

**Looking Back to Move  
Forward:**

**Guiding Biotechnology  
through Lessons Learned  
from Nuclear, Chemical and  
Information Technologies  
Workshop**

**Annotated Bibliography**

**CGSR**

Center for Global Security Research



***Annotated Bibliography Author and workshop contributor: Yong-Bee Lim  
Predoctoral Intern Researcher, Center for Global Security Research, LLNL***

**United States Nuclear Technology**

Roger E. Kasperson, Ortwin Renn, Paul Slovic, Halina S. Brown, Jacque Emel, Robert Goble, Jeanne X. Kasperson, and Samuel Ratick, (1988), “The Social Amplification of Risk: a Conceptual Framework”, *Risk Analysis*, Vol. 8, No. 2: pp. 177 – 187.

<[https://www.researchgate.net/profile/Ortwin\\_Renn/publication/227763756\\_The\\_Social\\_Amplification\\_of\\_Risk\\_A\\_Conceptual\\_Framework/links/00b7d51efd52b8cb50000000/The-Social-Amplification-of-Risk-A-Conceptual-Framework.pdf](https://www.researchgate.net/profile/Ortwin_Renn/publication/227763756_The_Social_Amplification_of_Risk_A_Conceptual_Framework/links/00b7d51efd52b8cb50000000/The-Social-Amplification-of-Risk-A-Conceptual-Framework.pdf)>

*The authors address the question of a perplexing issue that often arises in the study of risk: what is the mechanism that allows objectively minor risks or risks events to elicit disproportionately strong public concerns, resulting in substantive societal and economic impacts? Drawing data points from nuclear technology, as well as other technologies, this article argues that risk perception and risk-related behavior can be amplified through complex interactions between psychological, social, institutional, and cultural processes. Given the importance of defining events and social perception in affecting the trajectory and growth of a technology, this entry provides a useful conceptual framework to understand the intricacies of technology, risk, and society.*

Howard Kunreuther, Douglas Easterling, William Desvousges, and Paul Slovic, (1990), “Public Attitudes Toward Siting a High-Level Nuclear Waste Repository in Nevada”, *Risk Analysis*, Vol. 10, No. 4: pp. 469 - 484

<[https://www.researchgate.net/profile/Douglas\\_Easterling/publication/227706022\\_Public\\_Attitude\\_Toward\\_Siting\\_a\\_High-Level\\_Nuclear\\_Waste\\_Repository\\_in\\_Nevada/links/0a85e53210b2432c05000000.pdf](https://www.researchgate.net/profile/Douglas_Easterling/publication/227706022_Public_Attitude_Toward_Siting_a_High-Level_Nuclear_Waste_Repository_in_Nevada/links/0a85e53210b2432c05000000.pdf)>

*This piece by Kunreuther, Easterling, Desvousges, and Slovic assessed the sources of public opposition to a high-level nuclear waste repository by using two models of choice as contrasts: a cost-benefit model and a risk-perception model of individual choice. The study highlighted significant, subjective risk factors that affect the decision-making outcome for individual residents; in particular, the perceived seriousness of risk to future generations was found to be particularly important in deciding whether placement of a high-level nuclear waste repository was found to be acceptable or not.*

Thomas A. Birkland, (1998), “Focusing Events, Mobilization, and Agenda Setting”, *Journal of Public Policy*, Vol. 18, No. 1: pp. 53 – 74

<<http://cstl-cla.semo.edu/wmiller/ps691/Birkland.pdf>>

*Focusing events, such as nuclear energy disasters, can be used to mobilize groups and interests; subsequently, the size and scope of these mobilized interests have the potential to significantly impact both the policy agenda and outcome. Specifically, in the case of high technology focus events (such as nuclear or biotechnology), Birkland argues that the success of group mobilization and responses to call for policy change will vary depending on the visibility and the tangibility of the harms done by the event. Birkland’s contribution to the policy process literature provides an important framework for viewing the interactions between focusing (defining) events, the public, and policy outcomes.*

Barnaby J. Feder, (2006), “Technology’s Future: A Look at the Dark Side”, *The New York Times*, May 17th

<<http://www.nytimes.com/2006/05/17/business/businessspecial2/17tech.html>>

*This article focuses on how the same technologies that are often advanced as being critical to creating greater standards of living for mankind are also capable of being prone to unforeseen, and potentially negative, outcomes. Drawing parallels between the costs and risks characteristics of nuclear energy, biotechnology, and nanotechnology, this article provides a very succinct overview of these technologies, as well as their interactions with society.*

Stephen C. Whitfield, Eugene A. Rosa, Amy Dan, and Thomas Dietz, (2009), “The Future of Nuclear Power: Value Orientations and Risk Perception”, *Risk Analysis*, Vol. 29, No. 3: pp. 425 – 437

<[https://cybercemetery.unt.edu/archive/brc/20120621002428/http://brc.gov/sites/default/files/meetings/presentations/whitfield\\_et\\_alpublished.pdf](https://cybercemetery.unt.edu/archive/brc/20120621002428/http://brc.gov/sites/default/files/meetings/presentations/whitfield_et_alpublished.pdf)>

*This article researches how values, beliefs, and trusts in institutions that influence nuclear policy affect attitudes towards nuclear power and perceived risk. Utilizing survey data from a U.S. national survey, the researchers find that the individual values that people hold affect their attitudes toward nuclear power, perceived risk, and increased trust in nuclear governance institutions both reduce perceived risk of nuclear power and increase support for the future pursuit of nuclear power.*

Matthew Bunn, Martin B. Malin, Nickolas Roth, and William H. Tobey, *Preventing Nuclear Terrorism: Continuous Improvement or Dangerous Decline?* (Cambridge, MA: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, March 2016).

<<http://www.belfercenter.org/sites/default/files/legacy/files/PreventingNuclearTerrorism-Web.pdf>>

*This report provides a concise overview of the changing nuclear terrorism threat from the 1960’s to the modern threat represented by the Islamic State. The authors put forward two possible nuclear security futures in 2030 based on how effectively issues in committing to nuclear security principles, implementing nuclear security, progress on consolidating nuclear weapons and materials, building confidence in effective nuclear security, and maintaining on-going nuclear security dialogues are addressed.*

James M. Acton, “On the Regulation of Dual-Use Nuclear Technology,” in Elisa D. Harris, ed., *Governance of Dual-Use Technologies: Theory and Practice* (Cambridge, Mass: American Academy of Arts and Sciences, 2016): pp. 8 – 59

<[https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF\\_Dual-Use-Technology.pdf](https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF_Dual-Use-Technology.pdf)>

*In this comprehensive chapter, Acton provides a sweeping view of the landscape that exists at the intersection of nuclear technology, the dual-use problem, and nuclear nonproliferation efforts. Further, by highlighting the inherent difficulties in balancing innovation, security, and nonproliferation in the nuclear context, Acton convincingly argues how dual-use technologies inherently present highly complex challenges that require can only be addressed through an intricate balance of cooperation, regulation, and dialogue.*

## United States Chemical Industry

Martin Alexander, (2000), "Aging, Bioavailability, and Overestimation of Risk from Environmental Pollutants", *Environmental Science and Technology*, Vol. 34, No. 20: pp. 4259- 4265  
<<http://soils.ifas.ufl.edu/lqma/SEED/SWS6262/pdf/Alexander-00.pdf>>

*In this article, Alexander argues that methods utilized for the chemical analysis of soils for determining concentrations of organic pollutants may not be adequately accounting for aging, biodegradation, and bioremediation effects. The result of such methods, therefore, is an overestimation of result, with the subsequent consequence that the perceived risk from toxic chemicals in contaminated states may also be overexaggerated.*

Donna M. Riley, Baruch Fischhoff, Mitchell J. Small, and Paul Fischbeck, (2001), "Evaluating the Effectiveness of Risk-Reduction Strategies for Consumer Chemical Products," *Risk Analysis*, Vol. 21, No. 2: pp. 357 – 369  
<<http://sds.hss.cmu.edu/risk/articles/EffectConsumerChem.pdf>>

*In this study, the authors study the effectiveness of communication of risk within the consumer chemical context. By combining consumer interviews, feedback from users on their beliefs and behaviors, and quantitative exposure modeling, the authors present a framework that evaluates current levels of risk, as well as predicting the effectiveness of proposed voluntary risk-reduction strategies, for consumer chemical products.*

Sarah A. Vogel, (2009), "The Politics of Plastics: The Making and Unmaking of Bisphenol A 'Safety'", *American Journal of Public Health*, Vol. 99, Suppl 3: pp. S559 – S566  
<<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2774166/>>

*In this article, Vogel provides comprehensive research on the mechanisms that are activated when recent scientific findings challenge long-standing scientific and legal presumption. Vogel uses the case study of Bisphenol A (BPA) to show how conflicting scientific information, along with interactions with society and industry, and how mechanisms may exist outside of regulatory framework to create changes in industry.*

Hans Sanderson, Patrik Fauser, Marianne Thomsen, Paula Vanninen, Martin Soderstrom, Yuri Savin, Ildus Khalikov, Anu Hirvonen, Susa Niiranen, Tine Missiaen, Alexander Gress, Pavel Borodin, Nadezda Medvedeva, Yulia Polyak, Vadim Paka, Victor Zhurbas, and Pascal Feller, (2010), "Environmental Hazards of Sea-Dumped Chemical Weapons", *Environmental Science and Technology*, Vol. 44, No. 12: pp. 4389 – 4394  
<[https://www.researchgate.net/profile/Tine\\_Missiaen/publication/44599314\\_Environmental\\_Hazards\\_of\\_Sea-Dumped\\_Chemical\\_Weapons/links/55f13bd708aef559dc46ff69/Environmental-Hazards-of-Sea-Dumped-Chemical-Weapons.pdf](https://www.researchgate.net/profile/Tine_Missiaen/publication/44599314_Environmental_Hazards_of_Sea-Dumped_Chemical_Weapons/links/55f13bd708aef559dc46ff69/Environmental-Hazards-of-Sea-Dumped-Chemical-Weapons.pdf)>

*Historically, Chemical Weapons Agents (CWAs) were disposed of by dumping munitions into various underwater sites such as the Bornholm Basin. Despite laboratory simulations, very little was known about the effects of such munitions in the environment. This article filled the gap in this area by leveraging geophysical surveys and sediment samples to determine the continued presence, impact, and the rate of degradation of CWAs in the environment.*

Jody A. Roberts, “Creating and Controlling Chemical Hazards: A Brief History,” in Philip Wexler, Jan van der Kolk, Asish Mohapatra, and Ravi Agarwal, eds., *Global Collaborations in Managing Chemical and Environmental Risks* (London: CRC Press, 2011): pp. 3 – 14

*In this chapter, Roberts provides an overview of the interactions that exist to co-produce science and society. By displaying the history of chemistry throughout history from a sociological standpoint, Roberts brings out the important point that societal needs have driven the direction of the chemical sciences, and advancements in the chemical sciences have created changes in society; such changes, which recently include social movements (environmental justice movements, environmental health movements) and shifts in the geography of chemical production (moving from Global North to Global South), encourage questions of society, technology, and governance.*

Fernando J. Diaz Lopez and Carlos Montalvo, (2015), “A Comprehensive Review of the Evolving and Cumulative Nature of Eco-Innovation in the Chemical Industry”, *Journal of Cleaner Production*, Vol. 102: pp. 30 – 43

<http://publications.tno.nl/publication/34617039/08WF2B/diazlopez-2015-comprehensive.pdf>

*Building on the Roberts chapter, this article focuses on how the chemical industry can be led to pursue innovations that, at first glance, may not be of benefit to them. Specifically, Lopez and Montalvo focus on the factors that contributed to both environmental change and eco-innovation preference in the chemical industry. These factors, which include the intertwined nature of regulation, innovation, society, and technological change, are highly germane to the discussion at hand.*

### **United States Information Technology**

Jonathan Zittrain, (2006), “The Generative Internet”, *Harvard Law Review*, Vol. 119: pp. 1974 – 2040

[https://dash.harvard.edu/bitstream/handle/1/9385626/Zittrain\\_Generative%20Internet.pdf?sequence=1](https://dash.harvard.edu/bitstream/handle/1/9385626/Zittrain_Generative%20Internet.pdf?sequence=1)

*Since its inception, the internet was designed to serve two primary functions: a means of establishing a logical network, as well as a means of incorporating disparate networks into a singular whole while along those disparate networks to function independently. While these core functions of the internet have enabled growth and innovation in information technology, they have also given rise to regulatory and entrepreneurial backlashes. In this article, Zittrain presents an argument on balancing the generative internet with satisfying genuine and pressing security concerns facing the internet.*

Lauren B. Movius and Nathalie Krup, (2009), “U.S. and EU Privacy Policy: Comparison of Regulatory Approaches”, *International Journal of Communication*, Vol. 3: pp. 169 - 187

<http://ijoc.org/index.php/ijoc/article/viewFile/405/305>

*Despite its global nature, many conflicts arise in Internet governance due to the individual interests of sovereign nations. These individual interests often create different views on the regulation of private information, as well as to whom such information should be available. In this article, Movius and Krup present the different approaches of two major states, the U.S. and the EU, and how these differences arise from contrasting values, social norms, and interests.*

Deirdre K. Mulligan and Fred B. Schneider, (2011), “Doctrine for Cybersecurity”, *Daedalus*, Fall: pp. 70- 92

<http://www.cs.cornell.edu/fbs/publications/publicCybersecDaed.pdf>

*In this article, Mulligan and Schneider present the goals, strengths, and gaps that existed in the conceptualization and implementation of previous doctrines for cybersecurity; these doctrines included the doctrines of prevention, risk management, and deterrence through accountability. By building on public health and economic concepts, Mulligan and Schneider propose a new doctrine, public cybersecurity, to address the diverse array of cybersecurity issues facing us today.*

Martin Hilbert, (2011), “The End Justifies the Definition: The Manifold Outlooks on the Digital Divide and their Practical Usefulness for Policy-Making”, *Telecommunications Policy*, Vol. 35, No. 8: pp. 715 – 736

[http://www.martinhilbert.net/ManifoldDigitalDivide\\_Hilbert\\_AAM.pdf](http://www.martinhilbert.net/ManifoldDigitalDivide_Hilbert_AAM.pdf)

*As emergent technologies develop, questions of access become more and more salient. In the cyber context, these access issues are discussed within the context of the digital divide – an economic and social inequality regarding access to, use of, or impact of information and communication technologies (ICT). In this article, Hilbert presents a conceptual model of the digital divide, built on who uses ICT, the scale of the digital divide (individuals vs. states), how connection via ICT occurs, and what the purpose of the connection; different arrangements of these four variables not only lead to different combinatorial arrays of choices to define the digital divide in a given context, but also potentially provides policymakers with a tool to address issues created by the digital divide.*

Joseph S. Nye , (2014), *The Regime Complex for Managing Global Cyber Activities* (Cambridge, MA: Global Commission on Internet Governance Paper Series, 1)

[https://www.cigionline.org/sites/default/files/gcig\\_paper\\_no1.pdf](https://www.cigionline.org/sites/default/files/gcig_paper_no1.pdf)

*In this paper, Nye applies an international relations perspective to the emerging globalized cyber regime. Specifically, while his paper extends from the history to the modern iteration of cyber structure and regulations, he focuses on the construction of regimes and norms as governance mechanisms to decrease the risks presented by global cyber activities. While future predictions of which direction cyber regimes and norms will go are difficult due to the volatility of the technology, rapid changes in economic and political interests, as well as the changes in society that will occur, Nye correctly notes that state and non-state interests will take a long time to resolve.*

Catherine Crump, (2016), “Surveillance Policy Making By Procurement”, *Washington Law Review*, Vol. 91: pp. 1595 – 1662

<http://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?article=3637&context=facpubs>

*In this article, Crump looks at the intersection of procurement and local surveillance policy making to address the question of how local law enforcement agencies obtain cutting edge, and potentially intrusive, surveillance equipment with minimal interaction with elected local leaders or the general public. By showing the important role that the post-9/11 federal government plays in both supplying surveillance equipment to local authorities while keeping such procurements concealed from both local government and the general public, Crump highlights the complex issues of governance, privacy, and democracy in the information and communication technology context.*

Herbert Lin, “Governance of Information Technology and Cyber Weapons,” in Elisa D. Harris, ed., *Governance of Dual-Use Technologies: Theory and Practice* (Cambridge, Mass: American Academy of Arts and Sciences, 2016): pp. 112 – 157

<[https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF\\_Dual-Use-Technology.pdf](https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF_Dual-Use-Technology.pdf)>

*In this chapter, Lin uses a key characteristic of information technology (IT) to highlight why has such an immense impact on everyone from individuals to states and global industries: IT has been wholly integrated into the fabric of society, economy, and governance. Unfortunately, IT is a dual-use technology that can be used not only for beneficial purposes, but can also be misused for harmful purposes. Noting that these malicious uses of IT, often referred to as cyber weapons, can have effects on integrity, availability, and confidentiality, Lin provides a comprehensive overview of cyber weapons, norms and governance of said weapons, and shows the difficulties in creating an effective cyber weapon governance regime.*

### **United States Biotechnology**

Rob Carlson, *Biology is Technology: The Promise, Peril, and New Business of Engineering Life* (Cambridge: Harvard University Press, 2011)

*In this seminal text on the future of biology, Robert Carlson presents the economic and technological factors that make it possible for the rise of synthetic biology: the application of engineering methods and principles to the biological context. By leveraging case studies and past technological advances, he creates an even-handed approach in highlighting the promise and peril represented by this emerging biotechnological area.*

Jonathan Tucker and Richard Danzig (eds.) *Innovation, Dual-Use, and Security: Managing the Risks of Emerging Biological and Chemical Technologies* (Cambridge: MIT Press, 2012)

*As more advanced technologies continue to emerge and interact with each other, difficulties emerge in addressing the dual-use dilemma: technologies that offer benefits for medicine, health, agriculture, and national economies also pose a risk of being misused for hostile purposes. In this book, Tucker and Danzig provide a complete overview of the dual-use dilemma to formulate a rapid, decision-making framework for assessing the security risks represented by emerging technologies, including synthetic genomics, directed evolution, protein engineering, combinatorial chemistry, and immunological modulation.*

Morgan Meyer, (2013), “Domesticating and Democratizing Science: a Geography of Do-It-Yourself Biology,” *CSI Working Papers Series*, No. 32

<[https://hal.archives-ouvertes.fr/file/index/docid/784685/filename/WP\\_CSI\\_032.pdf](https://hal.archives-ouvertes.fr/file/index/docid/784685/filename/WP_CSI_032.pdf)>

*With the increased availability of inexpensive tools and Internet-accessible techniques, biological engineering and exploration are no longer limited to academia, industry, or the government; the general public now can engage in activities such as popular epidemiology, the production and evaluation of biomedical knowledge, and engaging in field research. In this article, Meyer evaluates the current state of these general public practitioners, collectively known as members of the Do-It-Yourself Biology (DIYBio) movement, including their geographic distribution, their projects, and their ethos and philosophy in how they approach issues of biological research, biological tinkering, and self-governance.*

Helge Torgersen and Markus Schmidt, (2013), “Frames and Comparators: How Might a Debate on Synthetic Biology Evolve?”, *Futures*, Vol. 48: pp. 44-54

<[https://www.researchgate.net/profile/Markus\\_Schmidt8/publication/242334327\\_Frames\\_and\\_comparators\\_How\\_might\\_a\\_debate\\_on\\_synthetic\\_biology\\_evolve/links/00b49525ec899b525c000000/Frames-and-comparators-How-might-a-debate-on-synthetic-biology-evolve.pdf](https://www.researchgate.net/profile/Markus_Schmidt8/publication/242334327_Frames_and_comparators_How_might_a_debate_on_synthetic_biology_evolve/links/00b49525ec899b525c000000/Frames-and-comparators-How-might-a-debate-on-synthetic-biology-evolve.pdf)>

*No debate on any topic begins in a vacuum. Precedents are often built up over time that are often used as frames or comparators to evaluate the benefits and the risks of a debated item. In this article, the authors argue that same holds true for the synthetic biology debate. Specifically, the framing of synthetic biology is done under three frames (biotechnology, nanotechnology, and information technology), each of which then influence the perceptions of the different risks and benefits associated with synthetic biology. Given the important effects of framing in structuring a discussion on synthetic biology, the authors prescribe that upstream engagement exercises carefully consider the frame chosen to initiate the debate of a given technology, as such framing decisions can have long-term impacts on the success or failure of launching emergent high technologies.*

Nancy J. Kelley, David J. Whelan, Ellyn Kerr, Aidan Apel, Robyn Beliveau, and Rachael Scanlon, (2014), “Engineering Biology to Address Global Problems: Synthetic Biology Markets, Needs, and Applications”, *Industrial Biotechnology*, Vol. 10, Issue 3: pp. 140 – 149

<<http://online.liebertpub.com/doi/pdf/10.1089/ind.2014.1515>>

*Synthetic biology not only offers many useful applications to agriculture, medicine, and energy industries, but is also potentially a large economy driver; projected growth estimates for synthetic biology market are \$11.8 by the year 2018. In this report, the authors review the development of synthetic biology from a historical perspective, with specific attention on the regulatory landscape, funding initiatives, and socio-ethical aspects. The authors, while acknowledging that the United States has been a leader in the development and commercialization of synthetic biology, argue that complacency would allow other nations, especially China, to overtake the United States.*

Nicholas G. Evans and Michael J. Selgelid, (2014), “Biosecurity and Open-Source Biology: The Promise and Peril of Distributed Synthetic Biological Technologies,” *Science and Engineering Ethics*, Vol. 21: pp. 1065 – 1083

<<https://link.springer.com/article/10.1007/s11948-014-9591-3>>

*The scientific process is heavily dependent on scientific information being freely available or easily accessible to fellow scientists and interested parties; open science is what maintains scientific rigor through peer-reviewed materials, replication studies, and debates in open forums. However, when the use of science and technology can pose particular dangers, such as those represented by research that have significant dual-use characteristics, scientists have historically accepted restrictions on freedoms or limitations to openness to promote security. This article takes a comprehensive look at the benefits and challenges that are presented through open-source biology (OSB), as well as the unique challenges that OSB represents to issues such as oversight and governance.*



Elisa D. Harris, “Dual-Use Threats: The Case of Biological Technology,” in Elisa D. Harris, ed., *Governance of Dual-Use Technologies: Theory and Practice* (Cambridge, Mass: American Academy of Arts and Sciences, 2016): pp. 60 – 111

<[https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF\\_Dual-Use-Technology.pdf](https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/GNF_Dual-Use-Technology.pdf)>

*The past half century has seen many different governance measures, along with many that were proposed and rejected, to address the issues of biosafety and biosecurity: the prevention of the accidental and deliberate release of biological agents, respectively. Harris’ chapter goes into the inherent difficulties in the governance of biological materials, equipment, and information, provides a detailed overview of the most salient governance measures that have been adopted both domestically and globally, then discusses the key challenges confronting further governance efforts to mitigate dual-use risks in the life sciences.*

Gigi Kwik Gronvall, *Synthetic Biology: Safety, Security, and Promise* (Baltimore: Health Security Press, 2016)

*The future that leverages synthetic biology to the fullest can potentially be a bright future; synthetic biology represents easier biology through technological convergence, enables greater industrialization and personalization of biotechnology and its products, and accelerates the development of consequential research and policy options for public health. However, this future is also fraught with perils, including accidental releases of biological materials, as well as the deliberate misappropriation of biological materials and the deliberate misuse of synthetic biology for biological weapons development. In her timely publication, Gronvall provides a detailed overview of the historic and current states of synthetic biology, the promise and perils that arise with its continued development, and policy prescriptions to balance the issues of safety, security, and innovation in the life sciences.*

### **Overlapping Topics**

David Collingridge, *The Social Control of Technology* (New York: St. Martin’s Press, 1980)

*Emergent technologies suffer from two main dilemmas. Not only do they suffer from an information problem, where lack of information negatively impacts our ability to accurately forecast the impacts of an emerging technology; they also suffer from an entrenchment issue, where a technology that is sufficiently developed and entrenched into society is difficult to roll back or change. In this book, Collingridge argues that the only dilemma that policymakers can successfully practice social control over technology is in addressing the entrenchment issue. By using case studies including lead in petrol, the nuclear arms race and energy futures, the Manhattan Project, and multiple independently targetable reentry vehicles (MIRVs), presents a unique perspective on technological assessment and control that emphasizes the need for technological decisions to be corrigible.*

Jens Rasmussen, (1997), “Risk Management in a Dynamic Society: a Modelling Problem”, *Safety Science*, Vol. 27, No. 2/3: pp. 182-213

<<http://lewebpedagogique.com/audevillemain/files/2014/12/maint-Rasmus-1997.pdf>>

*While systems are often built with safety features designed into them, it is not unusual for accidents to continue to occur. This issue is exacerbated in dynamic societies, where the fast-paced change of society, the steadily increasing scale of industrial installations, and the rapid development of ICT lead to high degrees of coupling and complexity; these are exactly the conditions under which Perrow would note that*

*“normal accidents” occur. In this article, Rasmussen explicates the difficulties that face academics and policymakers in approaching risk management in a constantly-changing environment, and concludes that modeling, and subsequent governance, will continue to be difficult.*

Luke A. Stewart, (2010), “The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review” Information Technology & Innovation Foundation  
<<http://www.itif.org/files/2011-impact-regulation-innovation.pdf>>

*Through a high-level, multi-industry review of the literature, this paper describes how regulation can both stifle and encourage innovation. The impact of regulation on innovation depends largely on the breadth and type of the regulation.*

Gregory D. Koblentz, (2014), “Dual-Use Research as a Wicked Problem”, *Frontiers in Public Health*, Vol. 2, Issue 113: pp. 1 -3  
<[http://www.unog.ch/80256EDD006B8954/\(httpAssets\)/3DE9EE1C906B7874C12580520053D66B/\\$file/Koblentz-Dual-Use+Research+as+a+Wicked+Problem-Frontiers-2014.pdf](http://www.unog.ch/80256EDD006B8954/(httpAssets)/3DE9EE1C906B7874C12580520053D66B/$file/Koblentz-Dual-Use+Research+as+a+Wicked+Problem-Frontiers-2014.pdf)>

*The challenges in addressing issues, as well as the governance, of dual-use issues have often been described as socially complex, consists of large numbers of actors with diverse interests, and deal with multiple, overlapping subsets of problems. Koblentz uses this article to articulate how these characteristics place dual-use research issues firmly within the context of a wicked problem. Koblentz argues that, by viewing dual-use issues as a wicked problem, strategies can be built to manage them based on two factors: how concentrated or diffuse the power is among stake holders, as well as how strongly stakeholders struggle for power amongst themselves.*

Seth D. Baum, (2015), “The Far Future Argument for Confronting Catastrophic Threats to Humanity: Practical Significance and Alternatives”, *Futures*, Vol. 72: pp. 86 – 96  
<[http://sethbaum.com/ac/2015\\_FarFuture.pdf](http://sethbaum.com/ac/2015_FarFuture.pdf)>

*Differences exist in the perception of near-term catastrophic outcomes (such as natural disasters) and far-future catastrophic outcomes (such as climate change). A main difference is that, unlike near-term catastrophes, many people are not motivated to address far future cataclysmic events. In this article, Baum assesses the extent to which practical actions to address far future catastrophic threats require support, and proposes two alternative means to motivate actions.*

Bruce Schneier, (2015), “Resources on Existential Risk”  
<[https://futureoflife.org/data/documents/Existential%20Risk%20Resources%20\(2015-08-24\).pdf](https://futureoflife.org/data/documents/Existential%20Risk%20Resources%20(2015-08-24).pdf)>

*This comprehensive 179-page annotated bibliography for the Catastrophic Risk: Technologies and Policy Study Group that met in Fall 2015 at the Berkman Center for Internet and Society, Harvard University, covers General Scholarly Discussion of Existential Risk; Popular Journalism & Public Speeches; Catastrophic Risk Analysis; Risk Posed by Nuclear Weapons, Synthetic Biology, Cyber, and more.*

*Lawrence Livermore National Laboratory is operated by Lawrence Livermore National Security, LLC, for the U.S. Department of Energy, National Nuclear Security Administration under Contract DE-AC52-07NA27344. LLNL-TR-731277*