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SHAPING CODE*

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I. INTRODUCTION

One of the most significant theoretical advancements in the legal academy is the recognition that law is not the exclusive method of social regulation. Other methods, such as social norms and architecture, are available to help control and regulate social development.[1] This recognition has led researchers from a variety of disciplines to investigate the role information technology architecture plays in shaping our online experiences and activities.[2] This architecture includes the design and interaction of the hardware and software components of information technology. The Article uses the term "code" to refer to information technology architecture.[3]

This recognition also extends beyond the legal academy, as policymakers are beginning to look beyond purely legal solutions toward implementation of code-based solutions to societal problems.[4] Increasingly, code-based solutions are applied to societal concerns like preventing crime,[5] fostering competition,[6] limiting inappropriate

1. Among the most influential works on social norms are ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991); ERIC A. POSNER, LAW AND SOCIAL NORMS (2000); LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE (1999) (discussing the interrelationship among architecture, social norms, markets, and law in shaping property and regulatory schemes); Amitai Etzioni, *Social Norms: Internalization*, *Persuasion*, *and History*, 34 L. & SOC'Y REV. 157 (2000); Richard H. McAdams, *The Origin*, *Development*, *and Regulation of Norms*, 96 MICH. L. REV. 338 (1997).

2. *See* CARL SHAPIRO & HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY (1999) (discussing how the architecture of information technology can affect informational economics); François Bar, *The Construction of Marketplace Architecture*, *in* BRIE-IGCC ECON. PROJECT, TRACKING A TRANSFORMATION: E-COMMERCE & THE TERMS OF COMPETITION IN INDUSTRIES 27 (2001) (discussing how consumer choice and market outcomes can be affected by the architecture of information technology); Paul DiMaggio et al., *Social Implications of the Internet*, 27 ANN. REV. SOC. 307 (2001) (discussing the need for sociologists to attend to the architecture of information technology); Andrew J. Flanagin et al., *The Technical Code of the Internet/World Wide Web*, 17 CRITICAL STUD. MASS COMM. 409 (2000) (discussing the role of the architecture of information technology for communication scholars).

3. However, our references to existing uses of the term "code," such as "source code" and "regulatory code," still carry their commonly understood meanings.

4. *See, e.g.*, TIMOTHY D. CROWE, CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (2d ed. 2000); Neal K. Katyal, *Architecture as Crime Control*, 111 YALE L.J. 1039, 1041–42 (2002).

5. *See, e.g.*, Neal K. Katyal, *Criminal Law in Cyberspace*, 149 U. PA. L. REV. 1003 (2001).

6. The open access movement is based upon the principle that architecture can support competition as well as provide a platform to support innovative applications. *See* Mark A.

speech,[7] protecting privacy,[8] increasing security,[9] ensuring fair use in copyright,[10] and revitalizing democratic discourse.[11]

Policymakers, however, have had to rely on their own insights and experiences when developing code-based solutions, as no comprehensive analysis is available to help guide the government in regulating, shaping, and reshaping the architecture of information technology. This Article addresses this lacuna by defining and categorizing the various regulatory methods that policymakers can use when weighing the benefits and limitations of each approach. It builds on previous work by Joel Reidenberg and others to construct a framework that allows policymakers to influence, encourage, and shape the development of code to address a variety of societal concerns, such as privacy, security, and competition, through the use of governmental regulatory and fiscal powers.[12]

Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925 (2001).

7. This Article discusses the use of architectural solutions for addressing the problem of minors viewing inappropriate content. A number of commentators have addressed this issue. *See, e.g.*, Lawrence Lessig & Paul Resnick, *Zoning Speech On The Internet: A Legal and Technical Model*, 98 MICH. L. REV. 395 (1999); Jonathan Weinberg, *Rating the Net*, 19 HASTINGS COMM. & ENT. L.J. 453 (1997); *see also* David E. Sorkin, *Technical and Legal Approaches to Unsolicited Electronic Mail*, 35 U.S.F. L. REV. 325 (2001) (discussing approaches to limit unsolicited bulk e-mail); CASS SUNSTEIN, REPUBLIC.COM 182–89 (2001) (proposing the redesign of websites to increase exposure to different viewpoints by incorporating additional links).

8. An example of an architectural solution for privacy is the Platform for Privacy Preferences (P3P) Project. *See* William McGeveran, *Programmed Privacy Promises: P3P and Web Privacy Law*, 76 N.Y.U. L. REV. 1813 (2001) (discussing P3P as a solution to privacy problems); *see also* W3C, Platform for Privacy Preference (P3P) Project, *at* http://www.w3.org/P3P/ (last visited Apr. 12, 2005); Lorrie Faith Cranor, Web Privacy with P3P (2002); *cf.* Malla Pollack, *Opt-In Government: Using the Internet to Empower Choice — Privacy Application*, 50 CATH. U. L. REV. 653, 699 (2001) (proposing the creation of a government search engine that only links to websites that protect a user's privacy); Shawn H. Helms, *Translating Privacy Values With Technology*, 7 B.U. J. SCI. & TECH. L. 288, 290–291 (2001) (arguing that government, privacy advocacy groups, technology companies, and users should support the adoption of privacy enhancing technologies).

9. *See* PRESIDENT'S CRITICAL INFRASTRUCTURE PROTECTION BD., THE NATIONAL STRATEGY TO SECURE CYBERSPACE (Feb. 2003) (suggesting a number of architectural solutions for improving security), *available at* http://www.whitehouse.gov/pcipb/.

10. *See, e.g.*, Dan L. Burk & Julie E. Cohen, *Fair Use Infrastructure for Rights Management Systems*, 15 HARV. J.L. & TECH. 41 (2001) (providing an example of an architectural solution to allow fair use in digital intellectual property); Michael J. Madison, *Complexity and Copyright in Contradiction*, 18 CARDOZO ARTS & ENT. L.J. 125 (2000) (using the architectural metaphor to examine copyright law). The media industry has vocally supported architectural solutions that protect intellectual property. *See, e.g.*, Amy Harmon, *Hearings on Digital Movies and Privacy*, N.Y. TIMES, Mar. 1, 2002, at C4.

11. *See* ANTHONY G. WILHELM, DEMOCRACY IN THE DIGITAL AGE: CHALLENGES TO POLITICAL LIFE IN CYBERSPACE 44–47 (2000); Cathy Bryan et al., *Electronic Democracy and the Civic Networking Movement in Context*, *in* CYBERDEMOCRACY 1 (Roza Tsagarousianou et al. eds., 1998).

12. *See* Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553, 588–91 (1998) (addressing how public policy can change code); *see also* STUART BIEGEL, BEYOND OUR CONTROL?: CONFRONTING THE LIMITS OF OUR LEGAL SYSTEM IN THE AGE OF CYBERSPACE (2001)

This Article contributes to three different literatures. First, it augments the regulatory literature with a work tailored to information technology. It does so largely by building upon Justice Stephen Breyer's seminal work on regulatory theory.[13] The resulting framework provides a comprehensive approach for regulating the Internet. Second, this Article contributes to the emerging literature on the use of code as a regulatory mechanism. Code, rather than the threat of legal sanctions, is used to modify or limit users' behavior. In the process of developing this framework, it draws attention to numerous ways in which code is or can be used by government as a regulatory mechanism. Third, this Article contributes to the communications literature by highlighting how government shapes the medium of cyberspace. While communications scholars have focused on how code is developed, they have overlooked the numerous ways in which government has traditionally shaped communications technology to address societal concerns.[14]

This Article may seem anathema to the current conventional wisdom that government must keep its hands off the Internet; indeed, Andrew Pincus, former U.S. Department of Commerce General Counsel, emphatically argues that "the needs and dynamics of the marketplace, and not governments, must guide standards development and implementation activities. Governments should refrain from issuing technical regulations and instead should rely, to the maximum extent possible, on the private sector to self-regulate."[15] Belying the force of the rhetoric, however, is the reality that government has been, is, and will continue to be heavily involved in shaping the development and implementation of code for information technology. For example, consider recent legislation on unsolicited e-mail and regula-

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(discussing a broad framework for regulating cyberspace); *see generally* David M. Hart, *U.S. Technology Policy: New Tools for New Times*, NIRA REV. (Summer 1998) (providing a good summary of the various methods government can use to shape the development of technologies), *available at* http://www.nira.go.jp/publ/review/98summer/hart.html; OFF. OF TECH. ASSESSMENT, GOVERNMENT INVOLVEMENT IN THE INNOVATION PROCESS (1978), *available at* http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk3/1978/7809/780904.PDF (last visited Apr. 23, 2005) (discussing various methods for government to shape technologies).

13. STEPHEN G. BREYER, REGULATION AND ITS REFORM (1982).

14. Much of the communications literature focuses on how corporations shape the medium. *See* VINCENT MOSCO, THE POLITICAL ECONOMY OF COMMUNICATION: RETHINKING AND RENEWAL (1996); Robert McChesney, *The Political Economy of Global Communication*, *in* CAPITALISM & THE INFORMATION AGE 1 (Robert McChesney et al. eds., 1998). Newer work recognizes other institutions, such as the open source movement, in the development of communications technology. *See, e.g.*, Jay P. Kesan & Rajiv C. Shah, *Deconstructing Code*, 6 YALE J. L. & TECH. 277 (2004).

15. *The Role of Standards in Growth of the Global Electronic Commerce*: *Hearing Before the Subcomm. on Sci.*, *Tech. & Space*, *House Comm. on Commerce*, *Sci. & Tech.*, 106th Cong. (1999) (statement of Andrew J. Pincus, Gen. Counsel, Dep't of Commerce), *available at* http://www.ogc.doc.gov/ogc/legreg/testimon/106f/pincus1028.

tions requiring cell phone number portability.[16] In addition to the proposals mentioned above, the government is also involved in shaping the development of code for reasons involving antitrust,[17] national security,[18] protection of intellectual property rights,[19] accessibility,[20] safety,[21] and content labeling.[22] Regulating the development of infor-

16. *See* Controlling the Assault of Non-Solicited Pornography and Marketing Act of 2003, Pub. L. No. 108-187, 177 Stat. 2699 (2003); Telephone Number Portability, 68 Fed. Reg. 68831 (proposed Dec. 10, 2003) (to be codified at 47 C.F.R. pt. 52).

17. For example, in the Microsoft antitrust trial, the government attempted to restrain Microsoft from using its code for illegal competitive advantages. Microsoft commingled the code of its Internet Explorer browser and Windows operating system to protect its monopoly power in violation of antitrust laws. While the remedy is still unclear, the government is influencing the design of code for the benefit of competition and ultimately for consumers. The decision holding commingly illegal was upheld by the U.S. Court of Appeals for the District of Columbia. See United States v. Microsoft Corp., 253 F.3d 34, 118 (D.C. Cir. 2001) (upholding the district court's findings of fact); *Appeals Court Rejects Microsoft, Government Requests*, VARBUSINESS/REUTERS, Aug. 2, 2001, *available at* http://www.varbusiness.com/sections/news/breakingnews.jhtml?articleId=18815252; *see also* Jay P. Kesan & Rajiv C. Shah, *Fool Us Once Shame on You — Fool Us Twice Shame on Us: What We Can Learn From the Privatizations of the Internet Backbone Network and the Domain Name System*, 79 WASH. U. L.Q. 89, 195 (2001) (noting how government modified code for competition during the privatization of the backbone network). *See generally* Andrew Chin, *Antitrust Analysis in Software Product Markets: A First Principles Approach*, 18 HARV. J.L. & TECH. 1 (2004).

18. For national security reasons, the government has restricted the sale of code. *See* Steven B. Winters & John A. Blomgren, *How the U.S. Government Controls Technology*, COMPUTER & INTERNET LAW., Jan. 2002, at 1. For example, the U.S. restricted the export of code containing strong encryption until 2000. This law forced companies, such as Netscape, to market browsers with weaker encryption systems for download outside of the United States. In January 2000, a new encryption policy allowed the export of strong encryption to most of the world. David E. Sanger & Jeri Clausing, *U.S. Removes More Limits on Encryption Technology*, N.Y. TIMES, Jan. 13, 2000, at C1. Relatedly, the government eased export restrictions on the fastest computers. John Markoff, *White House Eases Exports*, N.Y. TIMES, Jan. 11, 2001, at C4. Despite the terrorist attacks, the U.S. government is not planning to require "backdoors" that would allow government access to encrypted communications. Declan McCullagh, *Senator Backs Off Backdoors*, WIRED NEWS, Oct. 17, 2001, *at* http://www.wired.com/news/conflict/0,2100,47635,00.html.

19. To protect intellectual property rights, the government uses both civil and criminal penalties. The courts effectively shut down the music-trading program Napster for copyright violations. *See* John Borland, *Database "Upgrades" Keep Napster Down*, CNET NEWS.COM, July 6, 2001, *at* http://news.com.com/2100-1023-269367. The government prosecuted a programmer who wrote a program that circumvented Adobe's E-book format. *See* Amy Harmon & Jennifer Lee, *Arrest Raises Stakes in Battle Over Copyright*, N.Y. TIMES, July 23, 2001, at C5; Roger Parloff, *Free Dmitry? Spare Me: Why the FBI Was Right to Arrest the Internet's Latest Martyr*, INSIDE.COM, Aug. 1, 2001, *available at* http://www.law.upenn.edu/fac/pwagner/law619/f2001/week09/parloff_dmca.pdf.

20. The government regulates the design of code for accessibility as a form of public welfare. For example, the government has required television manufacturers to incorporate closed captioning for the hearing impaired. *See* Closed Caption Decoder Requirements for Television Receivers, 47 C.F.R. § 15.119 (2004); *see also* FCC, Closed Captioning, *at* http://www.fcc.gov/cgb/dro/caption.html (last visited Apr. 23, 2005). Similarly, regulations require that federal agencies must become handicapped-accessible. This has created demand for code that allows the development of accessible websites. *See* Carrie Johnson, *A More Accessible Web*, WASH. POST, Aug. 21, 2000, at E01.

21. The Federal Aviation Administration ("FAA") and the Food and Drug Administration ("FDA") regulate the development of code for public safety. *See* Leslie A. (Schad) Johnson, *DO-178B*, *Software Considerations in Airborne Systems and Equipment Certification*,

mation technology through code can be considered analogous to the architectural regulation found in buildings and cities,[23] transportation,[24] the environment,[25]and biotechnology;[26] in each case, government regulation generally seeks to prevent harm and promote benefits such as innovation.

Discussed herein are various methods government can use to shape the development of code. For each method, this Article identifies and discusses regulatory and technological issues that must be weighed when assessing alterative approaches to shaping code. The Article does not attempt to make a one-size-fits-all determination regarding the comparative efficiency for the different approaches because, in part, such an analysis is a factually laden inquiry that depends on the specific characteristics of and issues related to the type of code in question. Generally, government becomes involved when societal concerns are not addressed in the marketplace. It often uses a combination of these methods. The goal of this Article is to provide policymakers with the proper information and framework to analyze, assess, and select the most effective approach to address these societal concerns.

This Article is organized in three parts. Part II discusses how government can use its regulatory power to shape code: specifically, placing prohibitions on code, using requirements or market-based incentives, modifying liability, and requiring disclosure. It also argues that government needs to develop a comprehensive regulatory strat-

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CROSSTALK, Oct. 1998, *available at* http://www.stsc.hill.af.mil/crosstalk/1998/10/schad.asp; George Romanski, *The Challenges of Software Certification*, CROSSTALK, Sept. 2001 (discussing how to ensure safe air transportation while using computer-controlled systems), *available at* http://www.stsc.hill.af.mil/crosstalk/2001/09/romanski.html. Similarly, the FDA regulates medical device software for the benefit of public safety. These regulations require developers to use accepted software engineering practices during the development process to ensure that the software will operate properly. *See* 21 C.F.R. § 820.30 (2004); FDA, Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices (May 29, 1998), *available at* http://www.fda.gov/cdrh/ode/57.html.

22. The government has required television manufacturers to incorporate the "V-Chip," which allows parents to block inappropriate television programs. *See* Requirement for Manufacture of Televisions that Block Programs, 47 U.S.C. § 303(x) (2000). *See also* FCC, Excerpts from V-Chip Legislation, *at* http://www.fcc.gov/vchip/legislation.html (last visited Apr. 23, 2005). Similarly, the Children's Internet Protection Act ("CIPA") requires federally funded public libraries to install software to block obscene or pornographic images. *See* United States v. Am. Library Ass'n, 539 U.S. 194 (2003).

23. This literature encompasses urban planning through zoning, as well as architecture through building codes. *See, e.g.*, JOHN LEVY, CONTEMPORARY URBAN PLANNING (1999); INT'L CODE COUNCIL, INTERNATIONAL BUILDING CODE (2000).

24. *See, e.g.*, ROBERT W. CRANDALL ET AL., REGULATING THE AUTOMOBILE 155–56 (1986).

25. *See, e.g.*, PETER S. MENELL & RICHARD B. STEWART, ENVIRONMENTAL LAW AND POLICY (1994).

26. *See, e.g.*, MICHAEL J. MALINOWSKI, BIOTECHNOLOGY: LAW, BUSINESS, AND REGULATION (1999 & 2004 Supp.).

egy for code. Part III discusses fiscal measures government can employ, which include research and development funding, education and training sponsorship, and the use of the government's procurement and tax expenditures powers. Part IV analyzes how government can shape code through intellectual property rights. It discusses this shaping in a general sense and then focuses on compulsory licensing and technology transfer issues.

II. SHAPING CODE THROUGH REGULATORY METHODS

It is a well-established proposition that government can and should shape code with its regulatory power.[27] This section provides a framework that describes various regulatory methods and analyzes how each can be used to shape code. Its goal is to highlight some of the critical issues that policymakers must address when using any specific regulatory approach, providing a framework to highlight some of the critical issues that policymakers must address. This framework is preferable to a simplified formulaic approach that is bound to fail when applied to the numerous and fact-specific factors prevalent in any attempted government regulation.[28]

Thus, policymakers should consider a coherent and comprehensive regulatory strategy for code. Currently, the regulation of code is spread over a variety of agencies, including the Federal Aviation Administration ("FAA"), the Federal Communications Commission ("FCC"), the Food and Drug Administration ("FDA"), the Federal Trade Commission ("FTC"), and the National Highway Traffic Safety Administration ("NHTSA").[29] This patchwork regulatory approach fails to provide adequate guiding principles or rationales for the development of code.

In contrast, the regulatory frameworks applied in areas other than code have clear rationales that guide the development of regulation. For example, firms in the biotechnology industry are regulated by a coordinated framework of federal agencies, rather than by a single

27. The principle that government has a role in regulating the Internet has amassed considerable support. *See, e.g.*, LESSIG, *supra* note 1, at 201–02; Neil W. Netanel, *Cyberspace Self-Governance: A Skeptical View from Liberal Democratic Theory*, 88 CAL. L. REV. 395 (2000); Reidenberg, *supra* note 12; Kesan & Shah, *supra* note 17; Margaret Jane Radin & R. Polk Wagner, *The Myth of Private Ordering: Rediscovering Legal Realism in Cyberspace*, 73 CHI.-KENT L. REV. 1295 (1998); David Post, *What Larry Doesn't Get: Code, Law, and Liberty in Cyberspace*, 52 STAN. L. REV. 1439 (2000) (discussing a libertarian argument that the government may have a role in regulating the Internet); Jay P. Kesan & Andres A. Gallo, *Optimizing Regulation of Electronic Commerce*, 72 U. CIN. L. REV. 1497 (2004).

28. *See* BREYER, *supra* note 13, at 4–11.

29. The NHTSA is responsible for automobile safety. Their regulatory authority now covers code due to the ubiquitous use of computers in various motor vehicle systems — pollution control, transmission, anti-lock brakes, heating and air-conditioning, sound, steering, and electronic and mechanical systems.

agency.[30] This multi-agency approach was recommended in a report by the Office of Science and Technology Policy ("OSTP"), on the grounds that the current laws in the area were largely adequate.[31] This report led to two guidelines: first, each agency would coordinate its actions with other agencies, and second, one agency would take the responsibility for regulating each product's use. As a result, the U.S. Department of Agriculture ("USDA"), Environmental Protection Agency ("EPA"), and the FDA are each responsible for different phases in the development of biotechnology products, ranging from research in laboratories to entry into the marketplace.[32]

The Authors believe that a regulatory framework modeled after the biotechnology regulatory approach is appropriate for the regulation of code. Like biotechnology, code has many different uses and is created by a variety of industries and companies. This diversity would cause enormous difficulties for one agency attempting to regulate all forms of code. Instead, regulatory authority over product use should be vested in a single agency based on the product's specific application, not its underlying technology.[33] Recent concerns over security and terrorism have already encouraged the government to attempt to unify the coordination of code-based security among various agencies.[34] Government needs to likewise expend more resources to develop a coordinated strategy for the regulation of code.[35]

Government can employ its regulatory power in five different ways to influence the development of code, all of which are currently

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30. *Cf.* National Traffic and Motor Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 730 (1966) (establishing a single agency responsible for setting the safety standards that automobile manufacturers must meet).

31. Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23302, 23303 (June 26, 1986).

32. *See* Linda Maher, *The Environment and the Domestic Regulatory Framework for Biotechnology*, 8 J. ENVTL. L. & LITIG. 133, 139 (1993); *see also* Kurt Eichenwald, *Biotechnology Food: From the Lab to a Debacle*, N.Y. TIMES, Jan. 25, 2001, at A1 (discussing the role of industry in both helping and hindering the development of regulations for genetically modified food).

33. This is similar to the argument that the regulation of code should be application-specific and not technology-specific. *See* Timothy Wu, *Application v. Internet: An Introduction to Application-Centered Internet Analysis*, 85 VA. L. REV. 1163, 1164 (1999).

34. *See, e.g.*, *Critical Infrastructure Protection: Significant Challenges in Safeguarding Government and Privately Controlled Systems from Computer-Based Attacks Before the Subcomm. on Gov't Efficiency*, *Fin. Mgmt. and Intergovernmental Relations*, *Comm. on Gov't Reform*, *H.R*, 107th Cong. 35 (2001) (statement of Joel C. Willemssen, Managing Director, Information Technology Issues, Governmental Accounting Office), *available at* http://www.gao.gov/new.items/d011168t.pdf; Ted Bridis, *U.S. Cyber-Security Efforts Faulted*, ASSOCIATED PRESS ONLINE, July 22, 2002 (noting the large number of organizations that must be coordinated to achieve strong cyber-security).

35. For example, the government coordinates research on code through the National Coordination Office for Information Technology Research and Development. Although the government has moved toward a more coordinated strategy with respect to national security, this effort considers only a very narrow range of issues and does not take into account the research and development efforts for code. *See* PRESIDENT'S CRITICAL INFRASTRUCTURE PROTECTION BD., *supra* note 9, at 2.

used to regulate harmful technology. Table 1 briefly summarizes each regulatory method.

Table 1: Regulatory Methods for Addressing Harms

Method	**One-word Summation**	**Rationale**	**Examples of Code-based Regulation**
Prohibition	Ban	Harm is unacceptable at any level	Digital Millennium Copyright Act — ban on anti-circumvention code; Ban on transmitting obscene content to minors across the Internet
Set Standards	Stick	Require the use of technologies to reduce the harm	Closed captioning and V-Chip; Filtering software; Digital broadcasting
Market-based Regulation	Carrot	Limit the harm by increasing costs (taxes) or by limiting its quantity (property rights)	Creation of property, e.g., domain names and IP addresses
Modify Liability	Lawsuit	Encourage development of safer products	Advocating for increasing security (and part of the concern with the Uniform Computer Information Transactions ("UCITA")
Disclosure	Warning	Inform society about the harm	Labeling requirements for commercial e-mail; Disclosure of security violations in computer systems in California; CERT Coordination Center for informing users about security issues

A. Prohibitions

Unlike most regulations, a prohibition states that no level of technology or activity is considered acceptable.[36] Prohibited technologies and activities can involve national security, public safety, and environmental concerns. For example, in banning predatory fish such as the snakehead, the government is saying that the harms to society as a whole justify prohibiting individuals from possessing these fish.[37] For a technology-specific example, the Communications Decency Act ("CDA") of 1996 attempted to prohibit the transmission of indecent and obscene material to minors.[38] This section first presents the chief criticisms of the government's use of prohibition as a regulatory mechanism. The remainder of the section addresses these criticisms and illustrates how prohibitions can shape code.

Three primary criticisms challenge the use of government prohibition. First, a prohibition does not permit potentially beneficial uses and thereby generates great costs without regard to conferred benefits.[39] Prohibition is therefore an economically inefficient means of regulation. Critics suggest that less costly approaches include combining regulation with standards or requiring the use of product warnings. A second criticism, high enforcement cost, arises because of the inherent nature of information technology architecture: software code can be easily reproduced and transmitted, making enforcement difficult. For example, members of the hacker community distributed a program that deciphered the encryption used to protect DVDs.[40] In a short time, this circumvention code spread across the world and remains readily available despite the entertainment industry's efforts to stifle its distribution. The final criticism stems from the negative effect of prohibition on innovation. By prohibiting the development or sale of a technology, the government blocks a path for future research and development. This criticism is especially pertinent to emerging areas of technological development and has been used widely in the recent debate over the use of stem cells, in which proponents of stem

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36. We are focusing on prohibitions that actively shape code and not prohibitions that are focused on competition. In telecommunications, the government has long prohibited certain firms from engaging in certain activities to foster competition. *See* Steve Bickerstaff, *Shackles on the Giant: How the Federal Government Created Microsoft*, *Personal Computers*, *and the Internet*, 78 TEX. L. REV. 1 (1999) (describing how competitive restrictions on AT&T shaped code).

37. *See* Anita Huslin, *At Last*, *U.S. Hopes*, *Snakehead is History*, WASH. POST, Oct. 3, 2002, at B03.

38. Communications Decency Act, 47 U.S.C. § 223 (2000).

39. *See* James M. Buchanan, *In Defense of Caveat Emptor*, 38 U. CHI. L. REV. 64 (1970).

40. *See* David M. Ewalt, *DeCSS Case Could Change Your IT Shop*, INFO.WK., July 16, 2001, *available at* http://www.informationweek.com/story/IWK20010711S0010 (last visited Feb. 27, 2005).

cell research have argued that limitations on research could stifle the development of lifesaving medical breakthroughs.[41]

The first criticism fails to recognize that prohibitions can be often an efficient means of regulation, particularly in cases where the societal cost of failing to enact a prohibition greatly outweighs the needs of a limited number of citizens.[42] In these cases, society may decide not to permit the needs of a select few to outweigh those of the entire society.[43] Because regulations serve to provide an acceptable level of a technology or activity within society, prohibition becomes necessary when no such balance is acceptable. For example, the Consumer Product Safety Commission ("CPSC") will ban a product if "no feasible consumer product safety standard . . . would adequately protect the public from the unreasonable risk of injury . . . ."[44] Following this framework, the government has banned such technologies as polychlorinated biphenyls ("PCBs"),[45] chlorofluorocarbons ("CFCs"),[46] and, in the area of information technology, circumvention code.[47] In these instances, policymakers have found prohibition to be an efficient solution when balancing large-scale harm to citizens against limited benefits. In other words, prohibition is particularly effective when the affected population cannot come together since the harm felt by each individual is small compared to the costs of collective action. Thus, prohibition is an effective, welfare-enhancing alternative in face of collective action mobilization failures.

A prohibition's enforcement costs are generally much lower than the costs associated with other regulatory actions; it is much simpler to enforce a ban on all uses of a technology than to selectively limit a product, instance, or activity. Ready availability of substitutes can lower the cost of enforcement. Substitutes can reduce demand for the prohibited product, which accordingly makes enforcing the prohibition easier. Lack of substitutability and high demand for a prohibited

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41. *See* David Kocieniewski, *McGreevey Signs Bill Creating Stem Cell Research Center*, N.Y. TIMES, May 13, 2004, at B5. *See generally* Off. of the Dir., NIH, Stem Cells: A Primer, *at* http://stemcells.nih.gov/info/basics/ (last visited Apr. 23, 2005).

42. Such costs are not measured merely in economic terms. Many prohibitions are based on moral grounds, such as the prohibition on human cloning, while others encompass social concerns, such as the environment.

43. *See* DAVID W. PEARCE & R. KERRY TURNER, ECONOMICS OF NATURAL RESOURCES AND THE ENVIRONMENT 44 (1990) (arguing that product bans are useful when the social costs clearly exceed the social benefits).

44. 15 U.S.C. § 2057 (2000); *see also* Richard A. Merrill, *CPSC Regulation of Cancer Risks in Consumer Products: 1972–1981*, 67 VA. L. REV. 1261 (1981) (examining the CPSC's regulation of carcinogens).

45. *See* Toxic Substances Control Act, 15 U.S.C. § 2605(e) (2000).

46. *See* Environmental Protection Agency Protection of Stratospheric Ozone, 40 C.F.R. § 82.66 (2004).

47. *See* Digital Millennium Copyright Act, 17 U.S.C. § 1201(a)(1) (2000).

product increases the risk that an illegal market will develop.[48] The ongoing drug war demonstrates that the lack of substitutes for narcotics has led distributors to form a vast illegal market. This analysis suggests that prohibitions are most efficient when it is enforced broadly and when users have access to substitute products.

Although the ease with which software code is reproduced and transferred can lead to especially high enforcement costs, prohibitions on certain types of information technology may nonetheless be effective. While some members of society, like computer hackers, will never respect such a prohibition, a ban can substantially reduce the social costs of undesired technology by precluding law-abiding consumers.

For example, the government has passed anti-circumvention statutes intended to protect intellectual property rights.[49] As a result, no legitimate firms sell code designed to avoid protective measures in software.[50] While this prohibition has not completely stopped the creation of circumvention code, potential exposure to liability has severely limited the development and distribution of such code.[51] Similarly, the prohibition of unsolicited e-mail is not expected to eliminate such e-mail completely, but rather is expected to provide an important means of reducing its undesired effects.[52] These prohibitions may be efficient because they are enforced broadly and because users have access to substitute products, such as readily available non-pirated DVDs or alternative direct marketing techniques.

Under this enforcement cost framework, the government's current rationale for restricting the export of encryption technology faces several difficulties. First, the exceptions and loopholes frustrate a broad enforcement effort. While the government had historically restricted the export of encryption technology,[53] it has recently relaxed these

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48. *See, e.g.*, Huslin, *supra* note 37 (suggesting that the prohibition on snakehead fish will create a booming black market).

49. *See, e.g.*, *supra* note 47.

50. In the earlier days of personal computing, there were numerous, readily-available programs designed to circumvent copy protection. For example, *LockSmith* was a commercially available program that allowed its users to copy programs that were copy-protected. This was a legitimate need, as many software publishers would not provide a backup or replacement copy of their software if the disk became unreadable. *See* Donald W. Larson, Tales of Woz's Genius (July 21, 2000), *at* http://static.userland.com/userLandDiscussArchive/msg018908.html.

51. This can be seen in the efforts to place alternative programs and operating systems on Microsoft's Xbox gaming console. While individuals have circumvented the Xbox's security systems, this code has not been publicly distributed. *See* David Becker, *MIT Student Hacks into Xbox*, CNET NEWS.COM (June 3, 2002), *at* http://news.com.com/2100-1040-931296.html; David Becker, *"Mod Chip" for Hacking Xbox Discontinued*, CNET NEWS.COM (June 26, 2002), *at* http://news.com.com/2100-1040-939591.html.

52. *See* Jonathan Krim, *Anti-Spam Act Signed But Some Are Skeptical*, WASH. POST, Dec. 17, 2003, at A18.

53. *See* Peter H. Lewis, *Privacy For Computers?: Clinton Sets the Stage For a Debate on Data Encryption*, N.Y. TIMES, Sept. 11, 1995, at D7.

export regulations.[54] The major exception to this policy is the prohibition against exports to Cuba, Iran, Libya, North Korea, Sudan, and Syria.[55] Enforcement costs have increased both because this prohibition is a limited one,[56] and because prohibited encryption technologies are now readily available. One example of the latter arises in the context of export regulations that allow firms to post their code publicly on the web for download. According to the regulations, this is not considered a knowing export and is thus permissible even though anyone, including a user in a prohibited country, can download the code.[57] Second, there are no substitutes or alternatives that would alleviate the social costs arising from terrorists and criminal organizations concealing their communications.[58] The lack of a commercially viable, readily available, and government-approved encryption substitute drives up enforcement costs.[59] These aforementioned factors create enforcement hurdles that are unreasonably costly and highly inefficient, suggesting that current policy is suboptimal.[60]

In addressing the final criticism that prohibitions necessarily stifle innovation, prohibitions can instead provoke innovation and provide an impetus for research and development instead of stifling innovation.[61] Research has shown that prohibitions have varying effects on the development of substitutes by the existing "insider" firms within an industry.[62] However, prohibitions can lead to new "outsider" firms

54. *See supra* note 18.

55. *See* Export Administration Regulations, 15 C.F.R. § 740.13(e)(2) (2004).

56. For example, this provision is found in the license of the Netscape browser. *See* Netscape, Netscape Browser Distribution Program License Agreement, *at* http://wp.netscape.com/bisdev/distribution/agreement.html?cp=strdwnlicagree (last visited Feb. 27, 2005).

57. Export Administration Regulations, 15 C.F.R. § 740.13(e)(1) (2004).

58. While lesser-strength encryption products are not prohibited, they are not adequate substitutes for terrorist or criminal organizations because the government is able to decrypt communications protected by these weaker products. *See* Daniel Verton, *DOD: Encryption Export Troubling*, FED. COMPUTER WK., July 12, 1999.

59. The government attempted to solve this problem, but the effort failed. For example, the Clipper chip was an encryption technology that left a "back door" for the government to eavesdrop on communications. It met with opposition and was never adopted. *See* LAURA J. GURAK, PERSUASION AND PRIVACY IN CYBERSPACE: THE ONLINE PROTESTS OVER LOTUS MARKETPLACE AND THE CLIPPER CHIP (1997); A. Michael Froomkin, *The Metaphor is the Key: Cryptography, the Clipper Chip, and the Constitution*, 143 U. PA. L. REV. 709, 752–59 (1995).

60. While this policy is inefficient from the standpoint of enforcement cost, there are other reasons why it may still be necessary. For example, this policy is part of the Wassenaar Arrangement, which seeks to regulate dual-use technologies. *See* Export Administration Regulations, 15 C.F.R. § 730.3 (2004); Wassenaar Arrangement, *at* http://www.wassenaar.org (last visited Apr. 23, 2005).

61. *See* Nicholas A. Ashford et al., *Using Regulation to Change the Market for Innovation*, 9 HARV. ENVTL. L. REV. 419 (1985).

62. *See* Kurt A. Strasser, *Cleaner Technology, Pollution Prevention and Environmental Regulation*, 9 FORDHAM ENVTL. L.J. 1, 38–40 (1997) (discussing Ashford's research, *see supra* note 61).

developing technologically innovative substitutes.[63] One method of minimizing the impact of prohibitions on innovation and encouraging the creation of substitutes is a gradual phasing out of the technology. The government implemented just such a policy by phasing out CFCs, thereby promoting the development of alternative materials.[64] Although prohibiting technologies in emerging industries can reduce innovation,[65] this fact does not require a "prohibition" on the use of prohibition, but requires instead that policymakers use a better framework to help them distinguish between potentially generative and stifling prohibitions.

An example of a code-based prohibition that could have promoted technological change is the now-unconstitutional part of the CDA, which banned the transmission of indecent content to minors over the Internet. This prohibition could have accelerated the development of filtering programs and verification technologies to identify minors to ensure that minors do not access indecent content. Websites would have supported the development of such technologies in order to continue providing their large amount of indecent content accessible over the Internet. This provision illustrates how a broad-based prohibition can be used to shape the development of code.

B. Setting Standards: The Command-and-Control Approach

Government can also shape the development of information technology by imposing or endorsing standards that mandate technological requirements. This direct approach has traditionally been known as the command-and-control approach, with the government acting as both the standard-setter and the enforcer. This approach is often contrasted with the use of market-based incentives, discussed in the next section.

The government may shape three categories of standards. The first types are known as process standards and include standards that promote transactions, interconnection, and interoperability.[66] Exam-

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63. *See id*.

64. *See* U.S. CONG., OFF. OF TECH. ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE 98–100 (1995).

65. *See id*. at 101.

66. Many code-based standards are process standards. Process standards facilitate transactions, such as standards for bills of lading. *See* U.S. CONG., OFF. OF TECH. ASSESSMENT: BUILDING BLOCKS FOR THE FUTURE 100 (1992). One important code-based process standard is for interconnection. Government can use interconnection standards for a number of purposes, including facilitating competition. *See* Kesan & Shah, *supra* note 17, at 205 (discussing interconnection standards for the competition in telecommunications); Philip J. Weiser, *Internet Governance*, *Standard Setting*, *and Self-Regulation*, 28 N. KY. L. REV. 822 (2001) (discussing when government should regulate by mandating open, interoperable standards). Interconnection can even aid law enforcement. For example, the Communications Assistance for Law Enforcement Act requires telecommunication firms to ensure their infrastructure allows for wiretapping by law enforcement. 47 U.S.C. §§ 1001–1002 (2000).

ples of these include standards for wireless communication, such as 802.11b, or for commerce, such as secure sockets layer ("SSL"). The second category includes product standards, which provide information about a product's characteristics.[67] The USDA uses such standards in its labeling system for food.[68] A third type of standard protects against societal hazards or problems and is known as control standards.[69] These safety-oriented standards are commonly used in environmental and transportation regulation. This Section discusses how technologically forward-looking the government should be in its regulatory efforts. The next section describes the different methods government can use in mandating standards.

1. Technology Forcing

Technology forcing refers to regulatory efforts that direct the development of technologies along specific paths.[70] These standards force firms either (1) to innovate technologies, forcing the creation of new technologies, or (2) to disseminate technologies, requiring firms to incorporate existing technologies into their products. This use of technology-forcing regulation has varied by industry. Early automobile regulation used a significant amount of technology-forcing regulation, whereas building code regulations contain few technology-forcing aspects.[71]

This section begins by addressing criticisms of government's use of technology-forcing regulation to shape the development of code.

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67. This information allows for product identification, interoperability, and quality control. *See* U.S. CONG., OFF. OF TECH. ASSESSMENT, *supra* note 66, at 99. Government-mandated product standards are discussed in more detail in a later section on the disclosure of code's characteristics. *See infra* Part II.E.

68. U.S. DEP'T OF AGRIC., FOOD STANDARDS AND LABELING POLICY BOOK (May 2003), *available at* http://www.fsis.usda.gov/OPPDE/larc/Policies/PolicyBook.pdf.

69. An example of a control standard is the quality requirements for automobile tires. *See* 49 C.F.R. § 571.109 (2004) (requiring every tire to have information encoded on the sidewall specifying size, inflation pressure, load rating, tube type, and tire type). An example of a control standard for code is the requirement for televisions to incorporate closed captioning. *See* Television Decoder Circuitry Act, 47 U.S.C. §§ 303(u), 330(b) (2000); Sy Dubow, *The Television Decoder Circuitry Act — TV for All*, 64 TEMP. L. REV. 609 (1991). Another example is the FCC's regulation of radio frequency devices. *See* Marketing of Radio-Frequency Devices, 47 C.F.R. § 2.801 (2004). Control standards may also be used during the production of code. For example, the FAA and the FDA both use control standards to ensure the development process for code meets strict quality assurance guidelines. *See supra* note 21.

70. *See* Jerry L. Mashaw & David L. Harfst, *Regulation and Legal Culture: The Case of Motor Vehicle Safety*, 4 YALE J. ON REG. 257 (1987) (discussing the concept of technology forcing).

71. *See* Richard R. Nelson, *Government Stimulus of Technological Progress: Lessons from American History*, *in* GOV. & TECH. PROGRESS: A CROSS-INDUSTRY ANALYSIS 451, 472 (Richard R. Nelson ed., 1982); *see also* Eric Lipton & James Glanz, *Sweeping Changes Pushed for Code on City High-Rises*, N.Y. TIMES, Aug. 2, 2002, at A1 (noting that building codes are slow to change and incorporate new technologies such as sprinkler systems).

Next, it discusses code-based technology-forcing regulation and, as an example, analyzes the CDA from a technology-forcing perspective, to provide insight into the CDA's failure from both a legal and technological standpoint.

In using technology-forcing regulation, policymakers should consider a number of criticisms.[72] First, why is government directing technological development in specific areas? Critics argue that this approach is ineffective, and that the government can use other methods, such as market incentives, to shape technology. Second, the government faces numerous challenges in accurately setting technology-forcing regulations. The development of technologies is unpredictable,[73] and regulation depends on firms to share state-of-the-art information so government can develop a response — the very same firms that may have directly conflicting interests. A final criticism with technology-forcing regulation is that compliance costs are too high. The more radical a change is, the higher the cost to industry and the greater the incentive for firms to limit regulations. High costs can lead firms to attempt to reduce their costs by regulatory capture and litigation instead of focusing on the development of new technologies.[74]

In addressing these criticisms, a policymaker must first justify the use of a technology-forcing regulation (the stick approach) rather than a market-based incentive (the carrot approach).[75] Technology-forcing regulations are justified when market-based incentives prove inefficient or politically unfeasible.

Technology-forcing regulations can be more efficient than market-based regulatory programs. The first situation occurs when no technologies exist to address a societal concern. As an example, "for some pollutants in particular industries there may be no existing or theoretical control technology; the control of pollution will then re-

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72. *See, e.g.*, BREYER, *supra* note 13, at 106–07; Robert A. Leone, *Technology-Forcing Public Policies and the Automobile*, *in* ESSAYS IN TRANSP. ECON. & POL'Y 291 (Jose A. Gomez-Ibanez et al. eds., 1999) (arguing that we must consider alternatives to technology forcing); Peter Huber, *The Old-New Division in Risk Regulation*, 69 VA. L. REV. 1025, 1061–67 (1983) (noting the problems with technology-forcing regulation); *infra* note 112 (providing further criticisms on the use of technology-forcing for environmental standards). *But see infra* note 113 (providing a response from supporters of technology-forcing regulation).

73. *See* Nelson, *supra* note 71, at 454 (noting the uncertainty of technological advances based on a number of case studies); Robert W. Lucky, *Pondering the Unpredictability of the Sociotechnical System*, *in* ENG. AS A SOC. ENTER. 89 (Hedy E. Sladovich ed., 1991).

74. Another problem is that because Congress does not revise regulations, technology-forcing standards can become obsolete or in need of revision. This then shifts the problem of setting and enforcing these regulations to courts. *See* Carolyn McNiven, *Using Severability Clauses to Solve the Attainment Deadline Dilemma in Environmental Statutes*, 80 CAL. L. REV. 1255 (1992) (suggesting courts be given the power through severability clauses to remove obsolete deadlines).

75. *See* Leone, *supra* note 72, at 303.

quire the development of entirely new control equipment or manufacturing processes — that is, it will be necessary to force major technological innovation."[76] In passing the Clean Air Act, Congress addressed public health concerns with little regard for technological or economic limitations,[77] an approach validated by the Supreme Court.[78] Second, technology-forcing regulation can prove more efficient than a market-based regulatory program even when the technology already exists, in particular if the cost of implementing the technology is low and when the cost of monitoring compliance with market-based regulations is high.[79]

In addition, technology-forcing regulations may be more expedient than market-based regulations in addressing market externalities, particularly in politically difficult situations. For example, economists argue that the best method for increasing automobile fuel efficiency is a gasoline tax.[80] However, politicians are generally reluctant to support tax increases. Technology-forcing regulations provide a palatable alternative in these politically sensitive situations because they provide a clear objective, a direct method, and a tangible outcome for legislators.[81]

The second major criticism that technology-forcing regulation must overcome is that setting optimal technology-forcing standards is difficult. The unpredictability of technological advances poses par-

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76. *See* D. Bruce La Pierre, *Technology-Forcing and Federal Environmental Protection Statutes*, 62 IOWA L. REV. 771, 773 (1977).

77. *See* 116 CONG. REC. 32901–02 (1970). During the passage of the Clean Air Act, Senator Muskie, the manager of the Senate bill, stated:

> The first responsibility of Congress is not the making of technological or economic judgments or even to be limited by what is or appears to be technologically or economically feasible. Our responsibility is to establish what the public interest requires to protect the health of persons. This may mean that people and industries will be asked to do what seems to be impossible at the present time.

Id. *But see* La Pierre, *supra* note 76, at 837 (noting that although health-based standards can induce major innovation, the EPA and courts have favored technology-based standards that take into account economic constraints). Several commentators have written about the technology-forcing aspects of the Clean Air Act. *See, e.g.*, John E. Bonine, *The Evolution of Technology Forcing In The Clean Air Act*, Env't Rep. (BNA) No. 21 (1975); Russell V. Randle, *Forcing Technology: The Clean Air Act Experience*, 88 YALE L.J. 1713 (1979).

78. *See* Whitman v. Am. Trucking Ass'ns Inc., 531 U.S. 457 (2001); *see also id*., at 491 (Breyer, J., concurring) (noting explicitly the validity of the technology-forcing nature of the Clean Air Act).

79. *See* Daniel H. Cole & Peter Z. Grossman, *When Is Command-and-Control Efficient? Institutions, Technology, and the Comparative Efficiency of Alternative Regulatory Regimes for Environmental Protection*, 1999 WIS. L. REV. 887, 937 (1999) ("[W]here abatement costs are relatively low and monitoring costs are relatively high, command-and-control is likely to be at least as efficient and effective as effluent taxes or a tradable emissions program.").

80. *See* Charles D. Patterson, *Environmental Taxes and Subsidies: What Is the Appropriate Fiscal Policy For Dealing with Modern Environmental Problems*, 24 WM. & MARY ENVTL. L. & POL'Y REV. 121, 158 (2000).

81. *See* Leone, *supra* note 72, at 295–310.

ticular challenges for a government developing new technology requirements and forecasting its costs.[82] In order to obtain a reasonable estimate of development costs, regulators must understand both the current state-of-the-art technology and the industry's history of technological innovation.[83] The government must closely interact with firms to obtain information on their capabilities; these firms, however, have an incentive to withhold and mislead the government in order to ensure that technology-forcing standards are lax and easily met rather than optimized to address societal concerns.[84] Firms therefore have an incentive to try to capture the regulatory process in order to achieve competitive and economic advantages rather than the most efficient regulatory standards. In addition, it is possible that the industry simply does not know when its research and development will produce the next viable product. If a government agency cannot gather the necessary information or if legislators are concerned about regulatory capture during the information-gathering process, technology-forcing regulation might not be the proper regulatory approach.

The government must also have a clear understanding of the harm it is trying to prevent or the benefit it is trying to produce when it sets technology-forcing standards.[85] Without this clarity, the government will encounter difficulties in determining, enacting, and enforcing the proper level of regulation and the proper regulatory standards required to address the targeted societal concerns. The NHTSA standard for surviving head-on automobile crashes has been criticized for lacking such clarity.[86] Code developers face directly analogous problems. In order for such code-based regulation to be successful, the societal concerns being addressed must be clear. Without this clarity, an agency would quickly run into problems persuading the public and firms that its regulations benefit society.

The final major criticism that technology-forcing regulation must confront is high compliance costs. A firm's motivation to avoid compliance may be proportional to the cost of the technology-forcing regulation. Thus, ensuring that firms develop or diffuse the necessary technology requires an equally determined regulator. After all, tech-

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82. *See* Nelson, *supra* note 71, at 453–54.

83. *See* Ashford et al., *supra* note 61, at 422.

84. *See* Eban Goodstein & Hart Hodges, *Polluted Data*, 35 AM. PROSPECT 64 (Nov. 1997) (arguing that industry often inflates its estimated costs of complying with technology-forcing regulation).

85. A regulator must consider the efficacy of the proposed technology-forcing regulation. Innovation-fostering regulations should be focused on bottlenecks to technological development. Regulations encouraging the diffusion of existing technologies should seek to generate either incentives for continued innovation or economies of scale to reduce costs. *See* Leone, *supra* note 72, at 320.

86. *See* Michael J. Trebilcock, *Requiem for Regulators: The Passing of a Counter-Culture?*, 8 YALE J. ON REG. 497, 505–06 (1991) (noting the arbitrariness of a 30 miles per hour survivability standard).

nology-forcing regulation relies upon a stick as opposed to a carrot; firms will try to delay or reduce their compliance efforts without prodding.[87] Although delay may be prudent at certain times, if firms were generally successful in using this stalling tactic technology-forcing regulation would effectively be neutralized.

Despite the difficulties in implementation, technology-forcing regulation has led to numerous innovations,[88] including improved environmental quality,[89] safer automobiles,[90] cleaner automobile emissions,[91] and improved disclosure of corporate financial information.[92] For example, the development of the automobile airbag resulted from the standards for a "passive occupant restraint system" developed by the NHTSA in the late 1960's. Although the automobile industry initially fought this requirement, the resulting technology has since become standard equipment for automobiles.[93] Nonetheless, the NHTSA has moved away from a technology-forcing regulatory approach toward a more reactive approach in automobile regulation.[94]

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87. Technology-forcing standards can focus an industry's attention on a problem in a direct way. For example, automakers have an interest in automobile safety as a way of differentiating their products and selling more cars. But, it took Ralph Nader's *Unsafe at Any Speed* and subsequent legislation to force the automakers to enact safety reforms. *See* Leone, *supra* note 72, at 302.

88. *See* Ashford et al., *supra* note 61 (providing a number of examples of how technology-forcing regulation led to innovation).

89. *See* Nicholas A. Ashford, *An Innovation-Based Strategy for a Sustainable Environment*, *in* INNOVATION-ORIENTED ENVTL. REG. 67, 85 (Hemmelskamp et al. eds., 2000).

90. Technology-forcing regulation has led to many safety improvements, including seat belts, air bags, and bumpers. These regulations have been acknowledged as successful, because they prevent highway fatalities significantly. *See* ROBERT W. CRANDALL ET AL., REGULATING THE AUTOMOBILE 155–56 (1986).

91. Technology-forcing regulations have led to internal combustion engines that emit ninety-six percent less emissions, a reduction thought infeasible when the regulations were established. Some observers argue that the development of new technologies, such as catalytic exhaust treatment and low-emission vehicles, demonstrates the merit of technology-forcing regulation. *See* Ashley Morris Bale, *The Newest Frontier in Motor Vehicle Emission Control: The Clean Fuel Vehicle*, 15 VA. ENVTL. L.J. 213 (1995). It is not clear, however, whether there were other options, such as emissions fees, that could have led to the same technical advances. *See* Leone, *supra* note 72, at 292; *see also* CRANDALL, *supra* note 90, at 156–57 (arguing that the costs of emission regulation are higher than its benefits).

92. The Securities and Exchange Commission ("SEC") mandates that companies file their documents electronically through the Electronic Data Gathering, Analysis, and Retrieval system ("EDGAR"). SEC, Important Information About EDGAR, *at* http://www.sec.gov/edgar/aboutedgar.htm (last modified Feb. 3, 2005). This system accelerates "the receipt, acceptance, dissemination, and analysis of time-sensitive corporate information filed with the agency." *Id*. The goal is to "increase the efficiency and fairness of the securities market for the benefit of investors, corporations, and the economy." *Id*.

93. *See* Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 49 (1983) (noting the technology-forcing nature of the Motor Vehicle Safety Act for automobile airbags).

94. *See* JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY 69–105 (1990) (documenting the changes in NHTSA from technology-forcing to a more reactive regulation strategy). Some argue that this occurred largely because of judicial second-guessing of the systematic regulations. *See* Frank B. Cross, *Pragmatic Pathologies of Judicial Review of Administrative Rulemaking*, 78 N.C. L. REV. 1013, 1025–26 (2000).

There are numerous examples of code-based technology-forcing regulation: filtering software,[95] closed captioning,[96] the V-chip,[97] accessibility,[98] enhanced 911,[99] and digital broadcasting.[100] While a thorough assessment of technology-forcing regulations for code is needed, a few lessons can be gleaned from a brief analysis of these examples. First, it appears that technology-forcing regulation is often favored over market-based incentives when regulating information technology. The government prefers simply to require manufacturers to modify their code. Second, regulations focused on preventing harm provide clear standards when setting technology-forcing regulations, and therefore are easier to justify. Concerns about safety and violence have led to clearer guidelines and more political support than other targets for regulations. Indeed, technology-forcing regulations that produce fewer clear benefits, such as those requiring accessibility and digital broadcasting as opposed to enhanced 911 service, are much harder to justify. The third lesson is that compliance costs matter, especially when firms are forced to provide a vague benefit to the public, such as digital broadcasting. The high cost of compliance associated with digital broadcasting has led many to wonder if such technology-forcing regulation was justified to achieve such uncertain public benefits, or whether the market would have been a better

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95. *See, e.g.*, Children's Internet Protection Act, 47 U.S.C. § 254(h)(5)(A) (2001).

96. Before government regulation, consumers were forced to buy an expensive standalone decoder. *See* DuBow, *supra* note 69, at 615–17 (providing a history of legislative process to require manufacturers to incorporate closed captioning).

97. The V-chip was a relatively simply technology based on a modification of closed-captioning technology. *See* Lisa D. Cornacchia, *The V-Chip: A Little Thing But a Big Deal*, 25 SETON HALL LEGIS. J. 385, 391–92 (2001).

98. The Telecommunications Act requires manufacturers of telecommunication products and services to make their products and services accessible whenever it is "readily achievable." Telecommunications Act of 1996, 47 U.S.C. § 255 (1996).

99. In 1996, the FCC adopted regulations that require wireless carriers to deliver 911 calls and provide the location of the wireless emergency call. To meet these regulations, wireless carriers have had to develop new technologies. *See* Matthew M. Werdegar, *Lost? The Government Knows Where You Are: Cellular Telephone Call Location Technology and the Expectation of Privacy*, 10 STAN. L. & POL'Y REV. 103 (1998) (noting that the FCC has been repeatedly asked by the cell phone industry to delay implementation, although it appears that the industry will be able to comply); *see also* Peter P. Ten Eyck, *Dial 911 and Report a Congressional Empty Promise: The Wireless Communications and Public Safety Act of 1999*, 54 FED. COMM. L.J. 53 (2001) (arguing that the existing rules for enhanced 911 need to tighten in order to foster the development of a seamless, ubiquitous, and reliable wireless communication network with 911). For background on Enhanced 911, see FCC, Enhanced 911 — Wireless Services, *at* http://www.fcc.gov/911/enhanced/ (last modified Feb. 25, 2005).

100. In 1997, Congress mandated a transition to digital television by 2006. The technology in 1997 was in its infancy and for the most part not even commercially available. The intent of the law was to spur the development of digital television by not allowing broadcasters to transmit analog signals after 2006. *See* The Balanced Budget Act of 1997, Pub. L. No. 105–33, 111 Stat. 251 (1997); *see also* CONG. BUDGET OFF. ("CBO"), COMPLETING THE TRANSITION TO DIGITAL TELEVISION viii-ix (1999), *available at* http://www.cbo.gov/showdoc.cfm?index= 1544&sequence=0&from=1.

mechanism for gauging the level of societal concern and the appropriate response.[101]

The CDA provides a code-related case study for these issues. In 1996, Congress passed the CDA to prohibit the transmission to minors of indecent or obscene material over the Internet.[102] As discussed in the prohibition section, the CDA served a technology-forcing purpose — encouraging the development of new technologies that limited the transmission of indecent material to minors — even while literally acting as a prohibition.[103] The World Wide Web Consortium ("W3C"), which challenged the constitutionality of the CDA, directly responded by creating the Platform for Internet Content Selection ("PICS"), an alternative, less restrictive means for the government for to control indecent content on the Internet.[104]

Despite the general call for government to keep its hands off the Internet, policymakers chose to implement this technology-forcing regulation; the government feared that the free market would not or could not solve the problem of minors accessing inappropriate content. Congress ignored market-based incentives, instead instituting an inefficient technology-forcing regulation. The availability of existing technologies that prevented minors from accessing inappropriate content, such as filtering products, could also have provided an alternative approach. The CDA could have been designed to foster the efficient and expedient diffusion of these existing technologies, an approach likely to have been even more efficient than a market-based approach. Instead, the CDA led to the development of new technologies such as PICS, which has not solved the problem of minors gaining access to inappropriate content. Thus, the CDA can be seen as a failed opportunity to leverage the efficiency of the technology-forcing approach in diffusing existing technologies. In the end, the justification for the CDA seems to have been more about political expediency than about effectively addressing a societal concern, where the need to produce a politically tangible outcome trumped concerns regarding the efficacy of the legislation. Indeed, the CDA has been largely inef-

101. Alan Murray, *Failed Policy on HDTV Illustrates Why Free Markets Can Be Trusted*, WALL ST. J., June 4, 2002, at A4.

102. Communications Decency Act, 47 U.S.C. § 223 (1997).

103. *See supra* Part II.A.

104. Interview with James Miller, PICS Designer, in Bloomington, Ill. (Aug. 13, 1999).

> PICS, the Platform for Internet Content Selection, establishes Internet conventions for label formats and distribution methods, while dictating neither a labeling vocabulary nor who should pay attention to which labels. It is analogous to specifying where on a package a label should appear, and in what font it should be printed, without specifying what it should say.

PICS: Internet Access Controls Without Censorship, 39 COMM. OF THE ACM 87–93 (1996), *available at* http://www.w3.org/PICS/iacwcv2.htm.

fective from its inception, though this can arguably also be attributed to uncertainties surrounding its constitutionality.[105]

Second, the CDA was not limited to addressing only well-defined harms. The legislation regulated both obscene and indecent communications, and though the harm from obscene communications was widely recognized, the harm from indecent communications was not as apparent. In fact, the most vigorous debate over the CDA concerned banning indecent material that might be useful for minors, such as sexual education material.[106] The CDA illustrates the potential inappropriateness of technology-forcing regulation when government lacks a well-defined harm to address.

The final problem with the CDA concerns compliance. It was never clear how government would monitor and enforce the CDA on a worldwide medium.[107] While the U.S. government could clearly make an impact on the availability of explicit material on the Internet, any substantial change would require international cooperation.

2. Means of Standards Regulation

The three general types of standards-based regulating are: (1) performance standards, (2) design standards, or (3) best available technology standards. Performance standards do not specify a technology, but instead set forth guidelines for how a technology should operate.[108] The principal advantage of performance standards is that they allow the market to create and shape a product as it sees fit. The flexibility of performance standards is the reason why firms prefer them over design standards.[109] The flexibility of a performance standard can lead to enforcement problems due to the lack of specificity over the correct testing procedures.[110] On the other end of the spec-

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105. *See* Robert Cannon, *The Legislative History of Senator Exon's Communications Decency Act: Regulating Barbarians on the Information Superhighway*, 49 FED. COMM. L.J. 51 (1996) (noting the constitutional problems with the CDA).

106. *See, e.g.*, Reno v. American Civil Liberties Union, 521 U.S. 844, 877 (1997).

107. *See* David L. Sobel, *The Constitutionality of the Communications Decency Act: Censorship on the Internet*, 1 J. TECH. L. & POL'Y 2, ¶ 7–8 (1996) (noting the problems with jurisdiction) *at* http://grove.ufl.edu/~techlaw/vol1/sobel.html.

108. BREYER, *supra* note 13, at 105. As an example, the EU Privacy Initiative sets limitations on the use of data mining in Europe. As a result, code that contains these features can no longer be sold in Europe. This performance standard sets a limitation on firms developing code by limiting their potential market. *See The Role of Consortia Standards in Federal Government Procurements in the Information Technology Sector: Towards a Re-Definition of a Voluntary Consensus Standards Organization: Hearings Before the House Subcomm. on Tech., Env't, and Standards*, 107th Cong. 5 (2001) (statement of Carl F. Cargill) [hereinafter *Role of Consortia*], *available at* http://www.house.gov/science/ets/jun28/cargill.pdf.

109. *See id.* (noting firms that develop a cheaper or more effective method of achieving the regulation's objective will face many obstacles to get this method approved).

110. *See id.* at 105–06; *see also* Cary Coglianese et al., *Performance-Based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection*, 55 ADMIN. L. REV. 705, 708 (2003).

trum, design standards state precisely how a technology must operate. The advantage of a design standard for the government is enforceability. Manufacturers have strict guidelines for building a product, and an inspector can easily ascertain compliance.

A middle ground between design standards and performance standards is the best available technology ("BAT") approach. These regulations focus on gradually removing a harm through available technology. Statutes are often worded to require the use of "reasonably available control technology" or the "lowest achievable emission rate."[111] While BAT regulations have been mainly used to reduce pollution, they have been criticized for not accounting for differences among users, imposing large enforcement and information-gathering burdens on agencies, and slowing technological innovation.[112] The counterargument to these criticisms is that the BAT approach provides a much simpler, even-handed, and easily enforced regulatory process[113] that can adapt to changing circumstances because it relies on a "reasonably available" standard rather than a specific numerical value.

All three of these approaches can be used to shape code. These options, however, present clear tradeoffs. Though performance standards provide a great deal of flexibility and can accommodate market-based solutions,[114] design standards are fixed approaches that allow the government to easily ensure compliance. Both are limited in their flexibility to adapt to changing circumstances, while the BAT approach encompasses standards that can change over time. Even so, the BAT approach may fail to provide sufficient certainty in advance of adjudication. For example, the development of digital broadcasting, the FCC has been criticized for using design standards to protect users

111. *See, e.g.*, OFF. OF TECH. ASSESSMENT, *supra* note 64, at 90 (1995).

112. *See* CASS R. SUNSTEIN, AFTER THE RIGHTS REVOLUTION 88 (1990); *see also* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1334–37 (1985) (criticizing the BAT regulation strategy).

113. *See* Howard Latin, *Ideal versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-Tuning' Regulatory Reforms*, 37 STAN. L. REV. 1267, 1267–73 (1985) (arguing that BAT standards are more effective given the costs of regulatory decision-making); Sidney A. Shapiro & Thomas O. McGarity, *Not So Paradoxical: The Rationale for Technology-Based Regulation*, 1991 DUKE L.J. 729, 748–50 (1991) (responding to Sunstein's criticisms); Wendy E. Wagner, *The Triumph of Technology-Based Standards*, 2000 U. ILL. L. REV. 83, 94 (arguing that the BAT approach is more expeditious, enforceable, even-handed, and adaptable).

114. For example, government legislation requires schools and libraries to use some type of "technology protection measure" for online material that is harmful to minors. This performance standard allows schools and libraries to select the solution that best fits their own requirements. *See* Children's Internet Protection Act, 47 U.S.C. § 254(h)(5)(B) (2001); *see also* Cole & Grossman, *supra* note 79, at 911–18 (discussing the arguments in favor of a 1970 Clean Air Act before it was amended to use a command-and-control approach in 1977).

from electromagnetic interference.[115] Critics believed that these precise regulations were too restrictive and that industry should have been granted more freedom to deal with these interference problems.[116] A hypothetical code-based BAT standard may require government agencies to use the best available encryption technology in the storage of medical information. This standard would require government agencies to update their systems as more effective technologies appear.

C. Using Market-Based Regulation

Critics of standard-setting often tout market-based incentives as a better alternative to direct rulemaking. Market-based incentives can be based upon a number of different economic instruments and are more efficient than standard-setting in many situations.[117] That is, the cost of regulating with market-based incentives is generally less than the cost associated with government mandated standard-setting.

This section focuses on the use of taxes and marketable property rights as means for regulating code. While taxes can be used to penalize a particular conduct or technology (consider the gas-guzzler tax for fuel inefficient automobiles),[118] marketable property rights utilize the market as an allocation mechanism to limit conduct or a technology. This regulatory scheme, which allows firms to buy and sell their property rights to others, has been used to address a variety of societal concerns from congestion to pollution.

The choice between marketable property rights and taxes is largely a choice between a price-based system and a quantity-based system. Taxes increase the cost of undesirable behavior. When using marketable property rights, the government fixes the amount of undesirable behavior that is acceptable to society. As a result, a tax-based system has an uncertain impact on undesirable behavior, but known costs. A marketable property rights scheme can have a fixed impact

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115. Advanced Television Sys. Comm., *Transmission Measurement and Compliance for Digital Television, Revision A* (May 30, 2000), *at* http://www.atsc.org/standards/a_64a.pdf.

116. *See* Bruce Owens, Remarks at Meeting of the FCC on Economic Considerations for Alternative Digital Television Standards (Nov. 1, 1996) (transcribing Bruce Owen's arguments against the efficacy of government-imposed standards), *available at* http://www.fcc.gov/Reports/ec961101.txt; FCC, Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service, MM Docket No. 87-268 (Dec. 24, 1996) (noting comments by the National Cable and Telecommunications Association opposing the design standard aspect of the ATSC standard), *available at* http://www.fcc.gov/Bureaus/Mass_Media/Orders/1996/fcc96493.txt.

117. *See* Mona L. Hymel, *The Population Crisis: the Stork, the Plow, and the IRS*, 77 N.C. L. 15, 41 (1998).

118. *See* Gas Guzzler Tax, 26 U.S.C. § 4064 (2005).

on the undesirable behavior, but the cost to firms is unknown.[119] Therefore, the crucial decision for regulators is whether they are concerned about setting a fixed target for reducing undesirable behavior or for setting predictable costs borne by firms.[120]

The market-based method of regulation faces two principal criticisms. First, its proposed efficiency is purely theoretical and does not materialize in the real world. As discussed in the following section, monitoring and funding problems lead to higher costs than standard-setting regulations. The second criticism rests on moral/ethical grounds. A market-based incentive implies that it is morally acceptable to engage in some level of socially undesirable behavior. For some critics, this is intolerable.[121] As an extreme example, they contend that it is simply wrong for government to use a market-based approach to regulate murder; individuals and firms should not be allowed to engage in murder by merely paying a high "murder" tax. The following sections address these criticisms and highlight the advantages of these methods in shaping and regulating code.

1. Taxes

Government can increase an individual's or firm's tax burden and thereby encourage certain behavior by using its taxation powers. This section examines how taxes or fees can be used to penalize a particular activity or product.[122] This section discusses when taxes deter socially undesirable behavior better than regulation.

There are two approaches to using taxes: fees and penalties. Fees usually consist of a monetary disincentive affecting a product or activity that is unrelated to the user's income. In general, a fee is appropriate when users can be readily excluded from receiving the relevant service or product.[123] This is the case with alcohol, the gas-guzzler tax, and fees on the sale of tires to finance cleanup of improper tire disposal sites.[124] Tax penalties, like tax expenditures,[125] adjust the tax

119. For a further discussion on marketable property rights, see infra note 139 and accompanying text.

120. *See* ORG. FOR ECON. CO-OPERATION AND DEV., PUTTING MARKETS TO WORK: THE DESIGN AND USE OF MARKETABLE PERMITS AND OBLIGATIONS (1997).

121. *See* MARK KELMAN, STRATEGY OR PRINCIPLE? THE CHOICE BETWEEN REGULATION AND TAXATION 120–24 (1999).

122. *See generally* Eric M. Zolt, *Deterrence Via Taxation: A Critical Analysis of Tax Penalty Provisions*, 37 UCLA L. REV. 343 (1989) (discussing the use of tax penalties).

123. See KELMAN, *supra* note 121.

124. *See* David J. DePippo, *I'll Take My Sin Taxes Unwrapped and Maximized, With a Side of Inelasticity, Please*, 36 U. RICH. L. REV. 543, 545 (noting sin taxes such as those on alcohol); *see also* Stephen M. Johnson, *Economics v. Equity: Do Market-Based Environmental Reforms Exacerbate Environmental Injustice?*, 56 WASH. & LEE L. REV. 111, 114–15 (1999) (noting taxes on pollution).

125. For a more detailed discussion of tax expenditures, see infra Part III.C.

burden of the violators, but serve to penalize rather than reward.[126] This Section uses the term "taxes" to refer to both fees and penalties.

Taxes are preferable to regulation when the additional costs influence consumer behavior.[127] In contrast to the cost of complying with regulatory standards, the cost of paying taxes can be estimated easily. These costs can then be communicated to the consumer in the final cost of the product or through tax advisors. Consumers are thus aware both of the costs as well as the governmental policy disfavoring a specific activity or product. Consumers are pushed toward products and activities that are not subject to a tax. Indeed, firms have a continued incentive to innovate and improve their technologies to reduce their tax burden. Similarly, taxes are preferable to tax expenditures or direct spending because they are not limited by budgetary constraints.[128]

A regulation may be preferable to taxes for two main reasons. The first is political: tax increases are among the most-unpopular political actions. The second reason is that established firms prefer a standard-setting regulation to a tax because from the firm's viewpoint taxes cost more than regulation.[129]

Critics raise several objections to using taxes as a form of regulation. The first questions the efficiency of taxes due to the difficulty of setting tax rates at the optimum level.[130] If a tax is too high, the government will discourage too much of the activity. If a tax is too low, the government will not discourage the activity. Taxes cause some

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126. Zolt, *supra* note 122, at 348–50 (defining tax penalties within the income tax system).

127. Taxes use market mechanisms to transmit information to the consumer by charging a price for currently unpriced goods and services provided by the natural environment. *See generally* Wen-yuan Huang & Michael LeBlanc, *Market-Based Incentives for Addressing Non-Point Water Quality Problems: A Residual Nitrogen Tax Approach*, 16 REV. AGRIC. ECON. 427 (1994). Taxes on ozone-depleting chemicals as well as the gas-guzzler tax have shaped technologies. *See* 26 U.S.C. §§ 4681, 4682 (1988 ed., Supp. III) (ozone tax); 26 U.S.C. § 4064 (2005) (gas guzzler excise tax). Other undesirable activities subjected to taxes have included doing business with South Africa, engaging in greenmail transactions, and entering into golden parachute arrangements. *See* Zolt, *supra* note 122, at 344 (noting common examples of tax penalties). For example, Singapore has used tax surcharges on older cars and varying toll fees to cut congestion. *See Smart Card Taxes Singapore Drivers*, BBC News, Apr. 14, 1998, *available at* http://news.bbc.co.uk/1/hi/world/asia-pacific/78172.stm.

128. For example, to address concerns about climate change, the government could subsidize the use of alternative fuels. Alternatively, the government could place a tax on conventional fuel. The tax is functionally equivalent to subsidizing alternative fuels. However, while the subsidy is limited by the government's budget, the tax has no such limitation. *See* Chris Edwards et al., *Cool Code: Federal Tax Incentives to Mitigate Global Warming*, 51 NAT'L TAX J. 465, 475 (1998).

129. *See* Thomas W. Merrill, *Explaining Market Mechanisms*, 2000 U. ILL. L. REV. 275, 288 (2002) (noting that taxes harm all firms to some degree and industry opposition to taxation should be strong). *See generally* James M. Buchanan & Gordon Tullock, *Polluters' Profits and Political Response: Direct Controls versus Taxes*, 65 AMER. ECON. REV. 139 (1975).

130. *See* BREYER, *supra* note 13, at 165 (noting the problems associated with setting regulatory taxes).

taxpayers to alter their behavior, but other taxpayers may prefer to continue their activity and just pay the tax. The second objection also considers the efficiency of this approach, but focuses instead on the high administrative costs; when using a tax penalty, the government must enforce, collect, and distribute the taxes. The final objection is that the use of taxes is morally wrong in certain circumstances. Taxes allow the disfavored behavior to continue as long as the parties accept the monetary penalties. Entities with adequate financial resources not dissuaded by the tax. Additionally, if the penalty affects the income tax, it will not be a strong deterrent to those firms or individuals with low tax rates. In either situation, the tax does not prevent certain individuals and firms from performing the socially undesirable activity.

The first problem that a regulator must address is how to set the tax accurately. Although this task poses challenges to the policymaker, it is not necessarily an insurmountable obstacle. As with setting standards under the command-and-control approach, government will have to evaluate the costs and benefits of any action it undertakes. Based on this data, the government can establish a tax at the right level. The advantage of using a tax over other methods is that its initial impact upon the industry can be accurately forecasted. Moreover, even if the tax is initially either too high or too low, it can be later adjusted to the socially optimal level.

The government bears administrative costs when it either uses technology-forcing regulations or a market-based incentive such as a tax to reduce undesirable conduct.[131] In both cases, the government bears administrative costs. In the case of technology-forcing regulations, the government spends its resources on setting and enforcing regulations. With taxes, the government spends its resources collecting, enforcing, and disposing of the proceeds.[132] Since government can leverage its already established taxing system, taxes may pose lower administrative costs than technology-forcing regulations (as long as the tax can be collected with minimal non-compliance).[133]

Some critics object to using taxes on moral grounds. To address this concern, taxes should be limited to those actions that society considers suspect, but nevertheless permit. In general, taxes are best used when individuals and firms are allowed to engage in a socially undesirable activity, though only at a low level. In other words, the cost of monitoring and eliminating the activity outweighs the activity's detrimental effects. This permits a certain degree of flexibility across a population or industry. This uneven distribution of tax burdens limits

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131. KELMAN, *supra* note 121.

132. BREYER, *supra* note 13, at 170–71 (discussing the disposition of tax revenue proceeds).

133. KELMAN, *supra* note 121, at 94–95 (noting various factors that affect the administrative cost). *But see* Zolt, *supra* note 122, at 374–76 (questioning the lost administrative costs of tax penalties).

its use to particular cases. If an activity involves fundamental rights, such as worker safety or discrimination, clear-cut regulation is preferable.[134] Consequently, taxes are optimal in situations where society is not confronting basic rights and is comfortable with an unequal distribution of the undesirable activity.[135] This is, at least in part, because society values equal treatment when it comes to individual rights.[136]

One potential application for taxing information technology code involves the problem of unsolicited bulk e-mail ("spam"). By placing a tax on each e-mail message, the government could provide a disincentive to send e-mail messages. If this tax was small, such as \$.01/message, there would be a minimal impact upon most e-mail users, while bulk e-mailers who send out millions of e-mail messages would face a significant tax burden.[137] The major objection to this particular proposal is neither the difficulty in properly setting the tax-rate nor the moral propriety of such a tax. Instead, the issue is ensuring compliance. A firm or an individual can send e-mail messages, whether bulk or not, with minimal equipment and training. The ease of sending e-mail stems from the open philosophy designed into e-mail technologies. This has led some commentators to propose modifications to the underlying structure for transmitted e-mail messages.[138] Nevertheless, using current technologies, it would be very difficult to ensure compliance with such a tax. In this situation, a tax would not serve as the best method for shaping code.

2. Marketable Property Rights

An alternative market-based regulatory mechanism is a system based on marketable property rights. By creating exchangeable property rights, the regulator utilizes the market's superior allocative efficiency in distributing societal costs.[139] The government can create

134. *See* KELMAN, *supra* note 121, at 121–22 (arguing that there is a difference between regulation and taxes when it comes to rights. "[R]egulation, properly done, has liberal priority over taxation and spending; it purifies the private sphere of rights violations, a task to be achieved before redistribution (through taxing and spending).").

135. *See infra* text accompanying notes 158–159 (discussing further the ethical issue of a market-based incentive permitting socially undesirable behavior).

136. *See* Gloria E. Hefland, *Standards Versus Taxes in Pollution Control*, *in* HANDBOOK OF ENVIRONMENTAL. & RESOURCE ECONOMICS 223, 223–25 (Jeroen C.J.M. van den Bergh ed., 1999) (arguing that policymakers prefer standards because they emphasize the antisocial nature of polluting even though tax penalties are more efficient).

137. *See* Declan McCullagh, *Send Out Spam, Pay the Bill*, WIRED NEWS (Feb. 23, 2000) (describing a method to charge senders for sending e-mail messages), *available at* http://www.wired.com/news/politics/0,1283,34520,00.html.

138. *See* Katharine Mieszkowski, *E-mail is Broken*, SALON.COM (Oct. 2, 2003), *at* http://www.salon.com/tech/feature/2003/10/02/e_mail/index_np.html.

139. This concept was first developed in J. DALES, POLLUTION, PROPERTY AND PRICES (1968). *See also* Richard B. Stewart, *Environmental Regulation and International Competitiveness*, 102 YALE L.J. 2039, 2093–97 (1993) (providing an overview of the use of marketable property rights as an alternative regulatory mechanism).

property rights in either a tangible or intangible form, such as land, copyright, or even privacy. Government can also create a property right that allows an entity to engage in specific conduct, such as emitting sulphur dioxide. The resulting property right allows an individual either to engage in the conduct herself or to sell the right to others. In some cases, the government may establish a trading system for a property right to ensure efficient transfer. This mechanism allows prices to serve as a signal and as an incentive between prospective buyers and sellers, theoretically leading to an efficient distribution of the property. Moreover, the government can regulate the level of conduct by manipulating these marketable property rights. Over time, the use of marketable property rights can be an efficient way for the government to limit either a harm or a technology.

The creation of marketable property rights has been used to regulate a variety of issues from congestion to pollution.[140] In the United States, marketable property rights have been created for eliminating lead in gasoline, reducing ozone-depleting gases, reducing sulphur oxides, and reducing pollutants.[141] In these cases, the government created a system through which to trade marketable property rights. By limiting and reducing the amount of marketable property rights available, the government can control the extent of an activity.

The primary advantage to using a marketable property rights scheme rather than standard-setting regulations is its greater efficiency.[142] Allocating marketable property rights through a pricing mechanism is more efficient than government-mandated allocations of property rights for each entity.[143] It simply would be too expensive and burdensome for the government to collect information on individual costs to make accurate allocations. Moreover, the pricing mechanism provides firms with flexibility to choose their own allocation for their property rights. In some circumstances, marketable property rights can save billions compared to standard-setting regulatory approaches, especially in industries involving low monitoring costs.[144]

Another advantage of marketable property rights is the benefit created from continued technological innovation. Firms have an incentive to innovate because such innovations allow them to sell off or

140. *See* ORG. FOR ECON. CO-OPERATION AND DEV., *supra* note 120, at 8–9.

141. *See* Thomas H. Tietenberg, *Lessons From Using Transferable Permits to Control Air Pollution in the United States*, *in* HANDBOOK OF ENVIORNMENAL & RESOURCE ECONOMICS, *supra* note 136, at 275.

142. *See* Ackerman & Stewart, *supra* note 112, at 1341–42; Ruud A. de Mooij, *The Double Dividend of an Environmental Tax Reform*, *in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 302 (noting the efficiency of market-based mechanisms through Coase's theorem), supra note 136, at 302.

143. *See* BREYER, *supra* note 13, at 271–75.

144. Robert W. Hahn & Gordon L. Hester, *Where Did All the Markets Go?: An Analysis of EPA's Emissions Trading Program*, 6 YALE J. ON REG. 109, 111 (1989).

use their marketable property rights more efficiently.[145] In a standards-based regulation, firms have little incentive for further innovation once they meet the standard.

Several problems arise when using marketable property rights. The first is high overhead. The creation and administration of marketable property rights requires high administrative expenditures — the government must define, allocate, sell, and monitor the use of these property rights. These costs may cause marketable property rights to become inefficient despite their theoretical advantages over standards-based regulation. The second problem concerns the strategic use of marketable property rights.[146] Since there are no perfectly competitive markets, firms can distort the intent of marketable property rights to their advantage. The final problem is that the use of marketable property rights is also questioned on ethical grounds.[147]

First, the government must acknowledge that there are administrative costs in creating and administering a marketable property-rights system.[148] Policymakers must evaluate these costs when considering whether to opt for standards-based regulation or a marketable property rights program. The first issue they face is defining the property. The metes and bounds of the property right are key issues — they will be contested.[149] Second, once a marketable right is established, they must determine how the rights should initially be allocated. For example, should they be auctioned?[150] Or should existing users get free marketable rights through grandfathering?[151] Third, government may have to create and administer a trading system for the property right. This is a crucial ingredient since an efficient market depends upon low transaction costs for transferring property.[152] The final issue for the government is ensuring compliance. Government must ensure that firms have the proper property rights to engage in the regulated conduct. Otherwise, firms will continue to conduct the activity or use the technology without securing property rights,

145. *See* Ackerman & Stewart, *supra* note 112, at 1341–42.

146. *See* BREYER, *supra* note 13, at 173.

147. *See id*.

148. *See* OFF. OF TECH. ASSESSMENT, *supra* note 64, at 170 (providing background on the administrative issues); *see also* James T.B. Tripp & Daniel J. Dudek, *Institutional Guidelines for Designing Successful Transferable Rights Programs*, 6 YALE J. ON REG. 369, 374–77 (1989) (noting administrative issues in the use of marketable property rights).

149. Defining property rights is a continuing issue for government because uncertainty can lead to inefficiencies. *See generally* Hahn & Hester, *supra* note 144.

150. *See* Paul Koustaal, *Tradable Permits in Economic Theory*, *in* HANDBOOK OF ENVIRONMENTAL & RESOURCE ECONOMICS, *supra* note 136, at 271–72; *see also* BREYER, *supra* note 13, at 173.

151. *See* Koustaal, *supra* note 150, at 268; *see also* Merrill, *supra* note 129, at 284 (noting the predominant use of grandfathering).

152. Koustaal, *supra* note 150, at 270 (noting transactions costs in trading).

making low monitoring costs essential to a successful marketable property rights scheme.[153]

Second, a perfect market in which no actor has market power does not actually exist.[154] Hence, one expects firms to distort the market to their advantage. Firms could collude to keep prices low or set pricing levels,[155] or they could buy up the marketable property to create a high barrier to entry for new firms.[156] The government must strive to achieve a closely competitive market when establishing the marketable property right. Otherwise, government must rely upon antitrust law to ensure competition.[157]

Last, policymakers must consider a moral argument against marketable property rights.[158] When government creates a property right, some argue that it tacitly approves the behavior, at least to some extent. Moreover, government removes the stigma attached to the conduct by creating property rights that allow it. This is one of the reasons why people have been opposed to market-based approaches to minimize pollution; some have similar concerns about inequality in taxation.[159] Therefore, a regulator should try to avoid creating a marketable property right when society generally regards an activity as morally wrong.

In the realm of code, the first notable creation of marketable property rights has been for the domain name system ("DNS").[160] In this case, the government supported the creation of additional domain names[161] for greater consumer choice, lower prices, and better service.[162] Although the government's efforts to date have focused on creating property rights for greater consumer choice, the government can also use marketable property rights as a regulatory mechanism for code. One example of regulating information technologies through such a scheme would be to create new top level domains such as .xxx,

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153. *See* Cole & Grossman, *supra* note 79, at 937; *see also* Koustaal, *supra* note 150, at 271 (describing the effects of non-compliance).

154. Koustaal, *supra* note 150, at 266.

155. BREYER, *supra* note 13, at 173.

156. *Id*.

157. *See id*.

158. *See generally* STEVEN KELMAN, WHAT PRICE INCENTIVES?: ECONOMISTS AND THE ENVIRONMENT (1981) (providing a thorough discussion of the moral basis argument).

159. *See supra* text accompanying notes 134–136.

160. A number of commentators have considered whether a domain name is property. *See, e.g.*, David F. Fanning, *Quasi in Rem on the Cyberseas*, 76 CHI.-KENT L. REV. 1887 (2001); Susan Thomas Johnson, *Internet Domain Name and Trademark Disputes: Shifting Paradigms in Intellectual Property*, 43 ARIZ. L. REV. 465 (2001).

161. *See* David McGuire, *Commerce Department Urges ICANN to Add More New Domains*, NEWSBYTES (May 25, 2001), *at* http://www.findarticles.com/p/articles/mi_m0NEW/is/2001_May_25/ai_75024956.

162. *See* Press Release, Commerce Department, Network Solutions Agree to Extend Shared Registration Test Bed Until July 16 (June 25, 1999), *available at* http://www.ntia.doc.gov/ntiahome/press/testbed062599.htm.

.adult, or children-friendly domains.[163] This intervention is not about limiting behavior or allocating scarce resources, but instead attempts to fence off or contain an activity to a specific piece of property (akin to zoning regulations for real property).

In the context of the DNS, the government is already using marketable property rights to regulate code to ensure socially beneficial uses. The government has outsourced the management of the DNS to a private actor,[164] but nonetheless has maintained oversight and has thereby ensured that the system is not used strategically for the benefit of a few.[165]

The second possible use of marketable property rights for code is in the privacy area. The creation of a property right in privacy could correct market failures by providing people with control over their personal information.[166] This property right would lead firms to bargain for a person's information in contrast to the current system, which offers incentives for firms to disclose information without consent. Nonetheless, it is not clear whether this approach is warranted. A privacy property right may not truly meet the needs of its proponents. The problem for most proponents is the lack of negotiation and meaningful assent between parties during a transaction,[167] not issues involving the quantity of privacy (i.e., too much or too little). This is not a problem that marketable property rights can address.[168] These rights work best to limit quantity of harm and are not helpful in facilitating informed negotiations. Additionally, the purpose of property rights is to allow the market to allocate scarce resources, and it is not clear how the market can allocate privacy property rights that are tied to individuals.[169] Furthermore, it is not clear how such a privacy system

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163. *See* Oscar S. Cisneros, *Surfers Need to Roam Porn-Free*, WIRED NEWS (Aug. 4, 2000) (reporting the consideration of an adult top level domain name by the Child Online Protection Act Commission), *at* http://www.wired.com/news/politics/0,1283,37991,00.html; April Mara Major, *Internet Red Light Districts: A Domain Name Proposal for Regulatory Zoning of Obscene Content*, 16 J. MARSHALL J. COMPUTER & INFO. L. 21 (1997); David McGuire, *President Signs 'Dot-Kids' Legislation*, WASHINGTONPOST.COM (Dec. 4, 2002) (noting the creation of a .kids domain name within the .us space), *at* http://www.washingtonpost.com/ac2/wp-dyn/A8016-2002Dec4.

164. *See generally* ELLEN RONY & PETER RONY, THE DOMAIN NAME HANDBOOK (1998); A. Michael Froomkin, *Of Governments and Governance*, 14 BERKELEY TECH. L.J. 617 (1999); A. Michael Froomkin, *Wrong Turn in Cyberspace: Using ICANN to Route Around the APA and the Constitution*, 50 DUKE L.J. 17 (2000); Kesan & Shah, *supra* note 27; Jonathan Weinberg, *ICANN and the Problem of Legitimacy*, 50 DUKE L.J. 187 (2000).

165. Kesan & Shah, *supra* note 27, at 176–77 (noting actions taken by the government to ensure the transparency of DNS governance).

166. *See* Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 520 (1999). There are critics of this approach. *See, e.g.*, Paula Samuelson, *Privacy as Intellectual Property?*, 52 STAN. L. REV. 1125 (2000); Jessica Litman, *Information Privacy/Information Property*, 52 STAN. L. REV. 1283 (2000).

167. *See* Samuelson, *supra* note 166, at 1134.

168. *Id*. at 1136–38.

169. *Id*. at 1138.

will be administered. As a final note, some people object to allowing the buying and selling of privacy on moral grounds.[170] In sum, an analysis of marketable property rights shows that such a scheme is not a suitable alternative to regulation for addressing privacy.

D. Modifying Liability

Liability is the "legal responsibility to another or to society, enforceable by civil remedy or criminal punishment."[171] Changes in liability doctrine can drive changes in code.[172] This section examines two different ways government can use liability to shape the development of information technology architecture. The first is through the law of torts, specifically product liability law. The second is through the law of contracts. This section ends by discussing how the relationship between increased liability and insurance companies can encourage the development of third party regulators, such as the Underwriters Laboratories, to shape code to address societal concerns.

1. Product Liability Law

Product liability law is governed by tort law[173] and can affect the development of code. It depends not on government agencies, but on persons who have been physically harmed and are seeking compensation in the courts.[174] One function of product liability law is to encourage firms to improve product safety.[175] This section focuses on how products liability law can serve as an alternative form of regulation to encourage the development of safer code.[176]

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170. *Id*. at 1148.

171. BLACK'S LAW DICTIONARY 416 (8th ed. 2004).

172. For example, John Gilligan, chief information officer for the U.S. Air Force's computer networks, wants software companies to be subject to legal action for failing to create and maintain secure products. He believes that changing liability standards can improve product quality by requiring accountability from the developers of code. *See* Alex Salkever, *A World Wide Web of Organized Crime*, BUS. WK. ONLINE (Mar. 13, 2001), *at* http://www.businessweek.com/bwdaily/dnflash/mar2001/nf20010313_967.htm; *see also* NAT'L ACAD. OF SCIS., COMPUTER SCI. & TELECOMM. BD., CYBERSECURITY TODAY AND TOMORROW: PAY NOW OR PAY LATER (2002), *available at* http://books.nap.edu/html/cybersecurity/; *A Lemon Law for Software?*, ECONOMIST, Mar. 16, 2002, supp. 3.

173. *See generally* MICHAEL J. MOORE & W. KIP VISCUSI, PRODUCT LIABILITY ENTERING THE TWENTY-FIRST CENTURY: THE U.S. PERSPECTIVE 7 (2001) (providing a short history of product liability law).

174. *See* Susan Rose-Ackerman, *Tort Law in the Regulatory State*, *in* TORT LAW & THE PUBLIC INTEREST 80 (Peter H. Schuck ed., 1991) (noting that product liability is a form of private law).

175. *See* MOORE & VISCUSI, *supra* note 173, at 7–8; Richard M. Marrow, *Technology Issues and Product Liability*, *in* PRODUCT LIABILITY AND INNOVATION: MANAGING RISK IN AN UNCERTAIN ENVIRONMENT 23, 25 (Janet R. Hunziker & Trevor O. Jones eds., 1994).

176. *See* BREYER, *supra* note 13, at 177 (noting that changing liability rules may be a substitute or supplement for classic regulation). As an adjunct to product liability law, the government could require professional standards for code developers. This would provide

Product liability law varies considerably by industry.[177] As of yet, product liability law has not had a substantial impact on code.[178] This is not surprising, considering that most losses from code are merely economic with no accompanying physical injury.[179] Nevertheless, as the use of code continues to grow, an increase in physical injuries involving code is entirely foreseeable. As a result, the importance of product liability in shaping code will continue to grow.[180] This trend, however, may not be fully obvious because code is often only one element of larger products that are traditional targets of product liability, such as automobiles or medical devices that often rely on internal computers.[181]

One prominent example of product liability law shaping a technology is *Larsen v. General Motors Corp*.[182] General Motors argued that it had no duty to design an automobile that protects occupants in the event of a crash since crashing an automobile was outside its intended use.[183] The court disagreed, holding that the manufacturer of a vehicle has a duty to design one with reasonable care.[184] This imposed a duty to protect occupants of the automobile in the event of a crash, since automobiles crashes are foreseeable even though crashing is not the intended use.[185]

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an alternative basis for liability. There are many trades such as engineering, interior decorating, and hairdressing that require licenses. The same could be done for the creators of code. Currently, most code-related licensing is done by the private sector, such as Microsoft's Certified Professional program. The Association for Computing Machinery ("ACM"), the largest organization for computer programmers, is currently opposed to the licensing of software engineers. The licensing could be enforced by government as well as through malpractice suits. *See* Letter from Barbara Simons, ACM President, ACM's Position on the Issue of Licensing of Software Engineers (July 8, 1999), *at* http://www.acm.org/serving/se_policy/position.html. *See generally* Patricia Haney DiRuggiero, *The Professionalism of Computer Practitioners: A Case for Certification*, 25 SUFFOLK U. L. REV. 1139 (1991) (discussing government licensing versus an industry certification program).

177. *See* Peter W. Huber & Robert E. Litan, *Overview*, *in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 1, 4 (Peter W. Huber & Robert E. Litan eds., 1991).

178. Although the year 2000 problem with code created the potential for product liability, and industry was claiming potential liability losses of one trillion dollars, liability was limited with the passage of the Y2K Act. Y2K Act, Pub. L. No. 106-37, 113 Stat. 185 (1999).

179. *See* Thomas G. Wolpert, *Product Liability and Software Implicated in Personal Injury*, 60 DEF. COUNS. J. 519, 519 (1993).

180. *Cf.* Helen Nissenbaum, *Accountability in a Computerized Society*, SCI. & ENG'G ETHICS, Jan. 1996, at 25 (arguing that as computing matures liability may be necessary to protect the public).

181. *See* Wolpert, *supra* note 179, at 523.

182. 391 F.2d 495 (8th Cir. 1968).

183. *See id*. at 497–98.

184. *See id*. at 502.

185. *See id*.; *see also* John D. Graham, *Product Liability and Motor Vehicle Safety*, *in* THE LIABILITY MAZE, *supra* note 177, at 121. Since many modern safety features of automobiles are triggered by code-based mechanism, code could prove key to liability of this type.

Critics argue that product liability law is inefficient. They suggest that a more efficient method would be to allow consumers to select technologies based on their own evaluation of risk and safety concerns.[186] As the argument goes, this would encourage the market to develop a wide range of technologies that are responsive to consumer needs, and would also save firms substantial litigation costs.[187] Next, critics observe that the unpredictability of products liability law can lead to uneven results, which makes it difficult for firms to predict their liability exposure.[188] The third objection is that product liability law has a chilling effect upon innovation. In essence, the high level of risk resulting from product liability reduces innovation and keeps beneficial products off the market.[189]

Despite these criticisms, product liability law can actually be more efficient than market-based alternatives, which are subject to market defects and transaction costs. These defects can include buyers who are unaware of the risks or lack adequate opportunities to bargain for a safer, albeit more expensive, product.[190] In the case of a complex product where a buyer could not ascertain the risks adequately, scholars have argued that it may be best to place liability on the manufacturer, who has better information about risk to help it weigh the associated costs.[191] The threat of liability causes manufacturers to internalize social costs into their products, thereby increasing total costs.[192] Nevertheless, these costs produce safer products. Whether the costs of liability law are outweighed by its benefits is difficult to ascertain, because the deterrence aspect of product liability law provides a benefit to society that cannot be easily measured.[193] It is also difficult to account for the benefits that society gains by preventing unsafe products from being released. The change from a negligence standard to a strict liability standard could result in far fewer deadly acci-

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186. *See* BREYER, *supra* note 13, at 174–75.

187. *See* COMM. ON COMMERCE, SCI., & ,TRANSP., PRODUCT LIABILITY REFORM ACT OF 1997, S. REP. NO. 105-32, at 3–4 (1997).

188. *See id*. at 5–6.

189. *See id*. at 8–10.

190. *See* BREYER, *supra* note 13, at 175.

191. *See, e.g.*, *id*.

192. There is little evidence that product liability costs and insurance costs are too high. *See* MOORE & VISCUSI, *supra* note 173, at 13 (noting that in real terms insurance premiums have fallen between 1988 and 1998); COMM. ON COMMERCE, SCI., & ,TRANSP., *supra* note 187, at 65.

193. *See* Robert E. Litan, *The Liability Explosion and American Trade Performance: Myths and Realities*, *in* TORT LAW & THE PUBLIC INTEREST, *supra* note 174, at 127, 135.

dents.[194] Some argue that if product liability laws were more stringent, products would be safer.[195]

Critics also like to highlight the unpredictability of product liability law, but they are hard-pressed to refute the evidence that punitive damages result in safer products.[196] The purpose of punitive damages is twofold. First, punitive damages express to defendants that their conduct is intolerable.[197] Second, punitive damages encourage plaintiffs to bring actions against wrongdoers, even if the actions were otherwise economically unfeasible, because they reward plaintiffs with recovery above their actual damages.[198] As a result, punitive damages provide firms with a strong incentive to ensure their products meet society's minimal standards for safety. Although the use of punitive damages in product liability law is typically unpredictable, the actual risk of liability exposure to an individual firm may be low.[199] In fact, one study of product liability cases in state and federal courts between 1965 and 1990 found only 355 punitive damage awards over the entire twenty-five-year period.[200]

In rebutting criticisms of the chilling effects on innovation, there is no simple direct relationship between increased liability and decreased innovation.[201] Typically, the risk of product liability creates an incentive to develop safer products, with only extremely high levels of liability associated with lower research and development activity, and thus less innovation.[202] This leads to the conclusion that a balancing point exists between increasing safety and stifling techno-

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194. *Cf.* BREYER, *supra* note 13, at 174–77 (discussing the contention that strict liability reduces the costs of accidents by shifting incentives to encourage manufacturers to produce safer products).

195. *See* Nicholas A. Ashford & Robert F. Stone, *Liability, Innovation, and Safety in the Chemical Industry*, *in* THE LIABILITY MAZE, *supra* note 177, at 415–17 ("[T]ort liability for a chronic disease should be expected to stimulate innovation of significantly safer products.").

196. *See* COMM. ON COM., SCI., & TRANSP., *supra* note 187, at 76–78.

197. *See* Jane Mallor & Barry Roberts, *Punitive Damages: Toward a Principled Approach*, 31 HASTINGS L.J. 639, 648 (1980).

198. *See id*. at 649–50.

199. Awarding punitive damages is rare. One study found that punitive damages were awarded less than five percent of the time in civil jury verdicts. *See* Stephen Daniels & Joanne Martin, *Myth and Reality in Punitive Damages*, 75 MINN. L. REV. 1, 31 (1990) (analyzing 25,627 civil jury verdicts in forty-seven counties in eleven states for the years 1981 to 1985).

200. Michael Rustad & Thomas Koenig, *Punitive Damages in Products Liability: A Research Report*, 3 PROD. LIAB. L.J. 85, 89 (1992) (performing a thorough survey of punitive damages in reported product liability verdicts). Even though "the actual number of punitive damage verdicts in product cases is unknown and unknowable" due to a lack of a national reporting system, "they are clearly rare." *Id*.

201. One systematic study across several industries found that low levels of liability risk were associated with higher levels of research, development, and innovation. *See* MOORE & VISCUSI, *supra* note 173, at 25.

202. *Id*. at 27.

logical progress.[203] Innovation and safety cannot be separated: liability affects both. Liability promotes safety and innovation of desirable products while discouraging development of unsafe products.[204] In fact, a certain degree of liability can actually increase innovation.

One distinct advantage of product liability law is its public visibility.[205] The publicity of a product liability lawsuit can serve to stimulate safety through a variety of societal institutions.[206] Naturally, a product liability lawsuit will lead manufacturers to reexamine their practices. Moreover, publicity can also spur regulatory agencies to action and increase consumer demand for safety.[207] There is also evidence that product liability lawsuits provide firms with an incentive for developing safer products because liability affects firms' stock market value.[208]

Product liability already plays a role in shaping the development of code. Developers in industries where defective code can cause physical injury, such as aerospace and medicine, have a strong incentive to make safer code. In addition to the risk of product liability and other purely regulatory concerns, firms avoid developing unsafe code for many other reasons, including a loss of revenue and reputation.[209] As a result, firms developing code for aerospace applications and medical devices use a number of developmental strategies to ensure high quality code.[210]

Product liability can and will play a role in shaping the future development of code. One such potential application is to hold firms liable for failing to properly secure their computer systems. Firms that do not implement appropriate levels of security not only place themselves at risk, but may also serve as unwitting pawns in attacks on other computer systems or expose others to the threat of identity theft

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203. *See* MOORE & VISCUSI, *supra* note 173, at 26; W. Kip Viscusi & Michael J. Moore, *An Industrial Profile of the Links between Product Liability and Innovation*, *in* THE LIABILITY MAZE 81, *supra* note 177, at 84. *Cf.* Litan, *supra* note 177, at 149 (arguing that product liability diminishes innovation, but it is not clear what the net effect is on society because of deterrence and justice benefits).

204. COMM. ON COMMERCE, SCI., & TRANSP., *supra* note 187, at 77.

205. *See* Peter H. Schuck, *Introduction*, *in* TORT LAW & THE PUBLIC INTEREST, *supra* note 174, at 17, at 20–27.

206. Graham, *supra* note 185, at 181–82.

207. This was evident in several vehicle product liability cases involving the Ford Pinto, shoulder belts, and all-terrain vehicles. *See id*. at 181.

208. MOORE & VISCUSI, *supra* note 173, at 27.

209. *Cf.* Alexander MacLachlan, *The Chemical Industry: Risk Management in Today's Product Liability Environment*, *in* PRODUCT LIABILITY AND INNOVATION: MANAGING RISK IN AN UNCERTAIN ENVIRONMENT, *supra* note 175, at 47. "Responsible behavior of companies is driven by the simple fact that such behavior is vital for continued business success." *Id*. at 53.

210. *See generally* RICHARD C. FRIES, RELIABLE DESIGN OF MEDICAL DEVICES (1997).

or other crimes.[211] Analysts have argued that one solution to this problem is the imposition of tort liability.[212] This is not a hypothetical issue; recently hackers gained access to ChoicePoint's computer systems to gather 145,000 consumer profiles.[213] Liability for such breaches would motivate firms to adopt more secure code and better security procedures.[214]

2. Contract Law

Contract law provides a second option for regulating with liability. Typically, a transaction involving code falls under the Uniform Commercial Code ("UCC"),[215] which has been almost fully enacted by all states. The UCC contains default rules both for contracts and warranties.[216]

Recently, an amendment to the UCC, initially titled Article 2B, was proposed in order to better handle transactions with intellectual property and software.[217] However, sharp differences of opinion emerged from the drafting process. Eventually, the American Law Institute withdrew from the process and eliminated Article 2B as an amendment.[218] Supporters of Article 2B advanced this proposal as the Uniform Computer Information Transactions Act ("UCITA").[219] UCITA has since been enacted in Virginia and Maryland and is being considered by other states.[220]

UCITA is a contemporary example of how changes in liability affect code. The pro-UCITA movement, led by software industry vendors, has resulted in two states adopting this act. However, a number of organizations have been fighting its adoption, leading to the pas-

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211. For instance, the recent security breach at ChoicePoint has resulted in the threat of identity theft to thousands of Americans. *See* Joseph Menn, *Credit Data Is Stolen in Fraud Ring*, L.A. TIMES, Feb. 16, 2005, at Business Section.

212. *See* Alan Charles Raul et al., *Liability for Computer Glitches and Online Security Lapses*, 6 ELECTRONIC COM. L. REP. (BNA) 849, 851 (2001).

213. *See* Robert Lemos, *ChoicePoint Data Loss May Be Higher Than Reported*, CNET NEWS.COM (March 10, 2005), *at* http://news.com.com/ChoicePoint+data+loss+may+be+higher+than+reported/2100-1029_3-5609253.html.

214. *See* Raul, *supra* note 212.

215. In dealing with code, there is often a question whether the sale of software is considered a good or a license. Most courts have considered software a good and therefore subject to the UCC. *See* Douglas E. Phillips, *When Software Fails: Emerging Standards of Vendor Liability Under the Uniform Commercial Code*, 50 BUS. LAW. 151, 157–58 (1994).

216. *See, e.g.*, U.C.C. § 2-314 (2001) (providing a default rule for contracts for an Implied Warranty of Merchantability in the purchase of a good).

217. Warigia Bowman, *The Uniform Computer Information Transaction Act: A Well Built Fence or Barbed Wire Around the Intellectual Commons?*, 13 LBJ J. PUB. AFF. 80, 81 (2001).

218. *Id*.

219. NAT'L CONFERENCE OF COMM'RS ON UNIF. STATE LAWS, UNIFORM COMPUTER INFORMATION TRANSACTIONS ACT (2001), *available at* http://www.law.upenn.edu/bll/ulc/ucita/ucita01.htm.

220. Bowman, *supra* note 217.

sage of anti-UCITA legislation in a few states. This so-called bomb-shelter legislation protects residents against licensing provisions in contracts governed by UCITA.[221] Without addressing the merits of UCITA, we will highlight some of its provisions and other changes in contractual liability that could affect the development of code.

UCITA allows developers to insulate themselves from liability for damages caused by software.[222] According to Barbara Simons, the former president of the ACM, "[I]t is almost impossible to write bug-free software, [b]ut UCITA will remove any legal incentives to develop trustworthy software, because there need be no liability."[223] As a result, many software industry insiders believe that UCITA will lead to even lower quality standards for code.

A second criticism of UCITA is that it creates enforceable provisions against reverse engineering, the process of analyzing code to determine how it operates. Reverse engineering is an accepted practice under copyright and trade secret law, and is often used by competitors who wish to develop rival code.[224] However, UCITA allows firms to prohibit reverse engineering of products. Undoubtedly, this provision will make it more difficult to develop competing products. Though it may be difficult to enforce, this provision will still have an unsettling effect upon code development.[225]

A third criticism of UCITA is that it allows developers to enforce contractual provisions against publicly criticizing software, potentially affecting the writing of reviews, comparisons, and benchmark tests on software. These writings inform consumers and create a more competitive marketplace.[226] Though the wisdom of this provision may be questioned based on public policy grounds, it will still have a chilling effect on the public critique of code.[227]

UCITA is an example of how changes in liability can shape code. Although it is highly questionable whether UCITA in its present form

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221. Ed Foster, *Maryland Legislature Caves to UCITA, but Iowa May Offer a Safe Haven from Law*, INFOWORLD (Apr. 21, 2000), *at* http://www.infoworld.com/articles/op/xml/00/04/24/000424opfoster.html.

222. *Cf.* Cem Kaner, *Software Engineering and UCITA*, 18 J. MARSHALL J. COMPUTER & INFO. L. 435, 444–45 (1999) (discussing how UCITA's provisions for limited accountability will serve as an incentive for the software industry to develop lower quality products); *see also* Andrea L. Foster, *New Software-Licensing Legislation Said to Imperil Academic Freedom*, CHRON. HIGHER EDUC., Aug. 11, 2000, *available at* http://chronicle.com/free/v46/i49/49a04701.htm.

223. Barbara Simons, *Shrink-Wrapping Our Rights*, 43 COMM. ASS'N COMPUTING MACH. 168 (Aug. 2000), *available at* http://www.acm.org/usacm/copyright/ucita.cacm.htm.

224. *Cf.* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 16–37 (2001) (arguing that the traditional right to reverse engineer software under copyright and trade secret law should be extended to patents).

225. *See* Kaner, *supra* note 222, at 473–74.

226. *See* Inst. of Electrical & Elecs. Eng'rs, *Opposing Adoption of the Uniform Computer Information Transactions Act (UCITA) by the State* (Feb. 2000), *at* http://www.ieeeusa.org/policy/positions/ucita.html.

227. *See* Kaner, *supra* note 222, at 470.

will be widely adopted, the fundamental concepts behind its creation are highly relevant. In essence, this act balances various liabilities and conditions for the use of code between developers and consumers. Regardless of the outcome, it will shape the code developed in a post-UCITA world.

3. Insurance and Third-Party Regulators

One response to liability is the development of institutions to lessen and spread the risk of liability. Insurance has long been used to spread liability risks from events such as fire or earthquakes.[228] Of even greater interest is how liability and insurance companies can foster the development of third party institutions to regulate products. The archetype is the Underwriters Laboratories ("UL"), which conducts uniform testing of electrical appliances to assess their safety. A similar code-based laboratory could be established to ensure that code meets various societal concerns.

The factors that led to the growth of the UL help illustrate how to foster similar results in code. Its history began with a rash of electrical fires in major American cities in the 1890s,[229] leading a number of insurance companies, such as the Chicago Board of Fire Underwriters, Western Insurance Association, and the Electrical Bureau of the National Board of Fire Underwriters, to fund a testing laboratory.[230] This laboratory evolved into the UL and provided rigorous, unbiased testing of electrical devices for fire prevention.[231] Today, the UL works with over 60,000 manufacturers with its label present on over 100,000 products, each evaluated for safety.[232] Its success is the result of a close relationship with insurance companies and government regulators. This relationship ensures that manufacturers follow UL's safety standards. As a result, consumers and manufacturers consider products bearing the UL label to be safe.[233]

Due to recent concerns about security, the government is attempting to foster a similar system for code.[234] Such a system begins with

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228. *See generally* Orna Raz & Mary Shaw, *Software Risk Management and Insurance*, Third Int. Workshop on Econ.-Driven Software Eng'g Res., Toronto, Canada (May 2001), *available at* http://www.cs.virginia.edu/~sullivan/edser3/raz.pdf.

229. NORM BEZANE, THIS INVENTIVE CENTURY: THE INCREDIBLE JOURNEY OF THE UNDERWRITERS LABORATORIES 6 (1994).

230. *Id*. at 7.

231. *See id*. at 6 (stating that the UL's goal is to test for public safety, not to profit).

232. UNDERWRITERS LABORATORIES, 2001 ANNUAL REPORT, *available at* http://www.ul.com/annualreport01/AR2001.pdf (last visited Feb. 28, 2005).

233. *See* Courtenay Youngblood, Note, *A New Millennium Dilemma: Cookie Technology, Consumers, and the Future of the Internet*, 11 DEPAUL-LCA J. ART & ENT. L. 45, 70 (2001); Henry H. Perritt, *Economic and Other Barriers to Electronic Commerce*, 21 U. PA. J. INT'L ECON. L. 563, 568 (2000).

234. *See* Brian Krebs, *White House Pushing Cybersecurity Insurance*, WASHINGPOST.COM (June 27, 2002), *at* http://www.washingtonpost.com/wp-dyn/articles/

companies purchasing insurance for cybersecurity. Insurance companies would provide discounts to firms with better security practices and to those who use better security products. This encourages the creation of an analogous UL for testing code. Ideally, such a laboratory could work as efficiently as the UL and be able to test the vast amounts of code-based products in a timely manner. Companies using these approved pieces of code would have their premiums reduced, thereby increasing demand for more secure code and creating an incentive for developers to make sure their products meet the standards of the code-based UL.

The UL-based approach is largely based on private actors, with the government merely promoting and using the tested products. The incentive structure for insurance companies, the insured, and developers is apparent. Though this scheme has proved successful for electrical products, third-party regulators for code face significant issues with using insurance.

The government must consider three issues in trying to encourage the development of an insurance system for code. First, insurance is not appropriate for potential losses where self-protection measures play an important role. Insurance works best when its price is largely independent of expenditures on self-protection.[235] For example, homeowners demand insurance against fire and earthquakes because they cannot adequately protect themselves from these largely independent events. Conversely, when the price of market insurance depends upon self-protection, there will be a small demand for market insurance and a large demand for self-protection measures.[236]

In the current state of the Internet, self-protection measures play an important role in reducing losses, as shown by the existence of an entire industry devoted to developing and teaching self-protection skills to firms.[237] The natural inclinations of the market would not likely foster the development of code-based insurance for security. Without a viable market for code-based insurance, insurance companies have little incentive to encourage third parties to regulate code. Moreover, creating third-party regulators not backed by insurance companies — or some other entity that can force compliance — is

A55719-2002Jun27.html; Nancy Gohring, *Cyberinsurance May Cover Damages of Computer Woes*, SEATTLE TIMES, July 29, 2002 , at C1.

235. *See* Isaac Ehrlich & Gary S. Becker, *Market Insurance, Self Insurance, and Self Protection*, 80 J. POL. ECON. 623, 642 (1972).

236. Consider the following example for code. While there is little a firm can do to protect itself from a major Internet outage, it can protect itself from a minor outage through the use of redundant Internet service providers. Therefore, one would expect a higher demand for insurance against losses from a major outage, but not a minor one.

237. *See, e.g.*, SysAdmin, Audit, Network, Security Institute, *at* http://www.sans.org/ (last visited Apr. 23, 2005).

bound to fail.[238] Absent the support of insurance companies and the subsequent threat of financial repercussions, little incentive exists to spur the growth of vigorous third-party regulators for code.[239]

Another problem with insurance for code is the need for determinable damages. If losses cannot be estimated by insurance companies, they cannot provide market insurance priced in accordance with risk levels.[240] Code-based damages differ from fire or hazard damages because physical losses are tangible, obvious, and irreplaceable. Code represented in software, databases, and other similar media is often intangible. Moreover, many code-based losses — such as those due to computer viruses, hacker attacks, and the defacement of web pages — are reversible, rendering the actual losses difficult to define.[241] Moreover, it may be that damages are so low that firms prefer to self-insure.[242]

The final problem concerns the appropriate purchaser of insurance. Throughout the government's efforts to improve security, it has encouraged insurance for firms that use the Internet in their daily business.[243] If its goal is to develop more secure products, the government should focus on insurance for code developers, thereby addressing the problems of self-protection and determination of damages. If subject to liability, code developers and their insurers would have a tremendous incentive to reduce that liability, which could lead to several outcomes.[244] One possibility is that the developers could adopt voluntary "best practices" industry standards for security.[245] Their insurers could then require them to adopt these new

238. *See* Kesan & Gallo, *supra* note 27 (calling for government participation to spur the growth of third-party institutions to regulate firms). For example, a third-party private regulator for privacy, TrustE, has largely failed. This occurred because it has no enforcement authority or "stick" to ensure compliance. No laws hold actors accountable for privacy violations and thus TrustE could not meaningfully regulate violators' activity. The use of private regulators such as TrustE has proven unsuccessful because security firms cannot force parties to comply. Without compliance, a party only risks a slight loss in reputation capital, leaving little liability at stake. In contrast, not complying with standards set by UL can lead to problems in terms of lawsuits, loss of insurance coverage, and government oversight — very real penalties for violating or ignoring the standards promulgated by UL. *See* Kesan & Gallo, *supra* note 27 (discussing the failure of third party institutions in regulating online privacy); Paul Boutin, *Just How Trusty is Truste?* [sic], WIRED NEWS, Apr. 9, 2002, (noting the lack of an enforcement mechanism by TrustE) *available at* http://www.wired.com/news/exec/0,1370,51624,00.html.

239. *See* Kesan & Gallo, *supra* note 27, at 1531 (calling for government participation to spur the growth of third party institutions to regulate firms).

240. *See* Raz & Shaw, *supra* note 228.

241. *See* Krebs, *supra* note 234 (noting the problem with assessing damage).

242. *See* Ehrlich & Becker, *supra* note 235, at 642 (describing firms that tend to self-insure).

243. *See* Krebs, *supra* note 234 (noting the problem with assessing damage).

244. *See id*. (noting that security expert Bruce Schneier believes that firms will not improve security until they face either product liability lawsuits or stringent standards).

245. *See* Dan Verton, *Tech Consortium Created to Improve Software Reliability*, COMPUTERWORLD (May 20, 2002) (noting that the insurance industry can aid in promoting

practices. Another possibility is that insurers could encourage the development of a third-party regulator to test products to ensure they are secure. Finally, the industry could seek government regulation of code as a way to limit its liability. These scenarios demonstrate ways in which product liability and insurance could proactively shape code.

E. Requiring Disclosure

Government can shape the development of code by requiring firms to disclose information about their products to the public. Disclosure differs from the government-funded educational campaigns discussed later,[246] in that it is intended to facilitate efficient markets by providing more information to consumers.[247] Without disclosure, the technical sophistication of code often makes it difficult for the general public to understand its internal workings. For example, most Internet users did not understand the privacy risks posed by website cookies until reported by media.[248] With limited knowledge, many people did not realize that their personal information was being collected and were not able to protect themselves.[249] These problems would have been substantially reduced had the privacy risks of cookies been disclosed in a meaningful way.

According to Justice Breyer, disclosure works most effectively when it meets the following three conditions.[250] First, the public must be able to understand the information disclosed. Regulations are of no use if the information provided is too complex. Second, the public must have a choice within the market. Even if the public understands a risk, that understanding will be meaningless unless the public can

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"positive behavior" among developers), *at* http://www.computerworld.com/securitytopics/security/story/0,10801,71297,00.html.

246. *See infra* Part III.D.

247. *See* BREYER, *supra* note 13, at 161. Disclosure can also be used to expose particular conduct, such as requiring the disclosure of large currency transactions in order to uncover violations of tax and drug laws. *Id*.

248. Cookies are a technology that web sites can use to maintain information on their visitors. Early studies indicated confusion regarding cookies. *See, e.g.*, AT&T LABS, BEYOND CONCERN: UNDERSTANDING NET USERS' ATTITUDES ABOUT ONLINE PRIVACY (Apr. 14, 1999), *at* http://www.research.att.com/resources/trs/TRs/99/99.4/99.4.3/report.htm. Similarly, people have difficulty understanding the complex privacy policies put forth by web sites. *See, e.g.*, Brian Krebs, *Standard, Plain-English Privacy Policies Wanted — Update*, NEWSBYTES (Dec. 3, 2001), *at* http://www.findarticles.com/p/articles/mi_m0NEW/is_2001_Dec_3/ai_80510824.

249. Elinor Mills Abreu, *Shutdown Means Fewer Options for Online Anonymit*y, SAN DIEGO UNION-TRIB., Nov. 27, 2001, at Computer Link 8 (noting that people do not understand privacy issues on the Internet).

250. BREYER, *supra* note 13, at 164; *see also* WESLEY A. MAGAT & W. KIP VISCUSI, INFORMATIONAL APPROACHES TO REGULATION 5 (1992) (noting that disclosure will not be effective "if the information cannot be processed reliably or is viewed as not contributing any new information or perspective on a decision . . . ."); SUSAN G. HADDEN, READ THE LABEL: REDUCING RISK BY PROVIDING INFORMATION 225–26 (1986).

select an alternative. Third, the public must find the information materially relevant. If the public finds no value in the disclosure, requiring such disclosure will be useless. Based on this analysis, this Section offers three potential approaches for, and current examples of, the regulation of code via government-mandated disclosure: disclosure of product standards, targeted disclosure for specified products/activities, and industry-wide disclosure.

By requiring firms to label their products with consistent products standards, the government can provide the public with better information.[251] For such a label to be successful, it must be able to convey information in a meaningful and concise manner. An example of a useful labeling standard is the USDA's standard for food quality.[252] In some cases, existing labels should be clarified. For example, in order to combat unsolicited bulk e-mail ("spam"), the government required that the origin and the subject line of commercial e-mail messages not be "materially false" or "materially misleading."[253] This disclosure better informs people about the source and content of commercial e-mail messages, just as the USDA product standards keep consumers informed about the source and quality of food products.

Where labeling alone would be inadequate to inform consumers fully, the government can also mandate disclosures triggered by specific circumstances. For example, the SEC requires public companies to disclose meaningful financial information to the public. Similarly, a California law requires firms to disclose any computer security breach that endangers their privacy to California residents.[254] Another example of a code-based disclosure policy is the Children's Online Privacy Protection Act.[255] This law requires websites to report what information it collects from children and its planned use for that information.[256] This disclosure allows parents to make informed decisions about which websites their children can safely visit.

Finally, the government can shape code by encouraging industry-wide disclosure. In many circumstances, the public can benefit when firms share information. For instance, the government-supported CERT Coordination Center collaborates with industry to disclose all

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251. *See supra* note 66 and accompanying text.

252. *See supra* note 67 and accompanying text.

253. Controlling the Assault of Non-Solicited Pornography and Marketing Act of 2003, 117 Stat. 2699, 2706 (codified at 15 U.S.C. § 7704(a)(1) (2004)).

254. Notice of Security Breach, CAL. CIV. CODE § 1798.82 (2003). *See also* Menn, *supra* note 211 (noting that only Californians were initially notified of the ChoicePoint security breach); Robert Lemos, *supra* note 213 (suggesting that ChoicePoint may not have notified customers of possible identity theft occurring before California's notification law was enacted).

255. Children Online Privacy Protection Act of 1998, 15 U.S.C. §§ 6501–6506 (1998).

256. *Id*. § 6502(b).

known security incidents.[257] This communication benefits the public by allowing code developers to react quickly to potential security problems.[258] There is, of course, the legitimate concern that some firms might behave opportunistically. To avoid such problems, the government must ensure that these regulations are not used to create an uneven playing field. One way to encourage fair behavior is to provide incentives for full disclosure. For example, Congress may provide firms with additional protection when they disclose computer attacks to government law enforcement agencies.[259] Despite concerns that this protection is too broad and could lead to less disclosure to the general public, it would at least provide an incentive for firms to disclose information to the government.

III. Shaping Code Through Government Spending

Government can encourage the development and use of socially beneficial code through its fiscal powers. Current uses of that power include supporting medical research, subsidizing agriculture, and building the interstate highway infrastructure. This section discusses four different ways that government spending can influence the development of code, as summarized in Table 2.

A. Government Support of Research and Development

Government can support and shape the development of code by funding its underlying research and development activities.[260] The federal government can use two distinct approaches in spending money on research and development: the funding of basic knowledge-seeking research and mission-oriented research.

In this discussion, the Authors wish to avoid the more common distinction made between "basic" and "applied" research. A better distinction is to view research as being either knowledge-seeking (i.e., basic) or mission-oriented (i.e., applied).[261] This presentation focuses

257. *See* Robert Lemos, *U.S. Creates Cyberalert System*, CNET NEWS.COM, (Jan. 28, 2004) (describing the new Cyber Alert System run by CERT), *at* http://news.com.com/2100-7348-5148877.html. The CERT Coordination Center was originally called the Computer Emergency Response Team.

258. Elizabeth Hurt, *New Alliance Takes on Security: CERT Teams Up with Trade Group to Raise Awareness of Information Security Risks*, BUSINESS 2.0 (Apr. 19, 2001) (discussing the collaboration between industry and government to alert businesses of potential security threats), *at* http://www.business2.com/b2/web/articles/0,17863,530066,00.html.

259. Critical Infrastructure Information Security Act of 2001, S. 1456, 107th Cong. § 5(a)(1)(B) (2001).

260. Society's research and development spending on computers and electronics alone totaled thirty six billion dollars in 2000. 1 NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS — 2002, ch. 4, at 3 (2002).

261. *See generally* Lewis M. Branscomb, *From Science Policy to Research Policy*, *in* INVESTING IN INNOVATION 112, 129–33 (Lewis M. Branscomb & James H. Keller eds.,

on the motivations of the research and not on its methods or outcomes.[262]

Table 2: Fiscal Methods for Encouraging the Development of Code			
Method	**One-word Summation**	**Rationale**	**Examples**
Supporting Research and Development	R&D	Funding the creation of new technologies	National Science Foundation Grants; National Institute of Standards and Technology efforts
Procurement Power	Buying	Purchasing certain types of technologies for government use	Section 508 (accessibility) requirements; Energy star requirements
Tax Expenditures	Deductions	Favoring certain technologies through tax liability	Electric car tax deduction
Education and Training	Education	Informing and promoting socially responsible behavior	Campaigns to educate people about firewalls and computer security

1. Funding Knowledge-Seeking Research

Knowledge-seeking research strives to understand how things work without necessarily having specific applications in mind. Such basic research has resulted in great innovations — government-funded

1998) (suggesting different criteria for funding of "need-driven research" versus "opportunity-driven research").

262. Too often, research is divided into basic and applied. In this division, basic research is characterized as being theoretical work, having no clear application, producing science, and being conducted in academic laboratories. In contrast, applied research is characterized as being experimental work, having practical application, producing technology, and being conducted in industry laboratories. Implicit in this distinction is a linear model of development that holds that basic research leads to applied research and that advances in science lead to advances in technology. These divisions between subject matter, methods, and outcomes, and the resulting linear model, are anachronistic. Relying on this conception of technological development does not allow one to understand the development of code, especially in relation to government support of code. This is why more recent material ignores these divisions. *See, e.g.*, *id*. at 120; COMM. ON CRITERIA FOR FED. SUPPORT OF RES. & DEV., ALLOCATING FEDERAL FUNDS FOR SCIENCE AND TECHNOLOGY (1995), *available at* http://www.nap.edu/readingroom/books/fedfunds/part1/determining.html.

research eventually led to the development of the Internet and the World Wide Web.[263] Government funding of such research assumes that the private sector will not perform an adequate amount on its own. This market failure exists for a number of reasons. First, firms cannot predict the future economic value of investments in basic research because potential applications are unknown.[264] Second, firms cannot entirely capture the benefits of funding such research because it is difficult to keep knowledge produced by basic research from others.[265] Consequently, rational-acting firms concentrate their resources on solving specific problems so they can better capture the benefits of their research.[266]

The problem of under-funding by the private sector led to calls for government funding. A celebrated and influential supporter of this argument was Vannevar Bush, who asserted that researchers should be allowed to perform research without concerns about its practicality.[267] He believed that curiosity-driven research eventually leads to technological innovation. Accordingly, if government wants to increase technological innovation, it should fund more basic research.[268]

Dr. Bush's argument has been persuasive and has resulted in substantial government funding for basic research.[269] This emphasis on knowledge-seeking research led to the development of many technological innovations of code. Besides the development of the Internet, government support has been instrumental for a number of other important computer innovations such as timesharing, computer network-

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263. *See generally* Barry M. Leiner et. al., A Brief History of the Internet, *at* http://www.isoc.org/internet/history/brief.shtml (last modified Dec. 10, 2003) (discussing the evolution of the government-funded ARPANET into the modern Internet).

264. *See* Richard R. Nelson, *The Simple Economics of Basic Scientific Research*, 67 J. POL. ECON. 297 (1959). Nelson's view is called the informational approach. Today, most scholars do not believe the knowledge produced is just information that can be easily transmitted. Instead, they believe it is necessary to acknowledge that information implicitly requires a capacity to use it in a meaningful way, and gaining this capacity is not trivial. This latter view is called the evolutionary economic approach. *See* Ammon J. Salter & Ben R. Martin, *The Economic Benefits of Publicly Funded Basic Research: A Critical Review*, 30 RES. POL'Y 509, 511–12 (2001).

265. *See* Nelson, *supra* note 264, at 303. *See generally* COMPUTER SCI. & TELECOMMS. BD., NAT. ACAD. OF SCI., FUNDING A REVOLUTION: GOVERNMENT SUPPORT FOR COMPUTING RESEARCH (1999) (providing the economic rationale for government-supported research and development).

266. *Cf.* GREGORY TASSEY, NAT. INST. OF STANDARDS & TECH., R&D TRENDS IN THE U.S. ECONOMY (Apr. 1999) (arguing why industry under-invests in research and development), *at* http://www.nist.gov/director/prog-ofc/R&DTrends.htm.

267. *See* VANNEVAR BUSH, SCIENCE: THE ENDLESS FRONTIER (1945).

268. *Cf.* Michael Crow & Barry Bozeman, *R&D Laboratory Classification and Public Policy: The Effects of Environmental Context on Laboratory Behavior*, 16 RES. POL'Y 229 (1987) (finding that public institutions are best in carrying out basic research and development).

269. For example, in 1999 the government spent almost $900 million on academic research in the field of computer science. 2 NAT'L SCI. BD., SCIENCE AND ENGINEERING INDICATORS — 2002, ch. A5, at 15 (2002).

ing, workstations, computer graphics, the mouse, the windows interface, VLSI circuit design, RISC computing, parallel computing, and digital libraries.[270] Government funding of basic research is important because such research will no doubt lead to substantial future innovations.

However, a few critics argue that government funding of basic research is unnecessary and wasteful.[271] These criticisms have, in turn, been harshly criticized.[272] For example, Richard Nelson found that governmental support for research and development was valuable, even in industries that already have a high level of private research and development.[273]

The criticisms of government funding for basic research largely focus on the selection of research. In basic research, scientists determine research priorities instead of society. Yet society funds this research and quite rightly wants to ensure tangible societal and economic returns for its expenditure. Moreover, society can direct its basic research funding to certain areas of research that society believes demand higher priority. Recently, this belief has become manifest in a rapid increase for basic medical research along with a concurrent reduction in funding for other areas, such as energy and astronomy.[274] Nevertheless, the knowledge-seeking research model can be criticized validly since specific beneficial applications cannot be readily predicted or scheduled for immediate use. Therefore, another model for research and development merits consideration for addressing society's immediate problems: government funding of mission-oriented research.

2. Funding Mission-Oriented Research

Funding mission-oriented research seeks to force the development of scientific knowledge and technologies through increased funding on specific subjects.[275] This approach recognizes the need for basic

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270. COMM. TO STUDY HIGH PERFORMANCE COMPUTING & COMMS., NAT'L RES. COUNCIL, EVOLVING THE HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS INITIATIVE TO SUPPORT THE NATION'S INFORMATION INFRASTRUCTURE 17–18 (1995), *available at* http://www.nap.edu/catalog/4948.html.

271. *See, e.g.*, TERENCE KEALEY, THE ECONOMIC LAWS OF SCIENTIFIC RESEARCH (1996) (criticizing government funding for research).

272. *See, e.g.*, Paul A. David, *From Market Magic to Calypso Science Policy: A Review of Terence Kealey's* The Economic Laws of Scientific Research, 26 RES. POL'Y 229 (1997) (critiquing Kealey's arguments).

273. Nelson, *supra* note 71.

274. Dan Vergano, *Medical Research Has Healthy Budget*, USA TODAY, Mar. 20, 2001, at 9D. To protect against a pure politicization of research funding, agencies such as the NSF use peer review for the allocation of research funds.

275. This approach can be called the Jeffersonian approach, with an emphasis on both basic and applied research. *See* Gerald Holton & Gerhard Sonnert, *A Vision of Jeffersonian Science*, ISSUES IN SCI. & TECH., Fall 1999, *available at* http://www.nap.edu/issues/

research but suggests that the government must prioritize and allocate resources based on societal concerns. The mission-oriented approach permits society to shape code to address specific concerns like privacy and security. Government can shape code through this approach in two ways: by being the predominant purchaser of a product and by pursuing a specific agency agenda.

When the government is the predominant purchaser of a product, such as defense, it has a legitimate interest in shaping the underlying technology. The government's procurement interest allows it to define specific technological requirements necessary to satisfy its specialized needs.[276] Without government funding the underlying research and development, the government could not fulfill its needs; firms, lacking a private market, would not otherwise develop such particularized products. Although the mechanics of the actual funding may resemble a procurement contract, the essence of mission-oriented government funding focuses is increasing the supply of available technologies.[277]

Critics of this form of mission-oriented funding argue that it is too expensive and wasteful. In fact, there is ample evidence that some technology decisions made by the Department of Defense have been costly on both fronts.[278] Such waste usually occurs because of the politics and the sheer size of defense spending.[279] Nonetheless, this funding can broadly affect society through positive "spillover" effects, which occur when the private sector finds a commercial application for a government-supported technology.[280] These spillover effects mitigate to some extent the inherent inefficiencies in government funding of research and development for products.[281]

16.1/holton.htm; Lewis M. Branscomb, *The False Dichotomy: Scientific Creativity and Utility*, ISSUES IN SCI. & TECH, Fall 1999, *available at* http://www.nap.edu/issues/16.1/branscomb.htm; *see also* Michael Crow & Christopher Tucker, *The American Research University System as America's De Facto Technology Policy*, 28 SCI. & PUB. POL'Y 2 (2001) (arguing that such targeted research is the de facto policy in America, despite the rhetoric supporting Vannevar Bush's ideas for government support of basic research).

276. Nelson, *supra* note 71, at 460.

277. The government can finance the research and development in a variety of ways: funding basic research and development, supporting direct research and development, supporting a procurement contract, or hiding the cost of research and development within a procurement contract. *Id*.

278. *See, e.g.*, GOV'TL ACCT. OFF. ("GAO"), HIGH-RISK SERIES: DEFENSE WEAPONS SYSTEMS ACQUISITION REP. GAO/HR-93-7 (1992), *available at* http://www.fas.org/man/gao/hr9307.htm.

279. *See* William D. Hartung, *Corporate Welfare for Weapons Makers: The Hidden Costs of Spending on Defense and Foreign Aid*, CATO POL'Y ANAL. (Aug. 12, 1999), *available at* http://www.cato.org/pubs/pas/pa350.pdf.

280. Nelson, *supra* note 71, at 460.

281. *See* CBO, THE ECONOMIC EFFECTS OF FEDERAL SPENDING ON INFRASTRUCTURE AND OTHER INVESTMENT (June 1998) (concluding that justifying mission-oriented funding involves considering both its purpose as well as the spillover effects), *available at* http://www.cbo.gov/showdoc.cfm?index=601&sequence=0. *But cf.* Frank R. Lichtenberg, *Economics of Defense R&D*, *in* HANDBOOK OF DEFENSE ECONOMICS 431, 447–48 (Keith

The Defense Advanced Research Projects Agency ("DARPA") is one example of an agency that funds both basic and mission-oriented research for the Department of Defense. Its achievements include the F-117 stealth fighter, the Joint Surveillance and Target Attack Radar System ("J-STARS"), and precision-guided munitions — all of which were used in Operation Desert Storm during the Persian Gulf War.[282] Many of DARPA's achievements have spilled over beyond the military, including funding the ARPANET, the precursor to the Internet, and providing the seed funding for the W3C.[283]

The second way in which the government can shape code using the mission-oriented approach is through government agencies with agendas. By an "agency with an agenda," we mean an agency that is supporting research and development that advances its own well-defined purposes.[284] Such an agency can then evaluate and selectively fund projects that further those interests.[285] This is an effective way of supporting research that directly addresses current societal concerns. A good example of such a government agency is the National Institute of Health, which supports research addressing specific diseases.

Critics of this form of mission-oriented funding oppose the government "picking" winners rather than society determining its priorities through the research marketplace.[286] Second, they insist that government funding is a form of favoritism that essentially subsidizes a narrow class of "winning" firms that have gained political support.[287]

Though government generally is no match for the market in picking winners, in certain areas government can positively shape the de-

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Hartley & Todd Sandler eds., 1995) (finding a low rate of return for government research and development funding for defense, even after accounting for spillover effects).

282. DARPA, TECHNOLOGY TRANSITION (Jan. 1997), *available at* http://www.darpa.mil/body/pdf/transition.pdf.

283. *See* Charles Piller, *Funding the Impossible a Specialty for DARPA*, L.A. TIMES, Oct. 28, 2001, at A13; World Wide Web Consortium, DARPA Support of the Web, *at* http://www.w3.org/Consortium/Prospectus/DARPA.html (last modified July 31, 2001).

284. *See* Nelson, *supra* note 71, at 459–60.

285. See note 33 and accompanying text for a suggestion regarding a single agency approach focused on specific product applications.

286. *See* BD. ON SCI., TECH., & ECON. POL'Y, GOVERNMENT-INDUSTRY PARTNERSHIPS FOR DEVELOPMENT OF NEW TECHNOLOGIES 115 (Charles W. Wessner ed.) (2002), *available at* http://www.nap.edu/openbook/0309085020/html/115.html.

287. Mission-oriented funding approaches can lead to politicians and not scientists picking technologies. An example in medicine occurs when the government allocates resources for particular problems, such as breast cancer or Parkinson's disease. In 1993, Congress set aside $77 million in new funding specifically for breast, ovarian, and other cancers. This funding was outside the traditional method of using peer review to select the funding for what research to pursue, forcing the NIH to cut funding in other areas such as colon cancer to make up the shortfall. Similarly, in 1997, Congress passed legislation authorizing $100 million for research on Parkinson's disease. *See* Sue Kirchhoff, *Progress or Bust: The Push to Double NIH's Budget*, 1999 CQ WEEKLY 1058, 1062. There is also ample historical evidence of the government's inadequacies in picking winners. *See, e.g.*, *id*. at 1060. Legislators and government bureaucrats should not pick technologies; instead, consumers should.

velopment of technologies; in particular, areas where there are government agencies with well-defined missions. Well-defined missions ensure that funding decisions are based on solid criteria and goals and also provide for public support and accountability. Moreover, such agencies are likely to have specialized expertise in properly making such funding decisions. To prevent wasteful expenditures, an agency could also adopt peer review, evaluation of competitive proposals by informed agency officials, or both as part of its funding policy.[288]

Based on an application of this framework in regard to mission-oriented funding, the Authors recommend that the government change its funding policy for a current code-specific concern: computer security. It is no secret that there are fundamental problems with key components of the Internet's infrastructure.[289] In response, the federal government drastically increased its annual spending on computer security to over $4 billion.[290] This will result in various federal agencies such as the NSF and the National Institute of Standards and Technology ("NIST") funding additional research.[291] However, no sole government agency oversees or coordinates code development. The Authors recommend that an existing agency — for which code-related security issues are an integral part of its mission — coordinate this expected funding increase in computer security research.[292] Otherwise, it is unlikely that these funds will be managed judiciously. To improve efficiency, the government should consider charging one agency, such as the NIST, with researching code-related security issues. Further, this would help prevent duplicative research and loss of data between various agencies.[293]

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288. *See* Steven Kelman, *The Pork Barrel Objection*, AM. PROSPECT, Sept. 1, 1992, at 88, (providing recommendations to prevent funding from turning into congressional pork barreling) *available at* http://www.prospect.org/print-friendly/print/V3/11/kelman-s.html.

289. *See, e.g.*, Carolyn Duffy Marsan, *Fed Plan Exposes 'Net's Weak Links*, NETWORK WORLD FUSION (Oct. 7, 2002), (noting problems with IP, DNS, and the Border Gateway Protocol ("BGP")), *at* http://www.nwfusion.com/news/2002/1007security.html.

290. *Bush Gives $1.7 Billion Boost to Cybersecurity*, SILICONVALLEY.COM (May 23, 2002), *at* http://www.siliconvalley.com/mld/siliconvalley/news /3324403.htm.

291. *See* COMPUTER SCI. & TELECOMMS. BD., *supra* note 265; Brian Krebs, *Bush Signs $900 Million Cybersecurity Act*, WASHINGTONPOST.COM (Nov. 27, 2002) (noting that the funding increases will establish fellowships at the NSF and the NIST), *at* http://www.washingtonpost.com/ac2/wp-dyn?pagename=article&contentId=A47264-2002Nov27; Carolyn Duffy Marsan, *Congress: Tighten IT Security*, NETWORK WORLD FUSION (Apr. 22, 2002), *at* http://ww.nwfusion.com/news/2002/0422nist.html; Florence Olsen, *Universities Expand Their Anti-Cyberterrorism Research*, CHRON. HIGHER EDUC., Jun. 25, 2002 (noting how universities are shifting research priorities because of new financing), *available at* http://chronicle.com/free/2002/06/2002062501t.htm.

292. The National Security Agency, the NSF, and the NIST are some of the agencies currently researching code-related security issues. *See also supra* note 285 and accompanying text.

293. Another solution would be to fund an agency that needs to procure more security-conscious code for its mission. This agency would have an interest in not only funding such research, but also in ensuring that this research transfers to the private sector. *See* P.A. Geroski, *Procurement Policy as a Tool of Industrial Policy*, INT'L REV. APPLIED ECON. 182,

The Authors also recommend that the government consider using its funding powers to create and develop standards.[294] In the absence of governmental action, standards will be under-produced because they are impure public goods[295] and lack a purely private market to spur demand. Government can develop several different types of standards, including those promoting interconnection and interoperability and those that benefit public health and safety.[296] One example is the work on the Common Criteria, a set of mandatory security standards for code used in national security systems.[297] Funding this type of research is another way in which government can shape code to meet societal concerns.

Finally, consider an important caveat regarding the use of mission-oriented funding. This approach, when used to the exclusion of funding for basic research, may lead to long-term problems. The literature on innovation shows that technological innovation is often unpredictable.[298] History shows that advancement in any field depends upon advances in other fields, even those that are seemingly irrelevant. For example, recent successes in medicine have built upon advances in high-energy physics, computing, and mathematics.[299] As a result, the government may squander resources by focusing on its drive to resolve immediate concerns too narrowly while failing to pursue a broader, knowledge-seeking approach. The Authors therefore recommend that the government shape code through a balance of both approaches to research and development, by funding basic knowledge-seeking as well as mission-oriented research.

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189 (1990) (noting the positive effect of user-led procurement on the creation of innovative products).

294. For a discussion regarding industry-wide standard-setting, see Part II.B.

295. The federal government has issued the following assessment of impure public goods:

> [G]oods like education and standards are impure public goods. These combine aspects of both public and private goods. Although they serve a private function, there are also public benefits associated with them. Impure public goods may be produced and distributed in the market or collectively through government. *How they are produced is a societal choice of significant consequence*.

Role of Consortia, *supra* note 108 (quoting OFF. OF TECH. ASSESSMENT, 96TH U.S. CONG., GLOBAL STANDARDS: BUILDING BLOCKS FOR THE FUTURE 14 n.23 (1992)) (internal quotations omitted) (emphasis in original).

296. *See supra* text accompanying notes 66–67. For example, in response to concerns over computer security, NIST is expanding its efforts in setting federal security standards. *See* Marsan, *supra* note 289.

297. *See* Ellen Messmer, *Sun Earns Certification for Trusted Solaris 8*, NETWORK WORLD FUSION (May 1, 2002), *available at* http://www.nwfusion.com/news/2002/0501trustedsolaris.html; Ellen Messmer, *System Security Finds Common Ground*, NETWORK WORLD FUSION (July 8, 2002), *at* www.nwfusion.com/supp/government2002/ellencc.html; *see also* Common Criteria, *at* http://www.commoncriteriaportal.org/ (last visited Apr. 11, 2005).

298. *See, e.g.*, Nelson, *supra* note 71.

299. *See* Vergano, *supra* note 274.

B. Procuring Code

The government can use its procurement power to develop or support particular code by creating or increasing the market for a particular product.[300] This "power of the purse" focuses on the demand for technology, in contrast to the funding policies discussed previously. There is a long history of successful uses of the procurement power, from standardizing clothing sizes during the Civil War to the U.S. Army's giving credibility to generic drugs.[301] This power flows from the immense amount of government expenditures.[302]

One example of the influence of procurement power is the government's support of energy efficient computer equipment. An Executive Order in 1993 mandated that computers purchased by federal agencies must meet the EPA's Energy Star requirements.[303] In 1999, the Energy Star requirements for computers and monitors saved an estimated one billion dollars.[304] Moreover, the entire Energy Star program for labeling consumer products has prevented emissions of 5.7 million metric tons of carbon equivalent and saved over two billion dollars on energy bills in 1999 alone.[305] These savings are the result of a voluntary government standard supported by a procurement policy. Furthermore, these results suggest that the EPA's Energy Star labeling

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300. This Article emphasizes government procurement because it is the policy of the government to rely on private producers for goods and services rather than make or manufacture the goods. *See* 48 C.F.R. § 7.301 (2005). Though we are focusing on procurement policies that affect code, government procurement strategies can have other goals such as equitable distribution of contracts to businesses of all sizes. Some procurement mandates include preferences for businesses owned by minorities and women, the application of labor, environment, conservation, occupational safety, drug-free workplaces laws, the Indian Incentive Program, and minority university institutions. *See* Steven L. Schooner, *Fear of Oversight: The Fundamental Failure of Businesslike Government*, 50 AM. U. L. REV. 627, 683 n.182 (2001).

301. *See* Ralph Nader et al., *Shopping for Innovation: Government as a Smart Consumer*, AM. PROSPECT, Sept. 1, 1992, at 71–72, *available at* http://www.prospect.org/web/page.ww?section=root&name=ViewPrint&articleId=5221. This position would predict that the government requirement for filtering in libraries and schools would enlarge the market for filtering software. *See, e.g.*, *supra* Part II.A & II.C.1 (discussing the potential of the CDA in accelerating the development and adoption of filtering software).

302. In 2003, federal government spending was over $2 trillion, almost twenty percent of the Gross Domestic Product ("GDP"). OFF. OF MGMT. & BUDGET ("OMB"), BUDGET OF THE UNITED STATES GOVERNMENT: FISCAL YEAR 2004 (2003), *available at* http://www.gpoaccess.gov/usbudget/fy04/pdf/budget.pdf. Of this amount, more than $250 billion was spent directly on procuring goods and services, not civil service or military personnel salaries, grants, foreign aid, etc. *See* FED. PROCUREMENT DATA SYS., FEDERAL PROCUREMENT REPORT (2003), *at* http://www.fpdc.gov/fpdc/FPR2003a.pdf.

303. Exec. Order No. 12,845, 58 Fed. Reg. 21,887 (Apr. 21, 1993).

304. EPA Climate Protection Div., The Power To Make a Difference: ENERGY STAR and Other Partnership Programs, EPA 430-R-00-006 (July 2000), at 12 (estimating savings at 15 billion kilowatt hours at $.08 per kWh).

305. *Id*. at 11.

and the federal procurement guidelines have led the private sector to purchase energy efficient equipment.[306]

The government has a long and successful history of actively shaping technologies that have no private market, such as high technology weapons. Similarly, it can influence the development of commercial, off-the-shelf products.[307] In doing so, government could set an example for private industry by purchasing certain products or technologies that offset certain externalities. For example, the government has used procurement policies for energy-efficient products since 1976,[308] and recently has embraced environmentally friendly procurement measures, such as preferences for recycled products.[309]

There are two primary rationales for government's use of its procurement power to favor certain products. The first rationale is based on efficiency and directs the government to spend its resources wisely, such as buying goods in volume[310] and procuring inexpensive products like as generic medicines.[311] The second rationale is based on externalities — social costs not contained in the price of the product.[312] Measures embodying this rationale require government purchasers to consider the total cost of ownership or to internalize the environmental and other social externalities.[313] If the government does not account for these externalities in its purchase price, it essentially

306. EPA, PROTECTING THE ENVIRONMENT — TOGETHER: ENERGY STAR AND OTHER VOLUNTARY PROGRAMS 2003 ANNUAL REPORT 3 (2003), *available at* http://www.energystar.gov/ia/news/downloads/annual_report_2003.pdf.

307. In certain circumstances government may intervene on the supply side of procurement to ensure competition and innovation among producers. For example, the military has successfully utilized a number of strategies to ensure a viable military supplier community. These strategies include awarding contracts to new firms as well as established ones, ensuring technical information is widely disseminated across industries, and the use of second sourcing. However, these approaches seem most successful when limited to circumstances when government purchasing dominates in a specific market with few producers. If government spending is not significant its policies will likely be ineffective in affecting suppliers. Similarly, if there are a plethora of suppliers there is no need for the government to use procurement strategies to create competition and innovation. *See* CHARLES EDQUIST & LEIF HOMMEN, GOVERNMENT TECHNOLOGY PROCUREMENT AND INNOVATION THEORY (1998) (discussing various procurement strategies the military uses).

308. Exec. Order No. 11,912, 41 Fed. Reg. 15,825 (Apr. 13, 1976) (calling for several measures to improve energy efficiency).

309. *See* Jennifer McCadney, *The Green Society? Leveraging the Government's Buying Powers to Create Markets for Recycled Products*, 29 PUB. CONT. L.J. 135 (1999). *See generally* ORG. FOR ECON. CO-OPERATION & DEV., GREENER PUBLIC PURCHASING: ISSUES AND PRACTICAL SOLUTIONS (2000).

310. For example, the General Services Administration serves as a central purchasing agency for the federal government. Its enormous purchasing power allows it to negotiate volume purchase arrangements. *See* General Services Administration, GSA Federal Supply Service, *at* http://www.fss.gsa.gov (last visited Apr. 23, 2005).

311. *See* Nader, *supra* note 301, at 72.

312. A standard example of an externality is when a firm creates pollution in the course of production but does not fully pay for its clean-up or compensate those who are adversely affected.

313. *See* Schooner, *supra* note 300, at 683 n.183 and accompanying text.

sets their value at zero, sending the message that those externalities are not important.[314] By accounting for externalities, the government can "set an example to the private sector, advance . . . [specific societal] goals, and best serve the public interest."[315]

In addition to the general rationales for government procurement already presented, another reason for using government's procurement power to shape code is that new products take time to develop as innovators create and expand a market. This is a risky process usually characterized by slow growth. But when government uses its purchasing power, it creates a much larger market with possible economies of scale, lower unit costs, and lower risks. This larger market accelerates the process for new technologies and lower prices to spill-over to the public market.[316]

This section suggests that the government's procurement power can be effective in shaping code.[317] As the largest single purchaser of code, the federal government spent over $50 billion on information technologies in 2003.[318] In 2001, state and federal governments spent almost $9 billion on prepackaged software.[319] Government purchases made up a significant part of the $800 billion market for information technologies in the United States in 2001.[320] Such a large purchasing power can significantly influence the way that the private sector develops code.[321] Because government procurement presents such a tremendous opportunity to shape code, the Authors present additional considerations and recommendations throughout this section.

There are three major arguments criticizing the use of government procurement to shape technologies. First, critics argue that government should not attempt to influence the actions of private industry

314. *See* F. Paul Bland, *Problems of Price and Transportation: Two Proposals to Encourage Competition from Alternative Energy Resources*, 10 HARV. ENVTL. L. REV. 345, 386 (1986).

315. Nader, *supra* note 301, at 75.

316. *See* Nader, *supra* note 301, at 78.

317. A number of commentators have discussed government's procurement power. *See, e.g.*, Charles Edquist and Leif Hommen, *Public Technology Procurement and Innovation Theory*, *in* PUBLIC TECHNOLOGY PROCUREMENT AND INNOVATION (Charles Edquist et. al. eds., 2000); OFF. OF TECH. ASSESSMENT, *supra* note 12, at 37–38; Geroski, *supra* note 293.

318. *See supra* note 290.

319. Bureau of Economic Analysis, Tables 1, 11 (Sept. 3, 2002), *available at* http://www.bea.doc.gov/bea/papers/tables.pdf, *cited in* DAVID S. EVANS & BERNARD REDDY, NAT'L ECON. RESEARCH ASSOCS., GOVERNMENT PREFERENCES FOR PROMOTING OPEN-SOURCE SOFTWARE: A SOLUTION IN SEARCH OF A PROBLEM 51 n.159 (2002), *available at* http://ssrn.com/abstract_id=313202. The total sales of prepackaged software topped $71 billion. *Id*.

320. *See* Press Release, World Info. and Tech. Serv. Alliance, WITSA Global Research Shows World's Largest Consumer of Technology Increased Spending Less than 1% Last Year (Feb. 28, 2002), *available at* http://www.witsa.org/dp2002prelease.pdf.

321. Recently, the Consumer Project on Technology called for the government to consider competition and security in its procurement decisions for code. Letter from Ralph Nader and James Love, Consumer Project on Technology, to Mitchell E. Daniels, Jr., Director OMB, (June 4, 2002), *available at* http://www.cptech.org/at/ms/omb4jun02ms.html.

and instead act as a passive consumer.[322] The second criticism is that government "meddling"[323] in the market for a particular technology may not have much influence on the development of the technology and can even retard use by the private sector. The final objection is that the addition of such criteria leads to a more complicated procurement process, raising administrative costs.

First, critics should focus on whether government procurement has been successful instead of focusing on whether the government should be an active consumer. Although government procurement efforts may have a negligible impact on the market, to address this concern, the Authors suggest that government focus its procurement efforts.[324] Typically, this involves using government procurement to provide the early demand for a new technology.[325] It is at this crucial stage that government can most effectively shape the development of technologies for commercial use.[326]

Second, procurement efforts may fail even in markets where government demand is influential if there is a close substitute for the product available in the private market.[327] Consider the scenario of two goods that are close substitutes: green and brown. Government procurement of green goods would crowd out the availability of green goods to private industry. This would lead to private industry procuring more brown goods as substitutes for green goods. Thus, the net effect of the government's and private industry's actions would be offsetting.[328] The development of new products or technologies could be negatively impacted because government would be crowding out private purchasers of green goods. However, this analysis is based on the assumption that the products are close substitutes. If the marginal

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322. U.S. DEP'T OF ENERGY, TECHNOLOGY PROCUREMENT AS A MARKET TRANSFORMATION TOOL (Alison ten Cate et al eds.), *available at* http://www.eere.energy.gov/femp/pdfs/techproc.pdf (last visited Apr. 7, 2005).

323. *See* Donald B. Marron, *Buying Green: Government Procurement as an Instrument of Environmental Policy*, 25 PUB. FIN. REV. 285, 299 (1997).

324. *See supra* Part III.A.2, where this Article limits its support to government agencies with well-defined missions in regard to government funding of mission-oriented research.

325. *See* MICHAEL E. PORTER, THE COMPETITIVE ADVANTAGE OF NATIONS 645–46 (1990). Government can also serve as a positive force to improve technologies and the competitiveness of producers through using stringent product specifications rather than just purchasing what domestic firms produce. These product requirements should also consider international needs, as that is where future markets lie. Government also must not be afraid to procure competitively. This provides domestic firms an incentive to innovate.

326. A related criticism is that government efforts will be hampered by lack of cooperation with private industry. There are a number of examples of private industry fighting procurement policies. *See* Nader, *supra* note 301 (noting how contractors have successfully fought off requirements that would hold construction companies liable for the quality of roads); *see also* McCadney, *supra* note 309, at 147 (discussing how Lexmark used contract conditions for toner cartridges that conflicted with the government's procurement efforts to recycle toner cartridges).

327. Marrow, *supra* note 175, at 294.

328. *Id*.

cost of the green good was decreasing because of economics of scale, then government procurement would result in a lower price for green goods for all consumers. This analysis indicates that economies of scale are an important element in the success of government procurement for shaping technologies. Therefore, government procurement can produce significant benefits if the government is a particularly large buyer of a specific product, supply is particularly elastic, or private demand is particularly inelastic.[329]

Finally, this Article acknowledges the criticism that additional procurement policies would raise the cost of procurement and deter agencies from following these rules. For example, procurement guidelines require agencies to purchase equipment that meets the EPA's Energy Star requirements, and agencies are also supposed to purchase products that rank in the top twenty-five percent for efficiency for product groups without Energy Star labels.[330] One report suggests a low level of compliance with these rules for a number of reasons, including a lack of enforcement, no requirement to justify inefficient purchases, and agencies already having too many procurement requirements to make universal compliance feasible.[331] However, there is no compelling reason to believe that these issues could not be addressed.[332]

Another contemporary example of the government's procurement power is the requirement that the government comply with § 508 of the Rehabilitation Act, which states that any computers, software, and electronic equipment used to disseminate information, including telephones, copiers, and facsimile machines, purchased by the federal government must be accessible to persons with disabilities.[333] As a result, firms such as Microsoft, Macromedia, and Adobe have modified their products to ensure that their products are capable of producing accessible websites and content.[334]

The above examples illustrate that the government values societal concerns such as reducing carbon emissions and ensuring that disabled people have access to information technologies. Critics question the cost of administering those programs and the additional procure-

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329. *Id*. at 297.

330. Exec. Order No. 13,123, 64 Fed. Reg. 30,851 (June 3, 1999).

331. ALLIANCE TO SAVE ENERGY & FED. ENERGY PRODUCTIVITY TASK FORCE, LEADING BY EXAMPLE: IMPROVING ENERGY PRODUCTIVITY IN FEDERAL GOVERNMENT FACILITIES 18–19 (1998), *available at* http://www.ase.org/files/885_femp.pdf.

332. Recently a federal judge ordered fifteen federal agencies to increase their purchases of alternative fuel vehicles as required by existing law. *Agencies Ordered to Obey Alternative Vehicle Law*, ENVTL. NEWS SERVICE, Aug. 8, 2002, *available at* http://ens-newswire.com/ens/aug2002/2002-08-08-06.asp.

333. *See* 29 U.S.C. § 794(d) (2000); *see also supra* note 98 (noting that the Telecommunications Act requires code to be accessible when easily achievable).

334. Ann Moynihan, *Creating Web Pages That Are Accessible to the Disabled Is Good Business*, BUS. REV., Mar. 29, 2002, *available at* http://www.bizjournals.com/albany/stories/2002/04/01/focus5.html.

ment costs to the government that results from such requirements. First, no clear data are available on how much extra money, if any, the government has spent through procurement policies. Unless this data showed that the government spent significantly more money it seems irrelevant, because the government's procurement process takes into account various externalities and necessarily implies the government's willingness to pay more. By exercising its procurement power, the government hopes to prompt others to adopt similar value preferences, and perhaps make it economically attractive for them to do so.

This analysis suggests several recommendations for government procurement decisions regarding code. The efficiency rationale suggests that government should consider how to save money when making procurement decisions. In keeping with this idea, the U.S. General Services Administration ("GSA") already buys information technology products in volume.[335] This approach is a reasonable way to save government resources. The efficiency rationale also suggests that the government should consider standards for product quality, as well as standards that promote open uses and interoperability. Both of these types of standards have the potential to reduce costs. For example, the United Kingdom recently promulgated a policy seeking to use open standards that promote interoperability and avoid products that lock-in to proprietary code.[336] To conclude, the efficiency rationale suggests that government should consider the total cost of ownership and not just the initial purchase price when buying products. This rationale could lead government to support open source code if its total cost of ownership was less than that of proprietary code. However, government cannot justify its use of open source code on efficiency grounds without more data on its costs.

When it procures custom-made code, the government should consider placing its source code in the public domain.[337] While this is not current practice, the government can bargain for the source code in its contracts since this custom-made code would not exist but for

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335. William Welsh, *States Slow on Schedule 70*, WASH. TECH. (Jan 10, 2005), *available at* http://www.washingtontechnology.com/news/20_1/statelocal/25283-1.html.

336. OFF. OF GOV'T COM., OPEN SOURCE SOFTWARE: USE WITHIN UK GOVERNMENT (2002), *available at* http://www.ogc.gov.uk/oss/OSS-policy.pdf.

337. The government may require the development of custom-made code. This is usually to fulfill the requirements of law or the mission of a government agency. For example, the Federal Bureau of Investigation developed Carnivore, an electronic surveillance tool. It differs from commercially available surveillance tools, because it can distinguish between communications that can be lawfully intercepted and those that may not. For example, Carnivore can distinguish between e-mail and online shopping activities. *See Internet and Data Interception Capabilities Developed by the FBI, Statement for the Record: Hearings Before the House Subcom. on the Constitution, Comm. on the Judiciary,* 106th Cong. (2000) (statement by Dr. Donald M. Kerr, Laboratory Division Assistant Director), *available at* http://www.cdt.org/security/carnivore/000724kerr.htm.

the government contract.[338] Some vendors would rather secure a slightly higher premium for selling the source code outright than receive a lower payment in hopes that a more lucrative commercial market may eventually develop. Once government has access to the source code, duplicating this code for the public costs nothing.[339] If the government places its source code in the public domain,[340] then interested parties do not have to "reinvent the wheel."

Critics argue that this approach is wrong for two reasons. First, access to the source code could allow hackers to gain control of vital systems. This criticism persuasively indicates that the source code should not be placed into the public domain if there are national security concerns. For example, it may not be appropriate for code governing military satellite communications to be publicly accessible. Nevertheless, portions of the code may be placed into the public domain for society's benefit. Second, critics argue that placing code into the public domain will result in the code languishing there because exclusive property rights are required to incentivize further development. Part IV.C addresses this criticism, arguing that such property rights are not necessarily required for further improvement of code.

The government procurement process regarding code could also consider externalities such as supporting innovation, protecting pri-

338. Typically, when the government contracts out the development of code it does not have the right to distribute the code. GAO, TECHNOLOGY TRANSFER: CONSTRAINTS PERCEIVED BY FEDERAL LABORATORY AND AGENCY OFFICIALS 27 (1988).

339. The U.K. Government is considering placing the source code for custom-made code into the public domain. *See* OFF. OF GOV'T COM., OPEN SOURCE SOFTWARE: USE WITHIN UK GOVERNMENT (2002), *at* http://www.ogc.gov.uk/index.asp?id=2190. The EPA and the Department of Energy ("DOE") developed software for the evaluation of energy conservation features of networked computers. Although their goal was to save money on energy costs, it was relatively costless to make this code publicly available in the interest of energy conservation. *See generally* EPA, Save Up To $100 Per Computer Annually Through Power Management, *at* http://www.energystar.gov/powermanagement (last visited Apr. 23, 2005) (providing more information on the EPA's Enabling Monitor Power Management software).

340. A work in the public domain is not protected by copyright and is free to use by anyone. The work may enter the public domain in a number of ways, such as the term for the copyrighted work expiring, Congress passing an act, and the copyright holder expressly disclaiming copyright protection for the work. Legal ambiguity regarding how to disclaim a copyright has led organizations like Creative Commons to issue a sample disclaimer for copyright holders who wish to place their work into the public domain. *See* Creative Commons, Public Domain Dedication, *at* http://creativecommons.org/licenses/publicdomain/ (last visited Apr. 16, 2005). Works can also be made freely available to the public through permissible licensing conditions, such as those employed by Creative Commons or the general public license ("GPL") used by open source software projects like GNU/Linux; these licensed works, however, are not technically in the public domain. *See* Creative Commons, *at* http://creativecommons.org/about/history (last visited Apr. 12, 2005); Open Source, The GNU General Public License (GPL), (June 1991), *at* http://www.opensource.org/licenses/gpl-license.php; The GNU Operating System, GNU General Public License (Apr. 1, 1989), *at* http://www.gnu.org/copyleft/gpl.html; Free Software Foundation, *at* http://www.fsf.org/ (last modified Mar. 12, 2005); Open Source, The Categories of Free and Non-Free Software, *at* http://www.gnu.org/philosophy/categories.html (last modified Apr. 11, 2005).

vacy, and ensuring security. The government could use its procurement decisions to favor certain products. The government can favor innovation by buying products that support open standards and modularity, keys to code innovation. In the case of security, the government could ensure its products meet standards for security, such as the Common Criteria.[341] These decisions may be more costly, but can benefit the public in ways that the market may not reflect.

Commentators relying on the efficiency and externality rationales have proposed that government should use its procurement power to adopt open source code instead of commercial, off-the-shelf products.[342] From a quality-control standpoint, it is well-established that the quality of open source code, such as Apache, can be comparable to that produced by private firms.[343] However, the cost of implementing open source code is significantly lower.[344]

From an externalities standpoint, the government has several reasons for preferring open source code over proprietary code. First, government use of open source code can lead to public benefits because of free access to this code. For example, once the government develops or purchases open source code for one agency, department, or school, it can then be used for other government purposes. Additionally, this code could be freely adopted by the general public and serve as an infrastructure others could use and build upon. A second externality to consider is the more innovative nature of open source code that results from having fewer restrictions on its use than proprietary code.[345] Third, the open source movement's public development process allows for a plurality of influences not dominated by any

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341. *See System Security Finds Common Ground*, *supra* note 297.

342. *See* ROBERT W. HAHN, GOVERNMENT POLICY TOWARD OPEN SOURCE SOFTWARE (2002) (providing several articles on possible approaches for open source procurement by government), *available at* http://www.aei.brookings.org/admin/authorpdfs/page.php?id=210; *see also* MITCH STOLTZ, THE CASE FOR GOVERNMENT PROMOTION OF OPEN SOURCE SOFTWARE, NETACTION, *available at* http://www.netaction.org/opensrc/oss-whole.html (last visited Apr. 23, 2005). *But see* EVANS & REDDY, *supra* note 319.

343. *See* A. Mockus et al., *A Case Study of Open Source Software Development: The Apache Server*, *in* PROCEEDINGS OF INTERNATIONAL COMPUTER SOFTWARE ENGINEERING 263, 265 (2000), *available at* http://portal.acm.org/citation.cfm?id=337209. The Linux operating system is another popular open source option. Some consider it more secure and bug-free than code produced by Microsoft. This opinion stems from a view that the open source movement's public review process is much better and faster than the process used by firms. However, this claim is more anecdotal than empirical.

344. From an efficiency standpoint, open source code can also lead to less red tape because it lacks the licensing requirements that typically govern proprietary code. For example, there is no need to worry about whether there is a license for code running on each computer. This is a real concern for those who use proprietary software.

345. Steve Mann takes this idea further, arguing that the government should not use any proprietary code. Instead the government should create and use an electronic architecture that is available to everyone. For example, he suggests that all publicly funded institutions be required to use file formats and standards that are in the public domain. Steve Mann, *Free Source as Free Thought: Architecting Free Standards*, 5 FIRST MONDAY 1 (2000), *at* http://www.firstmonday.org/issues/issue5_1/mann/index.html.

one firm or country.[346] Finally, open source code's transparency allows government and society to easily examine code.[347]

The "political" property of code is analogous to the transparency citizens require in government legislation.[348] For example, transparency in filtering software allows the public to determine the rules for excluding sites.[349] Already, two dozen governments, including China, France, Germany, Brazil, and the United States, have encouraged the adoption of open source code.[350] For example, the ministries of culture, defense, and education in France are switching to Linux from Microsoft, Sun, and Lotus.[351] Their reasons are that open source code is politically palatable, technically superior, and cheaper. The political reasons include concerns about the influence of the United States on the software industry, national pride, and the well-known security flaws in Microsoft's products.[352] The objections to this proposal are largely that government is interfering in private markets and is taking money away from private industry. Despite these criticisms, society is better off if this code is freely provided than if the code must be purchased. By providing this code, the government creates an infrastructure that others can build upon, thereby inviting the creation of more innovative applications instead of wasting money on duplicative code.

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346. The public development process can lead to new features that society may value, but which may not arise naturally in the development of commercial code. This includes possible innovations in privacy, security, and support for multiple languages, all of which are in the interest of government to promote.

347. Transparency ensures the law of cyberspace is open to public examination. LESSIG, *supra* note 1, at 224.

348. The public's expectations regarding transparency are also supported by the Freedom of Information Act ("FOIA") and the Sunshine Act. FOIA provides for a general right to examine government documents. 5 U.S.C. § 552 (2000). The Sunshine Act strives to provide the public with information on the decision-making processes of federal agencies. 5 U.S.C. § 552(b) (2000).

349. Benjamin Edelman is seeking a declaratory judgment that will allow him to decrypt and publish portions of N2H2's list of blocked sites. By viewing the list, the public can determine what content N2H2 blocks. Edelman argues that this information is important, because it allows the public to evaluate N2H2's effectiveness in blocking content. *See* Ross Kerber, *ACLU Sues Firm Over Filtering Software*, BOSTON GLOBE, July 26, 2002, at E4; Benjamin Edelman, Edelman v. N2H2, Inc. — Case Summary & Documents, *available at* http://cyber.law.harvard.edu/people/edelman/edelman-v-n2h2/ (last modified Sept. 21, 2003).

350. Paul Festa, *Governments Push Open-Source Software*, CNET NEWS.COM (Aug. 29, 2001), *available at* http://news.com.com/2100-1001-272299.html; Steve Lohr, *An Alternative to Microsoft Gains Support in High Places*, N.Y. TIMES, Sept. 5, 2002, *at* C5.

351. Jim Krane, *World Governments Choosing Linux for National Security*, AP ONLINE (Nov. 30, 2001).

352. *See id*. (noting that "the programmer known as the father of Linux" is European and noting further that national security and national pride are among the reasons that governments are increasingly adopting Linux); Matt Berger, *Analysis: Microsoft vs. Open Source Battle Gets Political*, INFOWORLD (June 10, 2002), *available at* http://www.infoworld.com/articles/hn/xml/02/06/020610hnopensource.html (last visited Apr. 3, 2005) (mentioning that using open-source software enhances security and may "lead to growth of local software alternatives").

C. Using Tax Expenditures

The government's power of taxation is another tool for shaping code. Government can reduce or increase an individual's or firm's tax burden to create incentives for certain behavior. This Section discusses how tax expenditures can influence behavior, allowing the government to both support the development of code generally and shape code in a particular fashion.

The government can reduce the tax liability for individuals or firms to encourage an activity or use of a product. This tax reduction is effectively a substitute for government spending and is termed a tax expenditure.[353] The term "tax expenditure" highlights that the loss of tax revenue is equivalent to government spending.[354] Tax expenditures are commonly thought of as tax incentives or, more pejoratively, loopholes.[355] They serve many purposes and are a popular method for addressing societal issues.[356]

The use of tax expenditures to shape code is analogous to direct spending by the federal government. It follows that the same justification for using a directly funded government program also supports the establishment of a tax expenditure program.[357] Commonly, justifications of government intervention are based on a form of market failure. Different reasons exist as to why government may choose to use tax expenditures instead of direct spending to shape code. First, there are jurisdictional differences between tax expenditures and direct spending.[358] When government uses a tax expenditure, the administrative responsibility falls to the Treasury Department and the Internal Revenue Service.[359] In contrast, direct spending requires an agency within the executive branch to administer the program. This suggests

353. *See* STANLEY S. SURREY & PAUL R. MCDANIEL, TAX EXPENDITURES (1985).

354. Tax incentives can lead to a great deal of lost tax revenue. For example, the tax expenditures for energy conservation and alternative fuels to mitigate global warming were estimated as $10.6 billion from 1998 to 2002. This figure is about three times more than the amount budgeted for federal spending on addressing climate change. Chris Edwards, *supra* note 128, at 467 (noting that funding for the Climate Change Technology Initiative was about $3.5 billion from 1998 to 2002).

355. SURREY & MCDANIEL, *supra* note 353, at 1.

356. *See* URB. INST., THE CHANGING COMPOSITION OF TAX INCENTIVES: 1980–99 (Mar. 1999) (documenting that tax expenditures have increasingly been used to promote social policy goals instead of business investment), *at* http://www.urban.org/url.cfm?ID=410329. The total tax expenditures for fiscal year 2002 will be over $600 billion. *See* OMB, BUDGET OF THE UNITED STATES GOVERNMENT, Table 22-4, (2002), *at* http://www.whitehouse.gov/omb/budget/fy2002/bud22_4.html.

357. *See* SURREY & MCDANIEL, *supra* note 353, at 112.

358. "Jurisdictional" in this context refers to differences in the responsibility over the measure within the executive branch. There are also jurisdictional differences in Congress. Legislators with little expertise on the issue at hand often write tax expenditure provisions, because they sit on the tax writing committee rather than the committee dedicated to the issue. *See id*. at 106–07.

359. *Id*. at 106.

that tax expenditures are best used when the administrative costs of establishing and maintaining a spending program are high.[360] Additionally, administration of a program by the Treasury and IRS usually results in strict eligibility requirements because these agencies tend to limit deductions.[361] Moreover, the Treasury and IRS usually do not have motivation nor the expertise required to effectively administer the program beyond the tax expenditure.[362] Therefore, a tax expenditure is appropriate when a program does not require continued administrative oversight and discretion.[363]

Another reason for government to regulate through tax expenditures is the associated psychological and political benefits. A tax expenditure has much lower visibility than a direct spending program.[364] The expenditure is not represented by a government agency; rather, it is hidden in the tax code. A tax expenditure is viewed as encouraging private decision-making, not as a government reward to a few firms.[365] As a result, many politicians who regard themselves as fiscally conservative would rather use a tax expenditure than support another "big government spending program" — a key component to the popularity of tax expenditures.[366] Nevertheless, a tax expenditure is still government spending; virtually any tax expenditure provision could be rewritten in the form of a direct spending program.[367]

The use of tax expenditures gives rise to several criticisms. First, critics argue that tax expenditures are not equitable. They are of little use to firms or individuals with low tax liability. For individuals and firms with little tax liability or firms subject to the alternative minimum tax ("AMT"), a tax expenditure is of no value. However, legislators can utilize a refundable tax credit for these firms, which is effectively a direct grant.[368] Thus, this type of tax expenditure does not discriminate against those with little tax liability. Second, the benefits of tax expenditures accrue to those with the highest tax liabil-

360. *See* Edwards, *supra* note 128, at 476.

361. *See* SURREY & MCDANIEL, *supra* note 353, at 106.

362. *See id*.

363. One problem with the use of tax expenditures is that they may turn into tax shelters and lose their initial intent by subsidizing middlemen. In the past many tax shelters were used by well-off persons, not by their intended recipients, because investment professionals used techniques such as partnerships to gain tax advantages. In contrast, a direct grant program by an agency can ensure that funds go directly to the intended recipients. *See id*. at 105.

364, *Id*. at 104–05.

365. *Id*. at 100.

366. *See* CHRISTOPHER HOWARD, THE HIDDEN WELFARE STATE: TAX EXPENDITURES AND SOCIAL POLICY IN THE UNITED STATES (1997) (documenting how four major tax expenditures, including the home mortgage interest deduction and the work opportunity credit, are the result of political forces that differ from those supporting direct spending programs).

367. *See id*. at 105.

368. *See* SURREY & MCDANIEL, *supra* note 353, at 109–11.

ity,[369] stimulating a firm to adapt its practices to gain the full benefit of the tax expenditure in some cases. The tax expenditure program can be limited if some beneficiaries with high tax liability are unfairly reaping the lion's share of the benefits. Limits still provide incentives for behavior, but allow the government to ensure that a few taxpayers are not unjustly rewarded. Some critics object that tax expenditures are not efficient, because they reward behavior that would have occurred anyway, producing a windfall for a few firms.[370] This windfall can be limited by making the tax expenditure incremental in structure. For example, by limiting tax breaks to taxpayers' improvements in behavior since the previous year, only marginal improvements would be rewarded.[371] Critics also object that further tax expenditures will place too high of an administrative burden on the IRS.[372] This seems unlikely given that the IRS already handles hundreds of billions of dollars in tax expenditures involving numerous subjects such as energy, natural resources, agriculture, housing, and transportation.[373] Placing the burden on the IRS will likely result in lower overall administrative costs because the IRS already administers tax policy.

The final objection is that the tax code should not be used for social policy purposes. Instead, the government should fund social policy directly and openly.[374] Stated another way, the tax code should focus on raising revenue and not on social policy. These incentives are likely to further complicate the tax code and lead people to lose faith in it. While this argument has merit, the tax code has long been an instrument of social policy and most people view this use as acceptable.[375] In fact, according to Zelinsky, tax expenditures are a better way of communicating social policy to middle-income individuals and small businesses than direct spending. This is true because the existing information networks of tax professionals will communicate

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369. *See id*. at 71–82.

370. *Id*. at 102.

371. *See id*.

372. Edwards, *supra* note 128, at 476. *But see* Edward A. Zelinsky, *Efficiency and Income Taxes: The Rehabilitation of Tax Incentives*, 64 TEX. L. REV. 973, 975–76 (1986) (arguing that tax expenditures can be more efficient than direct government spending because of lower transaction costs); Martin Feldstein, *A Contribution to the Theory of Tax Expenditures: The Case of Charitable Giving*, *in* THE ECONOMICS OF TAXATION 99 (Henry J. Aaron & Michael J. Boskin eds., 1980) (arguing that in some cases a tax subsidy provides society with a better outcome than direct spending).

373. *See supra* note 356 (providing a more complete listing of all tax expenditures).

374. *See* Bernard Wolfman, *Federal Tax Policy and the Support of Science*, 114 U. PA. L. REV. 171 (1965) (questioning whether some of the favorable tax incentives given to encourage the development are needed and whether direct subsidies are a better option).

375. Although many tax scholars do not like to use the tax system for social policy, some economists see tax policy as an effective method of addressing societal concerns. Maureen B. Cavanaugh, *On the Road to Incoherence: Congress, Economics and Taxes*, 49 UCLA L. REV. 685 (2002). *See generally* A.C. PIGOU, WEALTH AND WELFARE 164 (1912); F.P. Ramsey, *A Contribution to the Theory of Taxation*, 37 ECON. J. 47 (1927).

information regarding tax expenditures in these groups.[376] In contrast, the transaction costs are high for individuals and firms who try to find and utilize direct spending programs set up by the government.[377]

Tax expenditures have long been used to support technological development. Examples include tax credits for research and development as well as proposed legislation to provide tax credit for the acquisition of information technologies.[378] Other tax credits attempt to shape specific technologies. For example, tax expenditures support alternative fuels, hazardous waste facilities, electric vehicles, and even research and development activities.[379] Consider the Orphan Drug Act, which seeks to stimulate the research and development of drugs for rare diseases through both tax expenditures and direct research grants.[380] This intervention is justified because rare disease therapies are often unprofitable for pharmaceutical companies. Therefore, the industry requires an incentive to invest in research and development.[381] Moreover, the FDA administers a program that provides direct grants to fund clinical testing programs for orphan drugs. In comparison, the tax expenditures allow a tax credit equal to fifty percent of the qualified clinical testing expenses for the taxable year.[382] However, the drug must first be designated as an orphan drug by the FDA.[383] To meet the goal of stimulating research, the tax expenditure requires a modest amount of cooperation between the applicable federal agency with the expertise, the FDA, and the Treasury department.

The government could also use tax expenditures to shape the development of code.[384] For example, government could encourage the

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376. Zelinsky, *supra* note 372, at 1036.

377. *See id*. at 975–76 (remarking that "tax incentives may be more efficient for the implementation of government policies than direct expenditure programs because of lower transaction costs.").

378. The government's Research and Experimentation Tax Credit is one example. It costs the government billions of dollars, but subsidizes research and development by firms. *See* OFF. OF TECH. ASSESSMENT, THE EFFECTIVENESS OF RESEARCH AND EXPERIMENTATION TAX CREDITS (1995); Kenneth C. Whang, *Fixing the Research Credit*, ISSUES SCI. & TECH., Winter 1998, *available at* http://www.nap.edu/issues/15.2/whang.htm (last visited Apr. 3, 2005). Senator Lieberman has proposed this tax credit to stimulate the economy. *See* Joe Lieberman, *U.S. Needs Policies That Encourage Tech Investment*, MERCURY NEWS, Nov. 6, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/4456934.htm.

379. *See, e.g.*, IRS, Qualified Electric Vehicle Credit, Form 8834 (providing a tax credit to purchasers of electric vehicles).

380. Orphan Drug Act of 1985, P.L. 97-414, 96 Stat. 2049 (2001). For more information see the FDA, Office of Orphan Products Development, *at* http://www.fda.gov/orphan/index.htm (last visited Feb. 24, 2005).

381. *See* Andrew Duffy, *Rare Diseases' Troubling Questions*, OTTAWA CITIZEN, Jan. 21, 2002 (discussing legislative activity in the United States and Canada on providing incentives for research and development regarding rare diseases).

382. *See* Orphan Drug Act, *supra* note 380.

383. Orphan Drug Regulations, 21 C.F.R. § 316.20 (1992).

384. Another proposal calls for tax expenditures or direct funding for firms and public organizations that manage DNS servers. An incentive to improve the security of such sys-

development of code to protect minors online, such as filtering software, which prevents minors from gaining access to inappropriate content. Government intervention into this market is justified because the current products, including PICS, are expensive, difficult to use, and not very effective.[385] Moreover, many parents seek a code-based solution to the problem of minors gaining access to indecent material.

One might choose tax expenditures over a direct spending program for any of three reasons. First, tax expenditures would not appear to be interfering in the market for current products. Government could avoid the problems of favoritism and picking "winners" for direct funding. Second, the administrative cost for this program would be modest, as there are only a few firms that would be eligible for this expenditure. Finally, tax expenditures are much more politically palatable because they are not viewed as tax-and-spend. This proposal would subsidize vendors, overcoming the current stalemate, where parents do not buy the code because it is overpriced and developers cannot earn enough revenue to improve their code, because of its low profits. Thus, tax expenditures could lead to lower costs for users while providing financial incentives for developers to improve their products.

Another example of using tax expenditures to support code is encouraging taxpayers to use computers. Instead of operating a directly funded program providing people with computers, the government could opt for a refundable tax credit. However, for the tax expenditure to operate properly and to prevent fraud, it must be simple for the IRS and Treasury to administer the program. In this case, the IRS could limit the deduction to new computers purchased from merchants registered as computer sellers with the IRS. Although this would limit fraud, it would also not allow consumers to purchase of used, less expensive computers. The tax expenditure could take the form of a refundable tax credit to ensure that taxpayers with low tax liability can take advantage of this provision.

D. Funding Education and Training

The purpose of government funding can vary from providing information about an activity or product to proactively attempting to

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tems is needed because of the poor state of security and the threat of attacks. *See* Paul Roberts, *Major Net Backbone Attack Could Be First of Many*, IDG NEWS SERV., Oct. 23, 2002.

385. COMPUTER SCI. & TELECOMMS. BD., NAT'L ACAD. OF SCIS., TECHNICAL, BUSINESS, AND LEGAL DIMENSIONS OF PROTECTING CHILDREN FROM PORNOGRAPHY ON THE INTERNET: PROCEEDINGS OF A WORKSHOP 36–47 (2002) (providing a critique of the effectiveness of existing filtering software products); Leslie Gornstein, *Locking Kids Out: Web Filters*, SEATTLE TIMES, Sept. 27, 1998, at C1 (quoting *Family PC*'s editor Joe Panepinto: "(Filters) are difficult to use, relatively expensive to maintain and difficult to configure . . . .") (internal quotations omitted).

change behavior. Such intervention is justified because of the general public's lack of information.[386] This section shows how educational campaigns can shape code. After discussing the criticisms of funding educational campaigns, it shows how government can shape code through such campaigns, focusing on two types: the first is a by-product of government's employee training and the second involves direct funding of educational campaigns.

The government currently aids consumer decisions by operating educational campaigns that provide information about code.[387] The FTC maintains information for consumers on e-commerce and the Internet, which includes information on buying low-cost computers, protecting minors online, and avoiding online scams.[388] Another notable government campaign is the SEC's use of fake websites to teach investors about potential scams.[389] The fake websites promote financial opportunities with the potential for tremendous financial gains. But once an investor tries to invest, they are led to a page that says, "[i]f you responded to an investment idea like this . . . you could get scammed!"[390] The websites also provide additional information on how to research investment offers and what to do if you were "scammed." Yet another example of an educational campaign is the Energy Star campaign, which helps consumers identify energy-efficient products and has led substantial numbers of consumers to purchase of such products.[391]

Criticism of government funded educational campaigns largely centers on the effectiveness of these programs. Critics argue that millions of dollars are spent on educational programs that provide no tangible benefits.[392] One notable article on educational campaigns identified three problems with their effectiveness.[393] First, not all behaviors can be corrected by educational campaigns: "Given human frailties, some accidents simply cannot be prevented."[394] Second,

386. For example, the European Union partially funds the Internet Content Rating Association, which educates parents and web sites about using content filtering technology, such as PICS. *See* Internet Content Rating Assoc., Internet Industry Leaders Gather for Launch of ICRAfilter (Mar. 21, 2002), *at* http://www.icra.org/press/icrafilter/.

387. Similarly, NIST provides the public with information on how to improve security. *See* NIST Computer Sec. Res. Ctr., NIST Special Publications, *at* http://csrc.nist.gov/publications/nistpubs/ (last visited Feb. 25, 2005).

388. *See* FTC, Consumer Information: E-Commerce & the Internet, *at* http://www.ftc.gov/bcp/menu-internet.htm (last updated Feb. 8, 2005).

389. Press Release, SEC, Regulators Launch Fake Scam Websites to Warn Investors About Fraud (Jan. 30, 2002), *at* http://www.sec.gov/news/headlines/scamsites.htm.

390. *Id*.

391. *See* Kevin Heslin, *EPA's Energy Star Program Pays Dividends*, ENERGY USER NEWS (Jan. 23, 2001), *at* http://www.energyusernews.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2584,19253,00.html.

392. Robert S. Alder & R. David Pittle, *Cajolery or Command: Are Education Campaigns an Adequate Substitute for Regulation?*, 1 YALE J. ON REG. 159, 192 (1984).

393. *Id*.

394. *Id*. at 191.

campaigns should focus on one-time actions instead of trying to alter patterns of behavior.[395] Third, changes come "slowly, modestly, and often expensively."[396] While these criticisms have merit, newer and more sophisticated approaches to educational campaigns have been shown to be more effective.

One way to raise the effectiveness of a campaign is simply to make it less costly. One tactic that allows the government to lower the price of a campaign is to utilize the by-products of the government's efforts to educate its own employees.[397] Information can be diffused through the Internet with ease, allowing these government education materials to be shared inexpensively with the public. Usability.gov is an excellent example of this approach.[398] Its original purpose was to assist the designers and managers of webpages for the Department of Health and Human Services ("HHS"). The website provides a methodology for improving the design of websites based on the experience of the National Cancer Institute ("NCI") experience in researching the preferences of visitors to its website. NCI recognized that its website was useful to people outside of HHS and proceeded to make it available to other federal agencies, as well as the general public.[399] The cost of making this information available to others via the Internet was extremely low. As a result, Usability.gov is now an important resource for making websites more "usable, useful, and accessible."[400] This example shows how effective educational campaigns can flow from the government's efforts to educate its employees.

The effectiveness of educational campaigns can vary depending on whether the government's goal is merely informing consumers about risks or attempting to change their behavior.[401] Although informing consumers is a straightforward process, changing behavior is much more difficult. Firms have long tried to persuade consumers to purchase their products with mixed success. Well-designed educational campaigns can in fact change behavior.[402] Today's educational campaigns use much more sophisticated marketing techniques, adapt-

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395. *See id*.

396 *Id*.

397. For example, the government strives to ensure that its employees consider energy efficiency through educational campaigns. *See* ALLIANCE TO SAVE ENERGY & FED. ENERGY PRODUCTIVITY TASK FORCE, *supra* note 331, at 31–34.

398. Usability.gov, *at* http://usability.gov (last visited Apr. 23, 2005).

399. *See* Usability.gov, About this Site, *at* http://usability.gov/about.html (last visited Feb. 25, 2005).

400. Sanjay Koyani, *The Story Behind Usability.gov*, BOXES & ARROWS (Apr. 1, 2002), *at* http://www.boxesandarrows.com/archives/002319.php; *see also* William Matthews, *Dot-gov by Design*, FED. COMPUTER WK., Dec. 10, 2001, at 16, 21 (discussing how Usability.gov helps to improve government web sites).

401. *See* Alan R. Andreasen, *Challenges for the Science and Practice of Social Marketing*, *in* SOCIAL. MARKETING 3, 5 (Marvin E. Goldberg et al. eds., 1997).

402. *See* PHILIP KOTLER & EDUARDO L. ROBERTO, SOCIAL MARKETING: STRATEGIES FOR CHANGING PUBLIC BEHAVIOR 8 (1989).

ing the same principles and practices firms use for marketing to bring about social change. This approach is aptly named "social marketing" and has been applied to a variety of social issues including health, education, safety, and the environment.[403] Despite these new tools, the effectiveness of social marketing depends on the problem it is trying to solve. Clearly, changing fundamental behaviors, attitudes, and values is much more difficult than altering less ingrained ones. Nevertheless, in some cases social marketing has proven successful in changing behavior.[404]

One example of a proposed code-based government education campaign concerns a common security problem that occurs when people do not update their computers or properly utilize code-based protections such as firewalls and anti-virus software. To persuade people to use these tools, the government has planned an educational campaign directed at home and small business users.[405] Another example would be a campaign that focused on limiting the use of social engineering. Social engineering is a scam that involves efforts to acquire information to bypass the security of computer users, but does not target the code directly.[406] Such a scam may involve tricking people into revealing passwords by pretending to be a technician. The best countermeasure is an education campaign, which would likely employ social marketing techniques.[407] Examples of basic security precautions that could be encouraged include using strong passwords with a mixture of alphanumeric characters, changing passwords frequently, and educating employees about the risks of e-mail attachments.[408]

IV. SHAPING CODE THROUGH INTELLECTUAL PROPERTY RIGHTS

Government can use intellectual property rights such as patents and copyright to shape code. The first section briefly notes that the

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403. *See id*. at 6.

404. *See id*. at 8–10 (noting the success of the Stanford Heart Disease Prevention Program and Sweden's campaign to change the rules of the road); *see also* M. Timothy O'Keefe, *The Anti-Smoking Commercials: A Study of Television's Impact on Behavior*, 35 PUB. OPINION Q. 242 (1971).

405. *See* Brian Krebs, *U.S. Gov't Plans Internet Security Ads*, WASHINGTONPOST.COM (Oct. 23, 2003), *at* http://www.washingtonpost.com/ac2/wp-dyn/A7600-2003Oct23?language=printer.

406. *See* KEVIN D. MITNICK & WILLIAM L. SIMON, THE ART OF DECEPTION: CONTROLLING THE HUMAN ELEMENT OF SECURITY, at xi–xii (2002) (defining a social engineer as a con artist who "uses deception, influence, and persuasion against businesses, usually targeting their information").

407. *See* Malcolm Allen, The Use of Social Engineering as a Means of Violating Computer Systems (Aug. 13, 2001), *at* http://rr.sans.org/social/violating.php.

408. *See* Cisco Systems, 10 Basic Cyber Security Tips for Small Businesses (Apr. 2000), *at* http://www.cisco.com/warp/public/cc/so/neso/sqso/secsol/cybsc_ov.pdf.

government may modify intellectual property ("IP") rights to further innovation and hence address societal concerns through the dissemination of code.[409] The second section focuses on the use of compulsory licensing and patent pools to foster the dissemination of code or content. Lastly, the Authors recommend a policy for transferring government-created code to the private sector.

A. Revising Intellectual Property Rights

Computer software innovation can be protected by a number of intellectual property regimes, including copyrights, patents, and trade secrets. Copyright law primarily protects the expression manifested by the actual code. Patent law protects any novel and non-obvious methods and processes employed by the creators of the code. Intellectual property rights differ from conventional property rights in one aspect: significant societal benefits accrue from intellectual property that is not privatized. Free-flowing information allows people to build upon the intellectual efforts of others. The framers understood this dynamic from the outset; the Constitution permits only limited protection for intellectual property rights in order to foster both creation and dissemination, promoting "the Progress of Science and useful Arts."[410]

Intellectual property rights in code have historically been different for hardware and software. Patent law traditionally protected the hardware components and only recently joined copyright law in protecting software. This change was due to recent judicial decisions allowing firms to patent software, not legislative action.[411] In contrast, legislators have steadily increased copyright protection of code, notably by the Sonny Bono Copyright Term Extension Act of 1998.[412] This act retroactively extended the duration of copyrights by twenty years.[413] Proponents argued that this extension would encourage both

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409. A detailed study of the shaping of code through the modification of IP rights is a vast and important topic beyond the scope of this work.

410. U.S. CONST. art. I, § 8, cl. 8.

411. *See, e.g.*, Diamond v. Diehr, 450 U.S. 175, 187–93 (1981) (finding that a software-related invention was patentable); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, 1375 (Fed. Cir. 1998) (holding that a computer software program that produces a useful result is patentable subject matter); *see also* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 8–11 (2001) (providing a brief history of federal court decisions relating to the patentability of software); Steven G. Steger, *The Long and Winding Road to Greater Certainty in Software Patents*, CBA REC., Apr. 2000, at 46, 46–51, *available at* WL 14-APR CBA Rec. 46 (providing a brief history of software patents); John T. Soma et al., *Software Patents: A U.S. and E.U. Comparison*, 8 U. BALT. INTELL. PROP. L.J. 1, 5–29 (2000) (providing a history of software patents in the United States).

412. *See* Sonny Bono Copyright Term Extension Act, Pub. L. No. 105-298, 112 Stat. 2827 (1998) (codified as amended at 17 U.S.C. §§ 301–304 (2000)).

413. *See id*. The extension ensured that no copyrighted works, such as Walt Disney's Mickey Mouse character, would enter the public domain in the United States until 2019, when works created in 1923 will enter the public domain. *See* Christina N. Gifford, *The*

investment in existing copyrighted works and the creation of new works, because of the longer exclusivity period.

A number of scholars have argued that current intellectual property rights are too strong and actually discourage innovation.[414] They believe that intellectual property law needs to facilitate the sharing of information to further innovation. Lawrence Lessig proposes limiting the duration of copyright protection and requiring renewal every five years.[415] If the copyright is not renewed, the work would fall into the public domain.[416] He also proposes that, to gain copyright protection for software, the author should be required to provide the source code so it may enter the public domain upon expiration of the copyright.[417] The net effect would place more content and code in the public domain.

Evaluating and justifying the revision of intellectual property rights is difficult for two main reasons. First, it is difficult to ascertain empirically whether intellectual property protection is too strong or too weak: the costs and benefits of concepts such as innovation or a public commons for knowledge cannot be easily compared. Second, the modification of intellectual property rights affects a fundamental social and economic characteristic of society.[418] Individuals and firms rely on the current legal understanding of intellectual property, and any change in IP rights undermines their expectations.[419] Neverthe-

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Sonny Bono Copyright Term Extension Act, 30 U. MEM. L. REV. 363, 385 (2000). This legislation was unsuccessfully challenged in Eldred v. Ashcroft, 537 U.S. 186 (2003). *See* Lawrence Lessig, *Copyright's First Amendment*, 48 UCLA L. REV. 1057, 1065–73 (2001) (explaining the First Amendment challenge to the Copyright Term Extension Act raised in *Eldred v. Ashcroft*); Neil Weinstock Netanel, *Locating Copyright Within the First Amendment Skein*, 54 STAN. L. REV. 1, 69–74 (2001) (arguing that the Act is unconstitutional on free speech grounds). The Sonny Bono Copyright Term Extension Act of 1998 is often pejoratively called "The Mickey Mouse Protection Act" since Disney heavily lobbied to pass this law. *See* Jeet Heer, *Free Mickey!*, BOSTON GLOBE, Sept. 29, 2003, at Ideas.

414. *See generally* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001); SIVA VAIDHYANATHAN, COPYRIGHTS AND COPYWRONGS: THE RISE OF INTELLECTUAL PROPERTY AND HOW IT THREATENS CREATIVITY (2001).

415. LESSIG, *supra* note 414, at 251; *cf.* Mark A. Haynes, *Black Holes of Innovation in the Software Arts*, 14 BERKELEY TECH. L.J. 567, 568–75 (1999) (arguing in favor of limiting copyright protection, because it is slowing down innovation in code).

416. LESSIG, *supra* note 414, at 251.

417. *Id*. at 253; *see* Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255 (1997). Lemley and O'Brien put forth another example of property rights affecting innovation. They argue that the existing model of copyright law discourages the use of modular components in code. Current copyright law favors new developers recreating portions of code, rather than copying the code for incorporation. They believe that the principles of patent law, which encourage incorporation rather than re-creation, may allow for greater use of modularity in code.

418. *See generally* Carol M. Rose, *Property and Expropriation: Themes and Variations in American Law*, 2000 UTAH L. REV. 1, 2–5 (noting the traditional justifications for the stability of property).

419. The Authors reject the argument that copyright terms are meaningless, and disagree with Adkinson's argument that lengthening the terms of copyright is "unlikely to interfere

less, for reasons of political economy, the long-term trend in copyright law toward more protection has not abated.[420]

B. Compulsory Licensing and Patent Pools

A second, more tangible method of shaping code is to use compulsory licensing and patent pools, which allow the government to force a party to license their copyright or patent. As a result, another party or the government can make, use, and sell the affected content or technology. This approach allows the government to expand the dissemination of intellectual property. In the United States, the government has occasionally required compulsory licensing of copyrights, but generally not of patents.[421] The prevailing justifications for the use of compulsory licensing and patent pools are promoting the public interest and reducing transaction costs that hinder downstream innovation.

In some industries, one must contract with a large number of intellectual property rights holders to secure any feasible opportunity to develop derivative technologies. This results in high transaction costs and thereby reduces the incentive to use such intellectual property. Government uses compulsory licensing and patent pools to reduce transaction costs and to provide an administrative method that ensures the rights holder is compensated.[422] For instance, the government requires compulsory licensing of the retransmission of broadcast signals by cable. The rationale is that transaction costs would make it impractical for cable companies to pay royalties to each individual copyright

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with creativity or confer power over consumers." Adkinson further contends that "copyrighted works are not monopolies in the antitrust sense — they lack monopoly power — and the ideas contained in them are in the public domain from the outset." William F. Adkinson, Jr., *Creativity & Control, Part 2*, AM. SPECTATOR, May–June 2002, at 21, 22.

420. *See* JESSICA LITMAN, DIGITAL COPYRIGHT 14 (2001) (noting the trend toward greater protection of copyrighted works).

421. The 1976 Copyright Act provides for a number of compulsory licenses, such as for cable television, jukeboxes, public radio, and public television. *See* 17 U.S.C. §§ 111, 116, 118 (2000). Patents can also be subject to compulsory licensing. *See* Kenneth J. Nunnenkamp, *Compulsory Licensing of Critical Patents Under CERCLA*, 9 J. NAT. RESOURCES & ENVTL. L. 397, 397–400 (1994) (reviewing compulsory licensing of patents for cleanup of hazardous waste); Joseph A. Yosick, *Compulsory Patent Licensing for Efficient Use of Inventions*, 2001 U. ILL. L. REV. 1275, 1277 (discussing the use of compulsory licensing of patents); *see also* James Love & Michael Palmedo, Examples of Compulsory Licensing of Intellectual Property in the United States (Sept. 29, 2001), *at* http://www.cptech.org/ip/health/cl/us-cl.html.

422. *See* Darlene A. Cote, *Chipping Away at the Copyright Owner's Rights: Congress' Continued Reliance on Compulsory License*, 2 J. INTELL. PROP. L. 219, 230 (1994) (noting that high transaction costs were a motivating factor in congressional action for compulsory licensing); Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293, 1295 (1996) (noting that compulsory licensing can reduce transaction costs, but arguing that the governance of privately established organizations is preferable to compulsory licensing).

owner of a broadcast signal.[423] Through compulsory licensing, the government reduces transaction costs for all parties and promotes the growth of new technology by ensuring an adequate supply of content.[424]

Accessibility to technology vital to public interests — public safety, national defense, agriculture, environment, and the like — is a second rationale for compulsory licensing.[425] The justification is that these public interests are so great that compulsory licensing is necessary to ensure public access to certain products. A classic example is a life-saving drug that would otherwise be sold only at a prohibitively high price.[426] A host country may choose to use compulsory licensing to bring down the price of a drug.

Objections to compulsory licensing rest largely on the cost of government action as compared with private action. Opponents of government-mandated compulsory licensing prefer privately established organizations that lower transaction costs, such as the American Society of Composers, Authors, and Publishers ("ASCAP").[427] Some critics argue that private organizations have more flexibility in their licensing decisions[428] and that government action is subject to special interests that may manipulate the rules for their own benefit.[429]

An additional objection is that a compulsory license leads to a loss of monopoly power, an essential condition for an intellectual property right, and results in lower revenue for the producer. More generally, the government's use of this power will reduce a firm's incentive to innovate.[430] Consequently, if firms believe they will be subject to compulsory licensing for a product, they may not develop

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423. *See* Cote, *supra* note 422, at 228–32.

424. *See id*. at 242.

425. *See* Cole M. Fauver, *Compulsory Patent Licensing in the United States: An Idea Whose Time Has Come*, 8 NW. J. INT'L L. & BUS. 666, 670 (1988); Yosick, *supra* note 421, at 1279–84 (evaluating court decisions that have addressed the legality of compulsory licensing in the public interest).

426. *See, e.g.*, Tracy Collins, *The Pharmaceutical Companies Versus AIDS Victims: A Classic Case of Bad Versus Good? A Look at the Struggle Between International Intellectual Property Rights and Access to Treatment*, 29 SYRACUSE J. INT'L L. & COM. 159, 164 (2001).

427. *See* Merges, *supra* note 422, at 1295 (arguing that compulsory licensing is inferior to privately established collective rights organizations that address the problem of high transaction costs).

428. *See id*. at 1295–96.

429. *See id*. at 1299.

430. *See* Fauver, *supra* note 425, at 669.

it.[431] Overusing this method could actually lead to fewer technologies that address various public concerns.[432]

A related objection to the use of compulsory licensing for public interest purposes is based on the delays and administrative costs of a licensing scheme. Such a scheme is a poor match for the rapid technological development associated with code.[433] As a result, compulsory licensing may reduce the incentive for firms to develop new business models that touch upon public interests because of the administrative costs and delays associated with compulsory licensing.

Compulsory licensing of code can be used in a number of ways. For example, to reduce transaction costs and promote the growth of new digital music technologies, the government could institute compulsory licensing of music in a digital format.[434] The critical issue is whether the government needs to intervene to address the lack of private action aimed at facilitating transactions of digitally-formatted music. In addition, compulsory licensing could be used in a variety of ways for the public interest. For example, one potential remedy in the Microsoft antitrust trial was the compulsory licensing of Microsoft Windows.[435] One could justify licensing because of the uniquely important role that the Windows operating system plays. Proponents of the compulsory licensing of code would have to show how such a license would increase innovation in the software industry. Yet another compelling reason for compulsory licensing would be to ensure wider dissemination of code that protects privacy, national security, or minors. Such a compulsory licensing scheme, however, would force the government to consider the administrative costs as well as the potential adverse effects on innovation. If firms are not adequately compensated by such licensing schemes, they may avoid developing code that addresses societal concerns.

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431. *But cf.* Fauver, *supra* note 425, at 676–77 (arguing that, while compulsory licenses could make innovation in a field of technology "a less attractive enterprise," the established market positions held by patentees would still create a strong incentive to invent under a compulsory licensing system).

432. *See id*. at 670–71. *But cf.* Theodore C. Bailey, *Innovation and Access: The Role of Compulsory Licensing in the Development and Distribution of HIV/AIDS Drugs*, 2001 U. Ill. J.L. TECH. & POL'Y 193, 210–14 (arguing that while compulsory licensing may reduce the level of innovation, the reduction may actually produce the socially optimal level of research activity).

433. *See* Adkinson, *supra* note 419, at 22.

434. *See* Neil W. Netanel, *Impose a Noncommercial Use Levy to Allow Free Peer-to-Peer File Sharing*, 17 HARV. J.L. & TECH. 1, 31–32 (2003); *Lawrence Lessig: The "Dinosaurs" Are Taking Over*, BUS. WK. ONLINE (May 13, 2002), *at* http://www.businessweek.com/magazine/content/02_19/b3782610.htm. *See generally* WILLIAM FISHER, PROMISES TO KEEP: TECHNOLOGY, LAW, AND THE FUTURE OF ENTERTAINMENT (2004).

435. *See* James V. Grimaldi, *States Want Microsoft to Cede Windows*, SEATTLE TIMES, Mar. 28, 1999, at A1. *See generally* James Love & Michael Palmedo, Compulsory Licensing as Remedy to Anticompetitive Practices (Sept. 29, 2001) (providing a list of cases in which compulsory licensing was used as a remedy to anticompetitive practices), *at* http://www.cptech.org/ip/health/cl/us-at.html.

C. Transferring Intellectual Property to the Private Sector

The government is capable of creating innovative code but is generally not the ideal institution to provide technical support, maintenance, and further enhancement of code. These functions are better accomplished by other institutions, such as firms, consortia, or the open source movement.[436] For innovative government-sponsored code to become useful to society, it is often necessary to transfer it to the private sector.[437] Consequently, a number of laws require the government and public universities transfer their technology to the private sector.[438] Federal agencies, such as the NSF, often seek to have their sponsored research commercialized.[439]

The government has enacted laws that allow for the transfer of intellectual property rights to the private sector. The first notable law was the Stevenson-Wydler Technology Innovation Act, which made technology transfer an integral activity for federal laboratories.[440] This was followed by the Bayh-Dole Act, which allows universities and firms to patent and license the results of government-sponsored research.[441] These laws represent a shift from public ownership of government-sponsored research toward private appropriation.[442] Some

436. *Cf.* Rajiv C. Shah & Jay P. Kesan, *Incorporating Societal Concerns into Communication Technologies*, IEEE TECH. & SOC'Y MAG., Summer 2003, at 28, 29–33 (noting the competencies of other social institutions).

437. *See* J.S. Metcalfe & L. Georghiou, *Equilibrium and Evolutionary Foundations of Technology Policy*, 22 STI REV. 75, 87–88 (1998) (arguing, from a European policy perspective, that effective innovation is dependent in part upon knowledge transfers between universities and the private sector).

438. *See, e.g.*, 35 U.S.C. §§ 200–212 (2000); Stevenson-Wydler Technology Innovation Act of 1980, Pub. L. No. 96-480, 94 Stat. 2311–2320 (1980) (since amended numerous times).

439. A former director of the NSF has commented on the amount of commercialized technology that started as government research:

> Much of the research funded by Federal agencies is implemented by researchers at universities and in the commercial sector. . . . In numerous cases, university researchers transfer their experience to start-up companies to rapidly make new capabilities available to the commercial sector. There are many success stories for this model of technology transfer. For example, Netscape began with a software package (Mosaic) originally written at the University of Illinois by an NSF-funded student. More recently, the Google search engine company was started by two Stanford students who took the results of NSF-funded research on digital libraries and built a commercial service using these ideas.

Next Generation Internet in the President's Fiscal Year 2001 Budget: Hearing Before the Senate Subcomm. on Science, Tech., and Space, 106th Cong. 60 (2000) (statement of Neal Lane, Assistant to the Pres. for Sci. and Tech., and Dir., Off. of Sci. & Tech. Pol'y).

440. *See* Stevenson-Wydler Technology Innovation Act of 1980, *supra* note 438.

441. Act of Dec. 12, 1980, Pub. L. No. 96-517, 94 Stat. 3018 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2000)) (commonly referred to as the Bayh-Dole Act).

442. *See* Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1663 (1996) (providing an historical overview of the government's technology transfer policy).

federally-sponsored inventions may now be patented — even though this policy limits their use.[443]

The standard justification for technology transfer laws is that they promote commercialization. These laws provide firms with the intellectual property protection necessary to support the eventual commercial development of a technology.[444] Firms argue that technologies developed by the public sector or government are immature and need additional refinement and testing before they enter the marketplace. Such further development is risky, and firms need the protection of intellectual property rights. Technology transfer laws encourage firms to accept risk in the development process by giving them exclusive ownership in the refined version of the technology.[445] Without intellectual property protection, government-sponsored technologies would arguably languish, unrefined, in the public domain.

The history of the Mosaic web browser and web server, both designed by the National Center for Supercomputing Applications at the University of Illinois ("NCSA"), highlights two different approaches the government can take to transfer technology. The government can license the technology to the private sector or place the technology in the public domain. In the case of the Mosaic web browser, the University of Illinois commercially licensed the code, earning several million dollars.[446] The dominant web browser today, Microsoft's Internet Explorer, is built upon the Mosaic web browser source code.[447] The University also placed the Mosaic web server into the public domain.[448] This method earned the university zero dollars. Yet, the most popular web server today, Apache, available for free, had its origins in the Mosaic web server source code.[449]

The Apache example challenges the prevailing view that intellectual property protection is essential to encourage commercialization of government-sponsored research.[450] By placing the Mosaic web server

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443. *See id*. at 1666.

444. *Cf. supra* note 265 and accompanying text (suggesting that firms are unwilling to support basic research due to an inability to secure the resulting information for their own exclusive use).

445. *See* Eisenberg, *supra* note 442, at 1669; *see* GAO, *supra* note 338, at 12–13.

446. U. ILL., RES. & TECH. MGMT. OFF., FISCAL YEAR 1999 ANNUAL REPORT (Oct. 1999).

447. *See* Blooberry, Internet Explorer (Windows), *at* http://www.blooberry.com/indexdot/history/ie.htm (last updated Oct. 1, 2003) (noting that the original Microsoft IE 1.0 browser code was based on the NCSA Mosaic browser codebase).

448. *See* NCSA HTTPd, Copyright for NCSA httpd, *at* http://hoohoo.ncsa.uiuc.edu/docs-1.4/Copyright.html (last modified June 13, 1995) (giving "to the public domain all rights for licensing of these versions of the source code, all resale rights, and all publishing rights.").

449. *See* GLYN MOODY, REBEL CODE: THE INSIDE STORY OF LINUX AND THE OPEN SOURCE REVOLUTION 127 (2001) (discussing the history of Apache).

450. *See* Jeanette Colyvas et al., *How Do University Inventions Get Into Practice?*, 48 MGMT. SCI. 61, 65 (2002) (arguing on the basis of case studies that firms do not need the assurance of intellectual property protection to commercialize university technology).

into the public domain, the government encouraged the dissemination and continued innovation of the web server; individuals and private firms incrementally and cumulatively improved the original source code created by the NCSA.

The Apache example also challenges the assumption that firms are the only entities capable of commercializing code. The prevailing logic for technology transfer laws assumes that only firms are capable of turning government-sponsored research into useful products. However, the success of Apache shows that the open source movement is capable of producing useful code and demonstrates that open source projects can utilize individual volunteers, as well as firms, to develop commercially viable products.

Although the Apache example provides a powerful argument for the general proposition that government-funded code ought to be placed into the public domain, this one example is not a sufficient basis for mandating that all government-funded code must be made available to the open source community. The empirical evidence on this subject is too limited to provide definitive conclusions either for or against intellectual property protection for government-sponsored research.[451] For example, consider the University of Illinois, which could have placed the Mosaic browser into the public domain instead of commercially licensing the browser for millions of dollars. Clearly, the University of Illinois financially benefited by commercially licensing the Mosaic browser. It is unclear, however, whether society would have been better off if the Mosaic browser had instead been made available to the open source community.[452] This latter scenario could have encouraged a larger number of entities to build upon the Mosaic web browser, perhaps resulting in greater societal benefits.[453]

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451. *Cf.* David C. Mowery et al., *The Growth of Patenting and Licensing by U.S. Universities: An Assessment of the Effects of the Bayh-Dole Act of 1980*, 30 RES. POL'Y 99, 117–18 (2001) (acknowledging the lack of definitive empirical evidence for or against IP rights for government-sponsored research, but still arguing that the emphasis on patenting and licensing could hamper technological innovation, because it limits researchers' access to new technologies).

452. *See, e.g.*, Eisenberg, *supra* note 442, at 1712 (arguing that intellectual property protection by universities is more likely to retard than promote product development).

453. There is evidence that revenue is the primary interest of technology managers and university administrators. *See* RICHARD JENSEN & MARIE THURSBY, PROOFS AND PROTOTYPES FOR SALE: THE TALE OF UNIVERSITY LICENSING (Nat'l Bureau of Econ. Res., Working Paper No. 6698, 1998) (conducting a survey of technology managers and university administrators to determine their perceptions of the objectives their universities most hoped to achieve through licensing), *available at* http://papers.nber.org/papers/ w6698.pdf. While licensing revenues are easily quantifiable and a measure of success, they are not necessarily equivalent to the public interest. The public interest is to ensure that technologies are transferred to the private sector. To achieve this goal, other methods are just as important as licensing. These methods include publication, conferences, informal information channels, and consulting. Similarly, a report for the National Institutes of Health ("NIH") pointed out that a university's principal obligation should not be the maximization of revenues, but rather the utilization of technologies. *See* NIH, REPORT OF THE NATIONAL

Accordingly, the government's efforts at technology transfer must recognize the value and strength of the open source movement in promoting the development of innovative code. To further the innovation and dissemination of code, the government should ensure that access to government-sponsored code is not unduly limited by restrictive intellectual property rights. As a general rule, code produced by government-funded research should be placed into the public domain and be made available to the open source movement.[454] Placing code in the public domain is the least restrictive method for preserving access, while also permitting downstream intellectual property protection.[455] This policy allows both firms and individual volunteers to build upon the government's code. Moreover, firms can still seek intellectual property protection for any improved or refined code.[456] This policy is consistent with technology transfer laws, such as the Bayh-Dole Act, which seek to further the utilization of government-sponsored research.[457]

The most likely objection to this proposal is that it treats all parties equally, including the foreign competitors of American companies. One purpose of intellectual property protection is to provide preferential treatment to American firms. This is one of the many

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INSTITUTES OF HEALTH (NIH) WORKING GROUP ON RESEARCH TOOLS (June 4, 1998), *at* http://www.nih.gov/news/researchtools/index.htm.

454. Our proposal focuses on the public domain because it is much less restrictive than the GPL employed by open source software project like GNU/Linux. The GPL requires any derivative code to be licensed under the GPL. While some people do want their work privatized, this is largely a personal decision. The government should focus on creating the building blocks of code, no matter who the end users are. *See* Evans & Reddy, *supra* note 342, at 76 (arguing that the government should favor the public domain or BSD style of licenses over the GPL). *See generally* Free Software Foundation, GNU General Public License (June 1991) (describing the terms and conditions of the GPL), *at* http://www.gnu.org/copyleft/gpl.html; Free Software Foundation, *at* http://www.fsf.org/ (last modified Mar. 12, 2005); David McGowan, *Legal Implications of Open-Source Software*, 2001 U. ILL. L. REV. 241 (2001) (discussing the social, economic, and legal implications of open source software and the GPL); Richard Stallman, *Letter to the Editor: Public Money*, *Private Code*, SALON.COM (Jan. 29, 2002) (providing practical advice for university researchers on getting university code released under the GPL), *at* http://www.salon.com/tech/letters/2002/01/29/stallman_ on_universities/index.html.

455. To ensure that the government places code into the public domain, it may be necessary to amend portions of the Bayh-Dole Act and the Federal Technology Transfer Act. In particular, these Acts need to be amended to include an exception to the government's encouragement and support of intellectual property rights during technology transfer with regard to software.

456. See Diane Leenheer Zimmerman, *It's an Original! (?): In Pursuit of Copyright's Elusive Essence*, 28 COLUM. J.L. & ARTS 187, 210–211 (2005) (noting that a work based on materials in the public domain are copyrightable). Firms could still profit from code by making it user friendly, adding documentation, and providing training.

457. 35 U.S.C. § 200 (2000) ("It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development . . . ."); *see also* NIH, *supra* note 453 (noting that the primary goal of technology transfer is to increase utilization, not to maximize financial returns to the government through licensing).

stated rationales for the Bayh-Dole Act.[458] However, preferential treatment for Americans is just one of the many underlying rationales for technology transfer. The main rationale is to ensure that government research is utilized. Moreover, the growing importance of the open source movement, which can involve international volunteers, complicates pro-American policy preferences. For example, Apache's development relied on individuals from around the world.[459] Preferential treatment toward American firms denies the open source movement access to code. In fact, American software firms have criticized the National Security Agency ("NSA") for developing an enhanced secure version of the open source operating system Linux.[460] Nevertheless, the NSA decided to continue working on its secure version of Linux as part of its mission to understand and improve computer security.[461] The open source community has applauded the NSA's work and has begun utilizing its code.[462] It is important to note that the government can support the open source movement while still providing preferential treatment to American firms in other ways, such as tax incentives for American firms that participate in open source projects, government procurements of open source software, and other approaches discussed previously in this Article.

Placing code into the public domain may be difficult for universities because licensing brings them much-needed revenue. Abandoning that potential licensing opportunity goes against the nature and mission of a university technology transfer office. Thus, for this policy to become widely used, it will be necessary to change the mindset of technology transfer offices.[463] Currently, universities are not "distinguishing between times when [it is] important to have a patent in place to get something disseminated and times when [it is] not . . . .

458. *See* 35 U.S.C. § 200.

459. *See* Roy T. Fielding, *Shared Leadership in the Apache Project*, COMM. ACM, Apr. 1999, at 42.

460. *See* Krane, *supra* note 351; Robert Lemos, *Linux Makes a Run for Government*, CNET NEWS.COM (Aug. 16, 2002), *at* http://news.com.com/2100-1001-950083.html.

461. Drew Clark, *Defense, NSA Move on 'Open Source' Software Development*, GOVTEXEC.COM (Mar. 17, 2003), *at* http://www.govexec.com/dailyfed/0303/031703td2.htm.

462. *See generally* Robert Lemos, *U.S. Helps Fund FreeBSD Security Project*, CNET NEWS.COM (July 9, 2001) (discussing the U.S. Department of Defense's work on improving the security of FreeBSD, an open source variant of Unix), *at* http://news.com.com/2100-1001-269644.html.

463. Licensing offices often derive their budgets from licensing revenue. This gives them an incentive to favor short-term revenue from licensing, instead of ensuring the long-term development of their products. This is especially relevant since many licensing offices are losing money. *See* Eyal Press & Jennifer Washburn, *The Kept University*, ATLANTIC MONTHLY (Mar. 2000) (explaining that many university licensing offices are "barely breaking even," even though they are "churning out patents"), *available at* http://www.mindfully.org/GE/The-Kept-UniversityMar00.htm.

[They are] just looking to see if they can make money."[464] As the Mosaic web server example shows, the benefits of placing code into the public domain may not flow directly to the university, and it may take a long time for the benefits to accrue to society.[465]

Already the government is slowly beginning to support the open source movement as an institution capable of developing code. Having already developed a significant amount of the code for the Internet, the open source movement now also plays a role in biotechnology.[466] This development has led the NIH to begin studying the appropriate level of intellectual property protection for its research tools, such as bioinformatics code. A NIH working group has recommended that the agency should promote the free distribution of research tools.[467] Other researchers have been even more aggressive in calling for the use of open source code.[468]

V. CONCLUSION

This Article has taken a different approach than most traditional scholarship, which focuses on how code affects a particular societal concern. The Authors' goal was to show that many methods of influencing the development of code are available to government. To this end, the Article analyzed a number of different regulatory and fiscal actions government can take to shape code. For each possible action, it discusses potential regulatory and technological issues that could affect the success of the action. This analysis should be valuable to

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464. Jeffrey Benner, *Public Money, Private Code*, SALON.COM (Jan. 4, 2002) (quoting Rebecca Eisenberg), *at* http://salon.com/tech/feature/2002/01/04/university_open_source/print.html. There are a few cases where it appears that technology transfer offices are placing a university's private gain over public benefits. For example, Michigan State University received a patent for a widely prescribed cancer drug, cisplatin, in 1979. Since then, the patent has generated over $160 million for the university. In more recent years, when its patent was about to expire, Michigan State University applied for a new, slightly altered patent to protect its revenue stream. As a result, generic-drug manufacturers are unable to develop cheaper versions of cisplatin. Press & Washburn, *supra* note 463.

465. Larry Smarr, former director of NCSA and current professor of computer science at U.C. San Diego, does not believe that "universities should be in the moneymaking business. They ought to be in the changing-the-world business, and open source is a great vehicle for changing the world." Benner, *supra* note 464.

466. *See* Bruce Stewart, Ewan Birney's Keynote: A Case for Open Source Bioinformatics (Jan. 29, 2002) (noting that "most of the important bioinformatics software is already open"), *at* http://www.oreillynet.com/pub/a/network/2002/01/28/bioday1.html; Bruce Stewart, Lincoln Stein's Keynote: Building a Bioinformatics Nation (Jan. 30, 2002) (arguing in favor of the further growth of open source code in the field of bioinformatics), *at* http://www.oreillynet.com/pub/a/network/2002/01/29/bioday2.html.

467. *See* NIH, *supra* note 453.

468. Harry Mangalam of TACG Informatics has called on the NIH to require research scientists who receive federal funding to make their code freely available for other researchers. *See* David Malakoff, *Petition Seeks Public Sharing of Code*, 294 SCI. 27 (2001). *But see* David W. Opderbeck, *The Penguin's Genome, or Coase and Open Source Biotechnology*, 18 HARV. J.L. & TECH. 167 (2005).

scholars and policymakers seeking to shape the development of code in order to address societal concerns.

In considering regulatory actions, prohibitions can be an effective method of regulation, but current export prohibitions on encryption code are impractical. Similarly, there are regulatory trade-offs involved with technology-forcing regulation. The current policy of mandating digital broadcasting technologies provides only vague benefits. This discussion leads to the conclusion that modification of liability systems can result in safer and more secure code. However, there are flaws in a proposed government policy to create more secure code by developing an insurance system for cybersecurity. Just as other regulatory objects, such as biotechnology and automobiles, have a regulatory framework, code needs the same comprehensive regulatory strategy.

In light of the government's fiscal approaches, the Authors offers a number of policy recommendations. Government can shape code by funding its research and development, and should use its procurement power to favor open standards and open source code. Such a policy is consistent with the government's goals of spending its resources efficiently while considering social and environmental externalities. Finally, government can further innovation by promoting technology transfer by placing its code into the public domain. This policy would allow a wide variety of parties to build upon and refine the work accomplished by government on behalf of its citizens.

Future scholarship will more fully examine each of the measures addressed in this Article. The Authors encourage and look forward to further discussion of how code can serve as a beneficial regulatory mechanism. To this end, this Article attempts to analyze the various methods that policymakers may use to guide and promote the development of code that contributes to our society.