TECHNOLOGY WARS: THE FAILURE OF DEMOCRATIC DISCOURSE[†]

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Conflicts over the use and regulation of various technologies pervade public discourse and have dramatic implications for the public interest. Controversies over the regulation of genetically modified products, nuclear power, and nanotechnology, among others, provoke some of the most socially and politically volatile debates of our time. These technology conflicts extract a substantial price from society—they create costly inefficiencies, prevent society from optimally managing new technologies, consume vast resources, and retard technological growth. This Article develops a framework for understanding technology controversies, and consequently proposes new means for resolving or ameliorating a variety of seemingly intractable legal and regulatory standoffs. These teachings have potentially far-reaching consequences for conflict resolution in non-technology areas as well.

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INTRODUCTION

Conflicts over the use and regulation of various technologies pervade public discourse and have dramatic implications for the public interest. Will genetically modified food eradicate hunger, wreak environmental havoc, or both? Will next-generation nuclear power plants provide safe, plentiful, emission-free energy that cures our foreign energy dependence, or invite nuclear catastrophe? Will rapidly advancing nanotechnology revolutionize health-care, the nature of computers, and the structure of materials, or will it lead to as yet uncontemplated new forms of pollution and cancer?

The resolution of these questions will significantly impact human health, the environment, the economy, and society as a whole. Optimal resolution could yield extraordinary societal benefits, but such a result seems unattainable. To deal productively with these vital questions, we must approach them not only with a scientific and social understanding of the relevant technology, but also in the context of a functional democratic discourse about use and regulation of the technology. The former task, though difficult, is achievable. Functional discourse, however, is largely absent from technology debates, and the climate necessary for productive discourse is poisoned.

Biotechnology and nuclear power[1] represent two of the most politically and socially explosive technology controversies, presenting legal and regulatory debates that appear largely unresolvable. One side in the genetically modified products debate argues vehemently that such products will provide spectacular food supply, pharmaceutical, and environmental benefits, and offer no significant causes of concern; the other side argues just as strongly that genetically modified products pose extreme human, environmental, and social risks, and offer no significant benefit to society. One side in the nuclear power debate argues strenuously that nuclear power is a safe, low-pollution energy alternative; the other side argues just as strongly that it is far too dangerous to consider using.

Many other technology conflicts[2] fit this same mold: debates over global warming and climate change, vaccination, energy production at the Arctic National Wildlife Reserve, stem cell research and use, and the application of nanotechnology are some examples. Decades of study

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1.   All discussion of nuclear power in this Article refers to the use of nuclear power for energy/electricity generation, not to the use of nuclear power for military or weapons purposes.

2.   The term "technology conflict," and similar terms used throughout this Article, refer to the social and political debates over how to use or regulate a given technology, not to potentially conflicting technologies.

have done little to ameliorate these conflicts. Impassioned appeals to evidence, research, and reason likewise appear ineffectual.

The persistence of technology conflicts exacts a substantial social price. First, the debates themselves create costly inefficiencies—they foster legal and policy paralysis that prevents implementation of socially and widely beneficial solutions to pressing problems. Second, technology debates consume vast resources–including public and private financial, legal, temporal, and personnel costs–that could more valuably be directed towards other problems. Third, technology conflict retards technological growth, resulting in lost opportunities for human health and environmental protection, economic growth, and improvements in social welfare.

Despite the prominence and costly nature of technology controversies, existing scholarship does not explain or adequately address the teleology of conflicts over technology. A significant body of work has considered institutional decision-making and paralysis generally, sometimes with direct or indirect application to technology controversies.[3] The existing literature, however, has largely ignored the critical role individual members of the public play in these controversies, and the manner in which the controversies are shaped by individual preferences. Individual opinion formation, behavior, psychology, and perception each play a considerable role in creating and perpetuating technology conflict. The battle over biotechnology, for example, depends significantly on individual psychology (is genetic engineering new, or similar to conventional cross-breeding?), perception (will genetically modified crops lead to the industrialization and monopolization of agriculture?), preferences (are family farms more important than inexpensive food?), and behavior (involvement in pro- or anti- biotechnology advocacy). Examining the crucial role of the individual in technology conflict sheds important light on understanding these conflicts, and reveals new opportunities for resolving them.

Any technology controversy solution must recognize that both science and culture strongly influence and generate conflict over technology preferences. The conflation of science and culture in technology debates, however, impairs understanding of the separate role of each and muddies their contours so that the independent impact of each on discourse cannot be clearly recognized. The role of culture blurs the understanding of science, while science blurs the understanding of cul-

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3. There are many models of institutional behavior and decision-making; public choice theory is one prominent example. *See, e.g.*, MAXWELL L. STEARNS, PUBLIC CHOICE AND PUBLIC LAW: READINGS AND COMMENTARY (1997). Other works have analyzed institutional decision-making in specific instances. *See, e.g.,* GRAHAM T. ALLISON & PHILIP ZELIKOW, ESSENCE OF DECISION: EXPLAINING THE CUBAN MISSILE CRISIS (2d ed. 1999).

ture's role. The conflation of science and culture renders technology debates dysfunctional and impedes resolution through democratic discourse. Solving technology conflict requires a distinction between the influences of science and culture so that each can be individually focused on and valued.[4]

Towards these ends, and in an effort to resolve some of the most intractable current legal and regulatory standoffs, this Article attempts to reconceptualize debates over technology by integrating original empirical research and a multi-disciplinary body of scholarship from the fields of law, behavioral economics, psychology, and political science. My goal here is first to create a framework that provides insight into inefficiency and polarization in technology conflict, and into the related democratic and market failures that inhibit resolution of these conflicts, and second to use that framework to provide more productive bases for seeking resolution to technology conflict. Ultimately, I hope to posit a means for transforming technology debates from dysfunctional diatribe into generative discourse. The framework developed in this Article applies to the biotechnology and nuclear power controversies mentioned above, as well as to many other technology conflicts; it does not, however, apply to every technology conflict, as discussed below.

Investigation of the causes and potential cures for technology conflict evolves in three steps: examining the nature of technology conflict, diagnosing the sources of such conflict, and developing solutions based on the diagnosis. The three Parts of this Article correspond to these three steps. Part I examines the characteristics of technology conflict and demonstrates empirically that polarization exists and has very costly consequences. Part II of the Article draws on a wide body of research to develop a framework that provides a descriptive account of the paralysis, polarization, and inefficiency present in technology conflict. Part III of the Article leverages insights from the framework to propose innovative recommendations for resolving technology conflicts. Taken together, the descriptive and prescriptive analyses have potentially far-reaching consequences for improving discourse and resolving conflict, not only concerning various technologies but in application to other polarized legal and political debates as well.

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4. As discussed further, identifying a distinction between science and culture does not indicate that the influences of each are precisely dichotomous. *See, e.g.,* Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 COLUM. L. REV. 1613 (1995) (arguing that scientific issues contain value choices embedded within them); Gregory N. Mandel,, Comment, *Toward a Better Decision-Making Process: Finding the Truth in Policy and Removing False Science*, 15 TEMP. ENVTL. L. & TECH. J. 65 (1996) (discussing the improper use of science as a basis for policy decisions).

I am not concerned with convincing anyone to change his or her beliefs or values concerning any particular technology. Rather, I hope, through the mechanisms suggested here, to enable individuals to recognize the actual preferences underlying their beliefs and the bases for those preferences, and how differing preferences often are mutually achievable, or at least reconcilable, even as individuals continue to disagree. Such achievement can lead to revolutionary resolution of decades-old technology wars.

I. Characteristics of Technology Conflict

The causes of technology conflict cannot be diagnosed without first understanding the various contours of the conflicts and the impact they have on society. For the purpose of investigating these contours and impacts, I focus on case studies of two of the most controversial technologies: genetically modified products and nuclear power.

A. *Interest Group Positions and Public Opinion in Technology Conflicts*

The regulation and use of genetically modified products and of nuclear power to produce energy present particularly socially and politically divisive issues. As noted in the Introduction, the opposing sides in each debate take almost completely contradictory positions. The sides disagree on each technology's benefits, risks, economic influences, human health effects, environmental impacts, social consequences, and a host of other issues. These mutually antagonistic positions create apparently intractable debates over use and regulation of the technologies.

Although the hypothesis that these debates exist and are both polarized[5] and deadlocked[6] appears self-evident, it nevertheless should be examined as it is important to the analysis of the causes of, and potential solutions to, technology conflict. This section provides empirical evidence demonstrating that the hypothesized characterization is well justified. The evidence for the existence of polarization and deadlock is found in the contrasting positions of interest groups and in public opinion surveys.

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5.   "Polarized" as used in this Article refers to opposing parties taking strongly divergent positions. The more every individual's position falls within one of the opposing camps, and few or no individuals take positions between the camps, the more polarized an issue is. In addition, the further apart the camps are, the more polarized they are.

6.   "Deadlock" as used in this Article refers to the maintenance of positions over time; a state in which few individuals alter their views on a given issue.

1. Interest Group Positions

This section presents the results of a survey study of the positions of interest groups involved in the genetically modified product and nuclear power debates.

Genetically modified product interest groups are considered first. To ensure an unbiased interest group dataset, an initial dataset of fifteen groups was taken from an unrelated earlier study on genetically modified foods.[7] Literature and media searches were conducted in order to identify additional interest groups that expressed positions concerning the benefits or risks of genetically modified products. All interest groups based in significant part in the United States that expressed significant opinions concerning transgenic products on a regional or national scope were included.[8] No groups were "weeded out." This resulted in a final dataset of twenty-eight interest groups.

Each of the groups in the dataset was evaluated to identify its positions on specific benefits offered by genetically modified products (e.g., that genetically modified crops will increase crop yields) or specific risks (e.g., that they will create herbicide-resistant "superweeds"). This evaluation was based solely on each group's own literature (primarily from each group's website). As such, it represents each group's self-proclaimed positions. The specific individual benefits and risks were then tallied for each group to provide an internal numerical representation of its level of support versus opposition to genetically modified products. The results are shown in Table 1.[9]

The ratio of risks to total risks-plus-benefits provides a good mechanism for examining the level of an interest group's support or opposition, and thus for examining polarization. These ratios for genetically modified product interest groups are charted in Figure 1.

The results are striking. The vast majority of genetically modified product interest groups (twenty-three of twenty-eight, or 82%) promote the position that genetically modified products are either entirely beneficial (and present no risks) or entirely risky (and provide no benefit). These twenty-three interest groups do not, in general, explicitly state that genetically modified products offer no benefits or pose no risks. However, by providing a wealth of information on the products, but

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7.   CAROL L. SILVA ET AL., MIDWESTERN POLICY SCI. ASS'N, 'BENEFITS FROM BIO-TECHNOLOGY' OR 'RISKS FROM GENETIC MANIPULATION': FRAMING EFFECTS, MENTAL IMAGES AND PREFERENCES FOR GENETICALLY MODIFIED FOODS (2002).

8.   "Significant" here simply contrasts with a group that may make a passing reference to genetically modified products, but does not appear substantially concerned with the issue.

9.   The total number of risks and benefits identified by each group ranged from a low of seven to a high of thirty-three; the median total was 14.5.

identifying either only benefits or risks, the groups implicitly indicate (at a minimum) that the products either are not risky or not beneficial, and thus promote such a conclusion. Only two groups (7%) identify numbers of benefits and risks that are remotely proximate (both present evenly balanced benefits and risks).

TABLE 1
GENETICALLY MODIFIED PRODUCT INTEREST
GROUP POSITIONS

Organization	Risks	Benefits
Alliance for Better Foods	0	10
Alliance for Bio-Integrity	14	0
American Farm Bureau	0	8
Biotechnology Industry Organization	3	30
Campaign to Label GE Foods	16	0
Center for Food Safety	16	0
Center for Science in the Public Interest	10	10
Council for Biotechnology Information	0	22
Council for Responsible Genetics	15	0
CropLife America	0	11
Earth Liberation Front	9	0
Environmental Defense	10	0
Farmers Declaration on GE in Agriculture	12	0
Free the Planet	12	0
Friends of the Earth	13	0
Greenpeace	12	0
Grocery Manufacturers of America	0	12
Hudson Institute	0	16
Mothers for Natural Law	17	0
National Campaign for Sustainable Agriculture	9	0
Natural Resources Defense Council	7	0
Organic Consumers Association	17	0
PEW Initiative on Food and Biotechnology	9	9
Public Citizen	13	0
Say No to GMOs	20	0
Sierra Club	19	1
Union of Concerned Scientists	18	4
U.S. PIRG	17	0

FIGURE 1

GENETICALLY MODIFIED PRODUCT INTEREST GROUP POLARIZATION
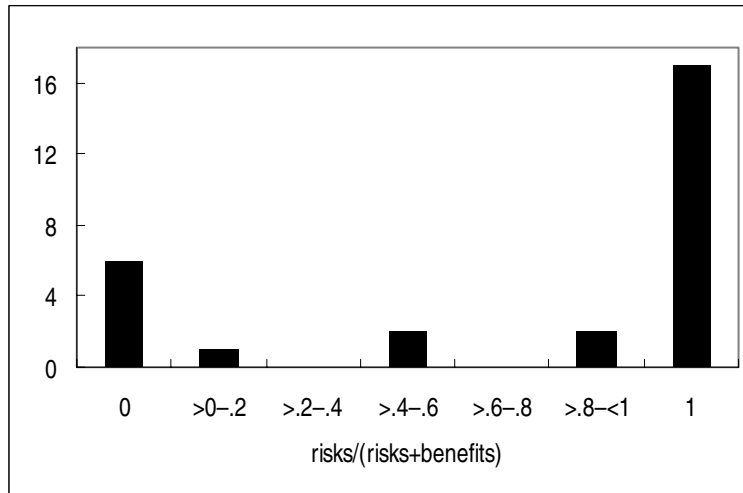
A similar study of the positions of interest groups involved in the nuclear power debate was conducted. Literature and media searches identified thirteen United States interest groups taking national positions on nuclear power issues.[10] Once again, each of the groups in the dataset was evaluated to determine its self-identified positions on specific benefits or specific risks, and these positions were tallied. The results are shown in Table 2.[11] The ratios of risks to total risks-plus-benefits for nuclear power interest groups are charted in Figure 2.

Though not as dramatic as genetically modified products, nuclear power interest group polarization is quite substantial as well.[12] Six of the thirteen groups (46%) promote the position that nuclear power is

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    10.   Local groups advocating only in relation to isolated plants were not included. The Nuclear Energy Agency is an intergovernmental organization based in Paris, in which the United States is a member.
    11.   The total number of risks and benefits identified by each group ranged from a low of three to a high of fourteen; the median was eight.
   12.   Two differences between the sets of interest groups are notable. First, as discussed below, the biotechnology groups appear more polarized than the nuclear power groups. This result was unanticipated, and appears to be converse to the public opinion survey data reported below, *infra* Part I.A.2, which indicate greater polarization among individuals on nuclear power. The results do not necessarily contradict each other: individuals may be more polarized on nuclear power, while interest groups are more polarized on biotechnology. This interpretation points to interesting dynamics worthy of further study. The second notable difference is that there are currently substantially more biotechnology interest groups than nuclear power groups (28 to 13).

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entirely risky;[13] all but one (92%) promote the position that nuclear power is either nearly entirely beneficial or nearly entirely risky. No groups identify numbers of benefits and risks that are relatively close to each other.

In sum, the interest group position analyses provide strong empirical evidence of substantial polarization on issues surrounding genetically modified products and nuclear power.[14]

TABLE 2
NUCLEAR POWER INTEREST GROUP POSITIONS

Organization	Risks	Benefits
American Lung Association	1	3
American Nuclear Society	4	10
Citizens Awareness Network	8	0
Environmental Defense	5	1
Greenpeace	3	0
Nuclear Energy Agency	1	5
Nuclear Energy Institute	1	13
Nuclear Information and Resource Service	11	0
Nuclear Management Company	1	12
Public Citizen	7	0
Sierra Club	3	0
Union of Concerned Scientists	13	0
World Nuclear Association	2	8

13.   As with the genetically modified product groups, these six groups, in general, do not explicitly state that nuclear power offers no benefits, but they implicitly indicate such by their presentation of information. *See supra text discussing Table 1 and Figure 1.*

14.   Although significant, these studies' results should not be over-interpreted. The studies are limited in several respects. First, the number of risks and benefits a group identifies provides only a surrogate (though likely a good one) for the actual level of support or opposition to a technology. Second, different interest groups have different levels of impact on the technology debates, and therefore on the levels of polarization and deadlock. This study, however, treats each group equally, rather than based on their prominence or weight in technology debates. There are possible surrogates for trying to measure these impacts, such as group membership levels or frequency of media references. These surrogates, however, are too weakly linked to offer enough added value in light of the additional uncertainty they would introduce. *See, e.g.,* Ariella Vraneski & Ravit Richter, *What's News? Reflections of Intractable Environmental Conflicts in the News: Some Promises, Many Premises*, 21 CONFLICT RESOL. Q. 239, 250 (2003) (noting that certain stakeholder positions in environmental conflicts receive significantly more coverage than others). For this reason, each group was effectively weighed equally.

FIGURE 2
NUCLEAR POWER INTEREST GROUP POLARIZATION
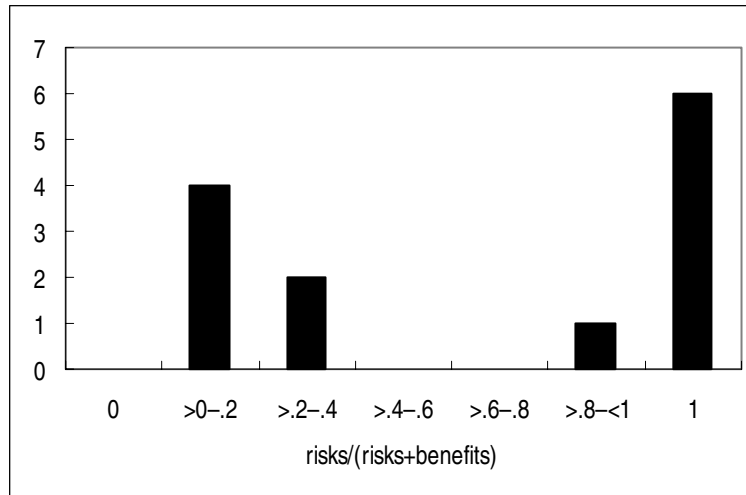
2. Public Attitudes

Surveys of public attitudes toward biotechnology and nuclear power also reveal polarization, though the general public is not as polarized as the interest groups. The Pew Initiative on Food and Biotechnology gathers information on public attitudes towards introducing genetically modified food into the United States food supply. Pew's most recent data, from 2003, show that 31% of respondents "strongly oppose" such an introduction and 13% "strongly favor" it.[15] Thus, close to half the respondents took positions at the extremes of their possible responses. 73% of respondents took oppose or favor positions in general, as opposed to a neutral or moderate position.[16]

These findings are supported by other public survey data, consistently revealing that about three-quarters or more of respondents take non-moderate positions on genetically modified products.[17] This polarization is

15.   Memorandum from The Mellman Group, Inc. & Public Opinion Strategies, Inc., to The Pew Initiative on Food and Biotechnology, *Americans' Knowledge of Genetically Modified Foods Remains Low and Opinions on Safety Still Split* 2 (Sept. 18, 2003), *available at* http://pewagbiotech.org/newsroom/releases/091803.php3 (last visited May 11, 2005).

16.   *Id.* at 2. The terms "polar," "extreme," and "moderate" (and their synonyms) as used throughout this Article are descriptive only; i.e., positions are defined as polar, extreme, or moderate in relation to each other. These terms are not intended to indicate that there is anything wrong or incorrect about taking a polar or extreme position on an issue, or that there is anything right or correct about taking a moderate position.

17.   The most recent National Science Board survey on public attitudes towards genetic engineering found that 40% of respondents believed the benefits of genetic engineering outweighed the harmful results, 33% believed the harms outweighed the benefits, and 28%

significantly greater, for example, than the polarization displayed in surveys asking respondents to rate themselves on a liberal-conservative scale.[18] The surveys also demonstrate a roughly even split between support for and opposition to transgenic products.[19]

Polarization also is revealed by greater divisiveness in public attitudes towards biotechnology than toward other technologies. A survey by Gaskell and Bauer queried respondents about their positions on seven different technologies.[20] Nuclear power was one, and is discussed below. Public attitudes toward the five remaining technologies all were considerably less polarized and more uniform than attitudes towards biotechnology.[21]

Longitudinal National Science Board data demonstrate that public opinion on genetically modified products is deadlocked as well as being polarized. Comparing the most recent survey (from 2001) with the survey from 1995, when the first genetically modified food item was

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believed the benefits and harms were roughly equal. NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS 7–17 (2002), *available at* http://www.nsf.gov/sbe/srs/seind02/start.htm [hereinafter INDICATORS 2002] (results do not add up to 100%, presumably due to rounding) (last visited May 11, 2005). Similar to the Pew results, 73% of respondents took a nonmoderate position. A third public attitude survey, the Gaskell and Bauer survey, found that over 50% of respondents believe genetic engineering would "improve our way of life" in the next 20 years, while over 30% believe it would "make things worse." *Id.* at 7–21. Close to 85% of respondents took a non-moderate position.

18.   John Tierney, *A Nation Divided? Who Says*, N.Y. TIMES, Jun. 13, 2004, (Week in Review), at 1. It is not possible to identify what an expected distribution of opinions is *ex ante*. A normal distribution, for instance, would yield significantly more individuals holding moderate positions than holding polar positions.

19.   The National Science Board data were relatively evenly split between support and opposition, while the Pew data demonstrated greater opposition and the Gaskell and Bauer data greater support. This discrepancy is likely partially due to the wording of the survey questions. The Pew study focused on genetically modified food, as opposed to genetic engineering generally; the latter includes the production of pharmaceutical products and other medical uses, which are generally supported to a greater extent. *See* Paul Slovic, *Perception of Risk: Reflections on the Psychometric Paradigm*, *in* SOCIAL THEORIES OF RISK 117, 127 (Sheldon Krimsky & Dominic Golding eds., 1992) (discussing how the use of technologies for medical purposes is generally supported to a greater extent than uses of the same or similar technologies for non-medical purposes).

20.   INDICATORS 2002, *supra* note 17, at 7–21. The six other technologies were solar energy, computers, telecommunications, nuclear power, space exploration, and the internet. *Id.*

21.   *Id.* at 7–21. The difference between levels of support and opposition to biotechnology was about 20%, and the ratio between these levels approximately 1.5:1. The differences between levels of support and opposition to the other five technologies were much greater, ranging from 50% to about 85%; the ratios between the levels were vastly higher, ranging from 4:1 to over 40:1. *Id.* As noted above, technology conflict does not arise with all technologies. Understanding when it arises is explored in Part II.

commercialized, reveals that public attitudes shifted little, if at all, during these six years.[22]

As with biotechnology, opinions on nuclear power are polarized and deadlocked. The debate over the use of nuclear power for electricity generation has been going on in the United States since the early 1970s.[23] The public survey data reveal that 75% to 85% of respondents take non-moderate positions on nuclear power.[24] The Gaskell and Bauer survey found that attitudes towards nuclear power are more polarized than attitudes towards any of the other technologies studied, including biotechnology.[25]

National Science Board data also demonstrate that public opinion on nuclear power has remained deadlocked. Reports reviewing data on public attitudes towards nuclear power from 1985 to 1999 conclude that Americans "have been evenly divided for more than a decade over the use of nuclear power to generate electricity."[26]

The empirical data on both interest group positions and public opinion demonstrate, as hypothesized, that attitudes towards genetically modified products and nuclear power are polarized and have remained deadlocked.

B. *Inefficient and Costly Technology Conflict*

In addition to being polarized and deadlocked, technology conflict is also costly. Such conflict creates substantial inefficiencies, prevents society from optimally regulating the technologies at issue, consumes

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22. INDICATORS 2002, *supra* note 17, at 7–17. For 1995, 43% believed the benefits outweighed the harms, 35% that the harms outweighed the benefits, and 22% that the benefits and harms were roughly equal. For 1999, the corresponding results were 44%, 38%, and 18%. For 2001, they were 40%, 33%, and 28%. *Id.*

23. MARY DOUGLAS & AARON WILDAVSKY, RISK AND CULTURE: AN ESSAY ON THE SELECTION OF TECHNOLOGICAL AND ENVIRONMENTAL DANGERS 139–51 (1982). Anti-nuclear protests prior to this time were focused on nuclear weapons, not nuclear energy. *Id.* at 139–40.

24. Gaskell and Bauer found that 42% of respondents believe that nuclear power "will improve our way of life" and 33% believe it "will make things worse." INDICATORS 2002, *supra* note 17, at 7–21. The National Science Board found that 48% of respondents believed the benefits of nuclear power outweighed any harms, 37% believed that the harms outweighed any benefits, and 15% believed that the harms and benefits were roughly equal. NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS 8–19 (2000), *available at* http://www.nsf.gov/sbe/srs/seind00/start.htm [hereinafter INDICATORS 2000] (last visited May 11, 2005).

25. INDICATORS 2002, *supra* note 17, at 7–21. Gaskell and Bauer found a nine point differential in support versus opposition and nearly 1:1 ratio between support and opposition, demonstrating greater polarization than any of the other technologies. *See supra* note 21.

26. INDICATORS 2000, *supra* note 25, at 8–19; NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS 7–13 (1998), *available at* http://www.nsf.gov/sbe/srs/seind98/start.htm (last visited May 11, 2005).

substantial resources–including public and private financial, temporal, and personnel costs–that could more valuably be directed towards other problems, and retards technological growth. In short, not only do technology conflicts exist, they matter.

The technology conflicts analyzed in this Article are inefficient because mutually beneficial, social welfare-superior positions almost undoubtedly exist concerning nuclear power and genetically modified products.[27] Nevertheless, these solutions are not achieved.

1. Nuclear Power

There are currently just over one hundred licensed and operating nuclear power plants in the United States.[28] All of these plants were built pursuant to construction permits approved and issued in the 1960s and 1970s.[29] Each plant received an initial forty-year license; many of them are now at the end or nearing the end of their originally licensed lives.[30] Following the initial forty-year term, nuclear plants are eligible to renew their licenses for an additional twenty-year period.[31] Scientists, engineers, and the nuclear power industry contend (and it is not substantially disputed) that better, more efficient, safer plants can now be built than those that are currently in operation.[32] Anti-nuclear activists' chief con-

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27. "Social welfare" is used in this Article in its broad sense to refer to overall well-being (not simply wealth) across all individuals in society. The social welfare-superior positions identified are not necessarily Pareto-superior because, as discussed below, a small group of individuals may be made worse off. Similarly, the positions are not definitively Kaldor-Hicks-superior because it is theoretically possible (though extremely unlikely) that the "winners" could not fully compensate the "losers." The claim made is that, in the positions identified below, there would be so many individuals made significantly better off that it almost undoubtedly results in a net increase in social welfare. The social welfare claim thus has a normative component, which is the basis for the "almost undoubtedly" modifier.

28. U.S. NUCLEAR REG. COMM'N, 16 INFORMATION DIGEST 38 (2003), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/v16/sr1350v16r1.pdf (on file with the MTTLR) (last visited May 11, 2005).

29. *Id.* at 101–14. No new nuclear power plant construction permit has issued since 1978. *Id.* No plant has been built based on an order placed subsequent to 1973. Matthew L. Wald, *7 Companies Band Together in Hopes of Building Nations First New Nuclear Plant in Decades*, N.Y. TIMES, Mar. 31, 2004, at A14.

30. U.S. NUCLEAR REG. COMM'N, *supra* note 28, at 52, 101–14.

31. *Id.* at 52.

32. *See* World Nuclear Ass'n, *Advanced Nuclear Power Reactors* (2005), *at* http://world-nuclear.org/info/printable_information_papers/inf08print.htm; ("[M]any new generation nuclear plants incorporate passive or inherent safety features which require no active controls or operational intervention to avoid accidents in the event of malfunction") (last visited May 11, 2005); Am. Soc'y of Mech. Eng'rs, Nuclear Energy in the United States–Recent Events, Major Trends, *at* http://www.asme.org/cns/ncsnews/nenergy.shtml ("[A]dvanced nuclear power plants contain many features that make them even safer. . . to operate than today's plants") (last visited May 11, 2005). Anti-nuclear activists certainly contend that new plants are not safe, but that new plants are *safer* than old ones is not significantly debated.

cern, on the other hand, is that nuclear power is not safe, primarily because of the risk of a nuclear accident and the production of nuclear waste that remains radioactive well into the future.[33]

A mutually beneficial partial solution to the nuclear power debate would be to replace some of the old nuclear power plants with new ones. I do not claim that this is an ideal solution for any party, or that it is a complete solution to the nuclear power debate, only that it is beneficial for (almost) all parties when compared with the status quo.[34] This solution would benefit nuclear power proponents by allowing the development of some new, more efficient plants. The solution would benefit nuclear power opponents by replacing what are perceived to be the riskiest plants with safer ones.[35] Nuclear power opponents could even be given significant say in deciding which plants to replace. The public at large would be better off as a result of the efficiency and safety improvements. Social welfare would further improve as the resources previously devoted by both sides towards stalemate on this part of the nuclear power issue could be redirected towards more socially beneficial purposes.[36]

Rather than achieving this mutually beneficial and more efficient result, polarization and deadlock has produced a trend of renewing existing, old plant licenses for additional twenty-year terms.[37] Proponents of

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33. *See, e.g.,* Pub. Citizen, *Nuclear Safety and Security, at* www.citizen.org/ cmep/energy_enviro_nuclear/nuclear_power_plants/reactor_safety/ ("U.S. nuclear power plants have a concerning record of violating safety regulations while regulators turn a blind eye") (last visited May 11, 2005); Union of Concerned Scientists, *Clean Energy: Nuclear Safety, at* http://www.ucsusa.org/clean_energy/nuclear_safety/index.cfm (stating that the Three Mile Island accident exemplifies the failure of the nuclear industry and government regulations to ensure safe operations at nuclear plants) (last visited May 11, 2005); Greenpeace, *Nuclear Power: Expensive and Deadly, text available at* http://www.greenpeace.org/ usa/news/nuclear-reactors-are-an-expens ("[T]he federal government and the nuclear corporations have developed the most expensive and dangerous means yet devised to boil water") (last visited May 11, 2005); Nuclear Info. and Resource Serv., *Routine Radioactive Releases from Nuclear Reactors–It Doesn't Take an Accident!, at* http://www.nirs.org/factsheets/ routineradioactivereleases.htm (stating that nuclear reactors' radioactive waste is released into the environment, potentially causing severe health problems) (last visited May 11, 2005).

34. Achieving the proposal would require surpassing a number of practical hurdles, including providing sufficient assurances to all groups, a detailed discussion of which is beyond the scope of this Article.

35. *See supra* note 32 and accompanying text.

36. *See* Gary S. Becker, *A Theory of Competition Among Pressure Groups for Political Influence*, XCVIII Q. J. ECON. 371 (1983) (discussing the economic waste resulting from interest group deadlock).

37. U.S. NUCLEAR REG. COMM'N, *supra* note 28, at 52; *see, e.g.,* Nuclear Energy Institute, *Nuclear Power Plant License Renewal* (Apr. 2003), *at* http://www.nei.org/ doc.asp?catnum=3&catid=286&docid=&format=print ("The [Nuclear Regulatory Commission] has renewed the operating licenses of 14 reactors. It is reviewing license renewal applications for some 16 reactors and expects to receive applications for 25 more by 2006.

nuclear power are able to prevent opponents from requiring the shut-down of existing nuclear reactors, and opponents are able to prevent proponents from obtaining regulatory approval for new reactors. However, each side's polarized focus on opposition strategies prevents recognition of mutually beneficial solutions. Because plant operators can recapture certain years spent in construction and add them to their licenses, old (riskier, less efficient) nuclear plants, built pursuant to decades-old construction plans, may continue to operate into the middle of the twenty-first century, far beyond their originally licensed and planned lives.[38] This outcome is detrimental both to nuclear power proponents and opponents, and to the public at large.

2. Genetically Modified Products

Genetically modified products are regulated in the United States pursuant to an unwieldy hodgepodge of twelve different statutes, many enacted decades prior to the advent of biotechnology.[39] For instance, the primary statutes governing genetically modified crops alone include the Federal Food, Drug, and Cosmetic Act, enacted in 1938;[40] the Federal Insecticide, Fungicide, and Rodenticide Act, enacted in 1947;[41] and the Plant Protection Act, enacted in 2000[42] (but which essentially consolidated the Federal Plant Pest Act, enacted in 1957,[43] and the Federal Plant Quarantine Act, enacted in 1912[44]).[45] The twelve statutes governing genetically modified products are enforced by five different governmental agencies and services.[46] For example, the Food and Drug Administration (FDA) governs genetically modified crops and other food products, ex-

These 55 reactors are more than half the total number operating in the United States. Most of the remaining 48 reactors are expected to receive renewed licenses as well.") (last visited May 11, 2005).

38.   U.S. NUCLEAR REG. COMM'N, *supra* note 28, at 55.

39.   Gregory N. Mandel, *Gaps, Inexperience, Inconsistencies, and Overlaps: Crisis in the Regulation of Genetically Modified Plants and Animals*, 45 WM. & MARY L. REV. 2167, 2228–29 (2004).

40.   21 U.S.C. §§ 301–399 (2000).

41.   7 U.S.C. § 136–136a (2000).

42.   7 U.S.C. §§ 7701–7772 (2000).

43.   7 U.S.C. § 150aa–ii (2000).

44.   *Id.* §§ 151–164, 166–167 (2000).

45.   The other statutes governing genetically modified products include the Federal Meat Inspection Act, 21 U.S.C. §§ 601–691 (2000), the Poultry Products Inspection Act, 21 U.S.C. §§ 451–471 (2000), the Egg Products Inspection Act, 21 U.S.C. §§ 1031–1056 (2000), the Public Health Service Act, 42 U.S.C. §§ 262, 264 (2000), the Animal Quarantine Laws, 21 U.S.C. §§ 101–135 (2000), the Virus, Serums, and Toxins Act, 21 U.S.C. §§ 151–159 (2000), the Animal Welfare Act, 7 U.S.C. §§ 2131–2159 (2000), the Health Research Extension Act, 42 U.S.C. §§ 201–300gg-92 (2000), and (perhaps) the Animal Health Protection Act, 7 U.S.C. §§ 8301–8320 (2000).

46.   Mandel, *supra* note 39, at 2228–29.

cept for transgenic pest-protected plants (which are regulated by the Environmental Protection Agency (EPA)) and genetically modified meat and poultry (which are regulated by the Food Safety Inspection Service), while the Animal and Plant Health Inspection Service also oversees the movement and field-testing of all genetically modified crops.[47]

Unsurprisingly, governing genetically modified products pursuant to twelve statutes implemented by five administrative entities has led to a system with numerous gaps in regulation, duplicative and inconsistent regulation, and agencies acting outside their areas of expertise.[48] Some striking examples of these deficiencies include the EPA's lack of authority over, or involvement in, the regulation of numerous transgenic products that could significantly impact the environment (such as crops other than those that are pest-protected and all transgenic fish and other transgenic animals); agencies using differing definitions of "genetically modified product" to trigger regulation and imposing differing levels of scientific review; and agencies reaching different conclusions regarding the risk posed by the same genetically modified product.[49]

Improvements in the structure of biotechnology regulation could benefit biotechnology proponents directly by making regulatory review more efficient and consistent, and indirectly by increasing consumer confidence in genetically modified product safety (for instance, by harmonizing levels of scientific review and conclusions regarding risk). Improvements would benefit biotechnology opponents by closing regulatory gaps, targeting regulation at significant concerns, and eliminating the problem of regulators acting outside their areas of expertise, all of which would reduce risks to human health and the environment. The public at large would benefit from the efficiency improvements and risk reductions, and from the redirection of resources from stalemate to more socially beneficial purposes. In addition, as the existence of deadlock limits technological investment, research, and development,[50] resolution of this conflict would also improve welfare by allowing greater technological advance.

As with the nuclear power proposal, I do not claim that this is an ideal solution for any party, only that it is at least beneficial to (almost) all parties. Just as with the proposed nuclear power solution, however,

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47.   *Id.* at 2218–29.

48.   *Id.* at 2230–42.

49.   *Id.*

50.   *See, e.g.*, Andrew Pollack, *Monsanto Shelves Plan for Modified Wheat*, N.Y. TIMES, May 11, 2004, at C1 (discussing Monsanto's decision to halt efforts to introduce genetically engineered herbicide-resistant wheat, and other genetically modified products, due to farmer concerns about selling the product).

polarization and deadlock preclude the proposed mutually beneficial, welfare-superior results from being achieved. Polarization and deadlock lead each group to focus on opposition and preventing the other side from achieving its goals, rather than searching for and pursuing mutually beneficial outcomes.

The preceding discussion made the strong claim that more efficient, social welfare-superior positions are available in the biotechnology and nuclear power debates but are not achieved.[51] Even if the suggested solutions here would not fully be effective, what is most disturbing is the fact that the potentially social welfare-improving solutions are not even seriously propounded or discussed. The earlier interest group analysis[52] and other studies[53] reveal that mutually beneficial solutions to conflicts receive minimal attention from interest groups, the media, and the public. Technology conflict itself appears to create a viscous cycle of policy paralysis that erodes avenues of democratic discourse, precluding efficient and beneficial solutions to the conflict from even being considered.[54]

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51. Just because a "compromise" or "moderate" solution to technology conflicts is more efficient does not demonstrate that such a position is "correct," or that polar or extreme positions are "wrong," but rather that social welfare can be improved by implementing these partial solutions, while allowing the right/wrong debate to continue on remaining portions of the debate. *See also supra*, note 54.

52. Supra Part I.A.1. Of the forty-plus biotechnology and nuclear power interest groups identified, no more than three even note compromise solutions; all three are in the area of biotechnology. The Center for Science in the Public Interest, the Union of Concerned Scientists, and the Pew Initiative on Food and Biotechnology take positions arguing for better regulation of genetically modified products. None of these groups, however, focus on improving regulations from an efficiency perspective to improve social welfare. *See* Union of Concerned Scientists, *Food and Environment*, *available at* http://www.ucsusa.org/food_and_environment/index.cfm (stating that the group's current priorities include convincing the federal government to strengthen safety regulations for genetically modified foods) (last visited May 11, 2005); Michael R. Taylor & Jody S. Tick, *Pew Initiative on Food and Biotechnology, Post Market Oversight of Biotech Foods: Is the System Prepared* (April 2003), *available at* http://pewagbiotech.org/research/postmarket/PostMarketExecSum.pdf (discussing the inadequacies of the federal regulatory system in properly accessing risks of "postmarket" genetically modified crops) (last visited May 11, 2005); Center for Science in the Public Interest, *Biotechnology Project*, *at* http://www.cspinet.org/biotech/ (stating that keeping the public informed and ensuring that the U.S. regulatory system is up to the task of preventing significant risk are some of the Center's goals) (last visited May 11, 2005).

53. Vraneski & Richter, *supra* note 14, at 252, 255 (analyzing multiple environmental conflicts in Israel).

54. That a middle-ground solution to these debates would improve social welfare does not indicate that a middle-ground solution is preferable for all polarized conflicts. In certain conflicts, one of the polar positions may be preferable or "right." In the biotechnology and nuclear power contexts, however, the preceding discussion reveals that mutually beneficial, more efficient solutions are available, rendering the proposed middle-ground solutions at least worthy of very serious consideration.

3. Conflict Entrepreneurs and Hardliners

The efficiency analysis above may be critiqued by traditional economic theorists on the basis that some individuals might be made worse off under the proposed solutions. Theoretically, such individuals primarily are those who have a particularized interest in the continuation of the technology controversies themselves, as opposed to individuals who are genuinely concerned about efficiency, health, environmental, or safety issues. Individuals with particularized interests could include various types of professional consultants or lobbyists who receive remuneration for advocacy, or individuals in interest group leadership positions who are concerned that their group may lose support or importance if a significant part of the debate is resolved.[55] Individuals falling within these categories can be termed "conflict entrepreneurs"[56]–they benefit from the existence of the conflict per se, and therefore may try to perpetuate it. As conflict entrepreneurs likely exist, one must evaluate whether it is legitimate to press for a solution that may not be in their best short-term individualized interest. The following discussion confirms that it is both equitable and efficient to do so.

Arguments that it is equitable flow from both liberalist and communitarian/republican conceptions. A classic liberal perspective is that of a social contract among private individuals, pursuant to which the principles and rules governing society are those reasonable participants would accept and abide by.[57] Under such a conception, individuals would be expected to conclude that conflict entrepreneurs should not be permitted to maintain a conflict for their individualized interest, unless it is necessary to protect basic liberties or is to the benefit of the least-advantaged members of society.[58] Maintaining these conflicts cannot be said to be necessary to protect any basic liberties, and it cannot reasonably be suggested that the types of conflict entrepreneurs identified are among the least-advantaged members of society. Communitarian and republican concepts of justice, on the other hand, emphasize the protection of the community and communal good. Common social goals should be

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55.   *See* Mariano-Florentino Cuellar, *Rethinking Regulatory Democracy*, 57 ADMIN. L. REV. (forthcoming 2005) (noting that "Leaders of interest groups are always likely to have subtly different agendas from those of their members"). That some such individuals may exist does not mean that all, or even most, consultants, lobbyists, or interest group leaders actually would prefer to continue the existing debate.

56.   *See* Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1509, 1519 (1998) (discussing the concept of entrepreneur roles in other contexts).

57.   *See* JOHN RAWLS, JUSTICE AS FAIRNESS: A RESTATEMENT 5–7, 95–96 (2001) (identifying this perspective of justice).

58.   *See id.* at 42–43 (stating the principles of justice under a social cooperation conception of justice).

elevated over individual private interests.[59] Under these conceptions, conflict entrepreneurs should not be allowed to perpetuate a conflict in their individualized interest to the detriment of the communal good.

These equitable conclusions are supported by efficiency analysis. Though the existence of conflict entrepreneurs indicates that the technology conflict solutions proposed are not Pareto-superior to existing polarization and deadlock, and may not definitively be Kaldor-Hicks-superior,[60] it still is safe to assume that conflict entrepreneurs are *de minimis* in number in relation to the great number of individuals who would benefit from the solutions. Similarly, on the face of it and assuming the benefits to be derived from solution, the role of conflict entrepreneur is likely internally social welfare inefficient–conflict entrepreneurs can be expected to decrease social welfare through perpetuating conflict to a greater extent than they increase social welfare by individually benefiting from the conflict. For these reasons, the normative claim that the proposed technology debate solutions are social welfare-superior is strongly defensible.

Another category of individuals possibly made worse off by the proposed solutions can be referred to as "hardliners." Hardliners are individuals who do not have a particularized interest in the perpetuation of the conflict, but who either (1) have developed such animosity toward the other side they may disfavor a solution which is beneficial to all in order to punish the other side, or (2) would support some solution based on preference in the abstract, but oppose it out of concern that it may make further undesirable changes more likely. Unlike conflict entrepreneurs, the former type of hardliners may be educated about their concerns to understand that animosity may not be a sufficient reason to deny an otherwise beneficial solution. Animosity is better understood as a cognitive barrier to an efficient solution, rather than as causing a potential reduction in social welfare.

The latter type of hardliner opposes compromise solutions due to slippery slope concerns. A nuclear power opponent, for example, may support replacing existing plants in the first instance, but be concerned that if the replacement plants are successful, they may lead to additional new plants. The validity of slippery slope concerns depend on the extent to which the initial compromise increases the likelihood that further, otherwise less likely, outcomes will occur.

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59.   PETER H. SCHUCK, DIVERSITY IN AMERICA: KEEPING GOVERNMENT AT A SAFE DISTANCE 63 (2003); DANIEL A. FARBER & PHILIP P. FRICKEY, LAW AND PUBLIC CHOICE: A CRITICAL INTRODUCTION 44 (1991).

60.   *See supra* note 27.

Eugene Volokh has created a typology to categorize the five manners in which slippery slope changes can occur.[61] The following analysis of these slippery slope possibilities demonstrates that such concerns are not significantly warranted for the technology conflicts discussed here.

The solutions proposed would not significantly lower the costs of potential further changes. Some regulatory change, for example, will not lower the cost of additional change. One exception may be that producing replacement nuclear power plants could move along a learning curve that would reduce the unit cost of additional new plants. Opposition to nuclear power, however, is based primarily on risk and waste handling concerns, not plant cost, so that even if this effect occurs it would not be expected to lead down a slippery slope.

Because public attitudes already are strongly set concerning biotechnology and nuclear power, it is unlikely that the proposed compromises would lead to significant shifts in public opinion. Attitude-altering slippery slopes are primarily a concern where most people do not already feel strongly about an issue.[62] Similarly, as the technology issues discussed here already are high-profile, small, unnoticed change slippery slopes are unlikely.[63] As the compromise solutions identified above involve both sides winning something and giving something up, they are not the type of change likely to lead to a change in political momentum.[64] Relatedly, because the solutions are unlikely to significantly alter the financial or lobbying strength of either side, there is not a significant political power concern.[65]

The characteristics of the biotechnology and nuclear power debates make it unlikely that material slippery slope effects would result from achieving partial solutions to the conflicts. For these and the other reasons discussed above, hardliner concerns should be soluble.

C. *Conundrums in Technology Conflict*

Beyond their inefficiency and other social costs, technology conflicts reveal three conundrums related to scientific information processing: increases in scientific knowledge do not lead to greater

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    61.   Eugene Volokh, *The Mechanisms of the Slippery Slope*, 116 HARV. L. REV. 1026 (2003). The five types of slippery slopes are initial changes that could: (1) lower the cost of further changes, (2) alter public attitude towards further changes, (3) proceed unnoticed if small, (4) shift political power, or (5) shift political momentum. *Id.* at 1130.

    62.   *Id.* at 1081.

    63.   Small, unnoticed change slippery slopes tend to occur where only one side feels intensely about an issue or where parties do not want to appear extremist. *Id.* at 1109–11. Neither of these elements are representative of the technology conflicts discussed here.

    64.   *Id.* at 1131–312.

    65.   *See id.* at 1114–20 (discussing how political power may shift due to an initial change).

agreement on how to handle the technologies; individuals hold strong convictions concerning issues they may not logically comprehend; and interest groups ostensibly base their advocacy on science while taking scientifically indefensible positions. Considering these conundrums sheds light on the causes and cures of technology conflict.

Most technology conflicts (including those over biotechnology and nuclear power) contain at least some issues on which scientific information is pertinent. Science, for instance, may be able to provide information concerning how much genetically modified crops will increase yields or how long certain nuclear waste will remain dangerously radioactive. These scientific issues, generally empirical-based, contrast with normative issues, such as whether it is morally acceptable to genetically engineer a living organism, which cannot be informed by scientific information in a significant manner.[66]

As scientific knowledge about a technology grows, there should be greater agreement among individuals regarding how to use and regulate that technology, or at least about the consequences of use and regulation. This does not mean that positions will become uniform–some uncertainty will often remain and individuals may still disagree about various normative aspects of the technology. Increasing scientific knowledge, however, should lead to reduced divergence of opinion.[67] This conclusion should follow to the extent that scientific information plays any role in technology preferences for a significant number of in-

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66. A primary distinction between scientific knowledge and normative concerns is that scientific theories are falsifiable. KARL POPPER, THE LOGIC OF SCIENTIFIC DISCOVERY 17–20 (Routledge Classics 1935/2002). This Article, as a premise, rejects the absolute relativist (solipsistic) position that there is no such thing as scientific truth. This premise is consistent with the law's treatment of science. *See, e.g.*, Daubert v. Merrell Dow Pharm., Inc., 509 U.S. 579 (1993) (treating scientific evidence as objective).

67. There is at least one important presumption in, and two potential exceptions to, this statement. The presumption is that the new scientific information be based on scientifically generally accepted research (i.e., not biased or poor studies). I use phrasing like "increased scientific knowledge" to indicate that this presumption is met. The first exception to this rule is that it is possible that new scientific knowledge may debunk a previously held common position, without demonstrating a replacement understanding on the same issue. As a result, society could logically move from a position of agreement to one of disagreement because it is no longer illogical to contest the now-debunked position. Though this scenario undoubtedly occurs, it is relatively rare, and does not appear to represent the situation with respect to the technologies discussed here. A second exception to this rule is that new contradictory research findings could represent an increase in scientific knowledge that would not be expected to increase public consensus. Though at first blush this may appear at least partially to represent the situation with biotechnology or nuclear power, in both cases, scientific consensus on risks and benefits has increased significantly over time. *See, e.g.*, Mandel, *supra* note 39, at 2179–2202 (discussing and reporting on scientific understanding of the benefits and risks of genetically modified products). I am grateful to Peter H. Schuck and Michael Saks for raising the points discussed in this footnote.

dividuals. As uncertainties about a technology's impact decrease, public opinion concerning that technology should tend to converge.

The ongoing debates concerning genetically modified products and nuclear power defy this analysis; they demonstrate that the anticipated pattern of increasing agreement does not hold. Despite a substantial growth in scientific knowledge and consensus about each of these technologies over a period of decades, public opinion concerning how to use and regulate them has not shown a tendency to coalesce around a particular solution (witness the deadlocked nature of public opinion discussed above).[68] This intractability, in the face of increasing scientific consensus, indicates that scientific knowledge does not play a decisive role in individual preference formation for these technology areas.[69] Other empirical data support this conclusion: a study of individuals' opinions concerning the risks and benefits of twenty-five different technologies concluded that, "Overall, the conclusion is compelling that self-rated knowledge and perceptual accuracy have a minimal relationship with risk perception."[70] In other words, individuals' actual knowledge about technological benefits and risks did not correlate with their reported perceptions of a given technology's risks and benefits.[71] These findings present one conundrum–increasing scientific consensus about a technology does not necessarily increase public consensus about the technology.[72]

Further confounding the technology debate analysis is the remarkable strength of individual conviction regarding support for or opposition to many technologies. The literature on the safety (or lack thereof) and beneficial tradeoffs (or lack thereof) of nuclear power is vast and complex. The equivalent literature on genetically modified products is similar. Few individuals possess the time, training, or education necessary to independently review this information and rationally evaluate for themselves whether either of these technologies is net beneficial or net detrimental; such evaluation is far beyond most individuals'

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68.   *See supra* Part I.A.2.

69.   Scientific knowledge sometimes can play a decisive role, as discussed below. *See infra* Part II.A.2.

70.   Aaron Wildavsky & Karl Dake, *Theories of Risk Perception: Who Fears What and Why?*, 119 DAEDALUS Fall 1990 at 41, 49 (italics omitted); *see also* Susanna Horning Priest et al., *The "Trust Gap" Hypothesis: Predicting Support for Biotechnology Across National Cultures as a Function of Trust in Actors*, 23 RISK ANALYSIS 751, 757 (2003) (reporting that differences in scientific education and knowledge are only weakly correlated to positions on genetic engineering).

71.   Wildavsky & Dake, *supra* note 70, at 48–49, 52.

72.   The failure of scientific consensus about a technology to increase public consensus about the technology is not universal. In certain circumstances, scientific consensus does lead to public consensus. *See infra* text accompanying notes 132–139.

capacities.[73] Despite this apparent limitation, the vast majority of the public has significant positions on these subjects. Empirical survey results consistently demonstrate that about three-quarters of respondents or more either support or oppose each technology (as opposed to being uncertain about it or holding a middle-ground position).[74] The number of individuals holding strong views may be even greater because certain individuals in the moderate position have strong views, as opposed to ambivalent or uncertain ones. Such strong convictions pose a second conundrum–individuals routinely form strong opinions without the cognitive ability to have processed the information expected to form their basis.[75]

A third conundrum is revealed by a facial analysis of interest group positions. Twenty-nine of the forty-one genetically modified product and nuclear power interest groups (71%) promote the position that the relevant technology offers either only benefits or only risks.[76] Framed another way, these groups implicitly contend that the technologies offer either no benefit or no risk. These positions are scientifically indefensible. Without getting drawn into the technology debates, it is worth noting that the following facts are not seriously debated:

- Certain genetically modified crops in the United States have increased crop yields, reduced grower production costs, and reduced pesticide use.[77]

- Allergenic proteins have been transferred by genetic engineering between organisms; gene-flow between transgenic crops and conventional plants has occurred.[78]

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73.   Consider a common response to indicate that a certain problem is *not* difficult: "It's not nuclear physics."

74.   *See supra* Part I.A.2.

75.   This second scientific conundrum bears a relationship to the first one identified: that individuals cannot process complex technology information relates to why increases in scientific knowledge do not increase consensus. This relationship is discussed further. *See infra* Part II.

76.   *See supra* Part I.A.1.

77.   LEONARD P. GIANESSI ET AL., PLANT BIOTECHNOLOGY: CURRENT AND POTENTIAL IMPACT FOR IMPROVING PEST MANAGEMENT IN U.S. AGRICULTURE 40, 55 (2002), *available at* http://www.ncfap.org/40CaseStudies.htm (last visited May 11, 2005). For a broad discussion of benefits and potential benefits offered by genetically modified products, see generally Mandel, *supra* note 39, at 2179–90.

78.   ROYAL SOC'Y OF CAN., ELEMENTS OF PRECAUTION: RECOMMENDATIONS FOR THE REGULATION OF FOOD BIOTECHNOLOGY IN CANADA 55 (2001), *available at* http://www.rsc.ca/files/publications/expert_panels/foodbiotechnology/GMexsummaryEN.pdf (last visited May 11, 2005); NAT'L RESEARCH COUNCIL, ENVIRONMENTAL EFFECTS OF TRANSGENIC PLANTS 67 (2002), *available at* http://www.nap.edu/books/0309082633/html/ (last visited May 11, 2005); NAT'L RESEARCH COUNCIL, GENETICALLY MODIFIED PEST-PROTECTED PLANTS: SCIENCE AND REGULATION 84 (2000), *available at* http://www.nap.edu/

- Nuclear power is the only major energy source in the United States that is emission-free and available for significant expansion.[79]

- The partial meltdown of a nuclear reactor core at Three Mile Island led to substantial remediation costs and to ongoing human health concerns; nuclear reactor waste remains highly toxic for tens of thousands of years.[80]

In short, there is scientific consensus that genetically modified products and nuclear power each offer certain benefits and pose certain risks. What the full extent of the benefits and risks are, and how to balance them, may be hotly contested. The position that either of the technologies offers no benefits or no risks, however, is scientifically unsupportable.

Despite the majority of technology interest groups espousing positions that are scientifically indefensible, these same interest groups ostensibly base their claims for or against a technology substantially on scientific contentions.[81] Interest groups simultaneously promote science

books/0309069300/html/ (last visited May 11, 2005). For a broad discussion of the risks and potential risks presented by genetically modified products, *see generally* Mandel, *supra* note 39, at 2190–2202.

79.   ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, IMPACT OF U.S. NUCLEAR GENERATION ON GREENHOUSE GAS EMISSION 4 (2001), *available at* http://tonto.eia.doe.gov/FTPROOT/nuclear/ghg.pdf (last visited May 11, 2005). Nuclear energy generates 20% of the United States' electricity. U.S. NUCLEAR REG. COMM'N, *supra* note 28, at 21. Hydroelectric power is the next largest emission-free source, generating 7%; opportunities for significantly expanding hydroelectric power generation are substantially limited. *Id.*

80.   WILLIAM M. EVAN & MARK MANION, MINDING THE MACHINES: PREVENTING TECHNOLOGICAL DISASTERS 269–78 (2002); Nuclear Info. and Resource Serv., *supra* note 33.

81.   *See*, *e.g.*, Alliance for Bio-Integrity, *Why Concerns about Health Risks of Genetically Engineered Food are Scientifically Justified*, *at* http://www.bio-integrity.org/heatlth-risks/health-risks-ge-foods.html (last visited May 11, 2005) (identifying only biotechnology risks yet making scientific claims against biotechnology: "foreign gene[s] produce a substance . . . in an essentially unregulated manner that is uncoordinated with the needs and natural functions of the organism"); Citizens Awareness Network, *Potassium Iodide*, *at* http://www.nukebusters.org/radioactivist/detail?rad_id=5 (identifying only nuclear energy risks yet making scientific claims against nuclear energy: "infants and children are most vulnerable to radioactive iodine," and "at 10 miles, 70% of exposed adults and 100% of exposed children are likely to experience thyroid damage") (last visited May 11, 2005); Council for Biotechnology Information, *Biotech Crops Raise U.S. Grower Incomes, Promote Environmentally Friendly Farming*, *at* http://www.whybiotech.com/index.asp?id=4718 (last visited May 11, 2005) (identifying almost no biotechnology risks yet making scientific claims supporting biotechnology: "genetically engineered [crops] increased grower incomes by an additional $1.9 billion, boosted crop yields by 5.3 billion pounds and reduced pesticide use by 46.4 million pounds in 2003"); World Nuclear Assoc., *Energy for the World–Why Uranium?*, *at* http://www.world-nuclear.org/education/whyu.htm (identifying almost no nuclear power risks yet making scientific claims supporting nuclear power: "the small quantity [of hazardous spent fuel taken from a reactor] makes the task readily manageable") (last visited May 11, 2005).

as an appropriate basis for decision-making concerning technology, yet ignore scientific consensus concerning technology.[82]

The above discussion reveals, in short, that individuals and interest groups do not revise their technology preferences in response to scientific and empirical information in the manner such information appears to indicate. Non-scientific factors must play at least some role in driving technology conflict. This understanding is revealed in the technology context due to a difference between technology conflicts such as those analyzed in this Article and other conflicts generally. Debates about technology often can be informed by empirical scientific information about the technology, for instance about its risks and benefits. In "more normative" debates, science often cannot provide significant information that would be expected to drive the debate.[83] It is necessary, therefore, to use the peculiar nature of technology conflict, as opposed to more general conflict resolution principles, to diagnose the sources of the conflict.

II. A Framework of Technology Conflict

Diagnosing the sources of technology conflict requires a multi-disciplinary approach. The approach provided here weaves together a variety of influences to form a four-part framework for understanding technology conflict. This framework is first summarized below, followed by a detailed analysis of each of its components.

The framework begins with how individuals form their initial opinions or preferences concerning a technology. Where there is inceptive scientific uncertainty concerning the benefits or risks of a new technology,[84] as with both genetically modified products and nuclear power (and many other technologies), initial positions about the technology are formed based on individuals' social and cultural worldviews. Individuals develop their positions based on what the technology means to them socially and culturally, and how they believe it will impact society, in light of their view of the ideal society.

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    82.   That the interest groups are acting in a scientifically irrational manner does not demonstrate that they are acting irrational per se. Rather, the interest groups may be motivated by various strategic or financial preferences to take positions that are scientifically irrational. *See infra*, Part II.B.
    83.   *See supra* note 60.
    84.   Scientific uncertainty is routinely present in technology conflicts, in part because such uncertainty often occurs in at least three broad levels in the technology context: uncertainty about the scientific facts surrounding the technology, uncertainty about what the facts indicate in terms of risks and benefits, and uncertainty about how to respond to those risks and benefits.

If scientific uncertainty concerning the risks and benefits of the technology remains for a period, then these initial positions become both polarized and deadlocked as a result of a variety of well-documented behavioral, psychological, and social phenomena. Certain of these phenomena tend to move individuals initially having only mildly held preferences to more polarized positions. Thus, individuals move from more moderate to more extreme positions. Other phenomena tend to make individuals significantly more steadfast in their views, increasing the deadlocked nature of the conflict.

Interest group advocacy also plays a significant role in technology conflict. Technology conflict often involves various interest groups engaged in a virulent battle over the technology, a battle that itself compromises the conflict-solving value of scientific knowledge for the technology debate. A central part of this battle includes publicized reliance on one's own science and experts, and attacks on opposing science and experts. The only consistent argument made by all sides is that certain science is not credible. This uniform argument causes a destabilization of public confidence in science as a discipline because science is no longer viewed as being objective. Individuals come to believe that science cannot be trusted, foreclosing a potentially promising avenue for resolving aspects of technology debates.

The last major component of the framework is that a variety of behavioral, psychological, and social phenomena combine to dissuade individuals, or groups of individuals, from actively advocating moderate or compromise solutions to technology conflict. This occurs both because certain phenomena substantially reduce the number of individuals holding moderate views and because other factors deter remaining moderates or other individuals from promoting compromise solutions. This void precludes compromise solutions from receiving full airing or consideration.

The four major elements of the technology conflict framework are thus: preference formation based on socio-cultural worldviews, the impact of behavioral and psychological phenomena, the destabilization of science, and the lack of moderate or compromise advocacy. The outcome of the interaction of these elements is a technology imbroglio that is inefficiently and unnecessarily paralyzed and polarized. This result precludes resolution of technology debates through the standard avenue of discourse favored in a democracy, and consequently precludes the optimal use and regulation of technology.

The integration of these four elements into a single descriptive framework provides a more powerful explanatory model for understanding technology conflict than prior theories. This framework provides

explanations for the various characteristics, conundrums, and inefficiency identified in Part I, as well as for additional conundrums identified below. The framework, however, cannot be applied universally to all technology conflict—a certain level of scientific uncertainty, such as exists in the biotechnology and nuclear power debates, is a prerequisite to its application.

The remainder of this Part examines empirical research that supports each of the four elements, analyzes how each element fits into the framework, and investigates how the genetically modified product and nuclear power debates are mapped by the framework. This reconceptualization of technology conflict yields insights into the conflicts themselves, and, perhaps most importantly, points towards novel solutions for trying to resolve these and other seemingly intractable legal and regulatory debates, including debates outside of the technology arena.

A. *Socio-Cultural Risk Preference Formation*

The first element of the framework concerns how individuals develop preferences concerning new technologies. As detailed below, a wealth of empirical data demonstrate that individual technology preferences are not based solely on scientific or actual benefits and risks. Rather, preferences are influenced significantly by individuals' cultural, societal, and political beliefs and concerns.

1. The Cultural Theory of Risk Preference

Anthropologist Mary Douglas and political scientist Aaron Wildavsky established one of the early frameworks for understanding social and cultural risk preference.[85] They theorize that individual risk preferences are based on cultural beliefs and values concerning what a given technology is perceived to mean, whether what it means is acceptable, and how it is expected to impact society.[86] Risk preference is functional–technologies are supported if they are anticipated to instill the cultural values and way of life that an individual desires, and weaken the values and ways of life that are disliked.[87]

Pursuant to Douglas and Wildavsky's work, individual cultural variation concerning risk preference is assessed along two dimensions: how strongly individuals should be bound by group membership and decisions, and the desired amount of and variety of prescriptions on in-

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85.   *See generally* DOUGLAS & WILDAVSKY, *supra* note 23.
86.   *Id.* at 8–10.
87.   Karl Dake, *Orienting Dispositions in the Perception of Risk: An Analysis of Contemporary Worldviews and Cultural Biases*, 22 J. CROSS-CULTURAL PSYCHOL. 61, 65 (1991).

dividual action and behavior.[88] These two dimensions define four quad-rants, each of which represents a different cultural worldview: hierarchist, egalitarian, individualist, and solidarist (see Figure 3).[89]

FIGURE 3
CULTURAL THEORY OF RISK PREFERENCE WORLDVIEWS[90]

Numberous & Varied	Solidarist	Hierarchist
Few & Similar	Individualist	Egalitarian
	Weak	Strong

Prescriptions (vertical axis label)

Strength of Group Boundaries

Hierarchists support traditional and institutionalized authority, and will support technology where it is backed by expert or official author-ity.[91] They are most concerned with risks related to social deviance or upsetting the social order, not with technological or environmental risk.[92] Egalitarians reject social stratification, favoring a culture of voluntary association and collective action. Egalitarians will oppose technology and technological risk where it is perceived to impose human health or environmental risks without volition, or where it may have a disparate impact based on an individual's wealth, status, or power.[93] Individualists

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88.   Aaron Wildavsky, *Choosing Preferences by Constructing Institutions: A Cultural Theory of Preference Formation*, 81 AM. POL. SCI. REV. 3, 6 (1987).

89.   Cultural theory also delineates a fifth cultural worldview, hermit. Because hermits have effectively removed themselves from society and social relations, this worldview has been little discussed in the cultural theory literature and is not relevant to the analysis here. *See*, *e.g.*, Ellen Peters & Paul Slovic, *The Role of Affect and Worldviews as Orienting Dispo-sitions in the Perception and Acceptance of Nuclear Power*, 26 J. APPLIED SOC. PSYCHOL. 1427, 1430 (1996) (identifying a hermit as asocial, and not further considering it in their study).

90.   Adapted from Wildavsky, *supra* note 88, at 6.

91.   Wildavsky, *supra* note 88, at 6–7, 14; DOUGLAS & WILDAVSKY, *supra* note 23, at 138.

92.   Dake, *supra* note 87, at 66.

93.   Wildavsky, *supra* note 88, at 6–7, 14; DOUGLAS & WILDAVSKY, *supra* note 23, at 139; Dan M. Kahan & Donald Braman, *More Statistics, Less Persuasion: A Cultural Theory of Gun-Risk Perceptions*, 151 U. PA. L. REV. 1291, 1297–98 (2003). This general analysis will not hold universally. A technology expected to break down social barriers and particu-larly advantage individuals with lower wealth, status, and power, for example, will be supported by egalitarians and opposed by hierarchists. The internet may be an example that falls partly within this category.

support individual autonomy and therefore will favor self-regulation and free markets; concomitantly, their greatest fear is market failure.[94] Solidarists perceive that individuals have little control over what happens to them, leading them to favor collective responsibility in the form of regulatory and social welfare programs for individual protection.[95]

Several implications flow from this analysis. First, no cultural worldview is inherently risk-averse or risk-seeking in the abstract. Rather, each worldview is concerned about particular types of risks. Each worldview is expected to be risk-averse with respect to the risks it is most concerned about, but risk-neutral or risk-seeking with respect to other risks. Second, the cultural worldviews exist only in relation to one another. An individual cannot be more strongly bound to group membership or social distinction without having complementary individuals who are less bound. Cultural worldview conflict is a necessary antecedent to cultural identity in the first instance.[96] Third, no cultural worldview is "best" or objectively better than any others. The worldviews represent competing normative conceptions about the ideal manner of relations in society, and cannot be empirically shown to be right or wrong.

The cultural theory of risk preference has been supported by a variety of empirical studies and theoretical analyses.[97] The empirical studies

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94.   Wildavsky, *supra* note 88, at 6, 14; DOUGLAS & WILDAVSKY, *supra* note 23, at 138–39.

95.   Wildavsky, *supra* note 88, at 6–7; Kahan & Braman, *supra* note 93, at 1303.

96.   Wildavsky, *supra* note 88, at 7.

97.   Wildavsky & Dake, *supra*, note 70 (concluding that cultural theory better predicts and explains individual preferences concerning twenty-five technologies than various political theories, personality theories, economic theories, actual risk knowledge, or a range of demographic variables); Dake, *supra* note 87, at 70–74 (concluding that cultural worldviews "are related pervasively and strongly with [thirty-six varied types of societal, technological, economic, and environmental] concerns"); Peters & Slovic, *supra* note 89, at 1439 (finding that "the egalitarian [worldview] was strongly related to concerns about technology and the environment, while persons [with the hierarchical/solidarist] and the individualist [worldviews] . . . show far less concern about these same issues"); *see also* Bernd Rohrmann & Ortwin Renn, *Risk Perception Research—An Introduction, in* CROSS-CULTURAL RISK PERCEPTION: A SURVEY OF EMPIRICAL STUDIES 38–40 (Ortwin Renn & Bernd Rohrmann eds., 2000) (compiling studies showing variations in risk perception among individuals from ten different countries).

The above studies generally did not compare cultural theory to two other influential socio-psychological theories of risk, the psychometric paradigm (or cognitive theory of risk perception) and social amplification of risk theory. The basic psychometric paradigm posits that individual risk perception is based on the degree to which a risk is perceived as dread and unknown. Slovic, *supra* note 19, at 119, 123. The psychometric paradigm fails to provide an account for differences in risk perception between individuals generally; for this reason, it does not explain the polarization and deadlock in the technology debates discussed in this Article. More complex versions of the psychometric paradigm incorporate cultural worldview into their analysis. *See, e.g.,* Paul Slovic, *Trust, Emotion, Sex, Politics, and Science: Surveying the Risk Assessment Battlefield,* 1997 U. CHI. LEGAL F. 59, 77–79 (1997);

found that cultural worldview is a better predictor of risk perception than many standard demographic characteristics, including political party affiliation, political orientation, age, gender, race, religion, geography, wealth, personality type, and education.[98] The theoretical analyses conclude that cultural theory better predicts and explains individual technology preferences than various political theories, personality theories, economic theories, or actual risk knowledge.[99]

It is therefore appropriate to examine how cultural worldviews influence individual opinions concerning nuclear power and genetically modified products.

Nuclear Power. Understanding and explaining attitudes towards nuclear technology was part of Douglas and Wildavsky's seminal work in cultural theory.[100] A study by Karl Dake confirmed that individual cultural worldviews correlate significantly with perceptions of the "dangers associated with nuclear energy."[101] Ellen Peters and Paul Slovic similarly found that individuals scoring higher on the hierarchical/solidarist and individualist worldview scales correlated positively with support for nuclear power (.20 and .17 respectively; $p < .0001$), while those scoring high on the egalitarian scale correlated negatively with nuclear support (-.28; $p < .0001$).[102] Relatedly, persons scoring high on the hierarchical/solidarist worldview scale perceived the health risks associated with nuclear power to be lower than egalitarians did, and were less likely than egalitarians to desire control over nuclear power issues and decisions.[103]

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see also infra note 152 (discussing the psychometric paradigm factors in relation to genetically modified products and nuclear power). Social amplification of risk concerns how events pertaining to risks interact with psychological, social, institutional, and cultural processes in ways that impact risk perception and behavior. Rohrmann & Renn, *supra* note 97, at 38–40. Social amplification provides an integrated, holistic approach to risk. It is somewhat too theoretical for application here and does not provide a direct mechanism to explain the polarization at issue in technology conflicts.

    98.   Kahan & Braman, *supra* note 93, at 1298, 1305–08 (finding that "cultural orientation scales have a bigger impact on gun control attitudes than does *any* other demographic variable"); Dan Kahan et al., *A Cultural Critique of Gun Litigation*, *in* SUING THE GUN INDUSTRY: A BATTLE AT THE CROSSROADS OF GUN CONTROL AND MASS TORTS 110 (Timothy D. Lytton ed. 2005); *see* Peters & Slovic, *supra* note 89, at 1447; Dake, *supra* note 87. *But see* Rohrmann & Renn, *supra* note 97, at 36 (citing studies, including Peters and Slovic, that arguably did not find significant worldview influence).

    99.   Wildavsky & Dake, *supra* note 70.

    100.   *See, e.g.,* Douglas & Wildavsky, *supra* note 23, at 139–51 (discussing differing worldviews in anti-nuclear activism).

    101.   Dake, *supra* note 87, at 71.

    102.   Peters & Slovic, *supra* note 89, at 1439. The statistical analysis that Peters and Slovic ran revealed three worldview factors, rather than the four theoretical ones. These three corresponded highly with the individualist, egalitarian, and a blend of the hierarchical and solidaristic worldviews described in the literature. *Id.* at 1436–38.

    103.   *Id.* at 1444.

Genetically Modified Products. Cultural worldviews are expected to influence the debate over the use and regulation of genetically modified products as well. Opinions about technology and technological risk, concerns about the environment and human health risks, opinions about regulation, and concerns about the economy and market relations all correlate significantly with worldview, and all are routinely raised in the biotechnology controversy.

The following worldview consequences are postulated. Egalitarians are predicted to oppose genetically modified products because the risks the products are perceived to create are expected to be widely-dispersed without individual volition. In this regard, the lack of an FDA requirement for government approval prior to commercialization of a new genetically modified food product, and the lack of labeling requirements for genetically modified food, would be viewed by egalitarians as particularly galling. Similarly, egalitarians would not be expected to trust government regulatory bodies (or industry) to adequately protect against the risks associated with genetically modified products. These issues, in fact, turn out to be top concerns for genetically modified product opponents.[104]

Hierarchists (and solidarists), on the other hand, are expected to support genetically modified products to the extent the products are supported by governmental or expert authority—which the products generally are in the United States. For hierarchists, the lack of an FDA requirement for approval prior to commercialization, or the lack of labeling requirements, are not a problem because the FDA is trusted to have developed the proper regulations in this area. For solidarists it is not a problem because they defer to the FDA's decision.

Individualists will tend to favor unfettered development of biotechnology due to their anti-regulatory, free-market worldview. Based on the Peters and Slovic study, however, they may have some concern that the

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   104.   *See*, *e.g.*, Union of Concerned Scientists, *Risks of Genetic Engineering*, *at* http://www.ucsusa.org/food_and_environment/biotechnology/page.cfm?pageID=346 (last modified Oct. 30, 2002) (last visited May 11, 2005) (contending that risk assessments performed on genetically engineered crops by government agencies are not adequate); Say No to GMOs!, *What's a GMO?*, *at* http://www.saynotogmos.org (last visited May 11, 2005) (noting concern with the lack of labeling requirements for genetically modified organisms); Alliance for Bio-Integrity, *Biodeception: How the Food and Drug Administration Is Misrepresenting the Facts About Risks of Genetically Engineered Foods and Violating the Laws Meant to Regulate Them*, *at* http://www.bio-integrity.org/FDADeception.html (last visited May 11, 2005) (arguing that the FDA violated the FFDCA by allowing genetically modified foods to be marketed without first assuring that they are safe); Michael F. Jacobson & Gregory Jaffe, *Who's Watching What You Eat?*, St. Louis Post-Dispatch, April 23, 2003, *available at* http://www.cspinet.org/biotech/pdtake.html (critiquing that "companies can market genetically engineered crops without the FDA approving them as safe") (last visited May 11, 2005).

government will not adequately regulate to fully protect the environ-
ment or human health.[105]

Although empirical study has not yet focused on the relationship be-
tween worldviews and attitudes towards biotechnology, related
empirical data are available that support the above analysis. One item in
the Peters and Slovic study queried respondents on their opinion of the
risk posed by the "use of genetically engineered bacteria in agricul-
ture."[106] The results demonstrated that having an egalitarian worldview
significantly and positively correlated with perceiving this activity to be
risky ($.18$; $p < .0001$); having a hierarchist/solidarist worldview was not
significantly correlated with this risk ($-.02$; $p > .001$); and having an in-
dividualist worldview was negatively correlated with this risk ($-.10$; $p <
.001$).[107]

The data from a study of framing effects for genetically modified
foods, while not intended to investigate worldviews, also supports the
analysis.[108] This national survey found that having a greater worry about
the United States' food supply or the environment (risks expected to be
prevalent for egalitarians) correlated positively and significantly with
perceiving greater risks from genetically modified food ($.115$; $p < .01$
and $.073$; $p < .05$, respectively).[109] Having a greater worry about the
United States' economy (a risk expected to be prevalent for hierarchists
and individualists) correlated positively and significantly with perceiv-
ing greater benefits from genetically modified food ($.079$; $p < .01$).[110]
Lastly, having greater trust in biotechnology companies (a view ex-
pected to be prevalent for hierarchists and rare for egalitarians)
correlated positively and significantly with perceiving greater benefits
from genetically modified food, and correlated negatively and signifi-
cantly with perceiving greater risks ($.188$; $p < .01$ and $-.145$; $p < .01$,
respectively).[111]

Cultural theory thus appears to provide a useful matrix for under-
standing individual technology preferences and some aspects of
technology debates.[112] However, a more detailed examination of individ-
ual technology attitudes and technology debates demonstrates that

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    105.   Peters & Slovic, *supra* note 89, at 1443.
    106.   *Id.* at 1441.
    107.   *Id.*
    108.   SILVA, ET AL., *supra* note 7, at 9–14.
    109.   *Id.* at 15.
    110.   *Id.*
    111.   *Id.*
    112.   For a related account of how individual positions are based on social and cultural
factors, *see* DONALD A. SCHÖN & MARTIN REM, FRAME REFLECTION: TOWARD THE RESOLU-
TION OF INTRACTABLE POLICY CONTROVERSIES (1994) (arguing that policy controversies are
the result of individuals' differing frames for understanding the issues).

actual technology preferences are more nuanced and complex than cultural theory predicts.

2. Critique of Cultural Theory

Despite cultural theory's descriptive and predictive strengths, it fails to provide an adequate model of technology preferences in significant manners: it fails to explain the polarization present in technology conflicts and it is not an accurate predictor of individual attachment to views on technology.

Cultural Theory and Polarization. Cultural theory fails to explain the polarization that pervades technology conflict because it predicts a continuum of worldviews along both cultural dimensions (group strength and social prescriptions).[113] There are strong hierarchists (individuals believing strongly in binding group membership and in substantial social prescriptions) and weak hierarchists (individuals just barely favoring being bound by group membership and supporting some, but not extensive, social prescriptions). Similarly, there are strong and weak egalitarians, individualists, and solidarists.

If everyone's worldview could be plotted on Figure 3, one would see a scattering of data points throughout the Figure, rather than four isolated bunchings located at the center or outskirts of each quadrant. Considering that there is a *relatively* ideologically homogenous and stable society in the United States,[114] and that the distribution of individuals' positions along each of the cultural axes may resemble a bell curve,[115] it is fair to hypothesize that the concentration of data points would be dense around some culturally-middling point (though by no means necessarily at the intersection of the axes) and sparser at the extreme edges of the cultural worldview matrix. Such a mid-point concentration is antithetical to the demonstrated polarization that marks technology conflict today. Cultural theory thus fails to predict actual technology positions.

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113.   *See, e.g.*, Steve Rayner, *Cultural Theory and Risk Analysis, in* SOCIAL THEORIES OF RISK 83, 90 (Sheldon Krimsky & Dominic Golding eds., 1992) (explaining that the two dimensions of cultural theory represent continua of possibilities for individuals).

114.   *See* PETER H. SCHUCK, DIVERSITY IN AMERICA: KEEPING GOVERNMENT AT A SAFE DISTANCE 10 (2003) ("[T]he United States does appear to be more ideologically homogeneous than most other societies.").

115.   *See, e.g.*, Tierney, *supra* note 18 (discussing a survey revealing a rough bell curve for individual self-identification along a liberal-conservative continuum). The bell curve (or "normal distribution") is the statistical distribution that results from sampling a random population; it represents the distribution of many natural phenomena. Individual positions along the cultural axes may, but do not necessarily, present a normal distribution. Evaluating the percentage of individuals holding various cultural worldviews, and more particularly the distribution of individuals along each of the two cultural theory axes, would be a valuable area for further study.

Cultural Theory and Nuance. Cultural theory underpredicts individual attachment to technology preferences. In certain situations, individuals seemingly act in ways that contradict their apparent cultural worldview—individuals apparently fail to appreciate that different uses of a technology may affect society differently.

Opponents of biotechnology (presumed egalitarians), for instance, have criticized initiatives to provide "golden rice" (genetically modified rice rich in beta carotene) for free or at cost in an effort to combat worldwide health problems associated with vitamin A deficiencies. Biotechnology opponents argue, for example, "golden rice is still a bad deal for hungry people. People are deficient in vitamin A because they are generally malnourished. Giving them beta carotene rice–even if it did work–does not address the poverty and other social and public health problems that lead to general vitamin deficiencies."[116] This quotation appears unfathomable from a cultural theory perspective because even as it disparages golden rice (with potential egalitarian benefits), it expresses classic egalitarian sentiments regarding protection of hungry, malnourished persons and a desire to combat the poverty and social situations that cause these problems.[117]

Biotechnology opponents also argue that the increased agricultural yields and lower costs promised by biotechnology will not aid in solving hunger problems because the problem is primarily one of inadequate resources for the delivery of food, not inadequate food supply.[118] Each of these potential benefits would appear to aid the lower wealth and power individuals that egalitarians are expected to be most concerned about.

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116.   MARTIN TEITEL & KIMBERLY A. WILSON, GENETICALLY ENGINEERED FOOD: CHANGING THE NATURE OF NATURE 134 (1999).

117.   Golden rice was identified by the non-partisan Copenhagen Consensus project as one of the best means to combat malnutrition. JERE R. BEHRMAN ET AL., COPENHAGEN CONSENSUS—CHALLENGES AND OPPORTUNITIES: HUNGER AND MALNUTRITION 37–40 (2004), *available at* http://www.copenhagenconsensus.com/Files/Filer/CC/Papers/Hunger_and_ Malnutrition_070504.pdf (last visited May 11, 2005).

118.   Biotechnology opponents argue, for example, that "[t]he real causes of hunger are poverty, inequality and lack of access [rather than insufficient food supplies]." Michael A. Altieri, & Peter Rosset, *FoodFirst: Ten Reasons Why Biotechnology Will Not Ensure Food Security, Protect the Environment and Reduce Poverty in the Developing World* (Oct. 1999), *at* http://www.foodfirst.org/progs/global/biotech/altieri-11-99.html (last visited May 11, 2005). The United Nations and other food experts have concluded that though food delivery is critical, food supply and enabling crops to be grown in currently inhospitable environments also will ameliorate the hunger problem. Andrew Pollack, *U.N. Unit Sees Great Promise in Biotech Research on Crops*, N.Y. TIMES, May 18, 2004, at C8 (reporting United Nations' position on the promise of biotechnology to ameliorate global hunger problems); Ellen Messer, *Food Systems and Dietary Perspective: Are Genetically Modified Organisms the Best Way to Ensure Nutritionally Adequate Food?*, 9 IND. J. GLOB. LEGAL STUDIES 65, 69–70 (2001); BEHRMAN, ET AL., *supra* note 117, at 37–40 (identifying agricultural technology as one of the best options for combating global hunger problems).

Similarly, egalitarians might be expected to laud the potential for nuclear power to reduce the disproportionate share of pollution from coal-fired power plants, and its concomitant detrimental health effects, faced by residents of low-income neighborhoods.[119]

Inconsistencies between individual worldview and positions on particular aspects of technology are not limited to egalitarians. Individualists are expected to support biotechnology based on their general support for technological growth and anti-regulation preferences; technological risk is not as salient for individualists as market or economic failure. In 1998, the European Union countries placed a moratorium on approving genetically modified crops, estimated to cost United States corn farmers alone $300 million a year.[120] In 2000, StarLink corn, a genetically engineered strain of corn not approved for human consumption, was discovered in human food in the United States. This discovery led to large-scale corn processing interruptions, a widespread recall of food products, and a sharp reduction in United States corn exports.[121] Despite the dramatic market impacts of the European Union moratorium and the StarLink corn contamination,

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119.   *See* Nuclear Energy Agency, Org. for Econ. Co-Operation and Dev., *Society and Nuclear Energy: Towards a Better Understanding* (2002), *available at* http://www.nea.fr/ html/ndd/reports/2002/nea3677-society.pdf (last visited May 11, 2005) "[T]he combustion of fossil fuels are responsible for the emission of particulate, nitrogen and sulphur oxides, and carbon dioxide. The atmospheric pollution . . . leads to deterioration of air quality, and eventually of living conditions, especially in large cities. Urbanization trends . . . are increasing the share of world population affected by those problems." *Id.* at 21. *See also* Nuclear Energy Inst., *Nuclear Electricity: A Key to Sustainable Development* 2, *at* http://www.nei.org/ documents/Nuclear_Electricity_Sustainable_Development.pdf ("Historically, using nuclear energy has promoted appropriate demographic policies envisioned by the Rio Principles by meeting the electricity needs of concentrated population centers without contributing additional pollution or consuming limited land resources. Demographic trends show higher percentages of the global population moving to urban areas . . . . Nuclear energy remains an effective tool in crafting appropriate demographic policies as urban areas adapt to growing populations and development demands.") (last visited May 11, 2005).

120.   Elizabeth Becker with David Barboza, *Battle over Biotechnology Intensifies Trade War*, N.Y. TIMES, May 29, 2003, at C1; Bob Kemper, *Bush Chews Out Europe over Ban*, CHI. TRIB., May 22, 2003, at C3. The European Union has since lifted the moratorium. Paul Meller & Andrew Pollack, *Europeans Appear Ready to Approve a Biotech Corn*, N.Y. TIMES, May 15, 2004, at C1. However, recently promulgated European Union regulations, as well as the Cartagena Protocol on Biosafety, that require labeling of genetically modified food and feed, are expected to have the same effect as the moratorium. Council Directive 1829/2003, O.J. L 268 2003, *available at* http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_268/ l_26820031018en00010023.pdf; Council Directive, 1830/2003, O.J. L 268 2003, *available at* http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_268/l_26820031018en00240028.pdf; Meller & Pollack, *supra* note 120; Aaron Zitner, *Sharp Talk on Biogenics*, L.A. TIMES, June 24, 2003, at 19.

121.   TAYLOR & TICK, *supra* note 52, at 90; Paul McAuliffe, *Is StarLink Corn a Problem for U.S. Corn Exports?*, WORLD COMMODITY ANALYSIS CORP., May 8, 2001, *available at* http://www.biotech-info.net/problem.html (last visited May 11, 2005).

individualists do not appear to have significantly changed their level of support for genetically modified products, as demonstrated by the relatively consistent level of support for such products over the time period at issue.[122]

Individual responses to numerous events and particular technology risks thus appear to contradict the cultural theory. Preferences are less nuanced than cultural theory predicts. Individuals appear to support or oppose a technology globally, rather than looking at particular benefit and risk impacts, and how each may promote or retard each individual's worldview. It may be possible to adapt cultural theory to fit these findings, particularly since viewing a technology globally, without nuance, is likely tied to risk salience and risk weighing influences, core components of cultural theory. Cultural theory, however, is not consistent with the demonstrated lack of nuanced preferences.

Cultural Theory and Preference Change. Cultural theory also overpredicts individual attachment to technology views. Pursuant to cultural theory, preferences should not change due to the development of further scientific information concerning the benefits and risks of a technology, because individual preferences are determined by worldview. This does not mean that under cultural theory individual preferences can never change, but that preferences only change where new information leads one to reevaluate the impact of a technology on group relations or social prescriptions. History reveals, however, that individual technology positions sometimes do change in response to greater scientific information, even where that information cannot be said to affect the predicted cultural impact of the technology.

This conclusion initially may appear to contradict the earlier observation that increasing scientific consensus about technology does not increase public consensus about the technology. The earlier observation was made with respect to biotechnology and nuclear power, but it is not universal. Understanding why and when scientific consensus influences or does not influence public consensus is a critical element in diagnosing technology conflict.

A prime example of a significant shift in public opinion resulting from scientific consensus that cannot clearly be explained by cultural

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122.   INDICATORS 2002, *supra* note 17, at 7–17. It is theoretically possible that the overall consistent level of support masks a loss of individualist support because individuals with other worldviews increased support. This seems highly unlikely. First, no particular events can be identified during this period that would be expected to significantly improve support among individuals with other worldviews (to the contrary, the StarLink scenario would be expected to reduce support). Second, as most hierarchists and solidarists already are expected to support biotechnology, the increased support would need to come primarily from egalitarians, where it is unlikely to originate.

theory is the shift in attitude regarding global warming and climate change. Not long ago the question of whether global warming was occurring was hotly contested.[123] New scientific information and data, however, have led to substantial scientific consensus that global warming is occurring.[124] The scientific consensus on global warming, in turn, effectively ended the public debate over whether global warming was occurring as well. Results from the National Science Board's 2001 survey found that 77% of Americans believed that global warming was occurring and that over 85% believed that the possibility of global warming should be treated as "very serious" or "somewhat serious."[125] In contrast, just four years earlier, only 24% of Americans were worried a "great deal" about global warming.[126] There is no indication that the resolution of this debate was due to a shift in how individuals understood global warming to impact group relations or social prescriptions. This change in public attitudes is attributable to an increase in scientific knowledge, not a change in cultural worldview.

Scientific consensus that a technology does not present a significant risk also can change preferences. In the mid-1990s, as cellular telephone use was exploding, reports surfaced about a possible causal link between cellular telephone use and brain cancer.[127] Not surprisingly, this caused great concern among many individuals. A large number of stud-

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123.   Joby Warrick, *Consensus Emerges Earth is Warming–Now What?*, WASH. POST, Nov. 12, 1997, at A1.

124.   *Id.* In 1995 the United Nations convened over 2,000 of the world's top climate scientists in the Intergovernmental Panel on Climate Change (IPCC) to investigate global warming. *Id.* The IPCC concluded that global warming was occurring, and put that part of the global warming debate to rest scientifically. *Id.*; INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 1995: THE SCIENCE OF CLIMATE CHANGE (J.T. Houghton et al. eds., 1996). The U.S. National Oceanic and Atmospheric Administration's administrator stated, "There's a better scientific consensus on this than on any issue I know–except maybe Newton's second law of dynamics." Warrick, *supra* note 123; *see also* Thomas C. Schelling, *What Makes Greenhouse Sense? Time to Rethink the Kyoto Protocol*, FOREIGN AFFAIRS May/June 2002 at 2, 3, *available at* http://www.foreignaffairs.org/20020501facomment8138/thomas-c-schelling/what-makes-greenhouse-sense.html ("[W]hat is least uncertain is that climate change is real and likely to be serious.") (last visited May 11, 2005). The causes of global warming, level of risk posed by global warming, and how to respond to the risk are, of course, still highly contested. To place this debate in the context of the three levels of uncertainty discussed earlier, there is now significant consensus on the fact of global warming (the first level), but uncertainty remains on the other two levels (the risks of global warming and how to respond). *See supra* note 84.

125.   INDICATORS 2002, *supra* note 17, at 7–23. Precisely, 53% of respondents thought that the possibility of global warming should be treated as "very serious," and 33% thought it should be treated as "somewhat serious." *Id.*

126.   Jeffrey J. Rachlinski, *Innovations in Environmental Policy: The Psychology of Global Climate Change*, 2000 U. ILL. L. REV. 299, 315 (2000) (citing The Pew Research Center for People and the Press, Americans Support Action on Global Warming).

127.   John J. Keller, *Are They Safe? Nobody Knows, But Studies are Underway to Determine Health Effects of Cellular-Frequency Radio Waves*, WALL ST. J., Feb. 11, 1994, at R13.

ies covering thousands of people were conducted to investigate this health concern.[128] As a result of these studies, scientific consensus emerged that cellular telephone use did not cause an increased risk of brain cancer.[129] This change in scientific knowledge greatly reduced public concern about cellular telephone use, a reduction that cannot be attributed to a change in cultural perceptions of the impacts of cellular telephone use on society.[130]

In addition to debates over global warming and cellular telephone cancer risks, technology debates as diverse as the risk of flying above the speed of sound, the risks of DDT spraying, and the use of asbestos all have been largely resolved as a result of increased scientific knowledge. Scientific knowledge can influence individual preferences and change debate discourse. Cultural worldview plays a significant role, but it is one part in an ensemble performance. At some point, scientific knowledge becomes strong enough that worldview preferences cannot ignore it or brush it aside, and there is a shift from cultural divide to greater public consensus.[131]

In sum, cultural theory's absolutist approach to risk preferences is unrealistic in real-world technology conflict application. Individuals cannot be neatly boxed in a four-worldview matrix (though recognizing multiple preference dimensions is an improvement over the traditional single continuum—e.g., from liberal to conservative). Similarly, cultural theory fails to account enough for the influence of scientific knowledge on preferences and discourse.

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128.   U.S. GEN. ACC'T OFF., GAO/RCED 95–32, TELECOMMUNICATIONS: STATUS OF RESEARCH ON THE SAFETY OF CELLULAR TELEPHONES 3–5 (Nov. 1994), *available at* http://www.gao.gov/archive/1995/rc95032.pdf (last visited May 11, 2005).

129.   *Id*. 3–5; *see also Scientists Find No Cancer Indications in DNA Study*, MOBILE PHONE NEWS, Jun. 17, 1996, at 3.

130.   The reduction in the level of public concern about the health effects of electromagnetic radiation from high-voltage power lines similarly occurred as the result of an increase in scientific consensus.

131.   The characteristics that cause this kind of a shift likely resemble a tipping point. *See* MALCOLM GLADWELL, THE TIPPING POINT: HOW LITTLE THINGS CAN MAKE A BIG DIFFERENCE (2000). Scientific knowledge about a technology can build over a long period of time, but as long as a significant uncertainty remains, cultural worldview preference may continue to dominate scientific preference. At some point, a small increase in scientific knowledge will reduce scientific uncertainty below a critical level, causing the situation to tip. This small increase may initially influence only a few individuals, but due to the salience of the particular information, the characteristics of the initial individuals it influences, and the social environment surrounding the information, a cascade ensues, resulting in a significant increase in consensus. *Id*. at 21–25, 139.

3. Functionalist Socio-Cultural Risk Perception

Despite its inadequacies, cultural theory does help in understanding technology wars, and consequently serves as a useful starting point for understanding individual technology preferences. Technology preferences are influenced by social, cultural, and political beliefs and concerns; risk perception is at least partially a social construct, not statistical law. Relatedly, risk preferences are functionalist—individual technology preferences depend significantly on how an individual perceives a technology to affect societal structures.[132]

This insight helps explain a variety of elements in actual technology conflicts. Consider, for example, seemingly unrelated concerns about genetically modified products. Some of the strongest criticisms of genetically modified products are that they will result in greater monopolization and industrialization of agriculture, with a concomitant disastrous impact on small family farms and the public at large.[133] Biotechnology opponents also frequently note concerns about product manufacturers' ability to obtain strong intellectual property rights for their products, about the potential impact of genetic engineering on people with certain religious or other ethical dietary restrictions, and about control of the food supply by large corporations.[134] Although none

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132. *See* Rohrmann & Renn, *supra* note 97, at 34–40 (noting that despite cultural theory's shortcomings, recognizing the influence of values and worldviews on risk perception is a major accomplishment, and recognizing that socio-psychological factors have substantial influence on risk perception). This conclusion is similar to that of Dorothy Nelkin. Dorothy Nelkin, *Science Controversies: The Dynamics of Public Disputes in the United States*, *in* HANDBOOK OF SCIENCE AND TECHNOLOGY STUDIES 445 (Shiela Jasanoff et al. eds. 1995) ("[certain] controversies over science and technology are struggles over meaning and morality, over the distribution of resources, and over focus of power and control").

133. *See* Greenpeace, *Life for Sale: Cloning and Genetic Engineering*, *at* http://www.greenpeace.org/raw/content/usa/press/reports/life-for-sale-cloning-and-gen.html (arguing large corporations' ability to patent genetically engineered crops enables them to take over the food market, force farmers to pay royalties, and produces giant corporate profits) (last visited May 11, 2005); Earth Liberation Front, *Biotech Out of Our Community! ELF Claims Attack on University of Idaho Biotech Building* (Jun. 10, 2001), *text available at* http://www.skeptictank.org/ecowar/gen01126.htm (arguing large corporations force farmers to sign contracts to continue to grow transgenic crops at the expense of public and environmental health) (last visited May 11, 2005); Organic Consumers Assoc., *Stop Genetically Modified Wheat*, *at* http://www.organicconsumers.org/wheat/ (discussing the negative economic impact on small farmers of Monsanto's control of 90% of the U.S. genetically modified seed market) (last visited May 11, 2005); TEITEL & WILSON, *supra* note 116, at 79–83, 97–106 (stating concerns about monopolization of agriculture and control of the food supply by large corporations, which wield their power in "tying farmer's hands").

134. *See* Earth Liberation Front, *supra* note 133 (contending large corporations are taking over the food supply by patenting seeds); Friends of the Earth, *Organic, Not Genetically Engineered*, *at* http://www.foe.org/camps/comm/safefood/gefood/factsheets/labelingfacts.html (discussing religious and ethical concerns associated with genetically engineered crops, including those voiced by Jewish, Buddhist, Moslem, and Christian denominations, and vegetarians) (last visited May 11, 2005); Organic Consumers Assn., *Label Genetically Engineered Foods*!, *at*

of these concerns is directly related to actual human health or environmental risks, they are logically coherent from particular socio-cultural perspectives.

The socio-cultural formation of technology preferences further helps explain how the significance of additional information is mediated by culture. Scientific knowledge is viewed through a cultural lens so that individuals view new facts and data differently depending on their social and cultural worldviews.[135] In certain technology conflicts, increased scientific knowledge does not lead to consensus or compromise because the debate is about culture, not scientific risk. Similarly, socio-cultural preference formation permits individuals to form technology preferences without the need for an in-depth, or accurate, understanding of the technology's complex benefits and risks.[136] A technology that is perceived to promote an individual's ideal society will be supported regardless of its actual benefits or risks, and regardless of the actual scientific knowledgability of the individual.

In short, socio-cultural worldview analysis can serve as a useful tool, but the failure of this model to account for the salient existence of polarization and non-worldview-based preferences requires that additional descriptive modeling be conducted to create a fuller, more accurate account of technology conflict.

B. *Behavioral Economics and Cognitive and Social Psychology*

The second element of the framework considers behavioral and psychological influences on individual preferences and decision-making. Deciding how much to support or oppose a given technology requires one to evaluate information and to formulate a conclusion concerning how the technology will impact one's preferences. Empirical evidence from the fields of behavioral economics and cognitive psychology demonstrates

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http://www.organicconsumers.org/Organic/ov4.cfm (stating that the FDA's and USDA's lack of labeling requirements violate many individual's religious and spiritual beliefs) (last visited May 11, 2005); Council for Responsible Genetics, *The Origins of CRG*, *at* http://www.genewatch.org/genewatch/articles/16-2hubbard_krimsky.html (arguing large corporations are monopolizing the food supply through control of genetically modified food seeds) (last visited May 11, 2005); Greenpeace, *supra* note 133 (arguing the patenting of genetically engineered crops allows large multinational corporations to gain control of the food chain); TEITEL & WILSON, *supra* note 116, at 92–113 (criticizing the patenting of living organisms and stating dietary concerns).

135.   *See* Kahan & Braman, *supra* note 93, at 1292 ("[Individuals] credit or dismiss empirical evidence . . . depending on whether it coheres or conflicts with their cultural values."); RAWLS, *supra* note 57, at 35–36 (contending reasonable disagreement can arise between individuals because they assess evidence differently based on their individual experiences and social groups).

136.   *See* Wildavsky, *supra* note 88, at 8–9 (cultural preferences can allow "people who possess only inches of facts to generate miles of preferences").

that humans are not rationally up to this task. People do not, and cannot, as assumed by traditional economic theory, always behave as rational actors striving to maximize their preferences. Due to limitations on time, perception, memory, cognition, and learning, individual preference-seeking is constrained, or only boundedly rational.[137] Understanding flaws in the weighing of evidence, formation of belief, and preference-seeking caused by bounded rationality are critical to comprehending the causes of technology conflict.

A central finding of behavioral and cognitive study is that people rely on heuristics to reduce complex analyses to simpler judgments. When faced with a difficult problem requiring the analysis of numerous probabilities, rather than engaging in a considered analysis of all available information, individuals rely on certain mental short-cuts to reach a judgment. In general these heuristics are useful–one could not get through a day if one had to carefully analyze every probability related to every decision. In certain situations, however, basing judgment on heuristics can "lead to severe and systematic errors."[138]

Decisions concerning whether to support or oppose genetically modified products or nuclear power are extremely complex and detailed. As discussed above, few individuals possess the training, experience, or time necessary to analyze the benefits and risks created by these technologies to arrive at a reasoned conclusion regarding what position to take. Given the impossibility of this task, it is not surprising that individuals rely on heuristics to formulate their positions on these complex issues. Though use of these heuristics are valuable, they also can lead to more extreme polarization and greater deadlock on technology issues than would otherwise exist. The following sections discuss the processes through which several well-recognized heuristics cause this result.[139]

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137. For a wealth of literature on these topics, *see generally* THOMAS GILOVICH ET AL., HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT (2002); DANIEL KAHNEMAN ET AL., JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Kahneman et al. eds., 1982).

138. Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 3 (Kahneman et al. eds., 1982).

139. The following treatment of psychological phenomena that impact technology conflict is not fully comprehensive–it is doubtful such a treatment would be possible. Various psychological effects not highlighted in the following sections also impact these debates (some are tangentially discussed). For instance, media and framing effects undoubtedly have impacts on preference formation, and phenomena such as groupthink likely impact judgment in these arenas. The phenomena discussed here, however, are those believed to have the greatest impact on polarization and deadlock.

1. Behavioral and Psychological Causes of Polarization

Several behavioral and psychological phenomena cause individuals with initially only slightly differing views on technology to gravitate toward more extreme, and as a result, more polarized positions. These phenomena, discussed in turn below, include the biased assimilation of new data, the affect heuristic, cognitive dissonance avoidance, and group polarization.

Biased Assimilation of New Data. Various studies demonstrate that individual beliefs are remarkably resilient to the introduction of new data that challenges the beliefs. New data and information that would logically be expected to lead to a moderation of position often is contra-logically interpreted by individuals to strengthen their beliefs.

The seminal study in this area involved subjects who either supported capital punishment and believed it was an effective criminal deterrent (proponents) or who opposed capital punishment and believed it was not an effective deterrent (opponents).[140] The subjects were given two purportedly authentic empirical studies, one supporting their position, the other opposing it.[141]

"Both proponents and opponents of capital punishment consistently rated the study that supported their beliefs as "more convincing" and "better conducted" than the study that opposed their beliefs."[142] In addition, the result of reading both studies was to polarize further the proponent and the opponent positions on capital punishment. Not only did reading the study supporting an individual's belief push the individual toward a more extreme position, but many individuals actually became even more convinced of the correctness of their position through reading the study that contained empirical data contradicting their position.[143]

Related research has found that empirical data explicitly refuting the information on which an individual based his or her initial belief did not lead the individual to fully discount that belief, as would be logically

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140.   Lee Ross & Craig A. Anderson, *Shortcomings in the Attribution Process: On the origins and maintenance of erroneous social assessments, in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 145 (Kahneman et al. eds., 1982) (citing Charles Lord et al., *Biased Assimilation and Attitude Polarization: The Effects of Prior Theories on Subsequently Considered Evidence*, 37 J. PERSONALITY & SOC. PSYCH. 2098 (1979)).

141.   *Id*. at 145.

142.   *Id.*

143.   *Id.* The manner by which individuals become more convinced based on contradictory information is complex. In the study discussed here, individuals tended to moderate their views slightly when they read a brief result statement from the study opposing their position, but upon reading the details concerning the data and procedure of the opposing study, the individuals tended to revert to their original beliefs, and often moved to an even more extreme belief. *Id.*

expected.[144] Beliefs, once formed, persist to a rationally unsupportable degree, even after the basis for the belief has been discredited.[145]

These findings speak directly to the problems faced in trying to resolve technology conflict. Improving scientific knowledge about, or educating individuals with greater scientific information concerning, the beneficial and detrimental impacts of genetically modified products and nuclear power does not help to build consensus concerning these technologies because individuals interpret the new information substantially differently depending on their pre-existing beliefs. Rather than helping to moderate positions or to build consensus, new scientific studies may actually lead to even greater polarization.[146]

The Affect Heuristic. The affect heuristic refers to people's tendency to rapidly and automatically have a positive or negative feeling when confronted with a certain word, concept, or other stimulus.[147] Though the affect heuristic is often useful, it also can cause judgmental errors where the substituted affective reaction differs from what the actual evaluation would be.

Empirical evidence demonstrates that individuals base their judgment of an activity or a technology, at least in significant part, on how they feel about it affectively.[148] If individuals feel positively about a technology, they will tend to judge its benefits as high and risks as low; if they feel negatively about a technology, they will tend to judge its

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144.   *Id.* at 146–49.

145.   *Id*. at 146–47; *see also* Emily Pronin et al., *Understanding Misunderstanding: Social Psychological Perspectives*, *in* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT 648–49 (Thomas Gilovich et al. eds., 2002) (noting that opposing individuals interpret identical facts differently, each to support their own beliefs). The biased assimilation of new data likely results in part from effects described by social judgment theory, which posits that individuals can make a judgment about an item only by comparing it with something else. MARVIN E. SHAW AND PHILIP R. COSTANZO, THEORIES OF SOCIAL PSYCHOLOGY 271 (2d ed. 1982). Individuals' positions serve as anchors with which they compare new information. Where the discrepancy between new information and an individual's position is small (within a "latitude of acceptance"), the new information is assimilated and the individual may move in the direction of the new information; where the discrepancy is large (within a "latitude of rejection"), the new information is rejected and the individual may boomerang in the direction opposite that which follows from the new information. *Id.* at 274–75.

146.   The biased assimilation of new data has been identified as one reason that the global warming debate appears particularly intractable. Rachlinski, *supra* note 126, at 304–07.

147.   Daniel Kahneman, *A Perspective on Judgment and Choice: Mapping Bounded Rationality*, 58 AM. PSYCHOLOGIST 697, 710 (2003); Paul Slovic et al., *The Affect Heuristic*, *in* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT 397 (Thomas Gilovich et al. eds., 2002). The latter authors use the example of the instant feelings that arise associated with the words *treasure* or *hate*. *Id.*

148.   Slovic et al., *supra* note 147, at 410–11.

risks as high and its benefits as low.[149] As a result of the affect heuristic, individual judgments of the risks and benefits created by a technology correlate negatively, though such a correlation is not logically required.[150] The affect heuristic has been found to influence both lay and expert judgment of risk.[151]

The affect heuristic helps to explain why cultural theory "egalitarians," for instance, will view the risks of nuclear power and biotechnology as high and their benefits as low across the board, so that even if certain aspects or uses of these technologies would promote egalitarian goals, this will not be perceived. As a result of the affect heuristic, the preferences individuals develop concerning a given technology will be more global and less nuanced than is rational.

The affect heuristic will tend to cause polarization on technology issues by pushing each individual's position away from a more balanced position and towards a more extreme one. This occurs because individuals who view the technology positively and net beneficial (even by a small margin), consequently will perceive the technology's risks to be lower than they would absent the affect heuristic, causing the individual to support the technology even more. The opposite influence will occur for an individual initially opposing a technology, even only slightly.[152]

Cognitive Dissonance Avoidance. Numerous empirical studies have demonstrated that individuals have a hard time holding two apparently conflicting ideas in mind at once.[153] The presence of conflicting concepts creates psychological discomfort in an individual, leading him or her to

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149.   *Id.* at 411.

150.   *Id.* at 410–12; *see also* Slovic, *Trust*, *supra* note 97, at 81 (discussing how the affective responses create an inverse relationship between perceived benefit and perceived risk). The negative correlation persists regardless of whether the nature of the benefits of a given activity are similar to or distinct from the nature of the risks. Slovic et al., *supra* note 147, at 410–12.

151.   Slovic et al., *supra* note 147, at 412.

152.   The affect heuristic has been identified by others as likely influencing individual preferences concerning nuclear power. Paul Slovic et al., *Regulation of Risk: A Psychological Perspective*, *in* REGULATORY POLICY AND THE SOCIAL SCIENCES 241, 269 (Roger G. Noll ed., 1985) [hereinafter Slovic *Regulation*]; Cass R. Sunstein, *Cognition and Cost-Benefit Analysis*, 29 J. LEGAL STUD. 1059, 1067–68 (2000). Pursuant to the psychometric paradigm of risk, an individual's perceptions of nuclear power and biotechnology read like a laundry list of aggravating traits concerning risk. These technologies' risks commonly are perceived to be: dread, uncontrollable, potentially catastrophic, fatal, inequitably distributed, place future generations at risk, involuntary, not observable, unknown, new, irreversible, human created, complex, and unfamiliar. *See supra* note 97 (discussing the psychometric paradigm); Slovic, *supra* note 19, at 122; Slovic *Regulation*, *supra* note 152, at 269 (identifying how nuclear power has many feared risk traits); EVAN & MANION, *supra* note 80, at 149 (discussing factors that affect public perception of risk); Sunstein, *infra* note 160, at 1078 (providing lists of aggravating and mitigating risk factors).

153.   *See generally* LEON FESTINGER, A THEORY OF COGNITIVE DISSONANCE (1957) (analyzing a number of studies and proposing the concept of cognitive dissonance).

take steps to reduce or eliminate the conflict.[154] The psychological phenomena of this conflict has been termed "cognitive dissonance," and the motivation it inspires is "cognitive dissonance avoidance."

To avoid cognitive dissonance, individuals generally will not perceive a given technology to offer both benefits and risks. Such a perception creates cognitive dissonance because it implies that the technology is both good and bad. Individuals confronted with this conflict will engage in cognitive dissonance avoidance measures, such as denying the existence of either the benefits or the risks, and actively seeking and believing information that supports only one of the two qualities.[155] Relatedly, once an individual forms a given belief about a technology, he or she will avoid information that might contradict that belief, even if it is reliable, in an effort to avoid dissonance.[156]

Cognitive dissonance also may arise if there is a perceived conflict between the use (or non-use) of a given technology and an individual's cultural worldview. For instance, if an individual's worldview leads one to believe a given technology is a bad choice for society, but there is scientific consensus that the technology is beneficial and not risky, then cognitive dissonance may be experienced.[157] An individual in such a situation would be faced with two methods of cognitive dissonance avoidance: changing one's cultural worldview or changing one's perception of the technology. The latter will be a far more attractive option for most individuals, as it is less psychologically and cognitively imposing.

Cognitive dissonance avoidance will lead individuals to view issues surrounding a given technology as black-or-white: either the technology is beneficial or harmful, but not both.[158] Needless to say, such a result increases polarization. It also further explains the lack of nuance in technology preferences.

Group Polarization.[159] Individuals are social beings—they take part in various social networks and frameworks and are engaged in both in-

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154.   *Id.* at 2–3, 18.
155.   *See id.* at 6 (noting that a common method of cognitive dissonance avoidance is to change one's "knowledge," such as by simply changing one's beliefs or by acquiring much more knowledge supporting only one of the two apparently conflicting views).
156.   *Id.* at 22.
157.   *See id.* at 14 (noting that cognitive dissonance can arise as a result of cultural mores).
158.   Both the affect heuristic and cognitive dissonance avoidance tend to cause individuals to view a given technology as all benefit or all risk, thereby exacerbating polarization. The processes by which each phenomena occurs, however, is different. For the affect heuristic, it is the affect an individual associates with a technology that is the causative agent. For cognitive dissonance avoidance, it is the presence of apparently conflicting ideas that is the causative factor.
159.   As discussed below, "group polarization" is a psychological term of art referring to a particular psychological effect. Although the overlapping terminology is unfortunate, it

terpersonal and intergroup relationships. Individuals are therefore expected to discuss their views with others, and these discussions may impact technology preferences.

Deliberating groups made up of individuals with initial preferences falling on one side of an issue have a tendency to make a more extreme decision as a result of group deliberation than the typical or average member of the group would have made on their own.[160] This occurs because each individual's "initial tendency . . . toward a given direction is enhanced following group discussion."[161] The effect of this phenomenon is that intragroup discussions will lead to intergroup polarization as the individual opinions in each group tend to become more uniform around a more extreme position.[162]

To the extent groups of individuals with similar views on particular technologies discuss their views with each other, group polarization is expected to occur. It is expected that individuals with similar worldviews will often associate and discuss their views on technology issues as prevalent as nuclear power and biotechnology. The advent of the internet is likely to increase the prevalence of such association and discussion among like-minded individuals. Group polarization will cause greater polarization between groups on technology issues than would otherwise exist.

These four behavioral and psychological phenomena (the biased assimilation of new data, affect heuristic, cognitive dissonance avoidance, and group polarization) explain what the cultural theory of risk preference could not—why individuals with only slightly differing worldviews end up in starkly polarized conflict, and why individuals appear to judge a technology globally and without nuance.

2. Behavioral and Psychological Exacerbation of Deadlock

In addition to causing greater polarization concerning the use and regulation of technology, various behavioral and psychological phenomena also tend to entrench individual positions on technology issues, leading to greater deadlock than would otherwise exist. Phenomena causing polarization are those that push individuals further from compromise or moderate positions, while phenomena causing deadlock are

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should not be confused with the polarization generally discussed in this Article. As used in psychology literature, "group polarization" is defined internally to the group in question, not (as it is used in this Article) to a relationship between groups of individuals.

160.   Cass R. Sunstein, Essay, *Deliberative Trouble? Why Groups Go to Extremes*, 110 YALE L.J. 71, 85 (2000).

161.   *Id.* at 85 (quoting Daniel J. Isenberg, *Group Polarization: A Critical Review and Meta-Analysis*, 50 J. PERSONALITY & SOC. PSYCHOL. 1141, 1141 (1986)).

162.   Sunstein, *supra* note 160, at 85–86.

those that tend to make individuals more steadfast in their position but do not influence individuals to change their position. Several causes of exacerbated deadlock are discussed below: overconfidence bias, confirmation bias, naive realism and false consensus, and the availability heuristic.

Overconfidence Bias. A wealth of empirical data reveal that people have irrationally high confidence in their judgments.[163] Simply put, "people are often more confident in their judgments than is warranted by the facts."[164] Overconfidence is not limited to lay judgment or experimental situations. Various studies have found that experts often exhibit an overconfidence bias, and studies of real world, professional predictions routinely confirm overconfidence as well.[165] The overconfidence bias is extremely robust; various strategies employed to try to reduce its impact have met with only limited success.[166]

The manner in which overconfidence influences deadlock is relatively straightforward: individuals holding opposing positions will tend to be overconfident in the degree to which their position is rationally supported by science and evidence, and overconfident in the degree to which contrary positions are logically untenable. This will increase intransigence as individuals on each side of the issue become strongly convinced that their position is correct, and therefore less willing to compromise or consider alternative positions.[167]

Some experimental data indicates the overconfidence bias stems from a failure to consider why one's position may be wrong.[168] A more detailed analysis of this bias provides additional insight into technology debates. The persuasiveness of evidence depends on two factors, its relevance (strength) and its reliability (weight). Experiments on judgment have found people do not combine relevance and reliability properly. Rather, judgments are overinfluenced by the relevance of evi-

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163.   Slovic et al., *supra* note 147, at 472; Tversky & Kahneman, *supra* note 138, at 17.

164.   Dale Griffin & Amos Tversky, *The Weighing of Evidence and the Determinants of Confidence*, *in* Heuristics and Biases: The Psychology of Intuitive Judgment 230 (Thomas Gilovich et al. eds., 2002).

165.   *Id.*; Slovic et al., *supra* note 147, at 475–78. Overconfidence is not universal; for very easy issues, underconfidence is routine. Griffin & Tversky, *supra* note 164, at 230. The technology issues analyzed here cannot be classified as easy.

166.   Cass R. Sunstein, Review, *Hazardous Heuristics*, 70 U. Chi. L. Rev. 751, 774 (2003); Baruch Fischoff, *Debiasing*, *in* Judgment Under Uncertainty: Heuristics and Biases 432, 443 (Kahneman et al. eds., 1982).

167.   Daniel Kahneman & Amos Tversky, *Conflict Resolution: A Cognitive Perspective*, *in* Choices, Values, and Frames 474–75 (Daniel Kahneman & Amos Tversky eds., 2000).

168.   Gretchen B. Chapman & Eric J. Johnson, *Incorporating the Irrelevant: Anchors in Judgments of Belief and Value*, *in* Heuristics and Biases: The Psychology of Intuitive Judgment 134 (Thomas Gilovich et al. eds., 2002).

dence and underinfluenced by its reliability.[169] Extremely strong, but unreliable, evidence tends to be more persuasive than statistically appropriate; weak, but reliable, evidence is less persuasive than it should be.

This differentiation may help explain the extremity of positions taken by interest groups engaged in technology debates. A group opposing biotechnology may choose to argue that there are no benefits to genetically modified food, but many risks. Though this position is unreliable and should be afforded little weight, it is highly relevant and extremely strong. As such, it represents precisely the type of evidence that individuals rely on to a greater extent than appropriate.

Confirmation Bias. Individuals tend to seek information that will support their beliefs, take confirming evidence at face value, and interpret information they receive as consistent with their beliefs.[170] Conversely, individuals are unlikely to seek information challenging their beliefs, and when confronted with such information they are highly critical of it and scrutinize it carefully.[171] This suite of findings has been termed the "confirmation bias"–individuals are biased towards information that confirms their existing beliefs and biased against information that questions those beliefs.[172]

Confirmation bias was strongly revealed in the capital punishment study discussed above. It makes people more secure in their positions than is logically justified, and reduces the likelihood that people will perceive alternate positions or compromise solutions to be reasonable, perpetuating deadlock.

Naive Realism and False Consensus. Similarly confounding attempts to reduce deadlock is individuals' oft-held belief that their particular perspective or beliefs are especially accurate. This tendency has been termed "naive realism."[173]

Overcoming naive realism is particularly challenging because it rests, in part, on a proper recognition that one's perspective has been shaped by one's own experiences. Individuals simply believe that their own personal experiences have been particularly enlightening, and

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169.   Griffin & Tversky, *supra* note 164, at 231–40.

170.   Chapman & Johnson, *supra* note 168, at 133; Russell B. Korobkin & Thomas S. Ulen, *Law and Behavioral Science: Removing the Rationality Assumption from Law and Economics*, 88 CAL. L. REV. 1051, 1093 (2000); Pronin et al., *supra* note 145, at 637; Ross & Anderson, *supra* note 140, at 149.

171.   Chapman & Johnson, *supra* note 168, at 133; Pronin et al., *supra* note 145, at 637; Ross & Anderson, *supra* note 140, at 149.

172.   Group decision-making also has been found to be subject to the confirmation bias. Stefan Schulz-Hardt et al., *Biased Information Search in Group Decision Making*, 78 J. PERSONALITY & SOC. PSYCHOL. 655, 666 (2000).

173.   Pronin et al., *supra* note 145, at 646–47.

therefore render their position especially valid.[174] Individuals expect other rational people to agree with their position once they are provided with enough information. Consequently, the only reason someone would disagree after being fully educated is irrationality.[175]

A related phenomenon is the "false consensus" bias, pursuant to which people view their own judgments as relatively common (and more common than they actually are), while viewing alternative judgments as uncommon, deviant, and inappropriate.[176]

The implications of naive realism and false consensus on deadlock are clear. Opposed individuals firmly believe that their position is the only rational one, and that others will be convinced of their position if they are rational. As a result, individuals begin to view those with differing opinions very negatively because they are seen as being irrationally intransigent or unreasonably biased.[177] It is unnecessary, therefore, to seriously consider opponents' positions. The result of these dynamics is an environment that could hardly be less conducive to bridging deadlock.

The Availability Heuristic. The availability heuristic refers to the tendency for individuals to assess the likelihood of an event by the ease with which occurrences of the event can be brought to mind.[178] Availability can depend on many factors, including familiarity with the event, salience of images, and how recently a relevant event has occurred.[179] The availability heuristic affects both expert and lay judgment; the former may be even more influenced than the latter.[180]

To understand the impact of the availability heuristic on technology debates, one has to consider which images are available. This raises a

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174.   *Id.* at 646–47.

175.   *Id.* at 647. Naive realism likely relates to another bias, the egocentric interpretation of fairness, pursuant to which individuals perceive the solution that benefits them the most as being objectively fairest. *See* Barton H. Thompson, Jr., Essay, *Tragically Difficult: The Obstacles to Governing the Commons*, 30 ENVTL. L. 241, 260 (2000) (discussing how the egocentric interpretation of fairness impedes individuals from reaching mutually beneficial solutions to certain problems).

176.   Pronin et al., *supra* note 145, at 642; Ross & Anderson, *supra* note 140, at 140.

177.   Pronin et al., *supra* note 145, at 648.

178.   Tversky & Kahneman, *supra* note 138, at 11. A classic example of the availability heuristic involves individuals asked whether there would be more words ending in "-ing" or with "n" as their second-to-last-letter in a random sampling of an English novel. Individuals estimated there would be more than twice as many words ending in "-ing," despite the fact that this is logically impossible. Amos Tversky & Daniel Kahneman, *Extensional Versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment*, *in* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT 21 (Thomas Gilovich et al. eds., 2002). Because it is easier to think of words that end with "-ing" than words that have "n" as their second-to-last-letter, i.e., because the former is more available, people estimate the former group to be larger than the latter. *Id.*

179.   Tversky & Kahneman, *supra* note 138, at 11.

180.   Mark Seidenfeld, *Cognitive Loafing, Social Conformity, and Judicial Review of Agency Decisionmaking*, 87 CORNELL L. REV. 486, 502 (2002).

further question, as varied images are available for both biotechnology and nuclear power. The thought of genetically modified food could bring to mind either the StarLink corn fiasco or fields of unblemished pest-free crops; the thought of nuclear power can bring to mind emission-free energy generation or nuclear reactor meltdown.

Several factors will influence what image an individual will bring to mind when confronted with a question about a technology. Undoubtedly, two interrelated factors will be the individual's worldview and affect toward the technology. An individual's position concerning a technology will therefore be reinforced by the availability heuristic. Relatedly, the dichotomy of interest group positions on technology issues also will further polarize individual positions, particularly due to framing and labeling effects. The vast majority of images made available by interest groups are polarized ones; these are the images that will be most available to most individuals. Similarly, interest groups work hard to develop salient labels to support their positions (consider "frankenfood" or "clean energy").[181]

The availability heuristic bias can lead to informational and reputational cascades, further aggravating deadlock. An informational cascade occurs where someone with little knowledge or opinion on an issue bases his or her position on the apparent position of another.[182] Individuals are particularly susceptible to informational cascade effects when they lack information on a topic.[183] This situation is likely to occur often within technology debates where, as discussed, most individuals lack the capacity to reach a rationally deduced position on their own. Reputational cascades occur where someone takes and expresses a given position to earn social approval or avoid social disapproval.[184] Either of these effects can snowball (cascade) as individuals see more and more people agreeing on a certain position. Critical for the purposes of this Article is the concept of local cascades, in which a subgroup can become increasingly convinced of its position, both in strength and uniformity, due to these cascade effects.[185] Availability and cascade

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181. Not surprisingly, individual attitudes toward nuclear power have been identified as likely being significantly influenced by the availability heuristic. Slovic *Regulation*, *supra* note 152, at 487–88.

182. Timur Kuran & Cass R. Sunstein, *Controlling Availability Cascades*, *in* BEHAVIORAL LAW AND ECONOMICS 374, 374–75 (Cass R. Sunstein ed., 2000); Sunstein, *supra* note 160, at 78–83.

183. Sunstein, *supra* note 160, at 83.

184. Kuran & Sunstein, *supra* note 182, at 375; Sunstein, *supra* note 160, at 78–85.

185. Sunstein, *supra* note 160, at 77; Kuran & Sunstein, *supra* note 182, at 375 (discussing local informational cascades and local reputational cascades). One commentator has blamed informational and reputational cascades for "giving rise to growing and apparently unfounded fears of genetic engineering of food." Sunstein, *supra* note 160, at 1067.

effects may be enhanced by the aforementioned conflict entrepreneurs—individuals who have a self-interest in increasing polarization and deadlock.

Interest groups routinely try to take advantage of the availability heuristic and cascade effects to convince people to adhere to their view. This is why Keep Nature Natural (an organization that seeks greater regulation and labeling of genetically engineered products) organized winners of the James Beard Foundation's Chef of the Year Award to hold a press conference demanding mandatory labeling and pre-market safety and environmental testing of genetically engineered foods;[186] and why AgBioWorld Foundation (an organization that promotes biotechnology) lined up numerous scientists, including a number of Nobel Prize winners, to sign a "Declaration of Support of Biotechnology" promoting the development and use of genetically modified food.[187] These organizations are playing the role of "availability entrepreneurs," attempting to cause informational and reputational cascades to influence individual positions.[188]

The availability heuristic and cascade effects will make group members more convinced of the strength of their position, reducing the possibility of breaking deadlock.

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Almost any behavioral economics and cognitive psychology analysis can be criticized on the bases that one cannot conclusively state the impact of the various psychological factors, and that there are countervailing heuristics and biases. Here, certain heuristics may reduce conflict. The compromise bias and extremeness aversion, which cause individuals to avoid choosing extreme outcomes, for instance, should tend to reduce polarization and deadlock.[189] Nevertheless, it appears, both in theory and in practice, that the overwhelming strength of behavioral and psychological influences at work in technology debates tend to increase polarization and deadlock. Resolving technology conflicts, therefore, becomes even more complex and challenging.

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186.   Press Release, *Top Chefs Add Their Voices to "Keep Nature Natural"* (May 10, 2000), at http://mindfully.org/GE/Chefs-Join-Effort.htm (last visited May 11, 2005).

187.   AgBioWorld Foundation, Scientists in Support of Agricultural Biotechnology, *at* http://www.agbioworld.org/declaration/declaration_index.html (last visited May 11, 2005); *see* Nelkin, *supra* note 132, at 454 (discussing efforts of interest groups to attract public attention and political interest).

188.   *See* Jolls et al., *supra* note 56, at 1509, 1519 (discussing the concept of an availability entrepreneur).

189.   *See* Seidenfeld, *supra* note 180, at 506 (describing the compromise bias and extremeness aversion).

Considering the weight of biases that inhibit compromise agreements, it may be considered surprising that consensus is ever achieved. That consensus is achieved demonstrates that scientific knowledge can play a significant role in preference formation, and can break down psychological barriers and lead to agreement, as discussed further below.[190]

C. *The Destabilization of Science*

One of the central puzzles present in technology debates is why greater scientific consensus often does not lead to greater agreement over time. Science sometimes plays only a minor role in driving technology debates–witness the consistency of positions over decades in the biotechnology and nuclear power conflicts despite vast increases in scientific knowledge. At other times, however, science reaches a tipping point and substantially changes debate discourse—witness the debates over whether global warming is occurring and whether cellular telephone use causes brain cancer.[191] The effects of socio-cultural worldviews on preferences, and the behavioral and psychological phenomena discussed above, explain part of this puzzle. The impact of polarization itself on individual attitudes towards science also limits the ability of scientific knowledge to help resolve technology conflicts.

Earlier work has revealed that polarized interest groups have a natural tendency to destabilize public trust in science, often unintentionally.[192] This destabilization occurs because each interest group holds fast to its position and decries every other position as unreasonable. Each side marshals and publicizes a wealth of reports, scientists, and other figures to trumpet its position and attack that of its opponents. This battle takes place in all variety of media—press releases, website wars, celebrity spokespeople, and radio and television interviews. The competing actions of Keep Nature Natural and AgBioWorld Foundation discussed earlier provide a prime example.[193] For the same reason, various groups have trumpeted Prince Charles' position

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190.   *See infra* Part III. The degree to which the various psychological influences inhibit agreement is not innate or fixed, depending, for instance, on various cultural and social factors. We may be particularly susceptible to such a divide in the United States right now due to socialization of individuals to be very opinionated and view many issues in binary perspectives.

191.   *Supra* Part II.A.2.

192.   Gregory N. Mandel, *Building Confidence through Teamwork on Regulatory Proposals: The Genetically Modified Product Model*, 44 JURIMETRICS J. 41, 47–49 (2003). The following discussion draws from this article.

193.   *See supra* notes 186–187 and accompanying text.

against the introduction of transgenic crops and President Carter's support for genetically modified food.[194]

This mass of information and massive effort generally does little to change existing views. Rather, the polarized propaganda storm confuses the public, as most individuals are incapable of independently judging the science at issue and cannot determine which position is most reasonable or accurate.[195] The polarized debate erodes public trust in scientific knowledge itself because the one consistent argument asserted by every interest group is that opposing interest groups' science cannot be trusted. Many individuals will reason that the institution of science is not all it is claimed to be. After all, how can two members of a discipline allegedly based on rigorous methodology and objectivity reach contrary conclusions on the same issue? The consequence of the interest group assault on opposing scientific claims is that individuals will conclude that science, as a discipline, cannot be trusted.[196] Once this trust is eroded, it is very difficult to regain.[197]

The result of most interest groups taking an "all benefit, no risk" or "all risk, no benefit" position is thus severe. These positions help to effectuate the destabilization of science that occurs in technology debates. The diametrically conflicting positions taken by interest groups assault science as a discipline to such an extent that individuals find it impossible to assess or accept the merits of any scientific position. Individuals therefore discount the value of science as an objective means for resolving the conflict at issue. They begin instead to view scientific

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194.   *See also* Sheila Jasanoff, The Fifth Branch: Science Advisors as Policy-makers 37 (1990) ("[I]n a politicized environment . . . the deconstruction of scientific 'facts' into conflicting, socially constrained interpretations seems more likely to be the norm than the exception.").

195.   Mandel, *supra* note 192, at 48; Ortwin Renn, *The Social Arena Concept of Risk Debates*, *in* Social Theories of Risk 179, 192 (Sheldon Krimsky & Dominic Golding eds., 1992). A stark example of individuals' judgmental inabilities relevant to the technology issues discussed here is a survey study in which approximately half of the respondents answered (incorrectly) that it was true that "ordinary tomatoes do not contain genes, while genetically modified tomatoes do." Indicators 2002, *supra* note 17, at 7–21 to 7–22.

196.   Mandel, *supra* note 192, at 48–49; Rohrmann & Renn, *supra* note 97, at 192; Slovic, *supra* note 97, at 93 (describing how conflicts among experts destroy the public trust). The circumstances discussed here, in which people do not rely on science even though science may provide certain relevant and reliable information, may be juxtaposed with other situations in which decision-makers use pseudo-scientific arguments to support what is actually a non-scientific policy decision. *See* Mandel, *supra* note 4 (discussing this phenomenon).

197.   Wendy E. Wagner, *The "Bad Science" Fiction: Reclaiming the Debate over the Role of Science in Public Health and Environmental Regulation*, 66:4 Law & Contemp. Probs. Autumn 2003 at 63, 106 (citing Paul Slovic, The Perception of Risk 316, 317 (2000)); Slovic, *supra* note 97, at 87–93.

information as no more objective than value-based normative opinion.[198] As a result, increased scientific knowledge often fails to increase consensus, and technology debates remain paralyzed.

As long as a significant degree of scientific uncertainty about a technology remains and interest groups advocate polarly opposed viewpoints, destabilization will continue. Scientific uncertainty of several kinds is often present when dealing with technological issues. First, technology debates usually take place at the forefront of scientific understanding, where almost by definition there is not complete knowledge. Second, technology debates often concern issues of risk. Even if a risk hypothetically could be completely characterized there still would be uncertainty about who it would affect, how, and when, among other issues. Third, even if the risks' impacts were known, there would be uncertainty about how to respond to those risks. Finally, as scientists are trained to use caution in discussing their findings, individuals often will perceive even greater uncertainty than is actually present.[199] The circumstances surrounding technology debates thus make the destabilization of science almost inevitable.

Conflict entrepreneurs exacerbate the destabilization of science by actively encouraging and promoting it. As conflict entrepreneurs desire continued conflict, they will try to enhance destabilizing tendencies to the extent they are recognized. Taking a scientifically indefensible position therefore may be a strategic behavior aimed directly at entrenching conflict, not resolving debate, even if resolution would be socially beneficial.

The destabilization of science is closely tied to the politicization of science. Destabilization causes individuals to view scientific statements merely as statements of opinion, value, or belief. Scientific knowledge and information are therefore entitled no special weight or strength. As a result, politicians and others involved in political and social debate are free, in the extreme, to interpret science to support any position.[200] Since technology debates almost necessarily take place in an arena of scientific

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198.   Mandel, *supra* note 192, at 49. The problem of polarized interest groups destabilizing science is somewhat analogous to the battle of experts that occurs in courtroom litigation. Often the result of fact-finders hearing polar, conflicting scientific expert testimony is not that one side's experts are accepted as accurate and the other side's experts are perceived to be quacks, but that the fact-finder gives up on using science as a means to resolve the case and turns to other factors to evaluate the case. *Id.*

199.   Thompson, *supra* note 175, at 258. That people perceive uncertainty also may make them more susceptible to the influence of informational and reputational cascades. *See id.* at 259 (noting that individuals may look to others in the face of ambiguity).

200.   *See* Nelkin, *supra* note 132, at 453 ("as technical expertise becomes a resource, exploited by all parties to justify competing moral and political claims, it becomes difficult to distinguish scientific facts from political values"); Wagner, *supra* note 197, at 88, 93–94 (discussing the political deconstruction of science and scientific knowledge).

uncertainty, the destabilization and politicization of science occurs routinely, further exacerbating conflict paralysis.

D. *Lack of Compromise Advocacy*

The fourth element of the technology conflict framework concerns the paucity of individuals advocating moderate or compromise positions in technology debates. An active, vocal group of individuals supporting such positions would likely ameliorate the conflicts and increase the probability of a compromise solution being achieved. This type of group, however, usually does not exist.

As the interest group study reported in Part I revealed, only two of the forty-plus interest groups hold what could be considered moderate positions. Similarly, the substantial majority of individuals do not hold moderate positions on genetically modified products or nuclear power. The discussion of behavioral and psychological influences which tend to cause polarization helps explain why few individuals hold moderate positions or advocate compromise solutions. Additional phenomena also preclude individuals from organizing or strongly advocating for compromise solutions to technology conflicts.

First, proposals from the middle are likely to be criticized and critiqued from both extremes, who together outnumber the middle by three-to-one or more in the debates discussed here.[201] Though the extreme groups also criticize each other, these sides are roughly equally represented.[202] Further, individuals advocating moderate positions often receive attacks from both sides for being traitors or "gutless, spineless, passionless, malleable, and shameless shills for the 'other side,'"[203] attacks that discourage them from getting involved in the conflict. These same influences also deter individuals in the polar positions from offering compromises.

Second, as long as the two extremes are of relatively equal strength, there may be a rational incentive for moderate individuals to remain on the sideline. Each polar group is likely to preclude the other from achieving extreme ends, rendering unlikely a result that is wholly distasteful to most moderates. For this reason, individuals with moderate positions may rationally decide that it is preferable to devote their resources to pursuing other preference goals, ones that they may face less of an uphill, nasty battle to achieve. Individual decisions not to organize to strongly advocate compromise positions in this view are efficient, utility-maximizing decisions.

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201.   *See supra* Part I.A.2.
202.   *See supra* Part I.A.2.
203.   J.B. Ruhl, *A Manifesto for the Radical Middle*, 38 IDAHO L. REV. 385, 386 (2002).

Third, those holding a moderate position on a given technology are likely a less organized, more diffuse group than those holding more extreme positions—moderates are not clearly unified around a particular cause. Public choice theory teaches that the positions of attenuated groups are likely to be underrepresented in decision making fora, while positions of more compact and potentially impacted groups are likely to be overrepresented.[204]

Fourth, the lack of a vocal middle also may be attributable to certain heuristics, such as the status quo and omission biases. Most individuals exhibit a status quo bias–they prefer to keep things as they are, even if another position appears to improve their overall well-being.[205] The omission bias, also well-supported experimentally, refers to individuals' tendency to consider harmful commission (positive action) to be worse than equally harmful omission (inaction).[206] Individuals holding middle positions may often lack the necessary inertia to overcome the status quo and omission biases to advocate for proactive change.

It is worth noting that simply because compromise positions are not vocally advocated does not demonstrate that these positions are unsupported. Rather, there may not be enough moderate individuals who are willing to be the first to step forward (the "instigators") to initiate more widespread moderate collective behavior.[207] Models of collective behavior, as well as the earlier analysis of cascade effects, indicate that the expression of collective action and opinion often depends on the presence of some initial instigators.[208] If these instigators are not present in sufficient numbers, then larger scale collective behavior that would otherwise take place will not occur. It is plausible that individuals holding moderate positions in a given technology conflict may have personality characteristics that tend to make them less likely to take on the role of

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204.   *See* FARBER & FRICKEY, *supra* note 59, at 72, 153 ("[D]iffuse groups will generally find it difficult to obtain legislation that benefits them at the expense of more compact groups, even where the legislation creates much greater benefits than costs.").

205.   Kahneman, *supra* note 147, at 705; Daniel Kahneman & Amos Tversky, *Choices, Values, and Frames*, *in* CHOICES, VALUES, AND FRAMES 3 (Daniel Kahneman & Amos Tversky eds., 2000); Jolls et al., *supra* note 56, at 1535–36. Loss aversion and the status quo bias have been identified as psychological barriers to parties reaching agreement over various environmental and technological issues. *See* Thompson, *supra* note 175, at 256 (identifying loss aversion as a barrier to solving tragedy of the commons problems, including global warming and climate change); Rachlinski, *supra* note 126, at 307–11 (identifying loss aversion and the status quo bias as a barrier to solving the global climate change debate).

206.   JONATHAN BARON, THINKING AND DECIDING 400 (3d ed. 2000).

207.   Mark Granovetter, *Threshold Models of Collective Behavior*, 83 AM. J. SOC'Y 1420, 1420 (1978).

208.   *See id.* at 1424–28 (discussing how slight changes in individual dispositions towards action can have dramatic effects on the aggregation of collective behavior and action); *supra* Part II.B.2 (discussing cascade effects).

instigator. In other words, moderates often may be underrepresented in technology conflicts because individuals holding these views tend to be individuals who do not incite similarly-viewed persons to collective action. The end result is that the moderate voice effectively silences itself; it does not achieve the momentum to speak out in the first instance.

That two extreme groups will stalemate each other, however, does not indicate that an optimal equilibrium position will be achieved. In particular, the end result may be an eclectic solution that benefits special interests to some extent, but is both irrational and inefficient from a social-welfare perspective.[209] Nevertheless, the disincentives discussed above often preclude moderates from entering the fray to push actively for an equitable and efficient compromise agenda.

III. Bridging Technology Conflict

The foregoing analysis presents the four major elements of the technology conflict framework. As the analysis demonstrates, none of the elements independently explains the characteristics found in polarized technology debates. Combining the elements into an integrated whole, however, yields a substantially more powerful descriptive framework.

The framework works as follows. When an individual is confronted with an issue concerning the regulation or use of a new technology, on which there is a significant degree of scientific uncertainty,[210] initial views form in a functionalist manner, pursuant to an individual's sociocultural preferences. An individual evaluates the technology to estimate its likely effects on society and develops initial preferences based on

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209.   SCHÖN & REM, *supra* note 112, at 9 (noting that intractable policy controversies lead to suboptimal policy compromises); Ruhl, *supra* note 203, at 387 (noting that the result of a passive middle in environmental debates often leads to a "mish-mash that neither of the warring sides wanted and the middle had no hand in crafting"); Sheldon W. Halpern, *The Art of Compromise and Compromising Art: Copyright, Technology, and the Arts*, 50 J. COPYRIGHT SOC'Y U.S. 273, 293 (2003) (noting that compromise solutions of interested party negotiations have only a tangential relationship to the public good); *see also* THE FEDERALIST NO. 10 (James Madison) (arguing that representative democracy can protect individuals and the general public welfare from the self-interested demands of factions).

210.   Uncertainty concerning a technology's impact, and risk related to the uncertainty, are necessary prerequisites to the application of the framework. In the absence of uncertainty and risk, individuals are expected to substantially support the technology, and there will not be a conflict over its regulation and use. The internet provides a partial example in this regard. There are no more than *de minimis* concerns about the human health and environmental risks posed by the internet, and at most a low level of economic and social concern. Not surprisingly, public opinion concerning the internet is not polarized. The Gaskell and Bauer survey found that over 70% of respondents believed that the internet "will improve our way of life," and less than 20% thought it "will make things worse." INDICATORS 2002, *supra* note 17, at 7–21.

how these effects comport with the individual's worldview. Once these initial preferences are formed, so long as scientific uncertainty remains for a period, various behavioral and psychological phenomena interact to push most individuals away from moderate positions toward more extreme ones, and to make most individuals significantly more entrenched and unyielding in their views.

Socio-cultural preference formation thus divides individual positions, and behavioral and psychological biases widen and entrench the divide. Interest group reliance on science and scientists to stake out mutually exclusive, opposing positions destabilizes the public's trust in science as an objective means for resolving the debate. The lack of a vocal middle precludes compromise positions from being strongly advocated. These detrimental self-reinforcing cycles debilitate opportunities for bridging the divide once it has formed. The outcome is inefficient and intransigent polarization. This outcome blocks resolution of the conflict through normal avenues of democratic discourse, and precludes optimal use and regulation of the technology.

Though the elements of the framework are discussed serially, in practice they cannot be disaggregated. Rather, the framework should be viewed holistically, with each element continually shaped, and in return being shaped by, the other elements and the technology conflict. Understood in this manner, the framework provides descriptive explanations for the inefficiency, deadlock, and polarization that characterize technology debates. It deciphers the enigmas of why increased scientific knowledge does not lead to increased agreement; why individuals strongly adhere to positions they lack the cognitive capacity to rationally form; why interest groups take scientifically untenable positions, but strongly rely on science to support their cause; and why social welfare-superior solutions that are more efficient and mutually beneficial are not achieved. Relatedly, it explains those characteristics that cultural theory alone could not: why there is a high degree of polarization on certain technology issues, why individuals take positions that conflict with their cultural worldview, and how certain technology conflicts are resolved based on increased scientific knowledge.

Although many of the framework influences are empirically supported, the validity of the framework as a comprehensive descriptor cannot be empirically proven (like most, if not all, socio-psychological models that are not tautological). The empirical and analytical evaluation in this Article, however, demonstrates that the framework presented provides a more powerful explanatory tool than other extant models. On

this basis, the framework not only is strongly plausible, but also likely accurately describes technology debates.[211]

Without an adequate description of why technology debates persist in a polarized, deadlocked manner it is impossible to settle them. With an improved understanding of the conflict, resolution is still a daunting task, but some promising means for advancing it can be identified. These means, discussed in the following sections, include dialogue and deliberation, debiasing, and confidence-building measures.

With this approach, I do not seek to change individual beliefs; rather my goal is to help individuals and groups recognize the preferences underlying their beliefs, and understand that those preferences often can be satisfied through mutually beneficial compromises. These solutions, of course, also have direct application to other polarized social and political debates unrelated to technology.

A. *Cultural Dialogue and Deliberation*

The framework reveals that to resolve technology conflict it is necessary to shift the terms and language of technology debates from ones based primarily in science and objective claims to a discussion that incorporates worldview differences. It is impossible to resolve a debate that is significantly about culture and differing normative views of an ideal society when the debate is framed primarily in terms of fact and data.

Reframing technology debates to incorporate worldview discussion is not easy; a variety of pressures oppose this change. First, in the United States it is more socially acceptable to debate scientific claims than it is to debate culture. Scientific claims are supposed to be open to critique–this is the nature of science as a discipline.[212] Claims sounding in culture, and particularly claims of cultural-superiority (even if limited to particular contexts), on the other hand, often are frowned upon.[213]

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211.   In this regard, it accomplishes the goal for a model defined by Maxwell Stearns: "The true test of any proposed model is neither its complexity nor its novelty. It is, instead, whether the model explains more data than the one that it is intended to supersede. The easiest way to criticize a model . . . is to identify a point of reference, or datum, that the model fails to explain. The more difficult–and more useful–way to challenge a model, however, is to offer up an alternative that explains all the data that the prior model explains, plus one." Maxwell L. Stearns, *Standing and Social Choice: Historical Evidence*, 144 U. PA. L. REV. 309, 310 (1995).

212.   POPPER, *supra* note 66, at 9–10.

213.   Kahan & Braman, *supra* note 93, at 1319 (noting that in this liberalist society, claims sounding in culture are not well tolerated); Thomas O. McGarity, *Our Science is Sound Science and Their Science is Junk Science: Science-Based Strategies for Avoiding Accountability and Responsibility for Risk-Producing Products and Activities*, 52 U. KAN. L. REV. 897, 898–99 (2004) (noting political preferences for appeals to science).

Second, despite the destabilization of science that occurs, an elevated aura of authority about scientific knowledge remains.[214] Science is viewed as more objective than culture and therefore more persuasive. Individuals will try to mask their cultural perspective when making a rhetorical argument so that the argument will not appear culturally biased, and will be more convincing and attractive to a wider audience. Arguments originating from a cultural perspective will be dressed up in scientific clothing.[215]

Third, science can play a significant role in resolving technology debates.[216] Achieving broad consensus often requires this. Individuals realize that scientific information, if persuasive enough, will strongly affect the debate and therefore rationally rely on scientific information in an effort to prevail.

Despite these barriers, parts of technology debates already take place in the arena of culture. Genetically modified product opponents' concerns about increased control of agriculture and the food supply by large corporations, about the greater industrialization of agriculture, and about a negative impact on small family farms and organic farmers, all concern how society should be organized. Similarly, biotechnology proponents' arguments for building a better, stronger, food-secure world through technology are cultural as well. The debates do contain cultural components, but lack cultural dialogue, as opposed to mere declaratory cultural statements. Without cultural dialogue, the cultural gap cannot be bridged.

Dan Kahan, Donald Braman, and John Gastil have proposed a deliberative model aimed at overcoming the entrenched divides that result from cultural worldview differences. Their model focuses on three components: overdetermined policies, vouching, and dialogue and deliberation.[217] These components are discussed in order.

Overdetermined policies are policies that can have multiple social meanings; they can mean different things to different individuals.[218]

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214.   *See* Indicators 2002, *supra* note 17, at 7-26 to 7-27 (reporting a high level of public confidence in scientists relative to other professions).

215.   *See* Nelkin, *supra* note 132, at 453 ("Though political values or moral issues may motivate disputes, the actual debates often focus on technical questions."). This is part of the reason that interest group advocacy sounds in science, even as the groups take scientifically indefensible positions.

216.   *See supra* Part II.A.2.

217.   Braman et al., A Cultural Critique of Gun Litigation 26–27 (2004) (manuscript on file with the author).

218.   *Id.* at 26. Cass Sunstein refers to this same concept as "incomplete theorization." Sunstein, *supra* note 160, at 1092. Incompletely theorized agreement occurs when individuals agree on a course of action, despite disagreeing about the basis for the decision. *Id.* John Rawls' concept of "overlapping consensus" is similar as well, referring to agreement on a

Developing overdetermined policies does not resolve a cultural conflict itself; after all, one of the central understandings of cultural theory is that these conflicts cannot be resolved–they are necessary for cultures to exist in the first instance. Rather, overdetermined policies allow individuals of differing worldviews to agree on one policy, even while disagreeing on its meaning or purpose.

The proposed partial solutions to the biotechnology and nuclear power debates identified earlier in this Article[219] provide good examples of overdetermined policies. Both pro- and anti- nuclear power constituencies can support replacing old nuclear plants with newer ones because each group can attach a different meaning to the replacement. For nuclear power supporters, it may be the promotion of technological progress and efficiency; for nuclear power opponents, it may be the reduction in health, safety, and environmental risk. Similarly, improving genetically modified product regulation may sound in improved efficiency for proponents and in risk reduction for opponents.

The second component is vouching–the need for figures with cultural authority from various cultural worldviews to publicly support a given solution.[220] It is not enough for government officials to vouch for the safety of a technology because, although these officials may be enough for hierarchists, they likely will not convince individualists or egalitarians.[221] Scientists may provide adequate cultural authority for some individualists and hierarchists, but not for egalitarians. Heads of activist organizations, on the other hand, may provide cultural authority for many egalitarians, but not for hierarchists.

In areas of significant complexity and uncertainty, individuals likely are particularly inclined to turn to the views of others who are culturally respected to inform their opinion. This inclination will be even stronger where individuals generally lack first-hand knowledge or experience with a technology, as with those discussed here.[222] To be successful, any solution to technology conflict will need a variety of cultural authority support.

The third component is dialogue and deliberation. Culture-conscious dialogue and deliberation can take place to settle on a policy choice, but only if the discussion focuses explicitly on values, not just

political conception that is endorsed by different individuals for different reasons. RAWLS, *supra* note 57, at 184–85.

219.   *See supra* Part I.B.1–2.

220.   Braman et al., *supra* note 217, at 27.

221.   This helps to explain why many risk communication programs are not very successful–the manner in which the information is communicated often does not comport with the culture of the targeted individuals. *See* Slovic, *Trust, supra* note 97, at 88 (noting risk communication efforts fail where the information recipient does not trust the communicator).

222.   Rohrmann & Renn, *supra*, note 97, at 31.

competing scientific claims. The dialogue is aimed at helping different groups learn about each other and each other's views, with a goal of cultural accommodation and understanding.[223] Once these objectives have been achieved, a substantive policy deliberation can begin, aimed at developing widely-acceptable policy solutions.[224]

Evidence suggests that dialogue and deliberation can lead individuals to better understand differing points of view. The National Issues Convention, for example, brought together a random national sample of over 400 United States citizens to spend four days in small group discussions on political issues including family policy, foreign policy, and economic policy.[225] The participants were polled on their positions concerning a wide-variety of issues related to these three policy topics both before and after the Convention. Material to the analysis here, a significant number of people changed their position on every one of the fifty-nine issues they were polled about as a result of this deliberation. The percentage of participants changing their positions ranged from over 14% to over 50% on the various questions, with most questions having a change in the upper end of this range.[226] Further, the average position of all participants displayed a statistically significant shift on half of the position questions.[227]

The participants at the National Issues Convention behaved in a manner conducive to productive dialogue and deliberation. Both the participants and observers perceived that the participants showed respect for the opinions of others, listened to each other, and enjoyed talking to people with different backgrounds and political beliefs.[228] As a result, the participants learned from each other and tried to connect with each other.[229] Further, with respect to resolving technology conflict, the participants routinely proposed solutions to the problems discussed.[230]

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223.   Braman et al., *supra* note 217, at 28, 30.

224.   *Id.* at 34.

225.   James S. Fishkin & Robert C. Luskin, *Bringing Deliberation to the Democratic Dialogue*, *in* THE POLL WITH A HUMAN FACE: THE NATIONAL ISSUES CONVENTION EXPERIMENT IN POLITICAL COMMUNICATION 3 (Maxwell McCombs & Amy Reynolds eds., 1999). The participants were provided with short briefing material describing three positions on each of the three main policy topics. *Id.*

226.   *Id.* at 25–27.

227.   *Id.* at 25.

228.   Tom W. Smith, *The Delegates' Experience*, *in* THE POLL WITH A HUMAN FACE: THE NATIONAL ISSUES CONVENTION EXPERIMENT IN POLITICAL COMMUNICATION 39, 46 (Maxwell McCombs & Amy Reynolds eds., 1999).

229.   Roderick Hart & Sharon Jarvis, *We the People: The Contours of Lay Political Discourse*, *in* THE POLL WITH A HUMAN FACE: THE NATIONAL ISSUES CONVENTION EXPERIMENT IN POLITICAL COMMUNICATION 59, 81 (Maxwell McCombs & Amy Reynolds eds., 1999); Smith, *supra* note 228, at 47.

230.   Hart & Jarvis, *supra* note 229, at 81.

Another effort at dialogue and deliberation, focused on an issue directly relevant to this Article, was the Pew Initiative on Food and Biotechnology's Stakeholder Forum. Periodically from 2001 to 2003, the Stakeholder Forum brought together various stakeholders directly engaged in the genetically modified food debate in an effort to build consensus on issues concerning this technology.[231] The Stakeholder Forum members were able to agree on the general outcomes, principles, and components of a regulatory system, but were not able to reach agreement in significant detail.[232] The members did agree that the dialogue was "very constructive" and that the Forum provided "a valuable opportunity for members to be exposed to different ideas and perspectives, learn from each other, and forge new relationships."[233] One reason the Stakeholder Forum did not achieve greater consensus may be its failure to explicitly include representatives with moderate views; polarized interest groups appear to have been over-represented at the Forum, and individuals with moderate positions under-represented.

Dialogue and deliberation also should have several second-order effects that attenuate the impact of certain negative behavioral and psychological phenomena. Discourse among individuals with varied preferences should aid in reducing the effect of group polarization. A prerequisite of group polarization is that the initial preferences of the group members all fall on one side of an issue. Groups of individuals who have mixed initial preferences, on the other hand, tend to reduce their polarization through deliberation.[234] Relatedly, groups made up of individuals with differing positions demonstrate less of a confirmation bias in their information searches and analyses.[235] This type of discourse also should make a greater variety of images available to individuals, reducing the polarizing effects of interest group framing,[236] the availability heuristic, and informational and reputational cascades.

The National Issues Convention in particular, as well as the Stakeholder Forum, demonstrate that dialogue and deliberation can cause individual and group positions to change significantly. Such discourse

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231.   PEW INITIATIVE ON FOOD AND BIOTECHNOLOGY, THE STAKEHOLDER FORUM ON AGRICULTURAL BIOTECHNOLOGY: AN OVERVIEW OF THE PROCESS 3 (2003), *available at* http://pewagbiotech.org/consensus/FinalReport.pdf [hereinafter PEW INITIATIVE] (last visited May 11, 2005). Participants included representatives from the biotechnology industry, environmental and consumer advocacy groups, farming and ranching communities, food processing and marketing companies, and academia. *Id.*

232.   *Id.*

233.   *Id.* at 3–4.

234.   Amiram Vinokur & Eugene Burnstein, *Depolarization of Attitudes in Groups*, 36 J. PERSONALITY & SOC. PSYCHOL. 872, 884 (1978).

235.   Schulz-Hardt et al., *supra* note 172, at 666.

236.   *See* Vraneski & Richter, *supra* note 14, at 246 (noting that discourse can promote reframing of issues).

promotes an environment for discussing worldview differences as well as scientific evidence, and it also attenuates the influence of several behavioral and cognitive biases. On these bases, dialogue and deliberation can be a productive means for defusing polarized technology conflict.

B. *Debiasing*

The numerous behavioral and psychological barriers that enhance polarization and deadlock mean that simply engaging in culturally forthright dialogue and deliberation will not be enough to resolve the technology conflicts at issue. Even an open cultural dialogue cannot be expected to overcome the impacts of various heuristics, the effects of group polarization, and the status quo bias. Many of these biases tend to make individuals view people with differing opinions as non-objective, self-serving, and unduly ideological.[237] As a result, methods for helping individuals understand how their views of the other side and the other side's position have become biased are required. Individual judgment must be debiased from the behavioral and psychological phenomena that increase polarization and deadlock.[238]

Unfortunately, psychological and behavioral biases have proven extremely robust in the face of varied efforts to eliminate them or lessen their impact.[239] One debiasing failure is particularly noteworthy here: having opposing individuals or groups of individuals discuss their differing viewpoints does not attenuate biases.[240] Often discussion among opposing individuals and groups further exacerbates polarization and perceived polarization, as each individual interprets the content of the discussion to reinforce their own position and weaken their opponent's, likely due in part to the biased assimilation of new data.[241]

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237.   *See supra* Part II.B.

238.   Another strategy would be to take advantage of countervailing heuristics that may tend to reduce polarization and deadlock ("if you can't beat them, join them"). One example would be to try to increase the effect of the compromise bias on individual judgment. This bias causes individuals to avoid choosing extreme outcomes. *See supra* note 189 and accompanying text. Trying to increase the influence of judgmental biases, however, is not well understood, and more importantly, is ethically problematic. In addition, one still will have to debias the influence of other heuristics.

239.   *See generally* Fischoff, *supra* note 166 (surveying debiasing efforts in a wide variety of studies).

240.   *See supra* Part II.B.1; Pronin et al., *supra* note 145, at 652–53.

241.   *See supra* Part II.B.1; Pronin et al., *supra* note 145, at 652–53. How biases impact group decision-making also is crucial to resolving technology conflict. Unfortunately, whether decision-making groups are more or less prone to bias than individuals is a complex issue without simple trends–group decision-making can exacerbate or ameliorate bias in manners that are not yet understood. Norbert L. Kerr et al., *Bias in Judgment: Comparing Individuals and Groups*, 103 PSYCH. REV. 687, 692–93 (1996); *see* Samuel Issacharoff, Comment, *Behavioral Decision Theory in the Court of Public Law*, 87 CORNELL L. REV.

Despite the intransigence of cognitive and behavioral biases, their effects are not absolute. For instance, roughly half the respondents to the National Science Board's survey thought that genetically modified food was risky, but approximately 70% perceived it to be useful.[242] These data demonstrate that the affect heuristic and cognitive dissonance avoidance do not entirely control individual preferences. Similarly, the discussion of global warming and the risk of brain cancer from cellular telephone use demonstrate that the biased assimilation of new data and confirmation bias are not unsurmountable.

Recent work concerning debiasing has focused on how individuals process information.[243] Individuals comprehend reality and process information through two parallel cognitive systems. One is an intuitive experiential system ("intuition"); the other a deliberative, analytic system ("reasoning"). Intuition operates in a fast, automatic, and associative manner; it is often emotionally charged and governed by habit, so it is difficult to control or modify.[244] Reasoning operates in a slower, serial, effortful manner; it is more consciously controlled and deliberative than intuition.[245] The two cognitive methods operate in parallel, but not in isolation. The impressions created by intuition generally control judgments and preferences. Reason, however, continually monitors intuition and will override an intuitive judgment or preference if it appears to be in error.[246]

Understanding how individuals perceive reality and process information points to two potential debiasing methods. The first is to make different information more available to individuals and to exploit individual intuitive biases. This solution, however, provides little practical application for technology debates concerning genetically modified products or nuclear power. Neither issue can be usefully contained in a narrowly limited amount of accessible information. In addition, trying to identify what this limited amount of accessible information should be would lead one right back into the polarized and deadlocked debate.

The second potential debiasing method is more promising but potentially even more difficult to achieve. This method requires a shift in individuals' manner of cognitive judgment concerning technology from

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671, 672–73 (2002) (noting the lack of experimental studies concerning how individual behavioral phenomena manifest themselves in complex institutional settings).

242. INDICATORS 2002, *supra* note 17, at 7–18.
243. Kahneman, *supra* note 147, at 698, 700.
244. *Id.*
245. *Id.* Intuition and reasoning also have been labeled System 1 and System 2, respectively. *Id.*
246. *Id.* at 710–11, 716. Errors in judgment thus involve a failure of both systems: intuition which generated the erroneous judgment, and reason which failed to catch and correct it. *Id.*

one based on intuition to one based more on reasoning. As a result, in-
dividuals would become more aware of intuitive errors they make and
would analyze technology issues more carefully.[247] How to cause a shift
from intuition to reasoning, however, is a complex problem on which
research has just barely begun.[248]

Directing individuals to consider why their position might be wrong
or to step into the opposition's shoes may be one method of achieving
this reasoning shift, and is one debiasing strategy that has shown prom-
ise.[249] Individuals required to express what they consider the other side's
best arguments subsequently view the other side as less extreme and
perceive the opposing sides to be closer together (less polarized) than
previously.[250] Having individuals who support a technology list all of its
risks, or individuals who oppose a technology list all of its benefits, may
be another way to accomplish this goal. In this regard, recall that a gen-
eral failure to consider why a position one holds could be wrong has
been suggested as a cause of certain biases.[251]

It is worth noting that some degree of paternalism or government in-
tervention is appropriate to achieve these ends precisely because it is a
debiasing effort.[252] Behavioral economics and cognitive psychology re-
search teach that heuristic phenomena lead individuals to make
judgments and take actions they would not choose if the judgments were

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247.   *Id.* at 711 (noting that people will correct, and possibly even overcorrect, intuitive
errors when they are made aware of them).

248.   *See id.* at 716 (identifying this as an area that needs research).

249.   Chapman & Johnson, *supra* note 168, at 134; Pronin et al., *supra* note 145, at 653;
Fischoff, *supra* note 166, at 438; Charles G. Lord et al., *Considering the Opposite: A Correc-
tive Strategy of Social Judgment*, 47 J. PERSONALITY & SOC. PSYCHOL. 1231, 1241 (1984)
(finding that the confirmation bias is attenuated if individuals are instructed to consider al-
ternatives).

Jeffrey Rachlinski and Cynthia Farina identify President Kennedy's use of his brother in
an explicit "devil's advocate" role as a productive means of reducing overconfidence bias
among President Kennedy's advisors. Jeffrey J. Rachlinski & Cynthia R. Farina, *Cognitive
Psychology and Optimal Government Design*, 87 CORNELL L. REV. 549, 561–62 (2002).
This role is comparable to directing individuals to try to argue from opposing perspectives.

250.   Pronin et al., *supra* note 145, at 653. Getting individuals to view technology issues
from the other side is certainly easier said than done. In addition to cognitive barriers already
discussed, it also will require individuals overcoming the egocentrism bias. This bias refers
to individuals' general inability to take another person's perspective, and relatedly, to assume
that other people's perspectives are the same as their own. Raymond S. Nickerson, *How We
Know–and Sometimes Misjudge–What Others Know: Imputing One's Own Knowledge to
Others*, 125 PSYCHOL. BULL. 737, 738 (1999).

251.   Chapman & Johnson, *supra* note 168, at 134.

252.   *See generally* Colin Camerer et al., *Regulation for Conservatives: Behavioral
Economics and the Case for "Asymmetric Paternalism"*, 151 U. PA. L. REV. 1211 (2003)
(arguing that paternalistic regulation is appropriate where individual decisionmaking is
flawed due to biases); Sunstein, *supra* note 160, at 1073–74; Jolls et al., *supra* note 56, at
1541 (arguing that understanding bounded rationality leads to an anti-antipaternalistic posi-
tion).

fully understood. Intervention aimed at assisting individuals in making fully informed, reasoned judgments to improve each individual's own welfare is legitimate under almost any political model.[253] Achieving these debiasing efforts will reduce polarization and deadlock, and if implemented early enough, will prevent them from becoming exacerbated in the first instance.

C. *Confidence-Building Measures*

Confidence-building measures are a potentially productive tool for resolving technology conflict.[254] Confidence-building measures are a concept developed in international relations. They are relatively quick and inexpensive incremental measures that reduce tension and build trust between parties in a conflict. Confidence-building measures do not seek to solve a conflict immediately, but rather to provide concrete steps that all parties can agree upon, in part to de-escalate tension in a conflict. Through improving communication and uniting the parties in common short-term goals, these measures can create a climate more conducive to negotiation and to reaching consensus on permanent solutions to a conflict.[255]

The technology conflict framework reveals that confidence-building measures are likely a necessary first step in resolving technology debates. Because of the elevated levels of cultural conflict and acrimony that have developed in these debates, they likely cannot be resolved without first reducing tension and building trust between opposing parties to create an environment more conducive to further negotiation regarding the conflict directly. The recommendations for resolving technology debates identified above fit neatly within the concept of confidence-building measures. Forthright cultural dialogue will improve communication and lower tensions. Having individuals proactively consider why their position may be wrong or provide the other sides' best arguments will lead to greater mutual understanding of differing positions and concerns, reducing acrimony between the parties and building trust.[256] The Stakeholder Forum demonstrates the potential value of confidence-building measures. Though the parties ultimately were unable to

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253.   Cass R. Sunstein & Richard H. Thaler, *Libertarian Paternalism Is Not an Oxymoron*, 70 U. CHI. L. REV. 1159, 1161–62 (2003) (arguing for paternalism "to steer people's choices in directions that will improve the chooser's own welfare"); Camerer et al., *supra* note 252, at 1211–14.

254.   *See* Mandel, *supra* note 192 (proposing the use of confidence building measures to resolve the genetically modified product debate).

255.   *Id.* at 42.

256.   *See* SCHÖN & REM, *supra* note 112, at 195–96 (discussing the importance of building trust to resolve policy controversies).

agree on a comprehensive regulatory plan, they believed that their dia-
logue and deliberation was "very constructive" and enabled them to
"learn from each other."[257] In addition, the Forum participants agreed
that further discussions aimed at pursuing consensus were warranted.[258]

Deliberation need not take place in an information vacuum. The par-
ticipants at the National Issues Convention were provided with jointly
developed briefing materials describing three different positions ("lib-
eral," "moderate," and "conservative") on each of the issues discussed
there.[259] Similar materials could be developed for technology issues as a
means of education concerning actual benefits and risks. These materi-
als could be prepared by various interest groups, including scientists and
others. Involving parties with various worldviews in drafting the brief-
ing materials will enable the materials to be accepted by individuals
with differing worldviews.[260]

Confidence-building measures do not seek to change individual
preferences, but to enable individuals to better understand others' pref-
erences and to recognize that differing preferences may be satisfied in a
single solution. One of the lessons of cultural theory is that expressed
disagreement may result from divergent perceptions of risk, rather than
different goals in the first instance. Hierarchists, individualists, and
egalitarians all may strongly support the goal of a healthy environment.
They may disagree, however, on whether genetically modified products
or nuclear power pose significant environmental risks. Recognizing mu-
tual goals in these instances will make the task of reaching agreement
significantly easier, particularly in situations where scientific knowledge
develops toward a consensus regarding whether certain risks should be
discounted or recognized.

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257.   *See supra* text accompanying note 233. Though partially successful as a confi-
dence-building measure, the Stakeholder Forum may have failed in part because of its
limited inclusion of representatives holding moderate or compromise positions. *See id.*

258.   PEW INITIATIVE, *supra* note 231, at 4.

259.   Fishkin & Luskin, *supra* note 225.

260.   Mariano-Florentino Cuellar's proposal to improve public participation in agency
rulemaking contains certain similarities to the proposal provided in this Article. *See* Cuellar,
supra note 55 (studying public participation in agency rulemaking). Cuellar proposes an
independent "participation agency" that would select members of the public to learn about,
and participate in discussions about, proposed regulatory rules. *Id.* at Part III.B. The partici-
pation agency would provide the participants with risk and cost benefit analysis materials
about the regulation, and provide moderators to facilitate the discussion. *Id.* The goal of such
participation is to improve the sophistication and salience of individual members of the pub-
lic's input on regulatory rulemaking, and to provide a better mechanism for taking into
account public values in regulatory rulemaking. *Id.* at Introduction, Part III.B.

Alternatively, a group made up of experts with various worldviews could be established
to engage in some degree of fact-checking of interest group claims. Such a group may have a
difficult time maintaining an aura of reliability as it would often come under attack from
both polar positions on many issues.

Giving experts an explicit role in the dialogue and deliberation also may reduce some of the cognitive limitations discussed earlier. Experience and expertise help individuals overcome cognitive biases in certain circumstances, for instance by having learned from similar situations and decision-making previously, and from expert training.[261] On the other hand, experts sometimes demonstrate greater cognitive biases than laypeople, a more extreme overconfidence bias being one oft-demonstrated example.[262] Allowing lay individuals to engage in deliberation, with input from experts, may provide the best means for taking advantage of each group's strengths (e.g., lay sensibilities and expert knowledge) while limiting the extent of each group's biases (e.g., lay inability to deal with factually complex judgment and expert overconfidence).

Integrating scientific knowledge in the manner described above also may ameliorate concerns some scientists feel about getting involved in what are seen as political policy and legal debates. Many scientists perceive that they should remain disinterested in the policy issues of technology debates, providing only factual scientific information. For this reason scientists often are disinclined to get involved and share their knowledge at all.[263] This attitude exacerbates the destabilization and politicization of science. The scientific community has a significant role to play in resolution of technology debates, both because many of the concerns involve scientific questions and because it is regarded with one of the highest levels of public confidence.[264] Involving scientists in the manner described above should provide an acceptable and comfortable way of achieving this goal. In addition, integrating scientists and scientific knowledge into the general dialogue and deliberation will help to re-stabilize the public's destabilized view of science, particularly as the public may come to recognize that there actually is significant scientific agreement on many of the issues involved.[265]

The technology conflict framework reveals that risk preference is a function of both scientific knowledge and cultural worldview. In extreme instances one factor can dominate the other: if there is near-complete uncertainty, culture dominates; if there is near-zero uncer-

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261.   *See* Rachlinski & Farina, *supra* note 249, at 558–61 (discussing how experts have advantages over laypersons with respect to having their judgment improperly influenced by cognitive biases because of past experiences with similar problems, the opportunity for feedback on past decisions, and expert training).

262.   Griffin & Tversky, *supra* note 164, at 230.

263.   Thompson, *supra* note 175, at 273 (noting one problem with convincing scientists to advocate for science-based positions is the scientists' concern that they should remain disinterested).

264.   INDICATORS 2002, *supra* note 17, at 7–26, 7–28.

265.   *See* Mandel, *supra* note 39, at 2179–80 n.32 (discussing significant expert agreement on the scientific benefits and risks of genetically modified products).

tainty, science dominates. In the substantial majority of circumstances, however, uncertainty lies somewhere between these poles, and both science and culture influence preferences. Unfortunately, these two factors are often conflated, blocking recognition and understanding of their actual impact. Confidence-building measures provide a means for both science and culture to play their appropriate, distinct roles in resolving technology conflict.[266]

Resolving technology conflict will require an initial group of highly-committed individuals with varied worldviews who are interested in cultural and scientific dialogue, engaging in debiasing efforts, and exploring overdetermined polices. As discussions evolve, this group will need to draw in individuals with cultural authority from various worldviews who can vouch for the process and the solutions being explored. Once these first steps have been achieved, parties can turn productively to second-order levels of dispute resolution. These may include the identification of common goals and interests, and seeking mutually beneficial solutions to portions of the conflict. That individuals have different cultural worldviews or are polarized in their positions does not preclude them from finding common goals. Overdetermined solutions often exist, as proposed earlier in this Article for both the biotechnology and nuclear power conflicts. Individuals with differing opinions can find different reasons to support the same goal. Vouching, in turn, will help to cause certain of the polarized interest groups and other individuals to join this process, eventually leading to a critical mass that can effect change.

Identifying common goals and developing broad-based solutions will steel those trying to resolve the conflict against conflict entrepreneurs, who will attempt to prevent resolution, or even partial resolutions, from being achieved. In a certain sense, the solutions proposed here aim to shift the outcome of technology conflict from a polarized status quo that has been co-opted by conflict entrepreneurs for their special interests to a social welfare-superior result that is mutually beneficial to a vastly wider population. Conflict entrepreneurs will oppose the change forcefully–they have much to lose and are well experienced in promoting conflict. To overcome this pressure, it is necessary to make the benefits of solution clear to a wide variety and large number of individuals.

Convincing individuals to engage in the forgoing tasks will not be simple. Many individuals may exhibit significant indifference to technology conflict issues and to a greater consideration of those issues, or

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266.   *See* Cuellar, *supra* note 55, at Introduction, Part III.B (recognizing that risk, cost-benefit analysis, and values all must be taken into account in agency rulemaking decisions).

they may exhibit rational ignorance towards debates they view their involvement as unlikely to change. Several mechanisms and influences should help overcome the inertia of indifference and rational ignorance. First, the research reported above demonstrates that individuals do value learning more about issues and more about various viewpoints on issues.[267] Second, a study of public comment on proposed federal regulation revealed that individual members of the public are interested in, and provided salient comment on, diverse regulation.[268] Third, the high level of public interest in technology issues, as well as the existing involvement of interest groups, will attract many individuals to learn more.[269] Fourth, the involvement of figures with cultural authority from various worldviews will engage as many people as possible.[270]

Parallel to the endeavors identified above should be efforts to reduce scientific uncertainty concerning the relevant technology. These efforts must be cast at all three levels of technological uncertainty: the facts surrounding the technology, the risks and benefits indicated by those facts, and how to respond to the risks and benefits.[271] As discussed, scientific knowledge can lead to greater consensus. It is not possible to know beforehand when the scientific tipping point will be reached, but this should not deter attempts to improve scientific knowledge and understanding. Reducing uncertainty, in turn, likely requires devoting greater resources to scientific research.

CONCLUSION

Technology wars extract a great toll on society. They create costly inefficiencies, lead to legal and policy paralysis, consume vast resources, and prevent the optimal use and regulation of technology. Despite these substantial consequences, little attention has been paid to placing the conflicts within a common framework. The attention that has been given has focused almost exclusively on institutional decision-making and has largely ignored the role that individual preference formation, behavior, psychology, perception, and action play in technology controversies. The technology conflict framework developed here seeks to fill this void.

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267.   *See supra* notes 225–233 and accompanying text.
268.   Cuellar, *supra* note 55, at Parts II.D.2, II.E.
269.   *See* INDICATORS 2002, *supra* note 17, at 7–4 to 7–5 (reporting a high level of public interest in science and technology issues).
270.   *See supra* notes 220–222 and accompanying text.
271.   *See supra* text accompanying note 199.

The framework identifies the critical roles that both culture and science play in shaping individual technology preferences, and reveals that these roles often are conflated and blurred, leading to polarization and dysfunctional debate. Achieving a frank discussion of culture and a clear view of science will go a long way toward creating a productive democratic discourse that can resolve technology debates. The solutions described provide a road map for using confidence-building measures to generate support for social welfare-improving solutions, starting with small groups and building to larger constituencies, eventually cascading to a tipping point that will lead to widespread implementation.

The culmination of the resolution efforts described above should be the development of greater consensus among a broad coalition of constituencies about goals for the use and regulation of a given technology, and the manner of achieving those goals. Such consensus would result in substantial improvement in individual and social welfare, both because mutually beneficial solutions to the technology conflict can be achieved and because these solutions will free up resources for all parties to use in more socially productive manners. Resolving technology conflict will provide further benefit by allowing greater technological advance. This advance will occur both as some of the recovered resources are devoted to additional research and development, and because the existence of polarization retards technology investment and efforts. Though the effort required to ameliorate technology conflict is significant, the potential gains are extraordinary.

The analysis contained is this Article applies to the genetically modified product and nuclear power debates discussed, as well as to any technology debate in which scientific knowledge can provide relevant and reliable information, but due to remaining uncertainty about benefits and risks does not appear to properly influence individual preferences. In coming years, debates over social, economic, and environmental impacts of nanotechnology are a prime candidate for demonstrating these inefficiencies.

Substantial portions of this framework can be applied to apparently intractable debates outside of the science and technology spheres. Many of the issues analyzed in the framework go fundamentally to individual preference formation and retention, and relatedly, to many forms of conflict and conflict resolution. The framework presented here provides a basis for resolving polarized, deadlocked debates in many areas.

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The questions posed in the first paragraph of this Article are not easily answered. Determining the optimal regulation of genetically modified products, nuclear power, and nanotechnology are complex issues. Application of this framework, however, will remove unnecessary inefficiency and polarization from these debates, and nurture a functional democratic discourse that can defuse these technology wars.