups will commit to personal responsibility for safety, act to preserve, enhance and communicate safety concerns, strive to actively learn, adapt and modify (both individual and organizational) behavior based on lessons learned from mistakes, and be rewarded in a manner consistent with these values.

Although these uses of safety culture refer to "the shared values, beliefs, assumptions, and norms which may govern organizational decisionmaking . . . about safety" (Ciaverelli & Figlock 1996), much of the research observes, measures, and assesses safety culture through survey instruments collecting individual expressions, attitudes, and beliefs, or what others define as safety climate. In effect, the terms are collapsed, so that safety climate becomes "the temporal state measure of safety culture," assessed and evaluated in terms of the degree of coherence and commonality "among individual perceptions of the organization" (Zhang et al. 2002, p. 10). Some studies recognize the inadequacy of assessing a diffuse, emergent phenomenon such as culture through individual measures, and as a consequence add a group or aggregate measure to designate that which is shared (Cox & Cox 1991) or applies to the group (Lee 1996), the set (Pidgeon 1997, 1998), or the assembly. Because a good part of the literature on safety culture seeks to develop tools to improve organizational performance, small linguistic variations in conceptualization of the often intangible system of signs and practices, even if not named as such, become critically determinant variations for empirical researchers and management toolmakers (Humphrey et al. 2007, Morgeson & Humphrey 2006). The resulting literature is littered with competing models, instruments, types of analysis, and measures, providing much occupation but unreliable instruction or guidance (Cooper 2000, Guldenmund 2000), offering more "heat than light" (O'Reilly & Chatman 1996, p. 159). Nonetheless, the repeated efforts to specify and measure safety culture in terms of individual attitudes and behaviors to "foster a reliable workforce" who will "commit to personal responsibility" (Zhang et al. 2002) illustrates well affinities between policies of responsibilization and advocacy of safety culture.

The *Report of the BP U.S. Refineries Independent Safety Review Panel* (Baker Panel 2007, hereafter BP Report 2007) marks, perhaps, the quintessence of talk about safety culture. Following a catastrophic accident at a BP refinery in Texas City, Texas, on March 23, 2005, resulting in 15 deaths and more than 170 injured persons, as well as significant economic loss, the U.S. Chemical Safety and Hazard Investigation Board recommended, with explicit urgency, that BP initiate its own parallel investigation into its safety management practices.[9] The BP Report, issued 21 months later, described what it repeatedly called a "damaged safety culture." The phrase safety culture appears 3 times on the opening page and more than 390 times in the approximately 150-page document. Clearly, safety culture has become the mantra for technologically complex and hazardous organizations.

The report claims early and often that BP has "come to appreciate the importance of cultural factors in promoting good process safety performance" (BP Report 2007, p. 59) but nonetheless adopted a rather shallow notion of safety culture that focused on individual actions rather than on systemic processes. Thus, alongside safety culture, the first of its three

[9] BP had experienced "two other fatal safety incidents in 2004, a major process-related hydrogen fire on July 28, 2005, and another serious incident on August 10, 2005" (BP Report 2007).

high-level findings, the report identified the need for process safety management systems and performance evaluation, corrective action, and corporate oversight. The report repeatedly states that, in contrast to the individualized notion of safety promoted by BP, safety is rather the responsibility of the corporate board, which must exercise leadership by establishing safety as a core value across all its refineries—exactly what it had failed to do. "Absent a healthy safety culture, even the best safety management systems will be largely ineffective" (BP Report 2007, p. 59).

Thus, the report specifically distinguishes between personal safety (slips and falls) and process safety, that is, safety built into the design and engineering of the facilities, management, and maintenance, exactly what BP had failed to do. In its own inquiry, BP had used interview and survey data that revealed significant variation in attitudes and perceptions about safety within and across five plant sites. On the basis of these attitudinal variations, BP declared its process safety damaged. By relying on attitudes as indicators, BP clearly identified individuals rather than the system as the central safety focus. In contrast, the panel report described systemic problems such as underfunded management of the U.S. plants and underresourced safety programs alongside an abundance of discrete safety initiatives that overloaded and underresourced management and workers. Similarly, in keeping with the responsibilization of lower-level workers, BP had cited worker fatigue as one of the root causes of the Texas City accident, despite the fact that fatigue was common across sites, including those that did not experience a major accident. The panel report argued that BP's focus on individual behaviors and errors ignored and failed to address the root causes of accidents: fatigue and sensory overload due to management policies, in this instance, specifically policies that relied on routine overtime to meet production needs rather than on hiring additional employees. By emphasizing personal safety, the report claims that BP leadership failed to establish process safety or system safety as a core value and target for investment. Because BP relied heavily on individual injury rates to assess safety performance and because these personal safety indicators showed improvement, BP was mistakenly confident that it was addressing process (design and management) risks. The report nicely highlights a feature of the culture that mistakenly defined safety as individual responsibility.

Culture as Engineered Organization

Other scholars speak less about organizational or safety culture in general than specifically about an organization's learning culture (Carroll 1998a,b), especially in high-reliability organizations (HROs) (Eisenhardt 1993, Klein et al. 1995, La Porte & Consolini 1991, La Porte & Rochlin 1994, Roberts & Rousseau 1989, Roberts et al. 1994, Rochlin et al. 1987, Schulman 1993, Weick 1987, Weick et al. 1999). Like the previous category, however, the main focus of these authors has been to understand how culture leads to particular outcomes, specifically, reliability and efficiency. Again, culture is instrumentalized in order to manipulate and manage its consequences. This work differs from the previous category, however, by its explicit articulation of the organizational configuration and practices that should make organizations more reliably safe. Nonetheless, the HRO literature also seems to invoke a notion of culture as homogeneous and instrumentally malleable.

HRO analysts suggest that good organizational design with built-in redundancies, decentralized decision making for prompt in situ responses, and extensive training alongside trial-and-error learning can create high reliability, that is, safety, even in organizations with particularly hazardous technologies (e.g., Marone & Woodhouse 1986, Weick & Sutcliffe 2001). Continuous operations and learning that allow for backup to compensate for failures will lead, HRO theorists argue, to reduced error rates and safer outcomes. Organizational learning takes place through trial and error, supplemented by anticipatory simulations. Although HRO scholars most

often describe the prevalence of these conditions in military-style organizations, each of which holds itself to a failure-free standard of performance, (e.g., nuclear submarines, nuclear power plants, aircraft carriers, space shuttles, and air traffic control), they argue that such organizational practices and what are called processes of collective mindfulness are appropriate in nonmilitary organizations as well. HROs provide, authors claim, "a unique window into organizational effectiveness under trying," dangerous (Weick et al. 1999, p. 81), and high-velocity environments (Eisenhardt 1993).

HRO scholars focus on what they claim is a distinctive though not unique set of cognitive processes that prevail in the better plants and systems. These five orientations (preoccupation with and proxies for failure, reluctance to simplify interpretations, sensitivity to operations, commitment to and capabilities for resilience, and resistance to over-structure or preference to under-specify the system) lead to mindfulness—a feature of safe organizations (Weick et al. 1999, pp. 83, 88). Mindfulness can be understood in terms of the quality and allocation of scarce attention, the repertoire of action capabilities, or active information searching (Westrum 1997), but is perhaps most concisely described by Vaughan (1996, chapter 4) as "interpretive work directed at weak signals." In contrast,

> when fewer cognitive processes are activated less often, the resulting state is one of *mindlessness* characterized by reliance on past categories, acting on "autopilot," and fixation on a single perspective without awareness that things could be otherwise. . . . [T]o say that an organization is drifting toward mindlessness is simply another way of saying that the organization is drifting toward inertia without consideration that things could be different (Weick et al. 1999, p. 91).

If many culture-as-cause analyses describe safety culture shaping members' safety attitudes and behavior, HRO analyses adopt a less reductionist or determinist epistemology (but see Klein et al. 1995). Nonetheless, slippages toward instrumental conceptions of culture and aspirations for homogeneously distributed cognitive capacities also appear in the corpus of HRO scholarship. Because the HRO is offered as a model for reliably safe performance, it becomes essential to operationalize with increasing specificity the particular mechanisms that will ensure that performance, pushing a less reductionist model of culture toward the same limitations as the culture-as-cause literature. Although many organizations share the named characteristics of high reliability, these are apparently insufficient for preventing accidents because not all such organizations are reliably safe. When organizations that ought to be highly reliable—because they exhibit the specified characteristics—are not, authors either claim poor management or alter the criteria of success. What is now called high-reliability theory (HRT) is a response that transforms a prescription into a hypothesis, in some cases by transforming the independent variables naming organizational processes, and at other times reframing the dependent variable or the definition of reliability. Early formulations emphasized the total elimination of error, absence of trial-and-error learning, a closed system buffered from environmental stresses, and a singular focus on safety (Weick 1987, Weick & Roberts 1993). Later versions basically inverted the criteria to value the role of trial-and-error learning, learning from failures, the importance of exogenous influences such as regulations and public perception, and the importance of multiple objectives alongside safety (e.g., safety and service) (LaPorte & Consolini 1991, LaPorte & Rochlin 1994).

Empirical tests of HRT have challenged its own reliability as well as validity. For example, Klein et al. (1995) compared the organizational cultures in a range of HROs to other organizations. Unlike most organizations, HROs showed few hierarchical differences in cultural norms, although there were differences across HROs. In a study restricted to two nuclear plants, Bourrier (1996) found that the "organizations use quite different strategies in their

search for reliability and effectiveness," including coordination of workers and structuring of tasks, variables specifically excluded in the basic HRO model. Although the lack of hierarchical variation emphasized the cultural homogeneity within individual organizations, research failed to demonstrate a shared culture across organizations.

In perhaps the most important empirical tests, Sagan (1993) failed to substantiate HRT's fundamental premises. Using Freedom of Information Act petitions, Sagan scoured previously classified archives to discover why there have been no unintended explosions of nuclear weapons. Is this a uniquely safe system—a model of high reliability? Sagan's analysis of two moments of near nuclear war (Cuban Missile Crisis, 1973 October defcon alert) and the loss of a nuclear armed aircraft (1968 bomber crash near Thule Air Base, Greenland) reveals that the system is anything but reliably safe. Even the necessary, if not sufficient, conditions for HRO failed; there were no accidents, however, although there were repeated near misses. Sagan's data discredit the fundamental features of the high-reliability model. He argues that redundancy, promoted by HRT to prevent accidents, is often the cause of problems, especially when redundancy is added on rather than designed into systems. The bomber crash was the result of planned redundancy that was itself the source of near disaster. Planes loaded with nuclear weapons routinely fly as a form of a "redundant triad of U.S. strategic bombers, submarine launch ballistic missiles (SLBMs) and intercontinental ballistic missiles (ICBMs), to ensure that retaliation would be possible under any conceivable circumstances in which the U.S. might be attacked" (Sagan 1993, p. 157). When a Strategic Air Command bomber with nuclear weapons crashed on January 21, 1968, "the conventional high explosive in all four of the nuclear bombs went off. No nuclear detonation occurred but radioactive debris was dispersed over a wide expanse" (Sagan 1993, p. 156; 1996). This near miss would not have occurred without the built-in redundancy that increased the number of nuclear weapons routinely deployed and circulating the globe.

Sagan (1993) also identifies conventional features of organizations that impede learning, for example, the persistence and limitations of bounded rationality that pervades "garbage can" processes (Cohen et al. 1972). These adaptive, yet unscriptable decision-making practices prevail in many complex, porous organizations where unstable environments, unclear goals, misunderstanding, mis-learning, and happenstance prevail.

Sagan shows that in each of the high-alert moments of crisis, protocols for ensuring against accidental detonation were violated. Because the supposed protections were not operating, only chance prevented nuclear detonation. He demonstrates that there was no learning among analysts or high-level officers from one incident to the next. More importantly, from my perspective, and a point I return to below, Sagan's work stresses the importance of competing group interests that undermined not only commitments to safety, but also HRT's notions of homogeneous organizational culture and self-reflexive learning. Group rivalries led to limited communication, burying information about what actually happened and impeding development of shared interpretations that can promote improvement over time. Concerns about organizational surveillance, fear of publicity about near misses, and inter- and intraservice rivalries produced a culture of informational secrecy among the military that leads to even more near misses[10] (cf. Galison 2004).

Culture as Emergent and Indeterminate

If optimism characterizes HRT, in effect suggesting that "if we only try harder we will have

[10]It may be worth remembering that just this kind of organizational competition and secrecy among law enforcement agencies contributed to the failure to respond effectively to intelligence information prior to the 9/11 World Trade Center disaster.

virtually accident-free systems," more skeptical scholars believe "that no matter how hard we try we will still have accidents because of intrinsic characteristics of complex/coupled systems" (Perrow 1999 [1984], p. 369). For those who eschew reductionist and instrumental conceptions, culture is understood to be emergent and indeterminate, an indissoluble dialectic of system and practice. As such, the consequences of safety culture cannot be engineered and only probabilistically predicted with high variation from certainty. For scholars who adopt this constitutive perspective, "safety as a form of organizational expertise is . . . situated in the system of ongoing practices. . . . [S]afety-related knowledge is constituted, institutionalized, and continually redefined and renegotiated within the organizing process through the interplay between action and reflexivity." Here, safety practices have "both explicit and tacit dimensions, [are] relational and mediated by artifacts, . . . material as well as mental and representational" (Gherardi & Nicolini 2000, p. 329). Rather than a specific organization of roles and learning processes or a measurable set of attitudes and beliefs, safety is understood as an elusive, inspirational asymptote, and more often only one of a number of competing organizational objectives.

In his original formulation of the theory of normal accidents, Perrow (1999 [1984], p. 94) identified those intrinsic characteristics of sociotechnical systems that challenge aspirations to total safety, breeding failure and catastrophe. Where system components are complexly organized (i.e., with many interacting parameters and subsystems, indirect and inferential sources of information, feedback loops, and personnel isolation), tight coupling among the subunits undermines the ability to recover from inevitable malfunctions. Tightly coupled systems have little slack and more invariant sequences in time-dependent processes, usually permitting "only one way to reach the production goal." Thus, when things go wrong, and they always do, if only because of the variability in component life spans or unobserved faults in minor or major parts, these tightly coupled and complex systems have limited temporal slack, substitutability, and response options. This conception of normal accidents directly challenges the high-reliability model of intense discipline, rigid socialization, and isolation. However, even in analyzing military organizations, which emphasize discipline, socialization, and relative isolation from environmental contamination, Sagan successfully challenged HRT and extended the normal accidents model by emphasizing issues of bounded rationality and interest competition within and between organizations. Finally, in a very different setting (the 1980s savings and loan crisis), Mezias (1994) also showed how tight coupling and complexity increased simultaneously to produce catastrophic results in a nonmechanical but nonetheless complex technology.[11]

In a series of thickly described accounts, Vaughan (1996, 1999, 2003, 2004, 2005a,b, 2006) has provided close, carefully nuanced analyses of how the routine features of bureaucratic organizations that make for effective coordination across persons, times, and tasks nonetheless lead to mistakes, misconduct, and disaster. Bridging micro and macro perspectives, Vaughan's work proposes a series of mechanisms that prevent well-intentioned actors and well-designed organizations from achieving desired objectives. Despite significant differences between loosely coupled networks of heterogeneously distributed, and often collegially connected, communities of diverse participants (Hughes 1998) and tightly coupled complex systems (Perrow 1999 [1984]), both display consistent cognitive patterns that undermine safety and render accidents normal. Vaughan (1999) describes these practices as the "dark side of organizations." However, rather than focusing on hidden information, Vaughan emphasizes the interpretive flexibility in all processes; she demonstrates how the cognitive

[11]I write this essay as the financial crisis of 2008 is unfolding. One cannot help but notice the unfortunate parallels with previous moments when supposedly expert technologies failed to perform as their promoters and beneficiaries insisted they would.

construction of situations is at the heart of the safety problem and why organizations do not learn from their mistakes.

Unusual events and accidents are generated by the same cognitive processes that enable the ordinary, routine interactions of daily life. Vaughan documents the ways that participants interpret uncertain and anomalous events as routine, thus failing to identify emerging disasters. This interpretive construction is an irreducible feature of organizational processes because it is also a necessary feature of all social action. Cognitive processes homogenize, or normalize, across differences, so that each event is not perceived as unique but is categorized, and responded to, as an example of something known and familiar for which interpretations and established responses exist. Thus, action can proceed across time and space rather than as if each moment, phenomenon, or interaction was being experienced for the first time. (This is exactly the import of defining culture as both system and practice. Each act is interpretable only as part of a system; the system is produced through myriad individual actions.) However, routinized habits and tacit knowledge that are fundamental constituents of sociality—mechanisms for assembling the social (Latour 2005)—also efface particular differences that can, and sometimes do, have catastrophic consequences.

Within rich ethnographies of sociotechnical systems, scholars display the local enactment of more general representational practices that constitute, reconstitute, and reform the cultural system in which safety is valued, if not consistently achieved (Clarke 1989, 1999; Gusterson 1998; Perin 2005; Vaughan 1996). This research varies by the specific foci of interpretation: on artifacts and objects (Hilgartner 1992, Schein 1992) including, for example, radiation (Hacker 1987), asbestos (Maines 2005), o-rings (Gieryn & Figert 1990), oil (Beamish 2002), system conditions or signals (e.g., Perin 2005, Walker 2004), the significance of a particular event (Galison 1997, pp. 352–62; Gieryn & Figert 1990), repeated events (Sagan 1993; Vaughan 2003, 2005a), or imagined events (e.g., Eden 2006). In these studies, researchers describe how:

1. Linguistic schema, formal categories, embedded norms, and familiar artifacts provide both fixed and flexible frames of reference with which people apprehend and interpret information system performances, risks, and safety (Clarke 1993, Heimer 1988, Kahneman et al. 1982, Pfohl 1978, Starbuck & Milliken 1988).
2. Information that might shape more cautious and responsive interpretations is often missing, actively buried (Sagan 1993), or discredited (Vaughan 1996, 2003). Some knowledge is removed or segmented by the distributed work processes and organizational norms of secrecy that impede the communication or understanding that is vital for our safety (Galison 2004).
3. Dangers that are neither spectacular, sudden, nor disastrous, or that do not resonate with symbolic fears, can remain ignored and unattended, and as a consequence are not interpreted or responded to as safety hazards (Alvarez & Arends 2000, Brown & Mikkelsen 1990, Glassner 1999). For example, Beamish (2002) describes oil spilling continuously for 38 years in the Guadalupe Dunes between Los Angeles and San Francisco and how agencies geared to answer dramatic and sudden pollution events lacked the frameworks to recognize or tools to respond to ongoing, routine environmental degradation by continuously leaking pipes. From the 1950s until the 1990s, the spill was ignored, existing physically but not in any organizationally cognizable form. Because it was continuous, ongoing for 20 years or more, it was in effect routine and interpreted as such. However, when the spill was no longer just a set of distributed puddles but began to appear in the ocean nearby, "impressions of what was normal quickly changed" (Beamish 2000, p. 481). Yet, because there was no category for perceiving, naming, and

responding to slow, long-term environmental degradation, the spill was again normalized through that part of the oil field subculture that expected rapidly unfolding disasters. It was reinterpreted as an emergency, an available category for those with expertise in short-lived but possibly big oil spills. Interpreted as an emergency, the experts responded with standardized responses that turned out to be inappropriate for the long-term system failure and environmental degradation that had actually taken place. Vaughan's (2003, 2005b) analyses of the *Challenger* and *Columbia* disasters provide parallel examples of situations in which patterned, systemic conditions are repeatedly misperceived and misinterpreted and, when disaster strikes, are reinterpreted once again, in these cases oppositely, not as emergencies but as random, incidental, contingent occurrences rather than the product of long-term systemic processes.

4. Organizational structures, roles, and routines shape interpretations so that different organizational routines produce very different understandings of risk and error. In a comparison of NASA's organizational structure with the FAA (Federal Aviation Administration, National Air Traffic System), Vaughan (2005a) shows how invariant and open discussion of the most minor variations or mishaps in the Air Traffic Control system and not in NASA facilitates effective self-scrutiny and sensitivity to mishap.
5. The larger macrosocietal and popular culture embeds particular interpretations of risk and safety (Douglas 1985, Douglas & Wildavsky 1982, Giddens 1999), and repeated organizational and institutional failures breed generalized and disproportionate fear and uncertainty. For example, Glassner (1999) argues that fears are generally focused on the wrong things: on chimerical dangers such as "superbugs," "killer kids," or "teenage moms" rather than more immediate, empirically demonstrable threats to well-being and safety such as poverty or guns. He suggests that the media, ever in search of salacious stories that will increase market share, are simultaneously the promulgators and debunkers of fear-mongering. He suggests that misplaced fears are propagated by those who seek to profit by selling protections against that which is feared, generating both demand (creating fears) and supply (safety). In contrast, Clarke (2006) suggests that although the harbingers of impending catastrophe are more reasonable and prescient than many imagine, the "ubiquity of worst cases . . . renders them ordinary and mundane"—no longer able to shock. Cumulatively, there is a loss of public trust and an increase in the likelihood of institutional failure (Freudenberg 1993); this generalized loss of trust in institutions explains three times as much of the variation in public fears as do sociodemographic and ideological variables.

CONCEPTUAL CONUNDRUMS, IDEOLOGICAL ELISIONS, AND STRUCTURAL SUPPORTS FOR SAFETY

Talk about safety culture presents a series of conundrums. First, "safety is defined and measured more by its absence than by its presence" (Reason 1999, p. 4); we are safe because there are no accidents. As non-events, we pay little attention to near misses. "Belief in the attainability of absolute safety . . . impede[s] the achievement of realizable safety goals" (Perrow 2007; Reason 1999, p. 11). By attempting to institutionalize an absence (no accidents), safety culture chases an ever-receding chimera, observable only when it ceases to exist. If absolute safety is chimerical, and if systems are never perfect, some suggest that research should

focus instead on adaptability and resilience. For example, Dekker (2006, pp. 83, 86) calls for research on "the drift into failure," that is, the ways in which a system's protective mechanisms slowly push it toward the boundary between resilient adaptability and failure. Rather than wait for the safety silence to be broken and rather than model safety failures, Dekker suggests that engineers should model the ordinary routines and micro decisions that often do not lead to failure but may nonetheless be "linked to macrolevel drift." Thus, some resilience engineers call for close, detailed observation of sociotechnical systems, for studies of the underlying dynamic relationships within organizations, especially on decisions that would relax production pressures and consequent risks. To become "wiser in the ways of the world" (Perin 2005, p. xix), engineers should learn "something meaningful about insider interpretations, about people's changing (or fixed) beliefs and how they do or do not act on them" (Dekker 2006, p. 86), and in this way achieve an observable (resilience), rather than spectral (safety), system condition. Eschewing the reductionist conceptions of safety culture, resilience engineering joins the interpretive turn and ends up calling for thick description; engineering becomes ethnography.

Second, "measures designed to enhance a system's safety—defenses, barriers, and safeguards—can also bring about its destruction" (Reason 1999, p. 6). Although "most engineering-based organizations believe that safety is best achieved through a predetermined consistency of their processes and behaviors, . . . it is the uniquely human ability to vary and adapt actions to suit local conditions that preserves system safety in a dynamic and uncertain world" (Reason 1999, p. 9; Hollnagel et al. 2006). Thus, organizations routinely succeed, and recover from near disaster, because workers do not follow predetermined protocols or designs; instead, they interpret rules and recipes, adapt resources to innovative uses, develop work-arounds, and invent in situ many of the routines that ultimately come to constitute the system in practice. Despite this well-documented understanding of organizational behavior, many engineering models fail to describe the way work is actually done, offering instead what turn out to be largely imaginary accounts of work and system performance (Sosa et al. 2003). [Pilot training is a notable exception, routinely instructing pilots to differentiate when to follow or break protocol (Galison 2004, Gladwell 2008).]

Even some who promote resilience in place of safety culture engineering and recognize safety to be an emergent system property—context rather than cause—offer what turn out to be merely more complex models of dynamically intercollated feedback loops. Like Dekker (2006), Leveson et al. (2006) also suggest that a resilient system should include systematic self-reflection. They differ, however, by proposing not deep ethnography, nor skepticism concerning information and communication, but mechanical observation, modeled in terms of a parallel control system that adjusts for variation in the development and behavior of a system from the engineered design. By constant comparison of behavior to design, Leveson et al. suggest that we can build resilience into safety-critical systems. They adapt standard cybernetic models with system-dynamic models that continuously and automatically modify system specifications. The research displays pervasive and persistent refusal to accept the basic feature of complex organizations and sociotechnical systems: They are continually in the making, constructed and reconstructed in every moment with every act. Each new safety process or procedure, each specification of the system, reinstantiates the system that was into something that is—something new, if not different (Ewick & Silbey 1998, pp. 43–44). Because adjustment to the new model always includes some adaptation (with implied variation and innovation), specification of the system is always pushing against an asymptotic aspiration of full information. Thus, there remains an unwarranted confidence in the ability to marshal information, as well as its credibility (Perin 2005), to control

system behavior that is belied by the history of system failure, inviting, Perrow (2007) claims, the next catastrophe.[12]

Quite noticeably, the discussions of safety culture ignore those features of complex organizations and technological systems from which cultural schemas and interpretations often emerge: normative heterogeneity, competitive and conflicting interests, and inequalities in power and authority. Thus, what is specifically missing from accounts of safety culture is attention to the mechanisms and processes that produce systemic meanings, including understandings of risk, safety, authority, and control. A reflexive, historically grounded, empirical research agenda should address these issues. I offer two suggestions about what such approaches might explore.

Challenging Hegemonic Normalization

Research on accidents and disasters has repeatedly demonstrated what sociologists have known for close to a century: All purposive social action has unintended consequences, and, although social action is inherently variable, social solidarity and coordination are sustained by perceptually, conceptually, and morally normalizing the variation. Thus, we fail to distinguish novel or threatening from familiar and manageable events, productively innovative from functionally destructive deviance. This is true in simple as well as complex relationships and situations. This is true in planning and in implementation. Thus, in studies of hazardous technologies, researchers have documented the ways in which the most rational and rigorous analysts regularly fail to imagine contingencies that later generate catastrophic hazards. For example, in his study of nuclear weapon deployment, Sagan (1993) noted that (*a*) American radar installations had been installed across the northern hemisphere to observe possible launches from the Soviet Union and could not observe or monitor missile launches from the southern hemisphere, including launches from Cuba during the missile crisis of October 1962; (*b*) strategic planning and nuclear safety relied on a design that limited detonation in the absence of at least two independent decision makers, but during the crisis of October 1962, planes were launched with armed nuclear weapons, with only a single pilot having the ability to detonate; and (*c*) planners generated at least 10 scenarios of common-mode failures[13] that might provoke an unintended detonation of a nuclear weapon; in none of these imaginaries did the analysts conceive the configuration of events that actually occurred in 1968 when a B-52 bomber crashed near Thule Air Base, Greenland, with four thermonuclear weapons aboard. [The conventional high-explosive materials detonated upon impact, but the bomb had been designed to withstand the heat and pressure of a crash. "This important safety feature worked" (Sagan 1993, p. 180).] Confident that the enemy was on the other side of the globe rather than 90 miles away, that redundant security systems reinforced rather than undermined each other, and that the collective imagination of the defense planners could anticipate any confluence of events, the United States managed only accidentally to avoid unintended nuclear detonation.

In similar lines of analysis, Perin (2005, p. 5) describes how nuclear power planners had imagined myriad possible problems but not what actually occurred in 2002. Although "leaks had been a generic problem known to the industry since 1990," at the Davis-Besse Station on Lake Erie near Toledo, Ohio, in 2002, leaks had

[12] Clarke & Short (1993, p. 375) suggest an additional conundrum deriving from the fact that we must respond to accidents and "disasters through organizations that may be precisely the wrong social instruments for such response" and may themselves be an independent source of risk. "Organizations are built on predictability, but accidents by definition involve unpredictability. . . . Organizations are organized to be inflexible," when flexibility is exactly what unpredictability requires (p. 392).

[13] Common-mode refers to a system component that serves multiple other components such that, if it fails, the other modes or components also fail.

eaten "completely through the 6.63 inch carbon steel [vessel head] down to a thin [3/16 inch] internal liner of stainless steel." No engineer had ever "considered that nozzle lead deposits could eat into the carbon steel of the reactor vessel."

Finally, Eden (2006) shows how, for more than half a century, government analysts failed to predict and plan for the consequences of nuclear fire during a nuclear war. Because organizations focus on and try to institutionalize what they do well, they often fail to value what lies outside their normal view and capacities. Having developed expertise in precision bombing, the Air Force also developed parallel skill in predicting accuracy and damage, but failed to imagine the fire that would follow, although much of the World War II bombing damage was due to fire. Working only with what they knew best and for which they had secure budgets, they produced a rather poor representation of the world as it had been (e.g., in Dresden, Hiroshima, and Nagasaki) or might be.

To challenge the processes of normalization that impede recognition of hazardously deviant events, future research might attempt to map more systematically not only the ubiquity of and variations within such processes, but most importantly the conditions and resources that challenge hegemonic normalization (Ewick & Silbey 1995, 2003). If hegemony refers to that which is unthinkable, and safety demands seeing what is not there—an accident in the making—then research needs to identify the processes that successfully unsettle organizational routines to make the unthinkable cognizable and the invisible apparent. Recalling that hegemony is what goes without saying, by articulating what is taken for granted and conventionally unspoken, closely observed ethnography can identify the moments in which critical self-reflection emerges to unsettle convention and make space for innovative practices (Kelty 2008, Suchman 2006). From her deep ethnography of nuclear power plants, Perin (2005) identified moments when unexpected knowledge flowed from one group to another, when outside observers brought new perspectives on routines, and when in-house meetings provided opportunities for sharing concerns about distractions. In her reimagined culture of control, information channels would be laid across functional boundaries, and observational and interpretive competencies would become high priority for staff.

Power Differentials and Structured Inequality

One is hard-pressed to find a reference to power, group interests, conflict, or inequality in the literature promoting safety culture. This may be the most striking feature of this research field. This is not to say that there is no recognition of hierarchy. Indeed, the proponents of safety culture recognize the greater authority and resources of top-level management and recommend using it to institute organizational change from the top down, mandated by organizational leaders, even if designed by hired consultants. Indeed, the consistent valorization of clear lines of hierarchy accompanies a surprising failure to see how this same hierarchy undermines communication and self-reflection about hazards. Recognizing the greater power of management, safety culture advocates nonetheless fail to adequately recognize the diminished power of those in subordinate positions (Edwards 1979, Hodson 2001). As a consequence, organizations often attempt to institute safety culture by addressing only one facet of the organization at a time, for example, people's attitudes, behaviors, coordinating structures (Cooper 2000), management messages, or organizational symbols, without considering dependencies and interdependencies. Vaughan (1996, 2003) and Perin (2005) refer at length to the dysfunctional safety consequences of the hierarchical credibility gap that derives from the embedded, but unacknowledged, stratification. Lower-level actors are often repositories of critical information and counterhegemonic views, yet are often unable to persuade higher-ups in the organization of either the credibility of their knowledge or relevance of their perspectives. To the extent that the consequences of hazardous technologies are

promoted and managed by advocating safety culture that elides issues of power and inequality, it becomes, intended or not, an ideological project (Silbey 1998).

Proponents of safety culture ignore the fact that although safety has mutual benefits, all are not made equally better off, even from a mutually beneficial objective. If management does not regard workers as substitutable costs, whose functions are more economically purchased through outsourcing, an opposite management theory imagines that all members of the organization are similarly situated, with commensurate interests, trust, and loyalty. From this latter, enlightened leadership perspective, corporate managers are safety stewards promoting a generally shared and valued objective and can thus expect organizational members to follow enthusiastically; after all, we all benefit from increased safety. Yet the differential interests of upper-level managers and lower-level workers are systematically elided through popular ideologies and representational practices that insist on our mutual self-interest. By assuming a similarity of interest, managers fail to address the differential positions and, more importantly, fail to recognize the differential resources workers bring to the organization that can be mobilized in the service of greater safety.

Moreover, with the decline in unionization, lower-level workers lack the institutionalized base from which to make their voices heard in their own interest or in the interests of the firm, including their knowledge of safe or unsafe operating conditions. Research has shown, for example, that safety violations, accidents, and product defects increase with outsourcing (Kochan et al. 1992). Because of a lack of oversight, integration across functions, and an intimate knowledge of the production process, contract suppliers are unable to provide the mitigation of hazard that had been supplied in the past through shop-floor, rather than upper-level-management, stewardship. Furthermore, as firms spread more of their capital risks through innovative financial instruments, they have inadvertently broken the organizational field, one might say, by eschewing the institutionalized mechanisms, such as worker expertise, oversight, and solidarity, that help mitigate risk. One cannot help notice, for example, the rapidity with which particularly hazardous technologies, such as oil refineries, are bought and sold. In the financialized world, a refinery is an asset, not an organization, neither a community nor a complex system. With each shift in ownership comes a new management regime with a new set of procedures, policies, and practices; new IT systems; and different safety regimes.

Attention to power and inequality suggests several lines of research. Studies might productively bring literature on financial risk and material hazards into conversation with each other. Surely they have been interacting with each other during the past decade, most obviously when changes in firm ownership bring changes in personnel and policies. Future research might also explore how safety culture discourse operates in different stratification systems. For example, where there is deep poverty and low education, obvious human need may outweigh concerns about safety, and rational discourse may function merely as a concession to external or symbolic constituencies. Where there is more education and material abundance, talk of safety culture may obscure the inherent risks of complex systems, disguising them behind a facade of personal risk and individual deviance.

Most importantly, however, research should explore ways in which differentially situated interests might be mobilized to produce countervailing power. Where the relation between the source and victims of hazardous risks are bound by neither space (across geographic boundaries), nor time (across generations), security and safety certainly seem elusive (Beck 1992). Some recent litigation campaigns suggest tactics that, if not directly controlling hazardous systems, might nonetheless highlight the links among dispersed organizations, technologies, and collectively as well as locally experienced harms. Deterritorialized risks can be brought to earth, so to speak, apprehended and localized by mass or class action litigations, such as in the

asbestos and tobacco litigations or in lawsuits against oil companies for global warming.

CONCLUSION

Safety culture is a particularly narrow attempt to tame Prometheus, where the central problematic—assembling the social (Latour 2005)—is assumed rather than explored. In its most common invocations, safety culture becomes either a thing or an ether. Culture names "what is left over after you forgot what it was you were originally trying to learn" (O'Reilly & Chatman 1996, p. 159). Rather than address the structural and historical conditions that either sustain or impede safe organizational performance, culture becomes a supplement, the detritus of social transactions. As the phenomena continually recede before efforts to control them, research advocating safety culture seems, in the end, to suggest that responsibility for the consequences of complex technologies resides in a cultural ether, everywhere or nowhere. If the ether proves elusive, the explanation of operator error is always available. In seventeenth century England, when experiments went wrong in performances before the Royal Society, the air-pump exploding for example, assistants and craftspeople were blamed for the failure rather than the gentlemen scientists or even the artifacts themselves (Shapin & Schaffer 1985). Because technologies concretize the scientific theories and social relations, hierarchy, and authority of the organizations assembled around them, it was difficult to point toward systemic failures in the apparatus without undermining the scientist designers. Since the seventeenth century, Prometheus has become omnipresent, if not omnipotent, scientific authority even more secure; yet, four centuries on, we still focus on the assistant, failing once again to tame Prometheus.

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