Dupont Summit 2014

::::::::: *Science, Technology, and Environmental Policy Issues*

December 5, 2014 ❖Historic Whittemore House, Washington, DC

The Policy Studies Organization

Panel
"Reimagining Perrow & *Normal Accidents*: A 30th Anniversary Reflection"

With over 7,700 citations, Charles Perrow's *Normal Accidents: Living with High Risk Technologies* is a highly influential text in understanding the propensity for unexpected, catastrophic, and yet normal accidents in technological systems central to modern societies. Perrow points out the potential laden in each of these systems for complex and unexpected interactions, while simultaneously providing a more nuanced story that reveals how the frequently applied label of 'operator error' often shifts stochastic and forced errors to the fault of an operator in the wrong place at the wrong time. In the 30 years since *Normal Accidents*, it has proved a powerful reminder of the importance of fully embracing the social dimensions of "technological disasters" as endogenous to the very design and operation of these systems.

Yet, *Normal Accidents*, and the uses of the text by subsequent scholars, remains unsatisfying. Undergirding Perrow's writing, and its influence on future scholars, is a deep ideological commitment to the inevitability of accidents – the very choice of "normal" as a typology of accidents (as though abnormal or non-normal accidents are fundamentally different) emphasizes this point. Perrow's normality theory at the macro level falls short on four major points. First, there is no clear definition of an accident; as noted by other scholars of safety, accidents are constructed through discourse about systems. Second, the broad typology of systems Perrow provides does not elucidate the social and technological nuances between system configurations and the specific cultures in which they reside. Roberts and Bea's 2001 study on high-reliability organizations reproduces this problem – and in doing so assumes that all social elements that lead to an accident are endogenous to an organization. In fact, social, economic, and political elements are especially important for parsing out Chernobyl, Three Mile Island, and Fukushima, as neither particular "accident" could have occurred in the context of the others. Third, the use of normal accidents as a theoretical frame either pertains to the "normality" of accidents or Perrow's stance towards the emphasis of loose coupling in systems design as a pathway towards minimizing accidents. As pointed out by Karl Weick in his 1976 study on educational systems, ranges of coupling (tight to loose coupling) function as sensitizing devices meant to encourage particular behaviors, not as an analytical tool for characterizing sociotechnical systems. Fourth, Perrow's commitment to the possibility of improving some systems (loosely coupled ones) over others as a pathway to addressing high-risk technologies fails to capture how his own abstraction of these systems to the point of production (nuclear power plants in particular) misses the global interconnectivity of technological systems. Changing systems to reduce risk in one locale (e.g. Three Mile Island) may end up simply fostering other risks and "normal" accidents as a response.

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"Reimagining Perrow & *Normal Accidents*: A 30th Anniversary Reflection" (continued)

In the face of a theory that, despite its pervasiveness, functions primarily as a treatise on the inevitability of accidents with no clear typology, we propose a new approach to understanding the potential for normal accidents in complex systems. At the core of this novel approach is the realization that complex systems are not solely technological. Rather, complex systems critically comprise people, knowledge systems, and sociotechnical interactions. In order to understand the complexity of systems, and complex system "accidents," a strong analytical program must take seriously social, organizational, and environmental factors, rather than simply brushing off structural factors.

We therefore propose a novel framework to improve Perrow's two-dimensional mapping of system coupling and linearity in order to better understand the relative risk of normal accidents by accounting for the critical social components of complex sociotechnical systems. Our framework poses three dimensions to map the complexity of knowledge systems and alignment of human values, along with the degree of understanding of complex technological systems. Our framework also captures external social elements that may not factor into a strict organizational study of accidents (e.g. the function of nuclear power in American and Soviet societies during Three Mile Island and Chernobyl, respectively) that, despite the analytical convenience of black-boxing these systems, factor into the production of accidents. Furthermore, by tracing these systems as cogent systems of production (e.g. energy or flight) rather than as discrete industries (e.g. airplanes and nuclear reactors versus uranium mines and aluminum smelting) we can capture disparate elements that may lead to accidents. At a discrete organizational level, these elements may not factor into an analysis of potential sites for accidents to occur, as the lack of clear vertical integration from resource extraction to final technological product is more common. However, externalities are useful to consider in developing a typology for policy analysis. Therefore, our three-dimensional approach affords a more complete and nuanced analysis of complex sociotechnical systems with implications for policymakers to better sculpt programs to manage normal risk.

We will explore this novel framework as an analytic tool by revisiting four case studies originally presented by Perrow in *Normal Accidents*. We will re-examine aircraft, nuclear power, DNA/genomics, and military adventures to compare and contrast Perrow's two-dimensional technological system analysis with our three-dimensional sociotechnical system analysis. We will demonstrate how technologies that were deemed quite similar in Perrow's framework possess markedly different implications for normal risk, and thus merit unique approaches to policy construction for risk management, when human knowledge systems and values are included in the analysis.

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Panel Biographies
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Eric Kennedy is a PhD student at the Consortium for Science, Policy & Outcomes at Arizona State University and has a Bachelor of Knowledge from the University of Waterloo. His work focuses on finding improved strategies to foster collaboration in solving complex & interdisciplinary real-world problems. Kennedy is fascinated by the ways people and communities work together to design, problem solve, and innovate, especially when these collaborations involve diverse and competing groups. He is also avidly interested and involved in work on innovation systems, social enterprise, and the redesign of educational systems.

Michael Burnam-Fink is a PhD student at Arizona State University in the Human and Social Dimensions of Science and Technology. His work spans, science and technology studies, the history of medicine encouraging innovation in assistive technologies for people with disabilities, and narrative foresight methodologies. His dissertation focuses on the use and regulation of cognitive enhancement in higher education; how the ADHD diagnostic category has expanded in recent decades, and how students and various educational and medical authorities control the flow of Adderall, Ritalin, and related controlled substances. This work analyzes the culture of study drugs in the context of diagnostic fluidity and policies for special education, in order to understand how the emerging biological management of the self may be enacted in concert or opposition to social values. In his spare time, Michael collects books on the Vietnam War and reads Department of Defense reports on weapons system procurement.

Abraham Tidwell is a Ph.D. student in the Human and Social Dimensions of Science and Technology Program in the Consortium for Science, Policy & Outcomes (CSPO) at Arizona State University. His research focuses on the construction and maintenance of energy systems and the relationship between domains of energy technoscience, liberal economic theory, and the state. Previous projects have included examining the functional components of climate change rhetoric in the American nuclear industry, the social dynamics of nuclear facility licensing controversies, and critically examining when and how energy security emerged as a focal point of U.S. government policy discourse. Abraham has also analyzed U.S. Navy surface fleet systems management practices as part of RAND Corporation, performed cost analysis on novel carbon capture designs for coal-fired power plants, and conducted process chemistry research in the building materials industry. He is currently co-editing a volume of the CSPO book series *The Rightful Place of Science* on energy ethics.

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Panel Biographies (continued)
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Heather M. Ross, DNP, is a PhD student in the Human and Social Dimensions of Science and Technology program in the Consortium for Science, Policy & Outcomes (CSPO) at Arizona State University. She is also an Instructor in the Doctor of Nursing Practice program in the College of Nursing and Health Innovation at Arizona State University. Her research focuses on complex sociotechnical systems in medical diagnostics and therapeutics, including invasive technologies for treating cardiac arrhythmias and wearable biosensors in ambulatory medicine. She also maintains an active clinical practice in cardiac electrophysiology at Arizona Arrhythmia Consultants in Scottsdale, AZ.

Dr. Jennifer Richter is a Visiting Assistant Professor in the School of Social Transformation and the Consortium of Science, Policy and Outcomes. Her research interests are at the intersections of science and society, and how federal policies are enacted locally. Specifically, she focuses on nuclear energy and waste policies and how they affect small communities in America's "nuclear corridor" in southeastern New Mexico. By examining how science and technology policies collide with local expectations and understandings of environment and economy, Dr. Richter explores the different scales of nuclear technologies and policies.