SHAPING CODE

Jay P. Kesan* & Rajiv C. Shah**

* Associate Professor, College of Law and Institute of Government and Public Affairs, University of Illinois at Urbana-Champaign.
** Doctoral Candidate, Institute of Communications Research, University of Illinois at Urbana-Champaign.
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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 only method of social regulation. Other methods of social control include social norms and architecture.[1] This has led researchers in a variety of disciplines to document how the architecture of information technologies affects our online experiences and activities.[2] The recognition of the role of architecture has led policymakers to consider architectural as well as legal solutions to societal problems.[3] Architectural solutions utilizing information technologies have been proposed for issues such as crime,[4] competition,[5] free speech,[6] privacy,[7] protection of intellectual property,[8] and revitalizing democratic discourse.[9]

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[1] LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 95 (1999) (noting the role of architecture and social norms). Among the most influential works on social norms are Amitai Etzioni, *Social Norms: Internalization, Persuasion, and History*, 34 L. & SOC'Y REV. 157 (2000); ROBERT ELLICKSON, ORDER WITHOUT LAW (1991); Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338 (1997); ERIC A. POSNER, LAW AND SOCIAL NORMS (2000).

[2] Paul DiMaggio et al., *Social Implications of the Internet*, 27 ANN. REV. OF SOC. 307, (2001) (discussing the need for sociologists to attend to the architecture of information technologies); CARL L. SHAPIRO & HAL R. VARIAN, INFORMATION RULES (1998) (discussing how the architecture of information technologies can affect informational economics); François Bar, *The Construction of Marketplace Architecture*, *in* TRACKING A TRANSFORMATION: E-COMMERCE AND THE TERMS OF COMPETITION IN INDUSTRIES (2001) (discussing how consumer choice and market outcomes can be affected by the architecture of information technologies); 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 technologies for communication scholars).

[3] Neal Kumar Katyal, *Architecture as Crime Control,* 111 YALE L.J. (forthcoming 2002); TIMOTHY D. CROWE, CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (2nd ed. 2000).

[4] Neal Kumar Katyal, *Criminal Law in Cyberspace,* 149 U. PA. L. REV. 1003 (2001).

[5] The open access movement is based upon the principle that the architecture can support competition as well as providing a platform to support innovative applications. Mark A. 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).

[6] 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. 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 email); CASS SUNSTEIN, REPUBLIC.COM 182-89 (2001) (proposing the redesign of web sites to incorporate links of different viewpoints to provide exposure to differing viewpoints).

[7] An example of an architectural solution for privacy is the Preferences for Privacy Project (P3P). *See* William McGeveran, *Programmed Privacy Promises: P3P and Web Privacy Law*, 76 N.Y.U. L. REV. 1813 (arguing for P3P as a solution to privacy problems; *infra* note 572 (providing background on P3P). *See also* Malla Pollack, *Opt-In Government: Using the Internet to Empower Choice—Privacy Application,* 50 CATH. U. L. REV. 653 (2001) (proposing the creation of a government search engine that only links to web sites that protect a user's privacy); Shawn H. Helms, *Translating Privacy Values With Technology,* 7 B.U. J. SCI. & TECH. L. 288 (2001) (arguing the government, privacy advocacy groups, and users should support the adoption of privacy enhancing technologies).

[8] 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 based intellectual property). The media industry has been very vocal in supporting architectural solutions to protection their intellectual property.

Understanding the development of legal solutions is a mainstay of the legal academy through fields such as legislation, administrative law, and public choice theory.[10] This knowledge allows for the development of legal solutions to address societal problems. However, there is very limited attention and understanding devoted to the development of architectural solutions. As a result, policymakers are at a loss when employing architectural solutions to address societal concerns. This Article addresses this lack of knowledge by analyzing the development of information technologies. We study the various societal actors that shape the development of information technologies. This allows us to comprehend why information technologies differ in various social and technical attributes, such as their support for standards or the attention to privacy considerations. To aid in the development of architectural solutions, we provide recommendations for how society can intervene to ensure that societal concerns are addressed during the development of information technologies. Our recommendations to shape code are extensive and include several regulatory actions; measures relating to the government's procurement policy; and measures that may be employed by public interest organizations to participate in the development of information technologies.

This Article analyzes the development of information technologies or "code." We use the term "code" to refer to the architecture of information technologies, which includes its hardware and software components. While code is usually associated with the Internet and information technologies, our analysis is intended to be much more encompassing. The Internet is made up of over one hundred million computers,[11] however, there were over five billion microprocessors sold in 1998.[12] These microprocessors are the code that governs many other technologies from aircraft and ships to refrigerators, lights, and smoke detectors.[13]

This paper studies code by analogizing code to law. There are a number of institutions that develop law including legislative bodies, acts and regulations of executive bodies, judicial

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Amy Harmon, *Hearings on Digital Movies and Privacy*, N.Y. TIMES, Mar. 2, 2002, *available at* http://www.nytimes.com/2002/03/01/technology/01DIGI.html.

[9] *See* ANTHONY G. WILHELM, DEMOCRACY IN THE DIGITAL AGE 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).

[10] For example, at George Mason University these topics are all addressed in courses in their regulatory track. *See* George Mason University*, Specialty Law Track: Regulatory Law*, *available at* http://www.gmu.edu/departments/law/academics/regtrack.html (last modified Jul. 17, 2002).

[11] NATIONAL SCIENCE BOARD, SCIENCE AND ENGINEERING INDICATORS – 2002 (2002).

[12] John Thackara, *The Design Challenge of Pervasive Computing,* INTERACTIONS, May 2001, at 48.

[13] *Id.*

precedents, and legal customs. All these can differ in their role in society, their individual and institutional motivations, and their processes. In studying code, we began by recognizing there is not one legislator for cyberspace, instead code is produced within a number of institutions.[14] These institutions or legislators include universities, firms, consortia, and the open source movement. These institutions have different roles, motivations, end users, and structures. As a result, they are differentially affected by social, political, economic, and legal influences. This is then reflected in the attributes of the final code. These attributes include technical features, such as the use of open standards, as well as features that impinge upon societal concerns, such as intellectual property rights and privacy. In this Article, we analyze this process and the resulting attributes of code. We then provide a number of recommendations on how society can shape code to address societal concerns. These actions include the use of the government's regulatory and fiscal powers as well as the role that may be played by public interest organizations.

This Article bridges and contributes to theoretical work occurring in both the legal and communications literature. Legal scholars have highlighted the importance of considering code as a method of social control.[15] More recent work argues for using code to address societal concerns. For example, Burk and Cohen argue for the incorporation of a technological "fair use" infrastructure into digital rights management systems.[16] This Article contributes to this scholarship by explaining how society shapes the development of code. This work also addresses the strengths and weaknesses of various societal institutions in developing code. This issue is a contentious one. Some commentators urge that government should allow consumers to choose code through the market.[17] For others, the significance of code is such that it should not be left solely to the market.[18] Our analysis allows policymakers to understand when the market will encourage the development of code that addresses societal concerns and when government intervention will be necessary.

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[14] We use the concept of legislators only in the descriptive sense and not in any normative sense. That is, we strive to understand who are the rule makers for cyberspace. We do not argue that the rule makers for cyberspace ought to act as legislators. Legislators are supposed to act in the interest of the people. As we show, the rule makers of cyberspace often have interests beyond democracy.

[15] Lessig, *supra* note 1; Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553 (1998); M. Ethan Katsh, *Software Worlds and the First Amendment: Virtual Doorkeepers in Cyberspace*, 1996 U. CHI. LEGAL F. 335.

[16] Burk & Cohen, *supra* note 8.

[17] David R. Johnson & David G. Post, *The New "Civic Virtue" of the Internet*, *in* THE EMERGING INTERNET (1998).

[18] Lessig, *supra* note 1; Neil Weinstock Netanel, *Cyberspace Self-Governance: A Skeptical View from Liberal Democratic Theory*, 88 CAL. L. REV. 395 (2000).

Communications scholars have long recognized the power of code.[19] They emphasize how code—the medium of an information technology—affects how communications occurs.[20] For example, McLuhan argued that the medium of communication fundamentally affects our understanding of the world.[21] Communications scholars versed in political economy also study the development of code.[22] Their work typically documents how social, economic, political, and legal factors affect the design and implementation of code.[23] For example, Crane has shown that international political differences led to different television standards around the world.[24] However, there is a lack of work on newer information technologies within this school. Moreover, this scholarship usually focuses on code developed by firms, with little attention to universities, consortia, or the open source movement.

Our analytical framework is based upon the methodologies of Science & Technology Studies (STS). STS analyzes how society affects the development of technology.[25] Their methodological approach is useful to our study, since code is a form of technology. STS examines how technology is shaped by societal factors such as politics, institutions, economics,

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[19] There have been several generations of scholars who have studied the role of the medium. Joshua Meyrowitz, *Medium Theory*, *in* COMMUNICATION THEORY TODAY 51 (David Crowley & David Mitchell eds., 1995) (providing an excellent overview of medium theory in communications).

[20] Harold Innis wrote about the role of the medium of communication in shaping cultures. For example, time biased media such as stone hieroglyphics led to smaller stable societies. In contrast, lighter media such as papyrus led to more unstable societies over a larger space, for example, the Roman Empire. HAROLD INNIS, EMPIRE AND COMMUNICATIONS (1950).

[21] MARSHALL MCLUHAN, UNDERSTANDING MEDIA: THE EXTENSIONS OF MAN (1964). There have been a number of articles applying McLuhan to the Internet. *See* Larry Press, *McLuhan Meets the Net*, COMM. ACM, July 1995, at 15.

[22] VINCENT MOSCO, THE POLITICAL ECONOMY OF COMMUNICATION: RETHINKING AND RENEWAL (1996); Robert McChesney, *The Political Economy of Global Communication*, *in* CAPITALISM AND THE INFORMATION AGE 1 (Robert McChesney et al. eds., 1998). Scholars in information studies are also studying the development of code, most prominently under the rubric of social informatics. Rob Kling et al., *Social Informatics: An Introduction*, 49 J. AM. SOC'Y FOR INFO. SCI. 1047 (1998); Steve Sawyer & Howard Rosenbaum, *Social Informatics in the Information Sciences: Current Activities and Emerging Directions*, 3 INFORMING SCI. 89 (2000).

[23] Rob Kling & Suzanne Iacono, *Computerization Movements and the Mobilization of Support for Computerization*, *in* ECOLOGIES OF KNOWLEDGE 226 (Leigh Starr ed., 1988) (studying the role of ideological beliefs in shaping computerization movements).

[24] RHONDA J. CRANE, THE POLITICS OF INTERNATIONAL STANDARDS: FRANCE AND THE COLOR TV WAR (1979). *See also* ROBIN MANSELL, THE NEW TELECOMMUNICATIONS: POLITICAL ECONOMY (1993) (noting how design of telecommunication networks reflects the institutionalized power relations between major multinational telecommunication companies and government).

[25] Wiebe E. Bijker, *Sociohistorical Technology Studies*, *in* HANDBOOK OF SCIENCE AND TECHNOLOGY STUDIES 229 (Sheila Jasanoff et al. eds., 1995); Wiebe E. Bijker & John Law, *General Introduction*, *in* SHAPING TECHNOLOGY/BUILDING SOCIETY 3 (Wiebe E. Bijker and John Law eds., 1992); Robin Williams & David Edge, *The Social Shaping of Technology*, 25 RES. POL'Y 865 (1996) (reviewing the literature with an emphasis on research on information technologies).

and social structures.[26] STS seeks to understand how technologies develop and why they are designed in a specific manner. This approach stresses that in order to understand technologies we must be cognizant that technologies can be designed in other ways.[27] Hence, we have chosen to use technological case studies to investigate how code is shaped.

The recognition that technologies can be designed differently is important because each specific design will necessarily favor certain social actors, and therefore, establish patterns of power and authority for these social actors. The classic example is the bridges over the parkways of Long Island. These bridges appear to have a strictly utilitarian purpose. However, the height of these bridges is quite low, as short as nine feet.[28] The reason these bridges were designed so short was to prevent buses from passing underneath them.[29] This serves to exclude poor people, who rely on public transportation to access Long Island. Thus, the seemingly neutral bridge design is in reality a method of social engineering to achieve class or racial exclusion.[30] This example illustrates how the design of a bridge is value-laden or political.[31] Similarly, scholars have shown how code is also value-laden.[32]

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[26] One central point of STS research is the rejection of technological determinism. Technological determinism conceives of technological change as an independent factor and argues that technological change causes social change. Technology is viewed as an outside force upon society. Thus technological determinism does not consider how societal factors affect the development of a technology. Donald MacKenzie & Judy Wajcman, *Introductory Essay: The Social Shaping of Technology*, *in* THE SOCIAL SHAPING OF TECHNOLOGY 2 (Donald MacKenzie & Judy Wajcman eds., 1985).

[27] *See* Bijker & Law, *supra* note 25 at 3.

[28] Langdon Winner, *Do Artifacts have Politics?*, *in* THE SOCIAL SHAPING OF TECHNOLOGY 26 (Donald MacKenzie & Judy Wajcman eds., 1995).

[29] *Id.*

[30] *Id. See also* Bernward Joerges, *Do Politics Have Artifacts*, 29 SOC. STUD. SCI. 411 (1999) (arguing that Moses may not have intentionally designed the bridges as such). An example of value-laden code relevant to law was the bias in airline reservation systems in the 1980s. The two dominant airline reservation systems were Sabre and Apollo, which were owned by American and United Airlines respectively. Their competitors claimed that the reservations systems were preferential to their owners' flights over other competing flights. This was manifested in competitors often being placed on a second screen of flights, which research had demonstrated that travel agents would not often view. Consequently, the Department of Transportation regulates airline reservation systems and bars any discrimination in displays. Reservation systems cannot favor their airline parent or allow airlines to pay for a better position. ROBERT ERNEST HALL, DIGITAL DEALING: HOW E-MARKETS ARE TRANSFORMING THE ECONOMY 169-75 (2001). This issue has resurfaced with the creation of the Orbitz online booking site created by five major airlines. Critics charge that Orbitz is favored by its owners, thus creating a biased reservation system. Joe Sharkey, *New Twist in Booking Airline Tickets,* N.Y. TIMES, May 21, 2002.

[31] Langdon Winner, *Political Ergonomics*, *in* DISCOVERING DESIGN 162 (Richard Buchanan & Victor Margolin eds., 1995) (arguing about the political significance of the design of technologies); Michael Crow, *Linking Scientific Research to Societal Outcomes*, *in* AAAS SCIENCE AND TECHNOLOGY POLICY YEARBOOK (Teich Albert et al. eds, 2001) (arguing scientific research needs to consider societal concerns).

[32] Batya Friedman, HUMAN VALUES AND THE DESIGN OF COMPUTER TECHNOLOGY 2-3 (Batya Friedman ed., 1997) (arguing the design of code favors or biases certain uses over others); Helen Nissenbaum, *How Computer Systems Embody Values*, IEEE COMPUTER, March 2001, at 118 (arguing that computer systems embody values); Lucas

Institutions were chosen as the unit of analysis because they are responsible for creating the vast majority of code. Their significance has led other scholars studying code to use an institutional framework.[33] We consider institutions to be composed of a group of actors who are subject to a system of rules that structures their activities. These rules concern goals, rights, procedures, social norms, and formal legal rules. Our analysis is focused on institutions and not on individuals because, in the aggregate, it is the institutions that design cyberspace. Although the designers are individuals, they work within institutions.[34] They are subject to the rules and norms of these institutions, thus attenuating individual preferences or desires.[35] Moreover, the institutional values and preferences are a composite reflection of the individuals compromising these institutions.

To illustrate the importance of institutions in design of technologies, consider the development of the Internet. Naughton argues that the Internet, as we know it today, would not have arisen in institutions outside academia.[36] The military-industrial complex would not have built a network without central control and based on open standards that allows anyone to connect to the network. Similarly, the media conglomerates would not have built a network that allows people so much freedom in choosing content. Even less likely, would be the media conglomerate's support of a network that allowed anyone to become a publisher. Instead, the

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Introna & Helen Nissenbaum, *Defining the Web: The Politics of Search Engines*, IEEE COMPUTER, Jan. 2000, at 54 (illustrating an example of bias with Internet search engines).

[33] *See* Walter W. Powell & Paul J. DiMaggio, *Introduction, in* THE NEW INSTITUTIONALISM IN ORGANIZATIONAL ANALYSIS 1 (Walter W. Powell & Paul J. DiMaggio eds. 1991) (providing a brief history of institutions). There are a number of other scholars who have discussed the relationship between code and institutions. *See* Phil Agre, *The Architecture of Identity: Embedding Privacy in Market Institutions*, INFO. COMM. & SOC'Y, Spring 1999, *available at* http://dlis.gseis.ucla.edu/people/pagre/architecture.html (insisting that we use an institutional approach to understand the role of code and society); Jane E. Fountain, *Constructing the Information Society: Women, Information Technology, and Design*, 22 TECH. & SOC'Y 45 (2001) (arguing the appropriate level of analysis is the institution in the development of code); Richard Hawkins, *Standards for Communication Technologies: Negotiating Institutional Biases in Network Design*, *in* COMMUNICATIONS BY DESIGN: THE POLITICS OF INFORMATION AND COMMUNICATION TECHNOLOGIES 157 (Robin Mansell & Roger Silverstone eds., 1996); SUSANNE K. SCHMIDT & RAYMUND WERLE, COORDINATING TECHNOLOGY: STUDIES IN THE INTERNATIONAL STANDARDIZATION OF TELECOMMUNICATIONS (1998) (using an approach titled Actor-centered Institutionalism).

[34] While the invention of certain code may be the result of one person, it takes an institution to design, develop, and implement code. For example, a college student invented Napster, but to market Napster it was necessary to create a firm. Similarly, Robert Thau rewrote the Apache server by himself in a month. But it took a whole network of people to continue to refine, develop, and support Apache. This network or group of people is an institution that shapes the development of code.

[35] *See* Fountain, *supra* note 33. This does not mean designers are irrelevant. For example, it is possible to affect the design process through changes in the designers. Fountain argues that information technologies would be designed differently if more women participated in the design process. For example, women are more concerned about end users in the design of information technologies.

media firms would have built networks premised on pushing content to consumers.[37] Thus, the architecture of the Internet itself was influenced by its institutional origins in academia.[38]

This Article focuses on four institutions that have been important in the development of code. The first of these is universities. Universities are an important source of innovative research and development for new technologies. Universities account for over half of all fundamental research within the United States and are the genesis of many technology firms.[39] Many significant information technologies have emerged from universities including the Internet, reduced-instruction set computing (RISC), and computer graphics.[40]

The second institution is the firm. Firms are the leading developers and implementers of code. For instance, firms spent over fifty billion dollars on research and development for new code in 1998.[41] Moreover, firms are the primary source of code for end users. Firms such as IBM, Hewlett-Packard, and Microsoft have long been leaders in providing code to consumers.

The third institution we consider is the consortium. A consortium is an institution that arises from the cooperative efforts between firms or individuals. The majority of standards for

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[36] JOHN NAUGHTON, A BRIEF HISTORY OF THE FUTURE: FROM RADIO DAYS TO INTERNET YEARS IN A LIFETIME 274 (2000).

[37] *See* Eileen R. Meehan, *Technical Capability Versus Corporate Imperatives: Toward a Political Economy of Cable Television and Information Diversity*, *in* THE POLITICAL ECONOMY OF COMMUNICATION 167 (Vincent Mosco ed., 1996) (highlighting interactive television's bias towards commercialism).

[38] Similarly, David Silver studied a non-profit and a for-profit community network in Seattle, Washington and Blacksburg, Virginia. He found that the institutional structure led to differences in both content and communication within the network. The network in Blacksburg was sponsored by a number of commercial sponsors, which became reflected in the commercialism that permeated the site and the avoidance of controversial issues of race, gender, and sexuality. In contrast, the community network in Seattle formed as a bottom-up process through a local computing organization. Its goal was public participation and the site largely consisted of a diverse community of non-profit groups. This recognition of diverse interests allowed the Seattle community network to blossom into an important resource for citizens. Thus the code of community networks was affected by its institutional structure. David Silver, *Localizing the Global Village: Lessons from the Blacksburg Electronic Village*, *in* THE GLOBAL VILLAGE: DEAD OR ALIVE? 79 (Ray B. Browne & Marshall W. Fishwick eds., 1999); David Silver, *Margins in the Wires: Looking for Race, Gender, and Sexuality in the Blacksburg Electronic Village*, *in* RACE IN CYBERSPACE 133 (Beth E. Kolko et al. eds., 2000).

[39] Harvey Brooks, *Research Universities and the Social Contract for Science*, *in* EMPOWERING TECHNOLOGY: IMPLEMENTING A U.S. STRATEGY 202 (Lewis Branscomb ed. 1993) (discussing the role of universities in the nation's technological policy); Edwin Mansfield & Jeong-Yeon Lee*, The Modern University: Contributor to Industrial Innovation and Recipient of Industrial R&D Support*, 25 RES. POL'Y 1047 (1996) (studying the role of universities on seven major industries in the United States).

[40] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, NATIONAL ACADEMY OF SCIENCES, MAKING IT BETTER: EXPANDING INFORMATION TECHNOLOGY RESEARCH TO MEET SOCIETY'S NEEDS 88 (2000). *See also* COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, NATIONAL ACADEMY OF SCIENCES, FUNDING A REVOLUTION: GOVERNMENT SUPPORT FOR COMPUTING RESEARCH (1999).

[41] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, *supra* note 40, at 64.

information technologies are created within consortia. Two prominent consortia for the Internet are the World Wide Web Consortium and the Internet Engineering Task Force.[42]

The final institution we studied is the open source movement. The open source movement strives to keep the source code, or the human readable instructions for code, freely available to the public. By keeping this code freely available, the open source movement utilizes the cooperative efforts of its members to create and continually improve the code.[43] The open source movement has created products that rival or surpass those created by firms, such as the Apache web server and the Linux operating system.

This Article is organized as follows. Part II provides a background with factual content from our case studies. We chose technological case studies to better understand the development of code within these institutions. Our case studies explore the influence of social, economic, and political factors on the development of code. The case studies include the development of the first popular web browser, NCSA (National Center for Supercomputing Applications) Mosaic, within a university. The second case study concerns Netscape's incorporation of the cookies technology into their web browser. Cookies are a technology that allows web sites to gather information about their visitors. The third case study focuses on the development of the Platform for Internet Content Selection (PICS) by the World Wide Web Consortium. PICS is a standard for labeling web pages for the purpose of limiting access to inappropriate material by minors. The fourth case study focuses on Apache, which is developed by the open source movement. Apache is the most widely used web server. Throughout the Article, we rely on these case studies to provide support for our analysis.

Part III provides an overview of the different institutions engaged in creating code. Just as the development of law can occur in various forms of legislative bodies, code is created in various institutions. This overview discusses how these institutions differ in their role in society, their motivations, intended users, and their structural characteristics that affect, in turn, the

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[42] The use of consortia has minimized the role of Standards Developing Organizations (SDOs) such as the American National Standards Institute and the International Organization for Standardization. *See* Carl F. Cargill, *The Role of Consortia Standards in Federal Government Procurements in the Information Technology Sector: Towards a Re-Definition of a Voluntary Consensus Standards Organization*, *available at* http://www.sun.com/standards/HouseWhitePaper_ver2_Final.PDF (June 28, 2001).

[43] The concept of voluntary cooperative efforts producing code has been termed peer production. *See* Yochai Benkler, *The Battle Over the Institutional Ecosystem in the Digital Environment*, COMM. ACM, Feb. 2001, at 84; Eric von Hippel, *Open Source Shows the Way: Innovation by and for Users – No Manufacturer Required!*, SLOAN MGMT. REV., Summer 2001. *See infra* note 264 (providing further discussion on peer production).

development of code. The intent of this section is to serve as a foundation for later sections that refer to the structural features of these institutions.

Part IV considers influences on the development of code. Just as constituents, campaign contributions, special interests, and a legislator's personal values influence legislation, code is also influenced along similar lines. This section discusses how code is shaped in the development process by the institutions' members as well as by outside social, economic, political, and legal factors. We find that institutions differ markedly in their response to outside influences. For example, while some institutions are primarily influenced by their membership, others are primarily influenced by outside factors such as economic influences.

Part V focuses on management decisions that affect the process of the development of code. These decisions are akin to the decisions made during the legislative process for law. Decisions on the speed of development, what features to include, and how widely to disseminate code differ from institution to institution. As a result, even if institutions were given identical code projects, the legislative process would shape the development of code with markedly different values.

Part VI discusses the different attributes of code that emerge from societal institutions. These attributes have enormous consequences on the use of code as well as social and political reverberations. The goal of this section is to analyze the different tendencies of institutions in shaping code. The technical attributes include open standards, choice of intellectual property protection, open source, and the quality of code. We also consider less technical attributes such as marketing, user-friendliness, documentation, and technical support. The final attribute we discuss is how social values are embedded in code. These values affect societal concerns, such as security and privacy, and are of the greatest concern for policymakers. This analysis is useful to policymakers who have an interest in predicting the development of code when determining social policy.

In Part VII, we present recommendations for how society can encourage and shape the development of code to meet societal concerns, such as privacy, safety, or competition. Our recommendations include regulatory measures as well as fiscal measures the government can take. The regulatory measures include prohibitions on code, using standards or market-based incentives, modifying liability, requiring disclosure, and the modification of intellectual property rights. We also argue that government needs to develop a comprehensive regulatory strategy for code. Fiscal measures by the government can include funding of research and development, use of the government's procurement power and tax expenditures, transfer of the government's intellectual property to the private sector, and finally funding education and training. We end by discussing how public interest organizations can support the development of socially beneficial code. Some possible actions they can take to shape code include wielding political pressure, informing the public, participating in the development of code, and supporting the development of code.

II. The Case Studies: The Development of Code Within Institutions

A common refrain in politics is that there are two things that you just don't want to see being made: sausage and law. It is our hope that you find the development of code fascinating and important. This part presents four case studies on the development of code in different institutions. These case studies provide the factual material for the later analysis. The case studies were chosen based upon the institutions that were represented and also upon the interaction of code with public policy issues. We accept that the case studies are not representative of all code, and therefore, this limits our generalizations. It also leads us to provide additional examples to buttress our arguments during our later analysis.

The first case study begins with the origins of the World Wide Web (web) at a government-funded laboratory in Europe. This case study follows the development of the first web browser to the creation of NCSA Mosaic, which became the first popular web browser. Its creators would leave the University of Illinois to form Netscape.

The second case study focuses on Netscape's cookies technology. Cookies have significant privacy implications, because they allow a web site to maintain information about its visitors. We also examine the cookies standardization effort by a consortium, the Internet Engineering Task Force.

The third case study is on the Platform for Internet Content Selection (PICS) developed by the World Wide Web Consortium (W3C). PICS is a method for rating inappropriate content on the web. PICS was developed in response to government regulation on the transmission of indecent content to minors.

The final case study examines the open source web server Apache, which is now the most popular web server on the Internet. Apache's roots go back to the NCSA Mosaic web server developed at the University of Illinois. A community of volunteer developers improved the NCSA Mosaic web server into the Apache web server. Apache is now the exemplar of how the open source movement's code rivals commercially available code.

A. World Wide Web

This section focuses on the role of governmental institutions and universities in the development of code. The first section discusses the creation of the first web browser and libwww, which became the foundation of later web browsers and servers. The second section describes the development of the first mainstream web browser, NCSA Mosaic.

1. Libwww

The origins of the World Wide Web (WWW or web) occurred at the Conseil Europeen pour la Recherche Nucleaire (CERN). This is a laboratory for particle physics funded by twenty European countries.[44] Tim Berners-Lee conceived of the web in 1989 at CERN as a way of connecting information resources for the particle physics community.[45] He envisioned the web as a networked environment, which used hypertext links to connect disparate information sources. For example, the web at CERN allowed access to the telephone book, conference information, a remote library system, and help files through a uniform addressing system.[46]

Berners-Lee initially followed CERN's "buy, don't build" motto by asking firms selling hypertext programs to incorporate his web concept. These firms were not interested. They did not find the appeal of the web compelling, despite the ease of adding Internet access to their products.[47] So Berners-Lee began creating the software for the web on his own as an informal

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[44] Conseil Europeen pour la Recherche Nucleaire, *CERN in 2 minutes*, *available at* http://public.web.cern.ch/Public/whatiscern.html (last modified Jan. 24, 2000) (providing background on CERN),
[45] JAMES GILLIES & ROBERT CAILLIAU, HOW THE WEB WAS BORN 183 (2000).
[46] TIM BERNERS-LEE, WEAVING THE WEB: THE ORIGINAL DESIGN AND ULTIMATE DESTINY OF THE WORLD WIDE WEB BY ITS INVENTOR 20 (1999); JOSHUA QUITTNER & MICHELLE SLATALLA, SPEEDING THE NET: AN INSIDE STORY OF NETSCAPE AND HOW IT CHALLENGED MICROSOFT 36 (1998).
[47] BERNERS-LEE, *supra* note 46, at 26-28.

project within CERN.[48] Over the next few years, CERN would spend over twenty man-years on the development of the web.[49]

By 1991, Berners-Lee and Robert Cailliau developed a web browser and server for the Next operating system.[50] To increase the web's popularity, the web browser and server code was freely available to the public. Berners-Lee announced this on Internet newsgroups such as alt.hypertext. These actions broadened the audience from a small group of high-energy physicists to the broader academic community. In turn, the academic community would send reports on problems along with requests for enhancements to Berners-Lee.[51]

In the summer of 1991, Richard Stallman visited CERN and talked about the Free Software Foundation (FSF). The FSF was based around the development of free software with programmers largely volunteering their labor.[52] Berners-Lee did not have a staff inside CERN and recognized that this community of volunteers could help design web browsers for other popular computer operating systems such as Unix.[53] Berners-Lee began publicly touting the development of web browsers as good projects for university students. As a result, students from Helsinki University wrote Erwise, the first web browser for a Unix operating system.[54]

To further encourage the development of the web, Berners-Lee asked his CERN-provided programmer to develop the individual pieces or bricks of code, which other programmers could build upon. Berners-Lee required the code be written in C, a common language for portable code, even though it meant rewriting the code from his original web browser.[55] These pieces, named libwww, became the foundation of many web applications including web browsers and web servers. Their portability allowed these pieces to be used with different computer operating systems.[56]

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[48] *Id.* at 42.
[49] GILLIES & CAILLIAU, *supra* note 45, at 234.
[50] *Id.* at 202-203.
[51] BERNERS-LEE, *supra* note 46, at 46-47.
[52] GILLIES & CAILLIAU, *supra* note 45, at 208-09. *See infra* text accompanying note 265 (providing more background on the FSF).
[53] BERNERS-LEE, *supra* note 46, at 46.
[54] BERNERS-LEE, *supra* note 46, 55-56.
[55] Berners-Lee had originally written the browser in an uncommon programming language known as objective-C. BERNERS-LEE, *supra* note 46, at 48.
[56] GILLIES & CAILLIAU, *supra* note 45, at 209.

Libwww was available to the public as public domain software.[57] Berners-Lee tried to get libwww released under the FSF's GPL license.[58] However, there were rumors that large companies, such as IBM, would not use the web if there was any kind of licensing issue. This came on the heels of the Gopher Internet technology, which was widely abandoned when the University of Minnesota began requiring licenses for commercial use.[59] Berners-Lee decided to release the code into the public domain, thus placing no restrictions on its use. This strategy worked, and within a year there were multiple browsers for Unix systems, and browsers were appearing for Macintosh and Windows operating systems.[60]

Berners-Lee's motivation was to persuade the computing community to adopt the web. He believed the web would be extraordinarily valuable to society. He did not act for his own financial gain. In fact, at several junctures, Berners-Lee decided to remain the benevolent father of the web. He put his vision of the web ahead of personal financial gain.[61] Today, Berners-Lee is the head of the World Wide Web Consortium, which is dedicated to developing open standards to unlock the full potential of the web.

2. NCSA Mosaic

The next major step in the growth of the web occurred at the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign. In the early 1990s, NCSA was working on visual and collaborative software to allow scientists to share data for networks in an easily comprehensive 3-D form.[62] In the fall of 1992, Marc Andreessen worked for Ping Fu on visualization projects at NCSA. Ping Fu asked Andreessen to write a graphical interface for a browser. He replied, "What's a browser?" She then showed him an early hypermedia system with links. She asked him to develop a tool that would allow people to

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[57] *Id*. CERN officially allowed the libwww code to be used free of charge without any royalty or constraint. BERNERS-LEE, *supra* note 46, at 73-74; Tim Berners-Lee, *Public Domain CERN WWW Software*, *available at* http://www.webhistory.org/www.lists/www-talk.1993q2/0259.html (May 7, 1993) (summarizing the announcement by CERN).

[58] *Id*. *See infra* text accompanying notes 466-469 (providing more information on the GPL).

[59] Gopher, an early text based web precursor, was developed at the University of Minnesota. It did not achieve popularity because the university sought to license Gopher to commercial entities. It wasn't just the licensing fees that scared off firms. Developers knew they had to ask their lawyers to negotiate rights in any use of Gopher. This action was too costly for firms and their developers. BERNERS-LEE, *supra* note 46, at 72-73; GILLIES & CAILLIAU, *supra* note 45, at 289-90.

[60] GILLIES & CAILLIAU, *supra* note 45, at 202.

[61] BERNERS-LEE, *supra* note 46, at 17, 83-84.

[62] Paul Andrews, *Profit Without Honor*, SEATTLE TIMES, Oct. 5, 1997.

download software by just clicking on a button. Andreessen replied, "Isn't that hard code FTP?" She answered, "Marc [Andreessen], you can do something more intelligent than that!"[63]

Later on November 10, 1992, Andreessen watched a demonstration of the web by NCSA staff member Dave Thompson. Thompson thought the web might be an innovative solution for the online collaboration project.[64] Andreessen was inspired by this demonstration and begin investigating the web through the www-talk newsgroup hosted by CERN.

A few days later, the first public release of Midas, an early web browser, was announced on www-talk. Andreessen was one of the first to download it. He then emailed Tony Johnson the author of Midas. He began by explaining who he was and what NCSA was. He then suggested possible improvements such as WYSIWYG hypertext editing, inclusion of graphics and animations, and scientific data files.[65] He also proceeded to give Johnson a long list of problems with the code that he found.[66] A few hours later, Andreessen emailed Johnson asking him if he was planning to add other Internet services such as FTP and gopher. Over the next few days, Johnson received a number of emails from Andreessen about fixes and possible improvements. But in the end, Johnson did not want to collaborate with NCSA and he wrote Andreessen, "Well, I'm not sure I want to change everything, I'm happy with it the way it is."[67] Johnson's rationale was that he was "first and foremost a physicist", and not a computer programmer.[68]

Next, Andreessen introduced NCSA staff member Eric Bina to the web, and they began discussing the potential of the web. They recognized that the existing web browsers were limited and not easy to use. Their first project was to write a better web browser.[69] Bina's and

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[63] GILLIES & CAILLIAU, *supra* note 45, at 238. To download files over the Internet a common protocol that is used is FTP, which stands for File Transfer Protocol.

[64] *Id. See also* Alan Deutschman, *Imposter Boy*, GENTLEMAN'S Q., Jan. 1997 (arguing that the idea for NCSA Mosaic belongs to Dave Thompson) *available at* http://www.chrispy.net/marca/gqarticle.html.

[65] WYSIWYG stands for "What You See Is What You Get". A WYSIWYG application allows one to see on the display screen exactly what will appear when the document is printed. In contrast, older word processors were incapable of displaying different fonts and graphics on the display screen although they would be present in a printed copy. Random House Webster's College Dictionary, *WYSIWYG* 1512 (2000); Webopedia, *WYSIWYG, available at* http://webopedia.internet.com/TERM/W/WYSIWYG.html (last visited Jan. 27, 2002).

[66] GILLIES & CAILLIAU, *supra* note 45, at 238-39.

[67] *Id.* at 239.

[68] *Id.* at 225.

[69] *Id.* at 239.

Andreessen's manger, Joseph Hardin, understood the significance of the project and approved the project.[70]

Andreessen and Bina began developing a web browser based upon CERN's libwww code.[71] They also followed the web standards set by Berners-Lee. They started writing code in December 1992 and by January 1993 they came up with a workable beta version called NCSA Mosaic.[72] The name Mosaic was suppose to represent the idea that the web is a single picture made up of many parts, a mosaic, of Internet services such as HTTP, FTP, Gopher, News, and WAIS.[73]

The web browser project initially met with little excitement within NCSA. However, the Internet community began widely using the beta version of the web browser, as indicated by the number of downloads for the browser from NCSA's server.[74] The popularity of the web browser led to NCSA formally approving the project, and allowing the Windows and Macintosh programmers to work full time on the project.[75] In November 1993, NCSA Mosaic was available as version 1.0 for the Unix, Windows, and Macintosh operating systems.[76]

The design of NCSA Mosaic was basically the work of two people, Bina and Andreessen. But there were many people who contributed to the development. Andreessen enhanced the web browser based on comments he received through discussions in public forums. Andreessen was one of the top participants in www-talk during 1993 when we was developing and refining NCSA Mosaic.[77] According to Berners-Lee, what made NCSA Mosaic great was Andreessen made "it very easy to install, and he supported it by fixing bugs via email any time night or day.

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[70] NAUGHTON, *supra* note 36, at 242.
[71] JIM CLARK, NETSCAPE TIME: THE MAKING OF A BILLION –DOLLAR START UP THAT TOOK ON MICROSOFT 162 (1999); GILLIES & CAILLIAU, *supra* note 45, at 239.
[72] Department of Computer Science University of Illinois, *Illinois's Boys Make Noise: And They're Doing It With Mosaic*, COMPUTER SCI. ALUMNI NEWS, Winter 1994, *available at* http://www.cs.uiuc.edu/whatsnew/newsletter/winter94/mozilla.html [hereinafter CS ALUMNI NEWS].
[73] CS ALUMNI NEWS, *supra* note 72. HTTP is the Hypertext Transfer Protocol used for the web. FTP is the File Transfer Protocol used for files transfers. Gopher was an early text based web precursor. The news service is used most prominently for Usenet newsgroups. WAIS stood for Wide Area Information System and was an early method of search and retrieving documents. For more information on these see the World Wide Web Consortium's web pages on Internet protocols *at* http://www.w3.org/Protocols/.
[74] *Id.*
[75] *Id.*
[76] GILLIES & CAILLIAU, *supra* note 45, at 241.
[77] This is evident in the archives of the www-talk *available at* http://ksi.cpsc.ucalgary.ca/archives/WWW-TALK/. Marc Andreessen, *NCSA Mosaic for X 0.9 released*, WWW-TALK MAILING LIST, *available at* http://www.webhistory.org/www.lists/www-talk.1993q1/0227.html (Mar. 4, 1993) (announcing a new beta version of NCSA Mosaic by Andreessen).

You'd send him a bug [problem] report and then two hours later he'd mail you a fix."[78] According to Berners-Lee, Andreessen was cultivating good customer relations with his rapid fixing and new enhancements. This was in sharp contrast to other student efforts.[79] This customer support led to NCSA Mosaic becoming the most widely used web browser in 1993.[80]

There were three important design features in NCSA Mosaic.[81] The first was that NCSA Mosaic was designed to be accessible and easy to use. Andreessen has stated that "the Net was at least ten years behind the mainstream computer industry" when he was at the University of Illinois.[82] Andreessen goes on to provide as an example the situation he was hired to improve. The lack of point and click software for FTP meant that people had to type in addresses by hand and remember the directory location of the FTP archives. Andreessen designed NCSA Mosaic as an easy to use navigational tool for browsing the web and linking together video images, graphics, audio, and text. He strove to make the program intuitive for people who were use to running ordinary applications such as word processing.[83]

The second significant design feature was the lack of publishing features. The original web browser designed by Berners-Lee allowed people to write, edit, and publish web pages. Instead of a browser, it was a browser/editor.[84] In this browser/editor, it was as easy to compose pages, as it was to read pages.[85] According to Berners-Lee, "my vision was a system in which sharing what you knew or thought should be as easy as learning what someone else knew."[86] In fact, Berners-Lee was uncomfortable with NCSA Mosaic, because of its emphasis on presentation, and the absence of functionality to allow people to easily write pages.[87]

The third significant design decision was the inclusion of images in web pages. To accomplish this, Andreessen had to add the capability into the web browser's code and add a

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[78] GILLIES & CAILLIAU, *supra* note 45, at 240.
[79] BERNERS-LEE, *supra* note 46, at 68-69.
[80] *See* GILLIES & CAILLIAU, *supra* note 45, at 241 (estimating over a million copies were downloaded).
[81] Marc Andreessen and Eric Bina, *NCSA Mosaic: A Global Hypermedia System*, INTERNET RES.: ELECTRONIC NETWORKING APPLICATIONS & POL'Y, Spring 1994, at 7 (providing a technical overview of the NCSA Mosaic World-Wide Web browser by and how it can be used).
[82] NAUGHTON, *supra* note 36, at 241.
[83] QUITTNER & SLATALLA, *supra* note 46, at 47.
[84] GILLIES & CAILLIAU, *supra* note 45, at 242-43; BERNERS-LEE, *supra* note 46, at 29.
[85] *Id.* at 193-95.
[86] BERNERS-LEE, *supra* note 46, at 33. While NCSA Mosaic did not allow people to write and publish pages, early versions did have an annotation feature. The browser had a collaborate button on the menu bar which worked with the Collage software designed by NCSA. This allowed users to select a web page and add their own annotations, which could be seen either for personal use or for a defined group of collaborators. *See* GILLIES & CAILLIAU, *supra* note 45, at 240.

new tag to the HTML standard for writing web pages. Andreessen added this capability in his the first version and announced it on www-talk. This announcement of multimedia capabilities led to controversy. Deciding how to introduce multimedia and what the appropriate standards should be was still undergoing discussion in the web community. However, the popularity of NCSA Mosaic led to the new tag becoming a de facto addition to the HTML standard.[88] Berners-Lee did not like this approach because this could lead to others adding their own tags resulting in a fragmented HTML standard.[89]

In the beginning, the management structure for NCSA Mosaic was loose at best. According to Andreessen, the team consisted of a loose confederation of people with no real management. However, this changed as NCSA Mosaic's popularity grew.[90] In the beginning, programmers would work late at night and talk over pizza. Once NCSA officially took over there were formal meetings, sometimes with over forty people. The original cadre of programmers was no longer independent and had to follow new management guidelines. Moreover, these programmers did not respect the management's decision-making capability. The programmers did not think the management had the adequate ability or foresight to develop NCSA Mosaic.[91]

Besides the new layers of management, Andreessen and the other programmers were perturbed about the highly political academic environment.[92] This was highlighted when the New York Times featured NCSA Mosaic in an article in December 1993. While Andreessen and Bina were both interviewed, the New York Times used a photo of NCSA director Larry Smarr and the Project Coordinator Joseph Hardin, instead of a group photo of the programmers. This incensed the programming team. Chris Wilson recalls, "at that point I just wanted to get out of NCSA and find something new to do . . . Some of the management decisions there were getting harder to deal with. There were rebellions breaking out all over, evidenced by the fact that the

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[87] GILLIES & CAILLIAU, *supra* note 45, at 242.
[88] GLYN MOODY, REBEL CODE 185 (2001).
[89] *Id.*
[90] Interview by David K. Allison with Marc Andreessen, Founder and Former Chief Operating Officer, Netscape Communications in Mountain View, Cal. *available at* http://americanhistory.si.edu/csr/comphist/ma1.html (June 1995).
[91] NAUGHTON, *supra* note 36, at 248.
[92] Interview by David K. Allison with Marc Andreessen, *supra* note 90.

entire team left shortly after I did."[93] The source of the rebellion was the insistence by NCSA to give the institution credit for NCSA Mosaic instead of the original programming team.

The University of Illinois acted similarly as NCSA. The university did not encourage the original programmers of NCSA Mosaic to commercialize their program. Instead, the university chose to assert ownership over the NCSA Mosaic web browser. The university did initially continue to support further development of NCSA Mosaic for public use.[94] The license for the NCSA Mosaic source code limited its use to "academic institutions and United States government agencies for internal use."[95] The rights for commercial use of the source code of NCSA Mosaic were initially licensed to about a dozen companies.[96] By mid 1994, the university licensed all future commercial licensing rights for NCSA Mosaic to Spyglass.[97] However, by the end of 1996, the popularity of commercial Internet browsers led NCSA to abandon its development of the NCSA Mosaic browser.

B. Cookies

The cookies technology was developed at Netscape. We begin by discussing how and why Netscape developed cookies. Netscape's cookies technology led the Internet Engineering Task Force to develop a precise technical standard for cookies. This effort by a consortium is examined in the second section.

1. Netscape's Cookies

In December 1993, a bitter Andreessen graduated from the University of Illinois. By March, he was talking to Jim Clark about a potential new Internet company.[98] Andreessen next persuaded almost all the core developers of NCSA Mosaic to leave NCSA and to join him at Mosaic Communications Corp., which eventually become Netscape Communications.

The new company would make money by selling web servers. According to Jim Clark, the profit margin on web browsers was slim, but significant on 50,000 secure server applications. These secure web servers would be in demand by corporations seeking to make money over the

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93 Andrews, *supra* note 62.
94 CLARK, *supra* note 71, at 41.
95 MOODY, *supra* note 88, at 186.
96 CS ALUMNI NEWS, *supra* note 72; QUITTNER & SLATALLA, *supra* note 46, at 107.
97 MOODY, *supra* note 88, at 186.
98 CLARK, *supra* note 71, at 52.

Internet. This business decision led to an emphasis on security, commerce, and performance in both web servers and browsers.[99] This led Netscape to develop new technologies such as cookies, referrer URL, and Secure Sockets Layer.[100] These new technologies would be incorporated in the new Netscape Enterprise Server as well as in the new browser code name Mozilla.[101]

The cookies technology was the most innovative feature and one that would forever alter the web. According to Lessig, "before cookies, the Web was essentially private. After cookies, the Web becomes a space capable of extraordinary monitoring."[102] In early web browsers, the Internet was a stateless place.[103] A stateless web is analogous to a vending machine. It has little regard for who you were, what product you are asking for, or how many purchases you have made. It has no memory. The lack of statelessness on the web makes commerce difficult. For example, without a state mechanism, buying goods is analogous to using a vending machine. You could not buy more than one product at a time and there would be no automatic one-click automated shopping feature that remembers your personal information.

The statelessness problem concerned the Netscape Enterprise Server Division, which was working on a contract for a new shopping cart application for online stores. A shopping cart would allow a web site to keep track of multiple items that a user requested. The current methods for shopping carts involved storing state information in the web address or Uniform Resource Locator (URL). However, these methods did not work very well, so the server division was open to ideas. This led to the idea state that the state data needs to be stored somewhere else other than the URL.[104] Over the next few weeks, Lou Montulli and John Giannandrea refined

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[99] *Id.* at 109. One performance goal was that Netscape must load graphic images faster than NCSA's Mosaic. MOODY, *supra* note 88, at 186; CLARK, *supra* note 71, at 151. The redesigned worked and Netscape loaded images 10 times faster than NCSA Mosaic. CLARK, *supra* note 71, at 157.

[100] Netscape developed the Secure Sockets Layer (SSL) technology, which allows for encrypted communications between a browser and server. This technology enabled Netscape to differentiate its browser and its new Netscape Commerce Server from the competition. ROBERT H. REID, ARCHITECTS OF THE WEB: 1,000 DAYS THAT BUILT THE FUTURE OF BUSINESS 35 (1997).

[101] The name was a mixture of Mosaic and Godzilla. *See* CLARK, *supra* note 71, at 97.

[102] John Schwartz, *Giving the Web a Memory Cost Its Users Privacy*, N.Y. TIMES, Sep. 04, 2001, *available at* http://www.nytimes.com/2001/09/04/technology/04Cook.html.

[103] Berners-Lee actually envisioned the web as a stateless place where information would not be kept on the client. *See* Tim Berners-Lee, *HyperText Transfer Protocol Design Issues*, *at* http://www.w3.org/Protocols/DesignIssues.html (last visited Sep. 24, 2001).

[104] Interview with Lou Montulli, Co-Inventor of Cookies, in Bloomington, Ill. (Aug. 2, 1999).

their ideas into a solid working concept termed, Persistent Client State HTTP Cookies.[105] Programmers used the term cookies to refer to a small data object passed between cooperating programs. Similarly, Netscape would use cookies to pass information between a user's computer and the web site they were visiting. Nowadays, Lou Montulli is known as the "Father of the Web Cookie."[106] The first use of cookies was by Netscape to determine if visitors to Netscape's web site were repeat visitors or first time users.[107]

Another related innovation at Netscape was the development of the referrer information. This innovation provides a website with the previous URL visited by the person. This allows web sites to easily track a person's movement through their web sites. The combination of cookies and referrer information allows web sites to develop considerable information about the long-term habits of their visitors. This ability to monitor and remember a users' movement is a central concern of privacy advocates.

The development process at Netscape was focused heavily on speed. According to Andreessen, the Netscape team, "cranked out the first clients and servers in the first two months or so. We tried to just blow this out the door. . . If you took two years to get it out, the product would be far more technically advanced. But it's more important to get it out there fast so people begin using it and begin to integrate the technology as rapidly as possible."[108] This pace left cookies as a technological kludge put together overnight.[109] This kludge was a natural consequence of the relentless pace that Netscape was undergoing.

The rapid development cycle and the emphasis on commerce led to cookies being stealthily introduced in Netscape's first web browser in four ways. Netscape turned the feature

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[105] *Id. See* Netscape, *Persistent Client State HTTP Cookies*, *at* http://home.netscape.com/newsref/std/cookie_spec.html (last visited Sep. 19, 2001) (providing the original Netscape specification on cookies); Persistent Client State in a Hypertext Protocol Based Client-Server System, U.S. Patent No. 5,774,670 (issued June 30, 1998), SIMON ST. LAURENT, COOKIES (1998) (providing an excellent overview of cookies and how to use them).

[106] Chip Bayers, *The Promise of One to One (A Love Story)*, WIRED, May 1998, *available at* http://www.wired.com/wired/archive/6.05/one_to_one_pr.html.

[107] The default home page for Netscape's web browser is Netscape's web site. This meant every user would visit Netscape's web site at least once. *See* Alex S. Vieux, *The Once and Future Kings,* RED HERRING, Nov. 1, 1995, *available at* http://www.redherring.com/index.asp?layout=story&channel=70000007&doc_id=1590015959.

[108] Interview by David K. Allison with Marc Andreessen, *supra* note 90; The relentless pace in described in CLARK, *supra* note 71, at 148-49.

[109] Schwartz, *supra* note 102 (quoting cookies expert Simon St. Laurent characterization of cookies as, "it kind of works, but it's definitely concocted overnight").

on by default without notifying or asking the consent of users.[110] Secondly, there was no notification mechanism to alert people when cookies were being placed on their computer. Users did not know that information about them was being saved. Third, the cookies technology was not transparent. Examining a cookies file provides no information about what is stored in the cookie file. Fourth, there was no documentation available that explained what cookies were and their privacy implications.[111]

While Netscape incorporated cookies into its web browsers released in 1994. However, it was not until early 1996 that the public became aware of cookies. The Financial Times broke the story on February 12, 1996 with an article on cookies and privacy.[112] The article immediately drew attention to cookies and resulted in a great deal of uproar about the use of cookies. Over the next few years, cookies became one of the top Internet privacy issues.

2. The IETF's Standard for Cookies

The development of cookies by Netscape led the Internet Engineering Task Force (IETF) to develop a standard for state management on the Internet. The IETF, as the de facto Internet standards body, sought to ensure there was a complete technical specification on state management. When the IETF began its work in mid 1995, it was not clear that Netscape's cookies specification would become the basis for the IETF's standard.[113]

The first proposed standard was based on a technology different from cookies, which was also more sensitive to privacy.[114] However, the IETF eventually switched to the Netscape

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[110] Lynette I. Millett et al., *Cookies and Web Browser Design: Toward Realizing Informed Consent Online*, CHI 2001 Proceedings, at 46 (2000) (conducting an analysis of cookie management tools in web browsers).

[111] In fact, technically proficient users in 1995 called for Netscape to document the cookies feature. For example, Marc Hedlund listed the following problems with Netscape's implementation of cookies, "1. Why doesn't the word "cookie" appear in the Netscape Online Handbook?, 2. Why isn't the cookie specification URL given in any README or implementation notes file?, . . . [3] How are users supposed to know what information is being kept about them, or for how long?" Marc Hedlund, *State Wars, part XI (was: Revised Charter)*, HTTP-WG MAILING LIST, Nov. 1, 1995, *available at* http://www.ics.uci.edu/pub/ietf/http/hypermail/1995q4/0161.html.

[112] Tim Jackson, *This Bug in Your PC is a Smart Cookie*, FIN. TIMES, Feb. 12, 1996. The next day a similar story appeared in the United States. Lee Gomes, *Web 'Cookies" May Be Spying on You*, SAN JOSE MERCURY NEWS, Feb. 13, 1996.

[113] David M. Kristol, *HTTP Cookies: Standards, Privacy, and Politics*, ACM TRANSACTIONS INTERNET TECH., Nov. 2001, at 10.

[114] The original basis of the IETF's effort was Kristol's State-Info proposal. Kristol's proposal limited the state information to a browser session. In contrast, for Netscape's cookies there is no requirement that cookies be destroyed at the end of the browser session. Netscape's cookies can persist for many years. David Kristol, *Proposed HTTP State-Info Mechanism, at* http://portal.research.bell-labs.com/~dmk/session.txt (Aug. 25, 1995).

cookies model.[115] This was largely because the Netscape version was a ubiquitous working model that had become a de facto standard. The IETF's goal was to now develop a more precise standard for cookies than Netscape's one page draft standard. However, the standards process soon ran into problems. The IETF found that Netscape's implementation of cookies was fraught with privacy and security problems.[116]

The most serious problem was third party cookies. The intent of Netscape's cookies specification was to only allow cookies to be written and read by the web site a person was visiting. For example, if the New York Times placed a cookie on a computer, Amazon.com could not read or modify the New York Times cookie. This provided security and privacy by only allowing sites access to information they authored. However, Netscape's cookies specification allowed third party components of a web page to place their own cookies. This created a loophole by which third parties could read and write cookies. This security and privacy defect was the outgrowth of the rapid development and incorporation of the cookies technology. This loophole has led to a new breed of businesses, the online advertising management companies.[117]

Third party cookies can be used by online advertising companies to create detailed records on a person's web browsing habits. Many sites contract out their banner advertising to advertising management companies. These companies find advertisers for web sites and ensure that their banners appear on the web site. For example, DoubleClick sells advertising space on sites such as ESPN and the New York Times. DoubleClick is also responsible for placing the banner advertising on their client's web site. Through the loophole of third party cookies, DoubleClick uses its advertising banners on an ESPN web page to place a cookie when a person visits ESPN. DoubleClick can then read and write to that same cookie when the same person visits the New York Times web site.[118] This allows DoubleClick to aggregate the information about a person's web surfing from its client web sites. They can then create a detailed profile of a person's surfing habits. This has obvious and serious privacy implications.[119]

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[115] Kristol, *supra* note 113, at 10.
[116] *Id.* at 11.
[117] Schwartz, *supra* note 109.
[118] *Id.* at 30.
[119] Michael Gowan, *How It Works: Cookies*, PC WORLD, Feb. 22, 2000, *available at* http://www.pcworld.com/hereshow/article/0,aid,15352,00.asp.

The IETF's cookies standard is critical of third party cookies allowed by Netscape's cookies specification. The standard states that third party cookies must not be allowed. It does allow an exception if the program wants to give the user different options. However, the baseline default must be set to off.[120] It also requires that the user be able to disable cookies, determine when a stateful session is in progress, and be able to save cookies depending upon the cookies domain. This last one is especially significant, because it allows users to manage what sites can and can't place cookies.

In February 1997, the IETF published a specification, RFC 2109, for state management.[121] The work had taken almost two years largely because of privacy problems with third party cookies. Members of the Internet Engineering Steering Group (IESG), which monitors and administers the IETF's activities, felt that third party cookies were a security and privacy issue.[122] They insisted the standard address these issues. However, this standard quickly became inadequate because of compatibility problems in its implementation. This meant a revised standard was necessary.[123]

It took the IETF three years to develop the revised standard. This was again largely because of issues with third party cookies. After the initial standard, RFC 2109, the IETF found a new opposition force. The web advertising networks sought to ensure that consumers could receive third party cookies. However, members of the IETF maintained their support for disabling third party cookies by default. These privacy issues slowed the development of the standard.[124] The IESG insisted on developing strong guidelines for the use of cookies before a new cookies specification would be approved.[125] The final standard for cookies was published as RFC 2965 in October 2000.

The long delay in the IETF standard has marginalized the use of this standard, but not its importance. It is unlikely that web sites and web browsers will adopt the standard specified by the IETF anytime soon. Nevertheless, the standard does meet the IETF's goal of developing the

[120] D. Kristol & L. Montulli, *HTTP State Management Mechanism*, RFC 2965, Oct. 2000, *available at* ftp://ftp.isi.edu/in-notes/rfc2965.txt. A central premise of the standard is that informed consent should guide the design of systems using cookies.
[121] D. Kristol & L. Montulli, *HTTP State Management Mechanism*, RFC 2109, Feb. 1997, *available at* ftp://ftp.isi.edu/in-notes/rfc2109.txt.
[122] Kristol, *supra* note 113, at 11.
[123] *Id.* at 12.
[124] *Id.* at 12-13.
[125] Keith Moore & N. Freed, *Use of HTTP State Management*, RFC 2964, Oct. 2000, *available at* http://www.ietf.org/rfc/rfc2964.txt.

best technical standard, even if it will not be adopted in the near term.[126] Moreover, the process of developing the standard heightened public discussion on cookies.[127]

The public discussion on cookies was manifested in the media uproar over the privacy problems, which led to hearings by the Federal Trade Commission (FTC). The hearings only skimmed the surface of the privacy issues and related technical considerations. In fact, the lack of technical sophistication by the FTC allowed Netscape to pull the wool over their eyes. For example, Netscape stated they would follow the IETF's cookies standard and also stated they would not allow third party cookies.[128] Netscape never fully followed the IETF standard for cookies and instead their browser by default allowed third party cookies.[129] The latest version of web browsers by Netscape and Microsoft still accept third party cookies by default to satisfy the

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[126] Kristol, *supra* note 113, at 29.

[127] *Id.* at 22.

[128] In a June 1997 FTC Public Workshop On Consumer Information Privacy, Peter Harter the Global Policy Counsel for Netscape was questioned concerning third party cookies. Harter said:

Mr. Harter: Our position is we are not in favor of allowing third-party domains to pass through. Basically the user couldn't tell if I go to CNN or Outbounders and a cookie is being passed through from the promoter of the ad banner, advertising firms that handle putting up ad banners in multiple sites also want to collect data about who passes over their banners and aggregate that data and report it to advertising for Chrysler or whatever company sees the ad, it is their advertising agency or aggregator. And certainly if they can have a cookie that follows you around and enables you to see a cookie from "cnnnews.com" and a variety of other news sites and sees that you have seen all the different Chrysler ads at different sites during that period of time, they can create some user demographics and surfing behavior data about that particular user. And that's the concern. And that was probably the most controversial issue asked about cookies and this RFC at the Austin meeting.

Mr. Medine: To clarify, Netscape's position is those third parties should not be able to place a cookie?

Mr. Harter: Right.

FTC Privacy Workshop '97 Hearings Transcripts for Session 2, Panel 2, Part 3 *available at* http://consumer-info.org/FTCpriv97/FTCprivacyw.asp (last visited Sep. 10, 2001).

[129] Netscape Communications, *Consumer Privacy Comments Concerning the Netscape Communications Corporation--P954807*, *available at* http://www.ftc.gov/bcp/privacy/wkshp97/comments2/netscape.htm (Jun 6, 1997) (providing a history of the Netscape's browser cookie management technology). *See also* Millett, *supra* note 110. Kristol believes that the defaults were set to accept third party cookies, because the customers of the browser makers were not consumers using free web browsers, but web sites paying for the web server software. These customers wanted to use third party advertising, and the browser makers did not want to alienate their customers. Kristol, *supra* note 113, at 21.

advertising management companies.[130] Nevertheless, the government investigations pushed the browser makers to provide cookie management tools and improved documentation on cookies.[131]

C. Platform for Internet Content Selection

The history of the Platform for Internet Content Selection (PICS) begins with proposed legislation to regulate indecent speech on the Internet by Senator Exon in the summer of 1994.[132] By December 1994, the idea for a standard for labeling content on the Internet, was discussed in an advisory committee meeting of the newly formed World Wide Web Consortium (W3C).[133] IBM, a member of the W3C, was concerned about minors viewing indecent material on the web. This problem was a concern to IBM because it was trying to install computers in classrooms. IBM understood that "something has to be done or children won't be given access to the Web."[134] AT&T joined IBM in proposing this project for the W3C.[135] However, no action was taken in response to their concerns.

Senator Exon reintroduced his legislation in February 1995. This would eventually become the Communications Decency Act (CDA).[136] On June 14, 1995, the Senate approved an amendment (the CDA) to the United States Telecommunications Competition and Deregulation Act of 1995 that would make it unlawful to transmit indecent material over the Internet to

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[130] The advertising management companies have long proposed methods to continue allowing third party cookies to be allowed by default from "trusted cookies" to the use of privacy policies and P3P technology. *See* Daniel Jaye, *HTTP Trust Mechanism for State Management, available at* http://www.ietf.org/proceedings/98aug/I-D/draft-ietf-http-trust-state-mgt-02.txt (Sep. 4, 1998) (trusted cookies); Stefanie Olsen, *IE 6 beta pushes ad networks on privacy,* CNET NEWS.COM, June 15, 2001, *available at* http://news.cnet.com/news/0-1005-200-6285910.html (stating that Microsoft's Internet Explorer 6 will require advertising networks to use P3P compatible privacy policies in order to place third party cookies).

[131] In an early version of Netscape the user could not set cookies preferences. In June of 1996 the FTC held a Public Workshop on Consumer Privacy On the Global Information Infrastructure. At this hearing, Netscape announced that the next version of Netscape (version 3.0) would allow users an option to be alerted whenever a cookie is placed on their computer. At the 1997 FTC Workshop, Netscape announced that its latest browser (version 4.0) would provide the user with the following cookie choices: Accept all cookies; Accept only cookies that get sent back to the originating server; Disable all cookies; Warn me before accepting a cookie. *See* FTC Privacy Workshop '97 Hearings Transcripts for Session 2, Panel 2, Part 3, *available at* http://consumer-info.org/FTCpriv97/FTCprivacyw.asp (last visited Sep. 10, 2001). Recently, Microsoft touted its improvements to cookie management at a Senate hearing into privacy. *See* Senate Commerce Committee, *Need for Internet Privacy Legislation*, July 11, 2001.

[132] 140 CONG. REC. S. 9745 (1994) (including the amendment to S. 1882 by Senator Exon) *available at* http://www.eff.org/Censorship/Internet_censorship_bills/exon_s1822.amend.

[133] Testimony of Dr. Albert Vezza at the CDA Trial in Philadelphia (1996) *available at* http://www.ciec.org/transcripts/April_12_Vezza.html (last visited Sep. 20, 2001).

[134] BERNERS-LEE, *supra* note 46, at 112.

[135] Interview with James Miller, Designer for PICS, in Bloomington, Ill. (Aug. 13, 1999).

[136] Communications Decency Act of 1995, S. 314, 104th Cong. (1995).

minors. This proposed legislation was followed by the now infamous Time cover story on cyberporn.[137] This combination of media and political pressure threw the upstart Internet companies into action.

In June of 1995, the W3C began setting up a meeting to discuss technical solutions to limit content regulation of the Internet.[138] According to Berners-Lee, "a group of companies quickly came to the consortium asking to do something now, because they knew Congress had plans to draw legislation very soon that would be harmful to the Internet."[139] The members of the W3C realized that without an industry solution, the government would regulate the industry.[140]

Microsoft, Netscape, and Progressive Networks created the Information Highway Parental Empowerment Group (IHPEG) in July 1995 to develop standards for labeling content.[141] IHPEG was chosen over the W3C because the members of IHPEG didn't believe the W3C could act quickly enough.[142] Their press release stated that the companies were cooperating to develop a solution that would allow parents to easily "lock-out" access to inappropriate material.

In August 1995, the W3C held a members meeting with two goals in mind. The first was to create a viewpoint independent content labeling system. This would allow content to be labeled in many different ways. This labeling system went beyond movie ratings of content but was more general to encompass other classification schemes such as the Library of Congress cataloging scheme. The second goal was to allow individuals to selectively access or block certain content.

The August meeting was planned for two days. The first day would address political concerns and the second day would discuss possible technical solutions.[143] The resultant project would be the Platform for Internet Content Selection (PICS). According to Berners-Lee, "the

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[137] Philip Elmer-Dewitt, *On a Screen Near You: Cyberporn*, TIME, July 3, 1995, *available at* http://www.time.com/time/magazine/archive/1995/950703/950703.cover.html.
[138] Interview with James Miller, *supra* note 135.
[139] BERNERS-LEE, *supra* note 46, at 113.
[140] *Id.*
[141] Information Highway Parental Empowerment Group, *Leading Internet Software Companies Announce Plan to Enable Parents to "Lock out" Access to Materials Inappropriate to Children*, *available at* http://www.csse.monash.edu.au/~lloyd/tilde/InterNet/Law/1995.parental.html (June 15,1995) (noting the members of the IHPEG).
[142] Interview with James Miller, *supra* note 135.
[143] *Id.*

PICS technology was created specifically in order reduce the risk of government censorship in civilized countries. It was the result of members of the industrial community being concerned about the behaviour of government."[144]

Soon after, the W3C was able to persuade IHPEG to join the PICS efforts. Previously, Microsoft had argued that the W3C could not act quickly enough, and therefore, the IHPEG was necessary. Microsoft even attempted to persuade others such as IBM to join in their coalition, however IBM supported the W3C. IBM's position was that "IBM does not join organizations founded by Microsoft, it forms them with Microsoft."[145] Microsoft capitulated and in September 1995, it was announced that PICS would be the result of a merger of the current efforts by the W3C and IHPEG.[146]

A small group of researchers led by Paul Resnick of AT&T and James Miller of the W3C began work on PICS. They knew their work would be taken seriously because of the intense political pressure and the threat of regulation. These pressures allowed the PICS team to rapidly push a standard on content selection through the W3C.[147] The PICS team also knew that working within the W3C, a consortium of important Internet companies, gave them another advantage.[148] A solution by the W3C would place pressure on companies to adopt such a solution. As a result, it was likely that their efforts would become widely implemented.[149]

The PICS group separated into two teams consisting of four to five people with approximately ten other people reviewing the work and offering suggestions. The teams used a combination of email and telephone conferences in developing the PICS specifications.[150] Communications between these teams was private and has never been made public. Because of the political pressure and the upcoming court challenge to the CDA, the PICS technical committee set a deadline of Thanksgiving for a draft technical specification of PICS. This date

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[144] Tim Berners-Lee, *Philosophy of the Web - Filtering and Censorship*, *at* http://www.w3.org/DesignIssues/Filtering (last visited Sep. 19, 2001) (detailing Berners-Lee views on filtering and specifically PICS).
[145] Interview with James Miller, *supra* note 135.
[146] W3C, *Industry and Academia Join Forces to Develop Platform for Internet Content Selection (PICS)*, *available at* http://www.w3.org/PICS/950911_Announce/pics-pr.html (Sep. 11, 1995).
[147] Interview with Paul Resnick, Designer for PICS, in Bloomington, Ill. (Aug. 10, 1999).
[148] Interview with James Miller, *supra* note 135.
[149] Interview with Paul Resnick, *supra* note 147.
[150] Interview with James Miller, *supra* note 135.

was purely “a political decision” that was based on upcoming trial dates in December for the court challenge of the CDA.[151]

The final PICS specification limited access to indecent material through two methods.[152] First, web sites could self rate their content. They could attach labels that indicated if content contained nudity or violence. Second, the PICS specification supports the establishment of third party labeling bureaus to filter content. For example, the Simon Wiesenthal Center could operate a labeling bureau that filtered out neo-Nazi hate sites. This allows the filtering of web sites without relying on self-rating.

By November 1995, the PICS technical subcommittee released the PICS specifications for public review. This was followed by several presentations at leading conferences on the Internet and the World Wide Web. By February 1996, Microsystems put the first PICS ratings server on the Internet.[153] By March, a number of companies including Netscape and Microsoft had publicly committed to using PICS in their browsers.[154] And by December 1996, the W3C made PICS an official "recommendation", the highest recognition a standard can receive by the W3C.[155] This recommendation, as is the norm in the W3C, was not patented and could be used royalty-free.[156]

The final version of the CDA was signed into law on February 8, 1996.[157] Immediately, a lawsuit was filed seeking to overturn the CDA.[158] Albert Vezza, Chairman of the W3C, testified at the trial. His testimony concerned the use of PICS as a method for content selection.[159] The judges were very interested in Vezza's testimony, especially his conclusions that the web has developed almost entirely because the government stayed out of the way.[160] Judge Stewart Dalzell speculated that he could imagine a marketing advantage for implementing

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151 *Id.*
152 For all the PICS technical specifications, *see* http://www.w3c.org/PICS/.
153 W3C, *Microsoft Teams With Recreational Software Advisory Council To Pioneer Parental Control Over Internet Access*, *available at* http://www.w3.org/PICS/960228/Microsoft.html (Feb. 28, 1996).
154 W3C, *PICS Picks Up Steam*, *available at* http://www.w3.org/PICS/960314/steam.html (Mar. 14, 1996).
155 W3C, *W3C Issues PICS as a Recommendation*, *available at* http://www.w3.org/Press/PICS-REC-PR.html (Dec. 3, 1996).
156 World Wide Web Consortium, *W3C Software Notice and License, available at* http://www.w3.org/Consortium/Legal/copyright-software-19980720 (last modified Sep. 7, 2001).
157 47 U.S.C.A. §223(a)(1)(B)(ii) (Supp. 1997).
158 Janet Kornblum & Rose Aguilar, *Clinton signs telecom bill*, CNET NEWS.COM, Feb. 8, 1996, *available at* http://news.cnet.com/news/0,10000,0-1005-200-310586,00.html.
159 Vezza, *supra* note 133.
160 Citizens Internet Empowerment Coalition, *Trial Update No. 9*, *at* http://www.ciec.org/bulletins/bulletin_9.html (Apr. 13, 1996).

PICS standards. Providers would sell their services by saying, "come online with us and your kids won't see what is in Mr. Coppalino's book", referring to the book of evidence containing sexually explicit images found online. The testimony held up PICS as an example of how the industry was developing solutions for the problem of access to indecent content by minors. The plaintiffs presented PICS technology as a less restrictive alternative to the outright banning of indecent speech on the Internet. Even the free speech advocacy groups, such as the EFF, CDT, and ACLU, were either positive or neutral regarding PICS.[161] The testimony on PICS was influential and on June 26, 1997, the Supreme Court found the CDA unconstitutional. Specifically, the Court's decision noted that the CDA's burden on adult speech "is unacceptable if less restrictive alternatives would be at least as effective in achieving the Act's legitimate purposes."[162]

After the CDA was struck down, the tide turned against PICS. PICS went from a solution to the problem. People realized it could be more insidious and affect free speech much more than the CDA. On February 1997, the influential Wired ran a story titled, *Good Clean PICS: The Most Effective Censorship Technology the Net Has Ever Seen May Already Be Installed On Your Desktop.*"[163] During the summer, Lessig would pen a story titled, *The Tyranny in the Infrastructure: The CDA Was Bad - but PICS May Be Worse*.[164] Even the ACLU joined in and released a report on the dangers of content rating technologies such as PICS.[165]

These stories emerged because people acknowledged the flaws in PICS. For self-labeling to work, there needed to be a critical mass. Self-labeling would be ineffective if it only covered a small portion of the web. However, to gain this critical mass would require urging many web sites to label themselves, which many people felt was akin to censorship. For example, news agencies refused to label their content with PICS.[166] Similarly, search engines never limited their

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[161] Interview with Paul Resnick, *supra* note 147.
[162] Reno v. American Civil Liberties Union, 521 U.S. 844, 117 S.Ct. 2329, 138 L.Ed.2d 874 (1997).
[163] Simson Garfinkel, *Good Clean PICS*, HOTWIRED, May 1997, *available at* http://www.hotwired.com/packet/garfinkel/97/05/index2a.html (last visited May 19, 1999).
[164] Lawrence Lessig, *The Tyranny in the Infrastructure: The CDA Was Bad - but PICS May Be Worse,* WIRED, July 1997, *available at* http://www.wired.com/wired/5.07/cyber_rights.html.
[165] American Civil Liberties Union, *Fahrenheit 451.2: Is Cyberspace Burning? How Rating and Blocking Proposals May Torch Free Speech on the Internet*, *available at* http://www.aclu.org/issues/cyber/burning.html (last visited Sep. 13, 2001)
[166] Tim Clark & Courtney Macavinta, *RSAC Shelves News Rating*, CNET NEWS.COM, Sep. 10, 1997, *available at* http://news.com.com/2100-1001-203141.html.

results to only PICS-labeled sites.[167] In the end, most sites refused to rate their sites with PICS compliant labels.[168] While there are a number of web sites that are rated with PICS compliant labels, at best this covers merely 0.4% of the web.[169]

The use of PICS for third party ratings never became viable. A system of third party labeling bureaus never emerged because of the lack of economic incentives and the necessary software tools.[170] A system of third party bureaus was seen by Resnick as the most realistic scenario through which PICS would become useful.[171] However, the existing filtering software companies did not see any commercial scenario for operating public label bureaus. The existing filtering companies incorporated the PICS specifications into their own products, but never committed to running public labeling bureaus.[172] In tandem with the lack of a business model

[167] James Miller recalls that the Internet search engines could easily implement such filtering, however there was never any communication with people "at the right level" to put this into use. Miller stated, "Alta Vista had implemented part of it [PICS filtering] and given us some of the results." However, none of the search engines ever limited their results to PICS based pages. Miller surmises that this was because search engines did not know how to make money off such filtering nor would they make any friends with such filtering. Interview with James Miller, *supra* note 135.

[168] There are two services that allow people to generate PICS compliant labels, RSACi and SafeSurf. *See* http://www.classify.org/pics.htm. Today, PICS largely relies upon web users and web sites labeling their own pages for two reasons. First, there is no server software to operate third party labeling bureaus for PICS. Consequently, people must trust the label a web site provides. Second, server companies have not consistently provided support for PICS labels. PICS labels can either be placed in the HTML of a web page or they can be attached as an HTTP header. Today, most PICS labels are in the HTML of a web page because of the historical lack of server support for PICS. The advantage to server support, is that it is possible to quickly label multiple web pages and web sites. However, only a few companies ever sold server software that supported PICS labels. According to James Miller, "we tried very hard to get servers to do it, but nobody wanted to do it." Miller believes that firms didn't see a "commercial advantage" either in terms of potential sales or "good-will" marketing. Interview with James Miller, *supra* note 135. Currently, Microsoft's Internet Information Server provides good support for PICS. However, Apache requires the installation of a module that is not a default module. This requires compiling/loading the module, which is not a trivial operation. *See* Internet Content Rating Association, *Professional Website Labeling, available at* http://www.icra.org/faq/server (Apr. 19, 2002).

[169] There are about 120,000 web sites that have adopted PICS. However, the adoption of PICS is lagging behind the growth of the Internet. At last count there are over 30,775,624 web sites. *See* Wendy McAuliffe, *Home Office Web Site Adopts Adult Rating*, ZDNET, May 4, 2001, *available at* http://news.zdnet.co.uk/story/0,,s2086022,00.html (noting the lack of progress of PICS labels); Netcraft, *August 2001 - Web Server Survey*, *available at* http://www.netcraft.com/Survey/Reports/0108/ (counting the number of web servers on the Internet).

[170] The filtering software companies realized that PICS separated the filtering software from the labeling of content. With the free PICS enabled web browsers, the filtering software companies would not be able to sell their filtering software. Instead, they would have to shift their business model to providing only the labeling of content. The filtering companies weren't persuaded that people would pay for just the service of labeling. As a result, the filtering companies chose to continue selling software and never embraced the idea of operating third party labeling bureaus. *See* Michael Stutz, *PICS Walks Fine Line on Net Filtering*, WIRED NEWS, Dec. 15, 1997, *available at* http://www.wired.com/news/technology/0,1282,9176,00.html (noting Jonathan Weinberg's statement that there seems to be no business model for PICS despite the efforts of the W3C); Interview with Paul Resnick, *supra* note 147.

[171] Interview with Paul Resnick, *supra* note 147.

[172] There was an effort to persuade one or two large companies to run a public labeling bureau as basically a public service, like a utility. In fact any such organization could have received partial funding from the European Union

for public labeling bureaus was the lack of support from software vendors. The server software for creating label bureaus was only developed for a few servers. Most notably, Netscape and Microsoft did not have this feature. The W3C's web page indicates the only commercial server software was IBM's Internet Connection Server.[173] In sum, once the CDA was found unconstitutional by the Supreme Court, the development of software for PICS was essentially stopped. The consequent lack of support from commercial filtering firms, the W3C's members, and other children's groups led to the abandonment of PICS.

D. Apache

NCSA developed both a browser for viewing pages and server software for delivering web pages to people. The web server, HTTPd, was written by Rob McCool in 1993 and was based on the CERN server code. NCSA released the program and its source code for free.[174] Consequently, the NCSA server quickly became the most popular web server for the Internet. Many sites chose the free NCSA HTTPd server over Netscape's web servers that cost several thousand dollars.[175]

When HTTPd was first released, the programmers at NCSA quickly patched any problems they received. But by 1995, the original team of programmers had left NCSA, and HTTPd was not updated in a timely manner.[176] This led individuals to begin to "patch" problems that they discovered. This was possible because the source code was in the public domain, and therefore, freely available.[177] An example of a patch was the addition of password authentication

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for running such a service. However, the idea never caught on. Interview with James Miller, *supra* note 135. The European Union has awarded the Internet Content Rating Association (ICRA) a $650,000 grant. The ICRA now owns and operates the PICS compliant RSACi rating system. *See* Internet Content Rating Association, *Testimony to Children Online Protection Act Hearing II*, *available at* http://www.rsac.org/press/testimony.html (last visited Sep. 13, 2001).

[173] IBM has since dropped support for PICS in later versions of its web server, which are based on Apache.

[174] MOODY, *supra* note 88, at 125. The source code is a human readable set of instructions for the computer. Access to the source code allows programmers to modify code. In contrast, the executable code is the computer readable set of instructions for the computer. Programmers cannot readily understand and modify executable code.

[175] *Id.*

[176] *Id.* at 126; Andrew Leonard, *Apache's Free-Software Warriors*, SALON, Nov. 20, 1997, *at* http://www.salon.com/21st/feature/1997/11/cov_20feature.html.

[177] The NCSA's HTTPd server software was public domain through and including version 1.4. NCSA HTTPd Development Team, *Copyright for NCSA httpd, available at* http://hoohoo.ncsa.uiuc.edu/docs-1.4/Copyright.html (last modified June 13, 1995). The last version released by NCSA, version 1.5, was not released as public domain and was instead copyrighted by the University of Illinois. Board of Trustees of the University of Illinois, *Copyright*, *available at* http://hoohoo.ncsa.uiuc.edu/docs/COPYRIGHT.html (last modified Aug. 1, 1995). According to Rob McCool, the creator of the NCSA HTTPd server, it was Marc Andreessen's decision to release the server as public domain, because of the problems Gopher had with restricted licenses. *See* Rob McCool et al., *The Apache Story*,

by Brian Behlendorf for the Hotwired web site. Other patches improved the security and performance of HTTPd.[178]

Eventually, there were a number of patches for HTTPd circulating across the Internet. Most of the patches were posted to the mailing list www-talk. However, if someone wanted the benefit of these patches, they would have to download the latest version of HTTPd, and then manually apply all the latest patches.[179] This prompted users of HTTPd to consider updating NCSA's code. According to Østerlie, the individuals viewed themselves as disgruntled customers. They were simply filling the gap left by the departure of NCSA's original programmers to Netscape.[180]

Behlendorf then began to contact other programmers.[181] By February 1995, the group put together a mailing list called new-httpd and began circulating patches.[182] The project's goal was to fix the existing problems and to add enhancements to the server. An example of an enhancement was the inclusion of Secure Sockets Layer. The first set of patches were applied to NCSA's HTTPd 1.3. The resulting code became the first official release of Apache in April 1995.[183] The project was named Apache–after all–the joke name for the server was "A PatCHy server".

The management structure for Apache is inspired by the IETF and its motto, "rough consensus and running code."[184] The procedural rules allow anyone to contribute code as they see fit. There is a voting system to decide what code will be released as the official Apache version. Only the core developers are allowed to vote. New voting members are added when a frequent contributor to the project is nominated and unanimously approved by the existing voting members.[185]

LINUX MAG., June 1999, *available at* http://www.linux-mag.com/1999-06/apache_01.html. *See supra* text accompanying note 59 (providing further discussion on the licensing issues with Gopher).

[178] MOODY, *supra* note 88, at 126. *See* Robert S. Thau, *NCSA server performance patch,* WWW-TALK MAILING LIST, Feb. 27, 1995, *available at* http://impressive.net/archives/www-talk/9502271534.AA23935@volterra (providing an example of a patch to improve performance).

[179] Thomas Østerlie, *Evolutionary Systems of Innovation*, *available at* http://www.pvv.ntnu.no/~toaster/writings/thesis/book/book1.html (last visited Jan. 27, 2002).

[180] *Id*.

[181] Leonard, *supra* note 176. *See* Patricia Krueger & Anne Speedie, *Web Crawlers*, WIDE OPEN NEWS, Dec. 16, 1999, *at* http://www.wideopen.com/story/285.html (providing further background on the core contributors).

[182] MOODY, *supra* note 88, at 127.

[183] *Id.* at 128.

[184] *Id.*

[185] Roy T. Fielding, *Shared Leadership in the Apache Project*, COMM. ACM, Apr. 1999, at 42.

The core developers are located in the United States, Britain, Canada, Germany, and Italy and maintain contact through a public mailing list. The members are not teenage hackers, but consist of doctoral students, a Ph.D. in Computer Science, professional software developers, and a software business owner.[186] There are about fifteen core developers at any time through the project.[187] The core developers create approximately 80% of the new functionality for Apache.[188] However, over 400 individuals have contributed code, and over 3000 people have contributed problem reports.[189]

During May and June of 1995, little work was done on Apache. The reason was described by Cliff Skolnick as follows, "[y]ou can add honey to shit, but you just get sweet tasting shit. No matter what you add to shit, you end up with some form of shit."[190] Apache had stagnated as developers didn't see it as worthwhile to contribute their time and code. This would change after Robert Thau announced his "garage project" – new code named Shambhala, which consisted of a rewrite of the server code.[191] Within a few months, the Shambhala code became the basis of the Apache server.[192] The new Shambhala code reignited discussion and work on the Apache server.[193]

One important aspect of Shambhala was the separation of the functionality into a set of modules. The modules are mutually independent. People can work on individual modules and not affect ongoing work in other modules. This design feature supports a decentralized development process. This design change was extremely important, because it fostered the use of the open source distributed development model.[194]

One of the reasons for Apache's success was the failure of servers from Netscape and Microsoft to meet the demands of the marketplace, specifically Internet Service Providers (ISPs). ISPs widely embraced Apache, because it allowed them to offer web hosting for corporate web

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[186] Rob McCool, *supra* note 177.
[187] A. Mockus et al., *A Case Study of Open Source Software Development: The Apache Server*, PROCEEDINGS OF INTERNATIONAL COMPUTER SOFTWARE ENGINEERING 263, 265 (2000), *available at* http://www.bell-labs.com/user/audris/papers/apache.pdf.
[188] Fielding et al., *supra* note 187.
[189] *Id*.
[190] Østerlie, *supra* note 179.
[191] *Id;* Robert S. Thau, *My Garage Project*, NEW-HTTPD, June 12, 1995, *available at* http://www.geocrawler.com/archives/3/417/1995/6/100/2310209/ (posting of the original message).
[192] Robert S. Thau, *New Apache Server Beta Release*, WWW-TALK, Aug. 7, 1995, *available at* http://impressive.net/archives/www-talk/9508071738.AA28471@volterra.
[193] Østerlie, *supra* note 179.
[194] *Id. See infra* text accompanying notes 441-442 (providing further discussion on the role of modularity).

sites for less money than an in-house corporate web site would cost. Apache could host 10,000 web sites on a single web server. This functionality, virtual hosting, was included in Apache by the summer of 1995.[195] ISPs as well as other users also choose Apache because they could modify it for their own needs. They would simply have to modify the source code, which was freely available. With Netscape's and Microsoft's servers, a customer had to wait for them to add a new feature or fix a problem.[196] Consequently, Apache's market share steadily grew from late 1995, and today, it is the most popular web server on the Internet.

Apache's success did not go unnoticed. IBM decided to adopt the Apache web server. In 1998, IBM announced it would ship the Apache web server with the IBM Websphere product family for commercial, enterprise-level support.[197] IBM chose Apache over its own products, because Apache was the best server available.[198] IBM understood that there was little money to be made from servers. Instead, IBM would profit from service and support as well as from proprietary add-ons such as an online e-commerce system. In turn, IBM has contributed to the development of Apache.[199] The relationship between IBM and Apache is still ongoing with both parties enjoying the benefits of the relationship.

III. LEGISLATIVE BODIES: SOCIETAL INSTITUTIONS THAT DEVELOP CODE

The development of law occurs in legislative bodies with various forms such as a parliament, assembly, or congress. These bodies may differ in representation, institutional motivation, and the process by which they create law. Similarly, code is not created by just one legislative body, but through a number of different institutions. This part analyzes four important institutions for the development of code. For each institution, we briefly explain its role in society, its motivations, and its intended users. We also mention relevant structural features that affect the process of developing code, such as the availability of resources, membership requirements, and intellectual property rights. This part, in whole or in part, maybe common knowledge to many readers and is intended to serve as background material. An

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[195] *Id*.
[196] MOODY, *supra* note 88, at 129.
[197] *Id.* at 205.
[198] IBM had its own experts ensure that the Apache web server was sufficiently high quality. *See* MOODY, *supra* note 88, at 208.
[199] *See* McCool, *supra* note 177.

understanding of these basics is necessary for later sections that discuss how the various institutions differ in shaping code. This section begins by discussing universities, and then continues on to firms, consortia, and the open source movement.

A. Universities

The university is the home of many important and innovative ideas for society. It has played a fundamental role in the development of various computing technologies including the Internet.[200] This section begins by discussing the historic mission of the university in supporting basic research. We then discuss its institutional motivations and its intended users.[201] The final part analyzes how an important structural characteristic of a university, limited resources, affects the development of code.

Universities have historically been places of learning and knowledge building within society.[202] Their role is to expand the frontiers of knowledge. This is an activity that private firms will under invest in, which therefore leads to public support of basic research.[203] Universities contribute through the creation of knowledge, but also through the dissemination of knowledge by teaching future generations.[204] The resulting information benefits society by leading to more innovation and lowering the cost of development for new technologies.[205]

In the pursuit of knowledge, universities support a wide variety of research. They realize that innovation does not happen overnight, but is the result of the steady accumulation of knowledge across disciplines. This leads universities to support a variety of projects with little

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[200] *See* NATIONAL ACADEMY OF SCIENCES, *supra* note 40 (providing a background on the government's role in computer revolution). *See also* Brad A. Myers, *A Brief History of Human Computer Interaction Technology*, ACM INTERACTIONS, March 1998, 44 (acknowledging the role of university research in innovations in human computer interfaces).

[201] Our focus is on the university's institutional role in developing information technologies, and hence, our discussion is restricted to the parts of the university engaged in such work and does not include other departments and colleges in a university.

[202] Philip E. Agre, *Commodity and Community: Institutional Design for the Networked University*, PLAN. FOR HIGHER EDUC., Winter 2000, at 5 (noting two different visions of universities, one creating a pool of knowledge and the second creating human capital).

[203] *See* Ammon J. Salter & Ben R. Martin, *The Economic Benefits of Publicly Funded Basic Research: A Critical Review*, 30 RES. POL'Y 509, 511 (2001). The tradition justification for this is the correction of market failure. Private firms will under invest in basic research because they cannot solely capture the benefits of basic research. This calls for government funding for basic research. *See infra* Part VII.B.1.A.

[204] Richard Florida, *The Role of the University: Leveraging Talent, Not Technology*, ISSUES SCI. & TECH., Summer 1999 (arguing that the university's role is not only to produce technology but also to produce talent).

[205] Richard R. Nelson, *The Simple Economics of Basic Scientific Research*, 67 J. POL. ECON. 297 (1959).

emphasis on individual projects.[206] For example, NCSA and CERN would not have been significantly affected if either Berners-Lee or Andreessen had failed.[207] Many of the projects universities support do not have an immediate impact on society. Sometimes, the research can have an immediate and significant effect on society such as with NCSA Mosaic.[208]

The motivation for research within a university is to build a reputation in the scientific community.[209] Reputation is derived from being the first to discover or develop new findings.[210] The emphasis on reputation-building can lead to problems when teamwork is required. The individualized reward system in a university setting leads researchers to worry about receiving individual credit. This can lead to team members, who assisted in the development efforts feeling ignored. For example, Andreessen was critical of NCSA's management because it continually sought credit for the development of NCSA Mosaic.[211] Eventually, the entire NCSA Mosaic programming team left the University of Illinois with bitterness.[212]

The end user of the fruits of university research is the public for two reasons. First, the central mission of a university is to create and disseminate knowledge to the public. Therefore, researchers within the university are obligated to provide their results to the public.[213] Second,

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[206] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, *supra* note 40, at 88; Partha Dasgupta & Paul A. David, *Toward a New Economics of Science*, 23 RES. POL'Y 487, 506 (1994).

[207] Berners-Lee's project was an informal project inside CERN. Andreessen's work was supported by federal grants for supercomputing research. The connection between the funding for NCSA to support supercomputing and software that allows you to access the Internet is tenuous. In fact, there seems to be little connection between NCSA's mission for supporting supercomputing and the development of NCSA Mosaic. *See* STEPHEN SEGALLER, NERDS: A BRIEF HISTORY OF THE INTERNET 296 (1998) (noting the role of federal supercomputing grants for NCSA).

[208] Martyne M. Hallgren and Alan K McAdams, *The Economic Efficiency of Internet Public Goods*, *in* INTERNET ECONOMICS 455 (Lee W. McKnight & Joseph P. Bailey eds., 1997) (providing an example of university research, the GateD routing software, which contributed to the development of the Internet because it was available to the public for free).

[209] *See supra* text accompanying note 61 (noting that Berners-Lee was not motivated by economic concerns). Tenure decisions for faculty often explicitly consider peer recognition. *See also* Conrad J. Weiser, *The Value System of a University - Rethinking Scholarship*, *available at* http://www.adec.edu/clemson/papers/weiser.html (Mar. 7, 1996) (noting the role of peer recognition for researchers).

[210] Dasgupta & David, *supra* note 206, at 499 (noting that "unlike tennis tournaments science does not pay big rewards to runners-up").

[211] *See supra* text accompanying notes 92-93. According to Aleksander Totic, a programmer for the Macintosh version of NCSA Mosaic, the environment at NCSA was "unbearable" and "academic politics of the worst kind." *See* Andrews, *supra* note 62.

[212] *Id*. Similarly, Bruce Maggs of Akamai Technologies and a former university professor noted there was a much stronger sense of teamwork within Akamai than in university settings. His explanation was that at Akamai individuals were focused on creating a quality product and satisfying customers, rather than who would get the credit.

[213] ROGER E. NOLL, CHALLENGES TO RESEARCH UNIVERSITIES (1998) (noting that the rationale for public funding of universities is to support the dissemination of information widely).

researchers have a personal interest in placing their knowledge before the public. Recognition is often given to those who were the first to create some particular knowledge.[214] The importance of priority has led to divisive debates in the academic world.[215] To this end, researchers widely disseminate their work for all users. This norm is an important one, but it is also changing as a result of changes in the law concerning the intellectual property of universities.[216]

The structural feature of limited resources at a university affects the development of code. The lack of resources is a consequence of universities supporting a large number of researchers in many fields. These researchers naturally desire large research staffs and the latest equipment to further their research. As a result, there are never enough resources for all the ongoing research within a university. Consequently, universities can't depend upon a large technical support staff, and functions seen as extras, such as technical support and documentation, are not fully supported.[217] The lack of resources during the development process gives researchers the impetus to seek resources outside the university. This was evident in the development of the World Wide Web, when Berners-Lee began encouraging university students to develop web browsers.[218]

B. Firms

In our capitalist economic system, it is the private sector that develops the majority of code.[219] Firms such as IBM, Digital Equipment Corporation, and Microsoft have historically developed much of the code widely adopted in society. Our definition of firm goes beyond the strict legal definition of corporation and is meant to encompass other constituent entities such as

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[214] Dasgupta & David, *supra* note 206, at 500.
[215] Katie Hafner, *A Paternity Dispute Divides Net Pioneers*, N.Y. TIMES, Nov. 8, 2001 (reporting on a tussle in the academic community over who invented packet switching technology).
[216] *See infra* Part VI.B.1.
[217] *See infra* Part VI.E. The lack of resources is evident in many projects at universities. The limited resources at Cornell for the GateD software project led the university to create a consortium to raise the necessary funding to ensure the continuing development of GateD. Hallgren & McAdams*, supra* note 208. The limited resources at NCSA were evident during the development of NCSA Telnet in the late 1980s. A firm called InterCon went on to create a commercial version of NCSA Telnet and offer technical support. QUITTNER & SLATALLA, *supra* note 46, at 30.
[218] *See supra* text accompanying notes 52-54.
[219] See U.S. Information Agency, *An Outline of the American Economy*, *available at* http://usinfo.state.gov/usa/infousa/trade/ameconom/homepage.htm (1991) (noting the role of private ownership of firms in the production of goods and services).

corporate research laboratories.[220] In this section, we focus on the motivations for firms and their employees and the implications of this on the development of code. We also discuss how firms use intellectual property protection to ensure that only their customers are the end users of their code.

The motivation of a firm is straightforward. Firms are driven by profit.[221] In order to make profits, firms must provide goods and services that meet consumer demand.[222] Successful firms listen to their customers, provide them services they need and will need, and provide support when they run into trouble.[223] However, we should remember the "goal of industry remains the satisfaction of shareholders by making a profit, not the advancement of science."[224]

The motivation of a firm's employees is similar. A firm's employees labor for the benefit of the firm. Even during the fun and casual workplaces of the heady dot com era, firms still maintained a management structure.[225] Simply put, firms provide financial compensation to

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[220] Corporate research laboratories are considered firms, because of the recent trend that emphasizes applied research that contributes to the bottom line over basic research. *See* COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, *supra* note 40, at 72-73 (discussing how IBM, AT&T and Lucent Laboratories, and Xerox have redirected their research to meet business interests); Chris Sandlund, *Paradise Lost?*, BUSINESS2.0, Mar. 26, 2001 (writing about how NEC's corporate research laboratory is under pressure to focus on applied science and products that feed the bottom line); John Borland, *AT&T Labs Struggles to Turn Theory into Profits*, CNET NEWS.COM, Aug. 6, 2001, *available at* http://news.cnet.com/news/0-1004-201-6769215-0.html (noting how the former Bell Laboratories has been split into smaller laboratories with more pressure to economically contribute to their firms); ROBERT BUDERI, ENGINES OF TOMORROW HOW THE WORLD'S BEST COMPANIES ARE USING THEIR RESEARCH LABS TO WIN THE FUTURE (2000) (describing how corporate R&D budgets are rising but corporate research laboratories no longer engage in basic research but instead focus on applied research); 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) (blurring the distinction between public and private laboratories).

[221] *See* Nelson, *supra* note 205, at 299.

[222] In the information economy, firms can use seemingly irrational methods, such as giving code away, to create profits. This is because firms can use concepts such as lock-in, switching costs, network effects, and standards. *See* SHAPIRO & VARIAN, *supra* note 2 (providing an excellent primer on economic concepts relevant for commerce in the information economy).

[223] Firms will value some types of consumers over others. For example, a recent advertisement for WordPerfect in the ABA Journal (a lawyer's magazine) read, "This lawyer knows nothing about software design. So why is she designing our software?" This advertisement explicitly states that lawyer's opinions matter, but one wonders about the opinions of secretaries, teachers, students, and other less profitable users. Nevertheless, this example shows that firms must be responsive to their likely customers. WordPerfect Advertisement, ABA J., July 2001, at 11.

[224] CLAUDE GELES ET. AL., MANAGING SCIENCE: MANAGEMENT FOR R&D LABORATORIES 32 (2000).

[225] *See* Dan Gebler, *End of the Dot-Com Cultural Revolution?*, E-COMMERCE TIMES, Sep. 28, 2000, *available at* http://www.ecommercetimes.com/perl/story/4412.html (discussing whether the dot com style of management will stay or whether more traditional distinctions between work and home will be maintained); Eric Wahlgren, *Legacies of the Dot-Com Revolution*, BUS. WK., Mar. 20, 2001, *available at* http://www.businessweek.com/careers/content/mar2001/ca20010320_628.htm (discussing whether the new organizational structure and management style of the dot coms will stay); BILL LESSARD AND STEVE BALDWIN, NETSLAVES: TRUE TALES OF WORKING THE WEB (2000) (describing eleven types of "slaves" in the computer industry).

employees and require them to fulfill certain tasks and obligations. These tasks are for the well being of the firm and not necessarily the employee.

The end users for firms are their customers and not the general public. To ensure that only their customers use their code, firms use a variety of legal protections including intellectual property protection. Scholars have argued that without adequate protection for intellectual property rights, firms will lack the incentives to produce new technological products that require significant research and development costs. Without protection, other firms can "free ride" by copying or developing similar products. Intellectual property protection allows firms to protect, control, and license out their knowledge to other firms.[226]

C. Consortia

The production of code is not done entirely by firms or by the government to the exclusion of the other. Often these entities cooperatively conduct research and development on code. The principal rationale is that as knowledge becomes more important, entities have realized that collaboration can allow the creation, support, and promotion of new knowledge. This cooperation can take many forms, such as a short-term contract, joint venture, university-industry relationships, or a consortium.[227] In this section, we focus on the consortium form of cooperation, because of its significance in developing standards for code. A consortium consists of a number of participants engaged in cooperative research and development.[228] Their rationale is to develop research that is useful to all of them and would not otherwise be developed by a

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[226] Nancy Gallini & Suzanne Scotchmer, *Intellectual Property: When Is It the Best Incentive System?, in* INNOVATION POLICY AND THE ECONOMY, VOL 2, (Adam Jaffe et al. eds., 2002), *available at* http://socrates.berkeley.edu/~scotch/G_and_S.pdf (reviewing the economic literature on the use of intellectual property as an incentive); Roberto Mazzoleni & Richard R. Nelson, *Economic Theories about the Benefits and Costs of Patents,* 32 J. ECON. ISSUES 1031 (1998) (noting several economic theories for patents).

[227] *See* WILLIAM J. MURPHY, R&D COOPERATION AMONG MARKETPLACE COMPETITORS 5 (1991) (discussing various forms of cooperative research).

[228] Carl F. Cargill, *The Role of Consortia Standards in Federal Government Procurements in the Information Technology Sector: Towards a Re-Definition of a Voluntary Consensus Standards Organization*, June 28, 2001, *available at* http://www.sun.com/standards/HouseWhitePaper_ver2_Final.PDF (defining the elements of a "good" consortium). To overcome antitrust liability, while encouraging innovation and commercialization, the government enacted legislation providing a legal basis for consortia. National Cooperative Research and Production Act of 1993, 15 U.S.C. § 4301 (2001). *See also* John T. Scott, *Historical and Economic Perspectives of the National Cooperative Research Act, in* COOPERATIVE RESEARCH AND DEVELOPMENT: THE INDUSTRY—UNIVERSITY—GOVERNMENT RELATIONSHIP 65 (Albert N. Link & Gregory Tassey eds., 1989) (reviewing the history of the law); Richard Hawkins, *The Rise of Consortia in the Information and Communication Technology Industries: Emerging Implications for Policy*, 23 TELECOMM. P'CY 159, 164 (1999) (reviewing the structure and origins of consortia).

single entity.[229] The work might not be completed by one firm, because of the sheer cost or the need for a standard that competing firms can also adopt.[230] By cooperating in a consortium, the participants can collectively work towards a common solution.[231]

This section begins by discussing standards and the role of consortia as compared to Standard Developing Organizations.[232] We also discuss the motivations for using a consortium, a consortium's end users, as well as important structural features that affect the development process. This section ends with a discussion of two prominent Internet consortia, the Internet Engineering Task Force (IETF) and the World Wide Web Consortium (W3C).

Standards for code are considered to be a quantifiable metric used by a group of people for common interchange.[233] Standards can be considered as the specification, schematic, or blue print for the parts of code that must interoperate or interconnect with other code. For example, for two computers to communicate with each other through the Internet requires them to use a common standard for communication. Because standards are a quantifiable metric, this allows for multiple developers of code that is based upon a standard. For example, many firms are capable of developing products based on the standards for cookies and PICS.

Consortia are the primarily developers of voluntary consensus standards for information technologies. Unlike in other fields, there is little activity in developing information technology standards within Standard Developing Organizations (SDOs), such as the International Organization for Standardization (ISO).[234] The standardization efforts of consortia occupy a middle ground between the de facto standards set by firms and the de jure standards of SDOs.[235]

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[229] S*ee* Nelson *supra* note 205, at 303. An example of a successful consortium is Sematech. It is devoted to supporting the semiconductor industry in the United States. LARRY D. BROWNING & JUDY C. SHETLER, SEMATECH: SAVING THE U.S. SEMICONDUCTOR INDUSTRY (2000).

[230] If there are strong economic incentives for certain code, this work will be done outside the cooperative reaches of a consortium. *See* MURPHY, *supra* note 227, at 162 (noting eight motivations for firms to cooperate); DAN DIMANCESCU & JAMES BOTKIN, THE NEW ALLIANCE: AMERICA'S R&D CONSORTIA 58 (1986) (noting five reasons why firms and universities may form consortia). Lorrie Cranor pointed out that there are generally two reasons a consortium is used. First, all parties have their own technology and want to now come up with a common standard. Second, some parties have the technology and everyone wants to have a universal standard.

[231] Andrew Updegrove, *Standard Setting and Consortium Structures*, STANDARDVIEW, Dec. 1995, at 143, 144.

[232] *See* SCHMIDT & WERLE, *supra* note 33 (analyzing standard setting in Standard Developing Organizations).

[233] CARL F. CARGILL, INFORMATION TECHNOLOGY STANDARDIZATION: THEORY, PROCESS, AND ORGANIZATION 13 (1989) (defining standards). While there are other types of standards, such as safety standards, these are not relevant in our analysis of the development of code. These types of standards are discussed later in the regulatory section of this Article. *See infra* Part VII.A.2.

[234] Cargill, *supra* note 228*,* at 4.

[235] Updegrove, *supra* note 231, at 144. *See* Paul A. David & Mark Shurmer, *Formal Standards-Setting for Global Telecommunications and Information Services*, 20 TELECOMM. P'CY 789 (1996) (reviewing the nature and economic

Consortia also differ from SDOs in that standard setting is only one aspect of a consortium's activities.[236] Consortia can also foster the implementation and adoption of standards. For example, they may require members to sign contracts to ensure compliance with standards.

The motivations for using a consortium emerge from limitations in the SDO development process. SDOs are perceived as too bureaucratic and too slow for a number of reasons. First, SDOs strive to ensure that all voices are heard. Any party directly or materially affected is allowed to participate in the standardization process.[237] The groups involved "represent personal, professional, national, disciplinary, and industry goals."[238] The diversity of the participants' goals typically leads to a longer time to reach consensus on a standard.[239] In contrast, a consortium can self-select its members to ensure a group of like-minded participants.[240] The consortium's members understand why they are engaged in a specific standards activity and what the outcome should be. This allows for a quicker consensus, but as we note later, their process can ignore the interests of third parties.[241] Second, SDOs have strict rules to ensure that they are open and accountable organizations.[242] These rules often lengthen the development time for standards. For example, an SDO standard may require several formal reviews, which can each take a minimum of six months.[243] This leads to a longer standardization process. For example, it typically takes seven years for an international SDO to develop a

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significance of the activities of formal standardization bodies); CARGILL, *supra* note 233, at 125 (discussing the characteristics of some international SDOs).

[236] Hawkins, *supra note* 231. Other significant differences between SDOs and consortia include their funding source, standards development, intellectual property rights, national focus, standards promotion, compatibility testing, and issues of collusion. *See* Ken Krechmer, *Market Driven Standardization: Everyone Can Win*, STANDARDS ENGINEERING, July/August 2000, at 15, *available at* http://www.csrstds.com/fora.html (comparing consortia and SDOs); Amy Zuckerman, *The Fight for Lingua Franca*, BUSINESS2.0, Oct. 2000 (summarizing the differences between consortia and SDOs for code).

[237] CARGILL, *supra* note 233, at 168.

[238] *Id.* at 117. *See also* Timothy Schoechle, *The Emerging Role of Standards Bodies in the Formation of Public Policy*, IEEE STANDARDS BEARER, April 1995, at 10 (arguing that SDOs can serve as a "public sphere" that ensures the consideration of broader social issues in the development of code, because of their openness and involvement of all stakeholders).

[239] Roy Rada, *Consensus Versus Speed, in* INFORMATION TECHNOLOGY STANDARDS AND STANDARDIZATION: A GLOBAL PERSPECTIVE 21 (Kai Jakobs ed., 2000).

[240] Cargill, *supra note* 228*,* at 4.

[241] Andrew Updegrove, *Consortia and the Role of Government in Standard Setting*, *in* STANDARDS POLICY FOR INFORMATION INFRASTRUCTURE 321, 332 (Brian Kahin & Janet Abbate eds., 1995).

[242] Cargill points out that traditional standards organizations are so rule-bound today precisely because of the antitrust concerns that arose in the 1960s and '70s. According to Cargill, "Congress was concerned about 102 companies working quietly behind professional associations and twisting standards . . . By publishing rules, they could ensure they weren't working behind closed doors. But in an effort to address those concerns, they've become so rule-bound as to be too slow to address market needs." Zuckerman, *supra* note 236.

[243] Cargill, *supra note* 228*,*at 19.

standard.[244] A consortium can develop standards more quickly, because it is not subject to the same procedural rules as SDOs.[245]

The end users of a consortium can vary. A consortium can choose to restrict its standards to its members or make the standard available to the public. Even in making standards available to the public, a consortium may charge a high price. Two important consortia for the Internet, the W3C and IETF, both make their standards freely available to the public.[246]

The structural features of a consortium affect the development of code. Typical areas of structural differences include decisions about membership requirements, procedural mechanisms, intellectual property rights, and the openness of the development process. Throughout this Article, we show how these differences shape the development of code. But first we discuss some structural differences in two prominent Internet consortia, the IETF and the W3C.[247]

The IETF's origins date from the early days of the Arpanet, the precursor to the Internet. The IETF develops many of the standards that underlie the Internet. The IETF is considered a gray standard body, because its standards are initiated and driven by implementers.[248] The IETF's structure is built around members who are individuals. Anyone may join the IETF, and there are no membership fees or dues. It conducts its business publicly with an emphasis on using online discussion lists. The IETF's meeting notes, mailing lists, and standards are available for free on the Internet.[249] Finally, the IETF requires "reasonable and nondiscriminatory licensing" of any intellectual property covering a standard.[250]

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[244] Paul A. David & Mark Shurmer, *Formal Standard-Setting for Global Telecommunications and Information Services*, 20 TELECOMM. P'CY 789, 793-95 (1996) (reporting the average time to develop a standard for a national SDO is two and a half years, to four to five years for a regional SDO, and over seven years for an international SDO).

[245] Cargill, *supra note* 228*,*at 5.

[246] *See infra* Part VI.A. (discussing this issue further in the section on open standards).

[247] Some commentators treat these consortia alike. *See The Consensus Machine*, ECONOMIST, June 8, 2000, *available at* http://www.economist.com/PrinterFriendly.cfm?Story_ID=335281 (describing the W3C and IETF as very similar organizations); Joseph Reagle, *Why the Internet Is Good: Community Governance That Works Well*, BERKMAN CENTER WORKING DRAFT, Mar. 26, 1999, *available at* http://cyberlaw.Harvard.edu/people/reagle/regulation-19990326.html (treating the W3C and IETF as very similar).

[248] Tineke M. Egyedi, *Institutional Dilemma in ICT Standardization: Coordinating the Diffusion of Technology, in* INFORMATION TECHNOLOGY STANDARDS AND STANDARDIZATION: A GLOBAL PERSPECTIVE 55 (Kai Jakobs ed., 2000). The IETF requires standards to have two working implementations. The IETF's emphasis on running code leads to solutions that are pragmatic "lowest common denominator" standard in comparison to a hypothetical and more complex approach a more formal standard organization may support.

[249] Kenneth Neil Cukier, *How Internet Standards Emerge*, RED HERRING, Jan. 2000, *available at* http://www.redherring.com/mag/issue74/mag-internet-74.html.

[250] Scott Bradner, *The Internet Standards Process -- Revision 3*, RFC 2026, *available at* http://www.ietf.org/rfc/rfc2026.txt (Oct. 1996).

The W3C began as a place for the producers of web related software to develop standards.[251] The W3C's members are largely private firms.[252] Annual membership costs are between five thousand to fifty thousand dollars. These funds support a paid technical staff that aids in the development of standards. Members are allowed to guide the strategic direction of the W3C as well as participate in the working groups that develop the standards.[253] While the final standards are public, typically only members participate in the development of standards.[254] The W3C's structure permits the rapid development of standards, sometimes as quickly as seven months.[255] Finally, the W3C has historically adopted a policy of royalty free licensing of any intellectual property covering a standard.[256]

An important feature of the W3C is its commitment to address societal issues. The W3C is developing technologies that affect social values with its Technology and Society Domain.[257] For example, the W3C has focused on issues of security, content filtering and labeling, security, electronic commerce, accessibility, and privacy.[258] Naturally, the issues chosen by the W3C are those that are in the interest of its members to address. Nevertheless, the consortium structure supports joint cooperation in addressing these societal problems.

D. Open Source Movement

The open source movement is an institution that stands apart from universities, firms, and consortia. Its list of successful projects, besides Apache, includes the Linux operating system,

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[251] Rohit Khare, *Evolution of the World Wide Web Consortium*, *available at* http://www1.ics.uci.edu/~rohit/w3c-evol (Apr. 10, 1998).

[252] The criteria for membership are available at http://www.w3.org/Consortium/Prospectus/Joining. A list of current members is available at http://www.w3.org/Consortium/Member/List. *See also* Simon St. Laurent, *An Outsider's Guide to the W3C*, *available at* http://www.simonstl.com/articles/civilw3c.htm (last modified Mar. 14, 2000) (contains frequently asked questions about the W3C).

[253] Besides standards, the W3C develops some sample code. However, this code is largely for testing and not for use by end users. This is largely because any code developed by the W3C could result in less revenue for the W3C members who sell code. Khare, *supra* note 251.

[254] The W3C allows working groups to decide whether the development of standards will be conducted publicly. W3C, Consortium Process Document, § 4.2.2, *available at* http://www.w3.org/Consortium/Process-20010719/ (last modified July 19, 2001).

[255] *Id.* *See also* Roy Rada et al., *Consensus and the Web*, COMM. ACM, July 1998, 17 (noting the rapid development of standards by the W3C).

[256] This may change, the W3C is in the process of revising their patent policy. *See* W3C, *Patent Policy Framework*, *available at* http://www.w3.org/TR/2001/WD-patent-policy-20010816/ (last modified Aug. 16, 2001). *See also* George A. Chidi & Tom Sullivan, *Royalty Woes Plague W3C Patent Policy Proposal*, INFOWORLD, Oct. 5, 2001, *available at* http://www.infoworld.com/articles/hn/xml/01/10/08/011008hnw3consort.xml (discussing the W3C's patent policy).

[257] W3C's Technology & Society Domain available at http://www.w3.org/TandS/.

the scripting language PERL, and the popular email server Sendmail.[259] The defining characteristic of the open source movement is that source code should be made available to the public.[260] The source code is the instructions for software that can be read and modified by programmers.[261] By keeping the source code publicly available, developers can build upon others' earlier work to create more complex and higher quality code.[262] In contrast, this reuse of code is not allowed with proprietary software; instead future developers must recreate the code.[263] The public nature of open source code leads to a cooperative development process. Hence, not surprisingly, many of the same issues associated with consortia are seen in the open source movement.[264] Nevertheless, the open source movement shapes code in its own particular way. This section discusses the two branches of the open source movement, the motivations of the developers, and the end users of open source software.

There are two branches of the open source movement. The first and oldest is the Free Speech Foundation (FSF). They maintain that source code should be free, not only as in free beer, but as in free speech. This freedom should allow a user to "run, copy, distribute, study, change, and improve the software."[265] They believe that there is a moral, social, and civic value

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[258] Khare, *supra* note 251 (describing the evolution of the Technology & Society Domain).
[259] Open Source Timeline, FEED MAG. (last visited Oct. 18, 2001) *in* http://www.feedmag.com/oss/ostimeline.html.
[260] OPEN SOURCES: VOICES FROM THE OPEN SOURCE REVOLUTION (Chris DiBona, et al. eds., 1999), *available at* http://www.oreilly.com/catalog/opensources/book/toc.html (providing a good background on the open source movement); JOSEPH FELLER & BRIAN FITZGERALD, UNDERSTANDING OPEN SOURCE DEVELOPMENT (2002). *See also* Joseph Feller & Brian Fitzgerald, *A Framework Analysis of the Open Source Software Development Paradigm*, *in* Proceedings of the 21st Annual International Conference on Information Systems (2001), *available at* http://afis.ucc.ie/jfeller/publications/ICIS2000.pdf (providing a basic background on the open source movement for academic research).
[261] *See supra* note 174 (defining source code). *See also* Cargill, *supra* note 228 (arguing that the open source movement's licenses define this institution).
[262] Eric Raymond, a leader of the open source community, says, "Good programmers know what to write. Great ones know what to rewrite (and reuse)." Eric Raymond, *The Cathedral and the Bazaar*, *available at* http://www.tuxedo.org/~esr/writings/cathedral-bazaar/cathedral-bazaar/ (last modified Aug. 24, 2000).
[263] Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255, 259 (1997).
[264] Scholars have argued that the ease of communication through modern technologies has led to a new form of production. They term this peer production and emphasized its decentralized nature. *See* Benkler, *supra* note 43 (arguing that open source peer production model is a radical shift from an atoms based economy to a bits based economy); von Hippel, *supra* note 43 (arguing that open source is a different form production compared to manufactured centered innovation). The open source movement is an exemplar of peer production with its reliance on email, discussion groups, and electronic distribution of open source code, to connect thousands of programmers from around the world. *See* Ed Frauenheim, *Crafting the free-software future,* SALON (Mar. 6, 2001) *at* http://www.salon.com/tech/feature/2001/03/06/sourceforge/print.html (describing SourceForge, a site which hosts thousands of open source programs supported by thousands of open source programmers). For example, the www-talk discussion group was vital in recruiting a team of volunteers to develop Apache. *See supra* text accompanying notes 190-191.
[265] Free Software Foundation, *The Free Software Definition available at* http://www.gnu.org/philosophy/free-sw.html (last modified Oct. 17, 2001).

to free code. Consequently, they protect their free code with copyright protection, to ensure it cannot be used for private profit. As a result, any code using free code, must be available for free. The second branch of the open source movement emerged later and more pragmatically for commercial reasons. This group favors the term open source instead of free software. The difference is that with open source code, it is permissible to make changes to the source code, copyright the changes, and then sell the code for commercial gain.[266] This allows firms, such as Apple and Microsoft, to incorporate open source software into the software they sell.[267] For this branch, the value of open source code is its openness, which allows for a technically superior development process. Thus, a principal difference between these two branches is whether open source code can be commingled with proprietary code.

The motivations of the open source movement are varied.[268] There are a small number of paid participants as well as private firms.[269] These entities, such as IBM, have a direct financial motivation in the development of open source code. For the vast majority of participants, who are unpaid, their motivations are fourfold.[270] First, they develop code that they themselves need. This occurs because there is no alternative in the marketplace or the alternative is costly.[271] Second, many developers find enjoyment in developing code as a creative endeavor.[272] Third,

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[266] Open Source Initiative, *The Open Source Definition*, *available at* http://www.opensource.org/docs/definition_plain.html (last visited Oct. 18, 2001) (defining open source); Open Source Initiative, *History of the OSI*, *available at* http://www.opensource.org/index.html (last visited Jan. 27, 2002).

[267] Apple's new commercial operating system, OS X, is built upon the open source operating system BSD Unix. Joe Wilcox, *Will OS X's Unix roots help Apple grow?,* CNET NEWS.COM, May 21, 2001, *available at* http://news.cnet.com/news/0-1006-200-5992099.html. Similarly, Microsoft's services and products such as Windows 2000 have components derived from the open source movement. Lee Gomes, *Microsoft Uses Open-Source Code*, WALL ST. J., June 18, 2001; Weston Cann, *Curing Steve Ballmer's Open-Source 'Cancer'*, OSOPINION.COM, June 6, 2001, *available at* http://www.osopinion.com/perl/story/10272.html.

[268] *See* FELLER & FITZGERALD, *supra* note 260, at 137-54 (discussing the various motivations for the open source movement).

[269] See Nikolai Bezroukov*, Are Key Open Source Developers Volunteer Developers?, available at* http://www.softpanorama.org/OSS/Bla_faq/are_oss_developers_volunteers.shtml (last visited Aug. 3, 2002) (explaining that "many important open source projects are developed with a mixture of volunteers and paid developers. The developers are paid by firms that have vested interest in the code.").

[270] Research into the motivations of open source programmers has so far overlooked previous research on volunteer motivation. *See* A. M. Omoto, et al., *The Psychology of Volunteerism: A Conceptual Analysis and a Program of Action Research*, *in* THE SOCIAL PSYCHOLOGY OF HIV INFECTION 333 (J. B. Pryor and G. D. Reeder, eds. 1993) (noting that five different motives that may explain volunteer behavior: values, personal development knowledge, personal development, esteem enhancement and community concern); MOTIVATING VOLUNTEERS (Larry F. Moore ed., 1985) (providing a comprehensive look at why volunteers volunteer).

[271] Raymond, *supra* note 262.

[272] Moglen questions the conventional economic perspective that people are only motivated by incentives. Instead, he argues that creativity, which is intrinsic and rewarding to people, leads people to contribute to the open source movement. Eben Moglen, *Anarchism Triumphant: Free Software and the Death of Copyright*, FIRST MONDAY, Aug. 2, 1999, at 4, *available at* http://www.firstmonday.dk/issues/issue4_8/moglen/index.html. *See also* Karim

they seek recognition from their peers by contributing to the development of innovative code.[273] Finally, there is a political motivation that sees open source as superior to proprietary software.[274] This is often manifested as an anti-Microsoft attitude. These differing motivations affect the choice of intellectual property protection for the source code.[275]

The end users of open source software are, by definition, the public. The basis of the open source movement is to provide the public with free access to the source code. The public can then use and modify open source code.

IV. CAMPAIGN CONTRIBUTIONS AND SPECIAL INTERESTS: INFLUENCES THAT SHAPE THE DEVELOPMENT OF CODE

Constituents, campaign contributions, political parties, special interests, and the legislator's personal values all influence the creation of legislation.[276] Similarly, the development of code is influenced by numerous factors. This section focuses on the influences that shape the development of code, whether they are internal influences from an institution's membership, or whether they are external political, economic, or social influences.[277] By understanding these influences, we can begin to predict the resulting institutional tendencies that serve to shape code. This section discusses these influences on each institution beginning with the university, and continues on to firms, consortia, and the open source movement.

Lakhani et al., *Hacker Survey*, *available at* http://www.osdn.com/bcg/bcg/bcghackersurvey.html (Jan. 31, 2002) (providing survey results that support Moglen's view).

[273] Josh Lerner & Jean Tirole, *The Simple Economics of Open Source*, J. INDUS. ECON. (forthcoming), *available at* http://www.nber.org/papers/w7600 (focusing on the role of reputation as part of an economic analysis on the motivations of the open source movement).

[274] Nikolai Bezroukov, *Open Source Software Development as a Special Type of Academic Research (Critique of Vulgar Raymondism)*, FIRST MONDAY, Oct. 1999, *at* http://www.firstmonday.dk/issues/issue4_10/bezroukov/.

[275] *See infra* Part VI.B.

[276] Citizens' Research Foundation, *New Realities, New Thinking: Report of the Task Force on Campaign Finance Reform*, *available at* http://www.usc.edu/dept/CRF/DATA/newrnewt.htm (noting the role of a legislator's principles, his or her constituency, and his or her political party, and campaign contributions).

[277] We treated the design, development, and implementation phases together, because our research found these phases intertwined. For example, consider the changes to NCSA Mosaic between the first beta release by Andreessen to a final 1.0 release. The implementation process involved considerable feedback from users, which in turned changed the original design of the software by fixing bugs and adding enhancements. *See generally* IAN SOMMERVILLE, SOFTWARE ENGINEERING 210-12 (1995) (describing the design of software as an iterative process based upon feedback from earlier designs).

A. Universities

The NCSA Mosaic case study identified a number of influences that shape the development of code in a university. These influences affected not only NCSA but also CERN. We treat CERN as a university style of institution, because CERN's structure and motive, as a government sponsored basic research laboratory, is akin to a university. The first notable influence on universities is the desire for peer recognition by the university's membership. The next influence is the autonomous research environment. The ivory tower of academia provides researchers with considerable discretion during the development of code. Finally, we discuss how economic pressures, such as the limited resources at universities and changing role of intellectual property in universities shape the development of code.

The first influence is the desire for peer recognition by the members of the university. This social influence stems from the motivations of researchers at universities.[278] For researchers, the criterion for excellence is peer recognition.[279] Researchers aspire to have their work cited by others or have their new tool or technique adopted by their peers. Consequently, this biases the development of code towards those matters that are regarded as important by a researcher's peers. This leads to a secondary regard for potential economic gain when developing code within a university.[280]

The influence of peer recognition was manifested during the development of NCSA Mosaic. The student developers for NCSA Mosaic sought to make "cool" programs. Andreessen thought it would be cool to add images to the web. He then designed the NCSA Mosaic browser to view images.[281] However, many within the Internet community, including Berners-Lee, disagreed with Andreessen's decision. Berners-Lee thought of the web as a tool for serious communication between scientific researchers. He didn't think the design of browsers should be about what looks cool.[282] This example shows the influence of peer recognition and also its lack of uniformity based on the peer group being addressed. In this case, Berners-Lee and Andreessen sought peer recognition from two different groups.

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[278] *See supra* text accompanying notes 209-210.
[279] *See* Mats Benner & Ulf Sandstrom, *Institutionalizing the Triple Helix: Research Funding and Norms in the Academic System*, 29 RES. POL'Y 291 (2000).
[280] *See supra* text accompanying note 61.
[281] *See supra* text accompanying notes 88-89.
[282] NAUGHTON, *supra* note 36, at 244-45.

This desire for peer recognition extends to the institutional level. This is unusual, because often influences at an individual level are often not the same at the institutional level. The consequence is that universities promote and support code to enhance their reputation. This can aid in the wider dissemination of innovative code. During the development of NCSA, once NCSA understood the significance of NCSA Mosaic, it devoted more resources to the development efforts.[283] The University of Illinois also began touting the accomplishments of NCSA Mosaic. It used the prestige of NCSA Mosaic to enhance its own status.[284] Thus, the desire for peer recognition affects both researchers and their institutions.

The second influence is the autonomy given to developers within the university research environment.[285] Stated alternatively, the ivory tower of academia allows the development of code that is insulated from external political, economic, and social influences.[286] Universities provide this autonomy because the freedom to pursue self directed research is necessary to develop innovative code and new knowledge, which is the central goal of research at universities. Exactly what autonomy and freedom means is explained in a study of Nobel Prize winners—

> not absolute freedom, and not endless time and boundless resources, but freedom above all to use one's own personality in pursuit of a scientific objective, freedom to pursue hunches down possibly pointless avenues of exploration and freedom to theorize, experiment, accept, or reject, according to the principal investigator's own judgment, with no interference.[287]

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[283] CS Alumni News, *supra* note 72. Similarly, recognition from the outside led the University of Minnesota to understand the significance of the Gopher program developed at the university.

[284] *See* University of Illinois, *Facts 2001*, *available at* http://www.admin.uiuc.edu/pubaff/facts96.html (last visited Sep. 2, 2001) (highlighting the role of Mosaic in a background statement about the university).

[285] Dasgupta & David, *supra* note 206, at 500 (noting the autonomy granted in academia); Nannerl O. Keohane, *The Mission of the Research University*, in THE RESEARCH UNIVERSITY IN A TIME OF DISCONTENT 153 (Jonathan R. Cole et al. eds., 1994) (noting the role of autonomy for faculty).

[286] Political and social influences can permeate the academic community through changing social norms or public funding for research. This is evident in the increased funding for some topics in biomedical research such as women's health issues, breast cancer, and AIDS. *See* Esther Kaplan, *The Attack of the Killer Causes*, POZ, May 2000, *available at* http://www.poz.com/archive/may2000/inside/attack.html. Consider the debate over federally funded research on stem cells. *See* President of the United States, *Remarks by the President on Stem Cell Research*, Aug. 9, 2001 *available at* http://www.whitehouse.gov/news/releases/2001/08/20010809-2.html (noting the political and moral nature of government funding decisions).

[287] JOHN HURLEY, ORGANISATION AND SCIENTIFIC DISCOVERY 4 (1997).

The case studies show that NCSA and CERN allowed their researchers considerable freedom. At CERN, researchers developed new software for everything from running the coke machine to conducting physics experiments.[288] Within this institutional environment, Berners-Lee was allowed to work on his radical proposal for the web, and he was free to pursue his project as he saw fit.[289]

Finally, economic influences can shape the development of code within a university in two ways. First, economic influences appear as a consequence of the scarcity of resources within universities. Universities do not have enough resources to fully fund every project to a researcher's satisfaction.[290] Nevertheless, there is pressure on researchers to develop new and innovative code. This leads to a focus on developing the standards and building blocks for future work. As a result, instead of developing a fully functioning complex program, a university researcher may concentrate on demonstrating that such a program would work by completing a few critical components.[291] Berners-Lee used this strategy during the development of the web. Berners-Lee lacked the resources to develop web browsers for all the major computing platforms. This led him to focus on developing standards and reusable building blocks of code. These standards included the language of the web, the Hypertext Markup Language (HTML), and the universal resource locator (URL).[292] These reusable blocks of code were known as libwww and became the basis for future web browsers and servers.[293]

The second economic influence is the result of legislation in the 1980s allowing universities to acquire intellectual property protection for the inventions of its researchers.[294] As result, universities can profit handsomely by licensing the rights to code to the private sector.[295]

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[288] BERNERS-LEE, *supra* note 46, at 43.

[289] Similarly, Andreessen initially developed NCSA Mosaic in an academic environment with considerable autonomy. It was only in the later versions of NCSA Mosaic and during the development at Netscape that Andreessen felt pressure to include or exclude certain features. QUITTNER & SLATALLA, *supra* note 46, at 22 (noting how NCSA had developed over many years into an unstructured work environment to support the development of innovative ideas and code).

[290] *See supra* text accompanying notes 217-218.

[291] *See supra* text accompanying notes 55-60. The program SCIRun by Chris Johnson of the University of Utah has the potential to serve as the basis for designing new medical devices. This led Johnson to seek a license that allowed academics to use the code without paying royalties. Jeffrey Benner, *Public Money, Private Code*, SALON, Jan. 4, 2002, *at* http://salon.com/tech/feature/2002/01/04/university_open_source/print.html.

[292] Gary Wolfe, *The (Second Phase of the) Revolution Has Begun*, WIRED, Oct. 1994, *available at* http://www.wired.com/wired/archive/2.10/mosaic_pr.html (noting the addressing system develop by Berners-Lee).

[293] *See supra* text accompanying notes 55-60.

[294] *See infra* text accompanying note 449 (discussing the Bayh Dole Act).

[295] Licensing NCSA Mosaic to the private sector earned the University of Illinois several million dollars. *See* Part VI.B.1.

This legislation does not appear to directly shape the development of code within universities. However, it plays a significant role in the transfer of code to the private sector.[296] In fields outside computing, the potential for an economic windfall has led universities to support certain research topics over others.[297] For example, universities are supporting research in profitable biotechnological pest control over less profitable but still effective methods of pest control.[298]

B. Firms

Firms produce goods and services for the market. An important consideration for firms is the anticipation of consumer needs. In short, economic concerns are the primary motivator of firms.[299] As a result, economic concerns shape the development of code by firms. This section first focuses on the economic influence of consumer demand. The next two points are consequences flowing from a firm's focus on consumer demand. We discuss how firms may miss innovative changes in technology and why firms do not develop unprofitable code despite its value to society. The final point is that strong political and social influences can shape the development of code by firms.

The major influence in shaping a firm's code is the anticipation of consumer demand. Firms strive to ensure code meets and creates consumer demand. If code does not generate revenue, it will be abandoned. Netscape was created to meet an anticipated demand for new browsers and servers to support Internet commerce. Netscape focused on selling its software to "large companies with deep pockets."[300] To accomplish this, Netscape developed and

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[296] *Id.* (analyzing how the Bayh Dole Act affects the attributes of code). *See also* Part VII.B.4 (discussing how to improve the transfer process).

[297] Eyal Press & Jennifer Washburn, *The Kept University*, ATLANTIC MONTHLY, March 2000, *available at* http://www.theatlantic.com/issues/2000/03/press.htm (noting how universities are acting like businesses in conducting research); DIMANCESCU & BOTKIN, *supra* note 230, at 46 (noting the shift in research towards "relevant" research instead of "exploratory" research); Peter W.B. Phillips, *The Role of Public-Sector Institutions*, *in* THE BIOTECHNOLOGY REVOLUTION IN GLOBAL AGRICULTURE: INVENTION, INNOVATION AND INVESTMENT IN THE CANOLA SECTOR 114 (Peter W.B. Phillips & G.G. Khachatourians eds., 2001) (discussing the shift away from basic research in agricultural research).

[298] Greg Kline, *Corporate Funded Research Negative at Universities*, NEWS-GAZETTE, Champaign, Ill., Feb. 03, 2001 (charging that university research is being influenced by potential profits and universities are ignoring other methods of reducing pests which have no long term profitability). *See also* Andrew Pollack, *The Green Revolution Yields to the Bottom Line,* N.Y. TIMES, May 15, 2001 (noting the decline of research into crop improvements for poor countries).

[299] Scholars have began to recognize the role of economic factors in innovation. *See* NATHAN ROSENBERG, INSIDE THE BLACK BOX: TECHNOLOGY AND ECONOMICS (1982); Martin Fransman, *Designing Dolly: Interactions Between Economics, Technology and Science and the Evolution of Hybrid Institutions*, 30 RES. POL'Y 263, 264 (2001) (noting the role of economic factors in pushing research on the cloning of the sheep Dolly).

[300] QUITTNER & SLATALLA, *supra* note 46, at 97.

incorporated technologies to support commerce, such as cookies and the Secure Sockets Layer.[301] These technologies were crucial to the early success of Netscape's web browsers and servers.[302]

The focus on consumer demand can lead to firms missing innovative changes in technology.[303] Firms do not invest in uncertain or unproven technology without a commensurate rate of return. This leads to underinvestment in basic research or radical new inventions.[304] This is illustrated in the development of the web. After Berners-Lee conceived of the web, he approached a number of firms that built hypertext products. He encouraged them to incorporate his web concept. But none of them were interested in his vision. They didn't think there was any money to be made there.[305] This is not unique to this case study. Firms often fail to realize the import of changes in technology. For example, during the development of the Internet, AT&T ridiculed the concept of "packet based" communications, which the Internet would later be based upon.[306]

The immense pressure to respond to economic influences, leads firms to ignore social influences that are viewed as unprofitable. Firms develop code to generate profits. Naturally, firms do not develop code to meet social concerns that are unprofitable, even if these values are important to society. In the case of cookies, Netscape did not spend its resources developing unprofitable code that would minimize the privacy concerns posed by the cookies technology. This explains why early versions of Netscape contained no cookie management tools or even documentation about cookies.[307] This neglect of unprofitable societal concerns by firms is

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[301] *See supra* text accompanying notes 99-101.
[302] David Legard, *Microsoft Wins Browser Battle,* PC WORLD, *available at* http://www.pcworld.com/news/article.asp?aid=13697 (Nov. 09, 1999) (noting Netscape's had over seventy percent of the browser market in the late 1990s).
[303] CLAYTON M. CHRISTENSEN, INNOVATOR'S DILEMMA: WHEN NEW TECHNOLOGIES CAUSE GREAT FIRMS TO FAIL (2000) (finding that firms that listen to the customers may miss innovative changes, because of the development of disruptive technologies).
[304] S*ee* Nelson *supra* note 205.
[305] *See supra* text accompanying notes 47-48.
[306] AT&T didn't see any reason for such a new communication method and actually refused to allow "their" network to carry such communication even though the U.S. Government would have funded the research. *See* KATIE HAFNER & MATTHEW LYON, WHERE THE WIZARDS STAY UP LATE: THE ORIGINS OF THE INTERNET 64 (1996). Another example is that of IBM's refusal in the late 1970s to embrace ARPANET. *See* Dan Gillmor, *IBM's Missed Opportunity with the Internet*, SAN JOSE MERCURY NEWS, Sep. 23, 1999. A final historical example is Western Union's telegraph business overlooking the potential importance of the telephone. *See* GERALD W. BROCK, THE TELECOMMUNICATIONS INDUSTRY 123 (1981).
[307] *See supra* text accompanying notes 110-111.

understandable.[308] However, there are steps society can take to ensure that firms address unprofitable, but socially desirable, concerns.[309]

The development of code can be shaped by strong political and social influences. Firms react to these influences, because if unheeded, these influences could result in higher costs. The costs could include customer acquisition and retention as well as potential regulatory costs.[310] This was evident in our cookies case study when the media uproar over online privacy problems led to hearings by the Federal Trade Commission (FTC). At the hearings, Netscape was forced to discuss how cookies work and how Netscape could improve privacy. As a result of these government hearings, the browser makers began incorporating basic cookie management tools and improving the documentation on cookies.[311] This example illustrates how the media and government can shape the development of code by drawing attention to the societal consequences of newly developed code.[312]

C. Consortia

The primary influence on the development of code within a consortium is its members. This is not surprising since consortia are structured to meet the demands of their members. The members typically choose to use a consortium, when there is no compelling reason for one entity to undertake the work. Our first point is that a consortium's members set the agenda. Second, the members' choice of the consortium's structure can have an enormous impact on shaping the development of code. Finally, we note that the development process within a consortium can overlook outside social influences or unrepresented third parties. This can occur even when the public is allowed to participate in the development process.

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[308] *See infra* Part VI.F.2.
[309] *See infra* Part VII.
[310] Firms will respond to political and media pressure to disable unprofitable code that affects societal values. *See* Polly Sprenger*, Intel on Privacy: 'Whoops!'*, WIRED NEWS, Jan. 25, 1999 *available at* http://www.wired.com/news/politics/0,1283,17513,00.html (Intel's decision to disable the serial number on its Pentium III processor for privacy concerns); Greg Lefevre, *Microsoft's GUID sparks fears of privacy invasion*, CNN, Mar. 8, 1999, *available at* http://www8.cnn.com/TECH/computing/9903/08/microsoft.privacy.02/.
[311] *See supra* note 131 and accompanying text.
[312] *See* Steven A. Hetcher, *The Emergence of Website Privacy Norms*, 7 MICH. TELECOMM. TECH. L. REV. 97 (2001) (arguing that the FTC was instrumental in pushing larger commercial sites into addressing privacy issues). We argue that this is an appropriate method of inducing change in code. *See infra* Part VII.C.1.

A consortium's members set the agenda.[313] It is the members who decide what projects to pursue and the appropriate level of resources. This was evident in the PICS case study. The W3C chose to work on PICS in response to their members' concerns.[314] Since PICS was seen as a technical solution to prevent government regulation of the Internet, they placed PICS on a rapid development cycle to ensure that it would be completed for the upcoming constitutional challenge to the CDA.[315]

The members' choice of a consortium's structure influences the development of code. The structural influences include the membership composition and membership rights, intellectual property rights, and the procedural rules that govern their work. For example, consider how the structural differences between the IETF and W3C shaped the development of code for labeling content on the web.[316] The W3C used a closed private process during the development of PICS.[317] This was because firms, such as Microsoft and IBM, agreed to work within the W3C only if PICS was developed rapidly.[318] The W3C relied upon a dozen people during the entire developmental process.[319] This structure allowed them to complete their work in a matter of a few months. In contrast, similar work by the IETF's Voluntary Access Control Working Group moved much more slowly. The IETF used a public approach that allowed anyone to participate. This group never made progress and was mired in discussion about the basic approach for the standard. So by the end of 1995, the W3C had a draft specification for PICS, while the IETF had not made any progress.[320] This led the IETF to abandon its efforts and

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[313] Cargill, *supra note* 228*,*at 5. Other consortia, such as the GateD project, state that membership in the consortium allows members to participate in developing features and goal setting. *The GateDaemon Consortium In Brief*, *available at* http://www.ifm.liu.se/~peter/doc/gated/node7.html (last visited Jan. 27, 2002) (noting that membership benefits the GateD consortium include participating in developing features and goal setting, although the code is available for free of charge); Hallgren & McAdams*, supra* note 208 (describing GateD project).
[314] According to James Miller, cochairmen of the PICS Technical Committee, PICS was motivated by desires to avoid regulation. Miller remarked that, "if we hadn't had the bill going through congress [the CDA] there is no way this group would have come together, in fact its evidenced by the fact we had been asked at our previous members meeting by both IBM and AT&T to look into this, nothing had happened." Interview with James Miller, *supra* note 135. *See also* text accompanying notes 132-140 (providing background on the history of PICS).
[315] Joshua Michael Marshall, *The Trouble with PICS*, FEED MAG., Sep. 1997, *available at* http://www.feedmag.com/html/feedline/97.09marshall/97.09marshall.html.
[316] *See supra* text accompanying notes 247-257.
[317] If the W3C used an entirely open process there would be no incentive to join the W3C. Thus in order to maintain the W3C, it is necessary to create incentives, such as private access to ongoing work and agenda setting to attract members.
[318] *See supra* text accompanying notes 145-146.
[319] *See supra* text accompanying note 150.
[320] According to the W3C, the IETF is only effective with coming up with ideas and criticizing ideas, while the W3C's structure is better at producing timely specifications for its members benefit. The W3C is more effective in

just rely on the W3C.[321] In this case, the W3C's structure favored a much more rapid development process than the IETF's public process.[322]

Consortia may ignore or overlook outside social influences or third parties during the development process.[323] This is important because consortia often appear to be working for the benefit of the public as a whole. Both the W3C and the IETF deem their mission as building a better Internet for society. But because consortia are accountable only to their members, they will inadequately consider the needs of third parties, such as independent software vendors and end users.[324] This can result in ineffective or technically poor solutions.[325] For instance, the PICS specification is of little use to firms selling filtering software to libraries and parents. This occurred because the needs of end users and the commercial filtering firms were not addressed in the PICS development process.[326] Since PICS, the W3C has established a more formal

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producing standards, because they employ personnel to develop and coordinate the design of new standards. In contrast, the IETF has no engineering budget. It must rely on its members to develop the standards and push them forward. *See* World Wide Web Consortium, *Process Document*, *Section 8.4, W3C and the Internet Engineering Task Force (IETF),* Nov. 11, 1999, *available at* http://www.w3.org/Consortium/Process/Process-19991111/appendix.html; World Wide Web Consortium, *Frequently Asked Questions*, *available at* http://sunhe.jinr.ru/docs/w3c/Consortium/Prospectus/FAQ.html (last visited Feb. 1, 2002).

[321] Roxana Bradescu, *Minutes of the Voluntary Access Control BOF (vac)*, *available at* ftp://ftp.ietf.cnri.reston.va.us/ietf-online-proceedings/95dec/area.and.wg.reports/app/vac/vac-minutes-95dec.txt (Dec. 1995).

[322] Another example is the development of HTML. The popularity of HTML led to over a hundred people actively involved with standards process in the IETF. At times the discussion would involve over two thousand messages in a few days. This approach alienated the browser firms such as Netscape and Microsoft. Instead, they preferred to work privately within the W3C. This allowed them to make quick decisions while also avoiding any public discussion of potential new features of their browsers. Thus the structure of the W3C, which supported private communication, was more amenable to producing a timely specification. DAVE RAGGETT ET AL., RAGGETT ON HTML 4 (1998) *available at* http://www.w3.org/People/Raggett/book4/ch02.html (providing a history of HTML and why the vendors moved to a private arena of the W3C).

[323] Peter Heywood et al., *Standards: The Inside Story Do Vendors Have Too Much Influence on the Way Industry Specs are Written and Ratified*, DATA COMM., Mar. 1, 1997.

[324] These third parties are still free to develop their own standards. In the case of XML, there have been a number of standards developed outside the W3C. The W3C may then later adopt them or incorporate them into its standards. Interview with Simon St. Laurent Interview, Author of XML: A Primer, in Bloomington, Ill. (Dec. 7, 2001).

[325] S*ee* Andrew Updegrove, *Standard Setting and Consortium Structures*, STANDARDVIEW, Dec. 1995, 145. This can also be seen in the work on XML. There are a number of people that have felt that the W3C’s approach to XML is far too complicated too vendor oriented. They are creating alternative lightweight solutions. *See* Roberta Holland, *XML Schema Catches Heat,* EWEEK, Apr. 23, 2001, *available at* http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2710691,00.html.

[326] *See supra* text accompanying notes 170-173. Similarly, the Platform for Privacy Preferences (P3P) project by the W3C, has been criticized for producing a solution that meets the needs of industry over consumers. *See infra* note 572. Another example is the neglect of the consumers’ needs in the development of the Secure Digital Music Initiative (SDMI), which is a consortium devoted to creating security standards for the digital transmission and storage of music. *See* John Gartner, *Digital Music Will Cost You*, WIRED NEWS, Dec. 8, 1999, *available at* http://www.wired.com/news/print/0,1294,32674,00.html.

standardization process that incorporates public comments.[327] This guarantees that standards are subject to public scrutiny, but does not address the problem of overlooking third parties in the development process.[328]

The problem of overlooking third parties even affects consortia that permit public participation. The IETF overlooked third parties during the development of the cookies standard. For example, there was inadequate consideration of browser makers, web site operators, and advertising management networks.[329] These potential stakeholders were affected by the cookies standard, but never participated in the development process.[330] Consequently, there were numerous problems with software compatibility and privacy issues, which ultimately delayed and marginalized the final standard.[331]

D. Open Source Movement

The open source movement's development process is primarily influenced by its membership of volunteer developers. In the first section, we discuss the limits of volunteerism in the open source movement. This affects the development process because the volunteer members are limited in their time, and they choose to work on tasks they find interesting. Our second point is that this biases code towards the needs of the volunteer members. Finally, we

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[327] The W3C process has evolved towards a more formal process. World Wide Web Consortium, *supra* note 254.

[328] Third parties can be overlooked even though public comment may be allowed, because they cannot participate in the development process. For example, during revisions of a standard, third parties may be unaware of the changes being made. However, the members of the consortium have access to the ongoing changes. This provides members with an advantage in understanding, shaping, and implementing new standards. For example, the W3C's X-Link standard took 15 months between drafts. In this time, the standard changed considerably. This delay most severely affected third parties who were not privy to the ongoing changes. *See* St. Laurent Interview, *supra* note 324; World Wide Web Consortium, *XML Linking Language, available at* http://www.w3.org/1999/07/WD-xlink-19990726 (July 26, 1999) (providing the dates between drafts).

[329] The author of the IETF cookies standard has stated that he would improve communication with these third parties if had this to do over. Kristol, *supra* note 113, at 19.

[330] There are valid reasons why these parties were not involved. They might not have been aware of the process or just thought it wasn't worthwhile to participate in the standards process.

[331] Another example of a consortium overlooking third parties is the IETF's almost unanimous rejection to developing standards with a built in ability to support wiretapping. The IETF's rejection reflects its memberships libertarian leanings. The IETF's behavior is stark contrast to other forms of telecommunications, which have a built in ability for government wiretapping. Declan McCullagh, *IETF Says 'No Way' to Net Taps*, WIRED, Nov. 11, 1999, *available at* http://www.wired.com/news/politics/0,1283,32455,00.html (noting the discussion within the IETF); IETF, *IETF Policy on Wiretapping*, RFC 2804, May 2000 *available at* http://www.faqs.org/rfcs/rfc2804.html (final position of the IETF); Carolyn Duffy Marsan, *Internet Community Debates Wiretapping*, NETWORK WORLD FUSION, Oct. 18, 1999, *available at* http://www.nwfusion.com/news/1999/1018wiretap.html (noting that other telecommunication devices such as central office telephone switches incorporate wiretapping capabilities).

argue that political and economic influences provide little influence on the development of code. At times, the open source movement even counters dominant political or economic concerns.

The limits of volunteerism by the open source movement's members serve to shape code. Volunteer members can only provide limited time and resources.[332] In contrast to a firm, there is no pressure to force volunteers to work on a particular project in a timely manner. Consequently, it is the volunteers who decide what code will be written and on what time schedule. The is well stated by Jordan Hubbard, a founder of the open source FreeBSD project:

> Developers are very expensive commodities (just ask any IT hiring manager) and getting their expensive time and effort for free means that it comes with certain stipulations. The developer has to have a personal interest in the features in question and they will implement those features according to the features in question, and they will implement those features according to the demands of their own schedule, not anyone else's.[333]

The limits of volunteerism also extend to the subject of the project. Volunteers wish to work on interesting tasks.[334] This problem is endemic in open source projects and is described accordingly:

> Those who can program naturally tend to work on programs they find personally interesting or programs that looks cool (editors, themes in Gnome), as opposed to applications considered dull. Without other incentives other than the joy of hacking and "vanity fair" a lot of worthwhile projects die because the initial author lost interest and nobody pick up the tag.[335]

This leads open source code to be biased towards the needs of its volunteer member developers. Code then addresses the needs and purposes of sophisticated developers and not ordinary users.[336] Open source projects are often those that developers think are interesting or

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[332] *See supra* text accompanying notes 270-274.
[333] Pair Networks, *An Interview with Jordan Hubbard*, WORKINGMAC, Aug. 16, 2001, *available at* http://www.workingmac.com/article/32.wm.
[334] This social influence also arises from the utilitarian concerns of its developers. That is "every good work of software starts by scratching a developer's personal itch." Raymond, *supra* note 262.
[335] Bezroukov, *supra* note 274.
[336] The creator of the open source Linux operating system acknowledges that the open source development process results in code for developers and not ordinary users. Linus Torvalds, *Interview with Linus Torvalds: What*

useful, such as a C complier or an mp3 player.[337] As a result, volunteer members may not necessarily work on code that is in greater demand or more socially beneficial.[338] For example, the development of the early web browsers, such as NCSA Mosaic and Erwise, relied on volunteer programmers all across the world.[339] According to Berners-Lee, these developers were more interested in "putting fancy display features into the browsers—multimedia, different colors and fonts—which took much less work and created much more buzz among users."[340] Berners-Lee wanted the developers to focus on a much more substantive issue—the addition of editing features to the browser. The concept of a browser/editor was important to Berners-Lee. He envisioned the web as a place where it should be as easy for people to publish information, as it is to read information. Berners-Lee believes that the reason people focused on browsing over writing and editing features was that it just wasn't fun to create an editor.[341] Thus, the limits of volunteerism led to a lack of browser/editors for the web, because there was a lack of interest in developing this type of code. Additionally, this bias is manifested in the usability of code. A typical compliant is that open source code is designed for use by sophisticated developers, and therefore, difficult for novice users to use the code.[342]

The influence of economic and political influences on open source code is minimal. An international team of volunteer members leads the open source movement. This diverse set of

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Motivates Free Software Developers?, FIRST MONDAY, Dec. 17, 1999, *available at* http://www.firstmonday.dk/issues/issue3_3/torvalds/.

[337] The development of code for developers by developers can be useful since it collapses the problematic distinction between users and developers. The developers don't have to envision an imaginary user, since they are the user. Paul Quintas, *Software by Design*, *in* COMMUNICATION BY DESIGN: THE POLITICS OF INFORMATION AND COMMUNICATION TECHNOLOGIES 93 (Robin Mansell & Roger Silverstone eds., 1996). Finally, we should note that there are design approaches that involve the user, such as participatory design. This approach originated in Scandinavia as a result of trade unions. They placed pressure on industry to ensure that technology was used to improve worker quality instead of displacing workers. The design process then includes both computer professionals as well as union workers. *See* DOUGLAS SCHULER & AKI NAMIOKA, PARTICIPATORY DESIGN: PRINCIPLES AND PRACTICES (1993) (leading textbook on participatory design); TERRY WINOGRAD, BRINGING DESIGN TO SOFTWARE (1996) (describing how to use participatory design to improve the development of software). This type of design process is actively promoted in the computer field by the Computer Professionals for Social Responsibility who hold a biennial conference devoted to participatory design. Computer Professionals for Social Responsibility, *Participatory Design*, *available at* http://www.cpsr.org/program/workplace/PD.html (visited July 17, 2001).

[338] The limitations of volunteerism are evident between the time of Apache's first official release and before Thau's announcement of Shambhala. During this time, work on Apache dramatically slowed. Østerlie argues that this occurred because the work before the group was of a menial kind. Everyone realized that the server needed to be rewritten, but nobody wanted to take on such as difficult and mundane task. *See* Østerlie, *supra* note 179.

[339] *See supra* text accompanying notes 52-54.

[340] BERNERS-LEE, *supra* note 46, at 71.

[341] *See supra* text accompanying notes 84-88.

[342] *See infra* text accompanying note 519.

developers is focused on developing what is interesting to them. This results in the development of code with features that contain little political or economic value. For example, Mozilla, an open source browser based on Netscape's web browser, contains features such as cookie management, and the ability to block images from third party web sites as well as pop-up advertising windows.[343] These features are part of an enhanced security and privacy package that was not present in Netscape's web browser. These features are present because the open source community felt they were important attributes that needed to be incorporated into the software.[344]

At times, the code developed by the open source movement can be defiant to conventional economic and political influences. For example, consider the development of the Gnutella file sharing program. Gnutella was developed by an AOL subsidiary Nullsoft, which also developed the popular Winamp digital music player.[345] Unlike Napster, which is based on a centralized server, Gnutella was based on a decentralized system. This design was intended to prevent users from being blocked accessed to the file sharing network. Nullsoft didn't intend to sell the program, but created it as a "labor of love".[346] While AOL quickly squashed Nullsoft's distribution of Gnutella, it was too late. The open source movement had begun to refine and distribute Gnutella.[347] The result was a cooperative effort to develop code whose chief purpose was music piracy. Another similar effort by the open source movement is the attempt to create an anonymous decentralized file sharing system. This system, Freenet, will make it impossible

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[343] *See Sneak Peak: Netscape 6 Preview Release 1*, CNET NEWS.COM, *available at* http://www.cnet.com/internet/0-3779-7-1581725.html (last visited Jan 27, 2002) (noting improved cookie management features in the latest version of Netscape's open source browser); *Banners, be gone*!, MOZILLA WEEK, *at* http://www.netartmagazine.com/mozweek/archives/00000026.html (Mar. 9, 2001) (describing how to block images from third parties with Mozilla); Stefanie Olsen, *Dodging Pop-Ups With Mozilla,* CNET NEWS.COM, Aug. 14, 2002, *available at* http://news.com.com/2100-1023-949572.html (discussing Mozilla's ability to block pop-up advertising).

[344] When the image-blocking feature was removed in an early version, there was a concomitant uproar. There were concerns that AOL-TimeWarner (who bought Netscape) was influencing the design of Mozilla. Eventually it was realized that this feature was temporarily not present solely for the purpose of releasing a beta version of Mozilla. Nevertheless, the outcry in the community highlights the importance of this feature, despite its lack of economic or political worth. *See* Slashdot, *Mozilla Junkbuster-like Feature Removed*, *available at* http://www.slashdot.org/articles/00/05/09/1410222.shtml (May 9, 2000).

[345] Wylie Wong, *AOL's Nullsoft Creates Software for Swapping MP3s,* CNET NEWS.COM, Mar. 14, 2000, *available at* http://news.com.com/2100-1023-237974.html.

[346] *Id.*

[347] John Borland, *Programmers Help "Napster" Clones Take Off,* CNET NEWS.COM, Apr. 10, 2000, *available at* http://news.com.com/2100-1023-239060.html.

for governments to track down users or remove information.[348] The motivations for this defiant behavior largely stem from the libertarian views of the open source developers.[349] These developers get a special satisfaction from code that complicates life for government. However, this may change, as people are increasingly concerned with non-governmental threats to security. In the future, code developed by the open source movement may address these concerns.

V. Legislative Process: Management Decisions During The Development of Code

The development of law includes decisions that affect how quickly a law can be enacted, the amount of consideration given to a potential law, the scope of the law, and the decision-making process for passing the law. These decisions are all part of the legislative process. Similarly, institutions that develop code have different legislative processes, as result of their structures and susceptibility to different influences, which affect the development of code. This section discusses three management decisions during the legislative process for code that serve to shape code. First, institutions differ in the speed of development process for code. Second, institutions differ in the decision-making process for what attributes should be included in the code. For example, firms seek to include profitable features, while the open source movement may include features that their members regard as important. The third management decision concerns how widely the code gets disseminated. Some institutions favor making their code widely available, while other institutions wish to limit access to their code.

A. Speed of the Development Process

One of the surprising findings from our case studies was that the development of code was not necessarily faster in any given institution. We expected that firms could develop code rapidly, but our case studies show that universities, consortia, and the open source movement are all also equally capable of developing code swiftly. The most significant variable that affects the speed of the development is management. The management of a university, consortium, or open

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[348] John Markoff, *The Concept of Copyright Fights for Internet Survival*, N.Y. TIMES, May 10, 2000 (discussing the Freenet project).
[349] Jedediah Purdy, *The God of the Digerati*, AM. PROSPECT, Mar. 1998, *available at* http://www.prospect.org/print/V9/37/purdy-j.html (noting the libertarian tendencies of Wired readers); PAULINA BORSOOK, CYBERSELFISH (2000) (criticizing the prevailing libertarian ethos of high technology). *See also* MANUEL

source project has a tremendous amount of variation that can affect how quickly code is developed. In our case studies, the projects were well managed and developed quickly. However, this is not always the case. We begin by discussing the speed of development in universities, and then continue on to firms, consortia, and the open source movement.

The typical norms for university research support a slower, more thorough approach over a rapid development process, according to Bruce Maggs, a former vice-president for research and development at Akamai Technologies, who has recently returned to academia.[350] The additional time allows researchers to ensure the accuracy of their results, to ponder interesting results, and consider new research trajectories.[351] Our case study on NCSA Mosaic was atypical. The rapid development process for NCSA Mosaic was the result of the university's commitment to the project as well as the extremely hard work performed by the developers.[352]

Firms are under pressure to develop code rapidly. It is well established that the first competitor in a market has a distinct advantage.[353] Netscape emphasized extremely rapid development, because it understood that its success depended on being the first commercial web browser.[354] As summarized by Andreessen they needed to "[k]ick the product out the door as quickly as possible. It doesn't matter if it's done or doesn't really matter if it does even 20 percent of what the full expression of it is."[355] The emphasis on speed leads to a tradeoff in the quality of the code.[356] In the case of Netscape, the rapid development process led to the

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CASTELLS, THE INTERNET GALAXY 42 (2001) (noting the autonomous nature of the open source movement in the development process).

[350] Mihai Budiu, *An Interview with Bruce Maggs*, *available at* http://www.cs.cmu.edu/~mihaib/maggs-interview (March 2001). Another factor that slows down the development process is publishing. In response, some academic fields are using electronic publication to speed up the dissemination of knowledge.

[351] *See* Committee on Science Views and Estimates, U.S. House of Representatives, *Basic Research*, *available at* http://www.house.gov/science/viewsfy2000.htm (discussing why the government should focus on long term research) (last visited Feb. 19, 2002).

[352] *See* GILLIES & CAILLIAU, *supra* note 45, at 241 (noting that NCSA supported a number of student programmers who worked long hours to develop NCSA Mosaic). Another example of universities developing technology as quickly as a firm is in the Human Genome Project. Frederic Golden & Michael D. Lemonick, *The Race Is Over*, TIME, July 3, 2000, *available at* http://www.time.com/time/magazine/articles/0,3266,48109-1,00.html.

[353] This is known as the first mover advantage. *See* SHAPIRO & VARIAN, *supra* note 2, at 29-32.

[354] *See supra* text accompanying note 108.

[355] MICHAEL A. CUSUMANO & DAVID B. YOFFIE, COMPETING ON INTERNET TIME: LESSONS FROM NETSCAPE AND ITS BATTLE WITH MICROSOFT 226 (1998).

[356] Esther Dyson summarizes this consequence "the seller [of software] wants to make it half-work and improve it next year." Joel Garreau, *Thinking Outside the Box*, WASH. POST, Mar. 19, 2001, at C01. *See infra* Part VI.D. (discussing the quality of code).

incorporation of an immature technology that contained security and privacy holes such as third party cookies.[357]

Consortia are chosen because of their rapid speed in developing standards as compared to Standard Developing Organizations (SDOs).[358] However, there is considerable variation in the speed of development within consortia and between projects within a consortium. The W3C was established with the intent of creating a faster standards process compared to the IETF.[359] As a result, PICS was completed in a matter of months, while competing solutions such as the IETF's Voluntary Access Group were still on the drawing board.[360] However, consortium work is not always completed rapidly. For example, the Secure Digital Music Initiative (SDMI) consortium has made little progress over the last few years.[361] Additionally, the speed of development can change over a consortium's lifespan. As the W3C has aged, it has added formal procedures that have slowed down the development process.[362] This has created a space for the emergence of new consortia to develop standards for the web. For example, the VoiceXML Forum, led by AT&T, IBM, Lucent, and Motorola, was created to develop standards for VoiceXML.[363] Only after a standard was developed in the new consortium, was it then submitted to the W3C.[364] Thus, as the W3C has slowed, other consortia have materialized to provide a rapid development process.[365]

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357 *See supra* text accompanying note 117.
358 *See supra* text accompanying notes 237-245.
359 Gary H. Anthes, *W3C's Worldwide Power,* COMPUTERWORLD, Sep. 9, 1999, *available at* http://www2.cnn.com/TECH/computing/9909/09/w3c.idg/; Khare, *supra* note 251; Interview with Joseph Reagle, Public Policy Analyst for the W3C, in Bloomington Ill. (Nov. 20, 2001) (noting the coordination role of the W3C's paid technical staff, who assist in ensuring that standards are developed in a timely manner).
360 *See supra* text accompanying notes 317-322.
361 For example, the Secure Digital Music Initiative (SDMI) consortium began in July 1999 and claimed that there would be SDMI-compatible portable digital music players in stores by Christmas. However, within a few months, SDMI had to backtrack from that promise. By early 2001, it was becoming clear that SDMI had failed. Lisa Nadile, *SDMI Needs to Secure New Chief,* WIRED NEWS, Jan. 24, 2001, *available at* http://www.wired.com/news/business/0,1367,41397,00.html; Junko Yoshida, *SDMI-Internet Players To Miss Holiday Season*, EE TIMES, Sep. 23, 1999, *available at* http://content.techweb.com/wire/story/TWB19990923S0027.
362 See *supra* text accompanying note 327.
363 Grant DuBois, *W3C Accepts VoiceXML 1.0 Spec*, EWEEK, May 25, 2000, *available at* http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2574350,00.html. Another similar example is the creation of the Wireless Application Protocol (WAP) Forum.
364 *Id.*
365 The W3C's slow action on developing a standard for web services has led a number of firms including Microsoft and IBM to create a new consortium. *See* Paul Festa, *Critics clamor for Web services standards*, CNET NEWS.COM, Feb. 12, 2002, *available at* http://news.com.com/2100-1023-834990.html.

The speed of an open source project can vary tremendously. The first issue that affects the speed of the development process is the difficulty of managing an open source project.[366] Typically, there is an individual or a core group of people that manage the various volunteer participants during the development process. This management process is often claimed to be akin to herding cats.[367] This process can involve endless fighting and even the abandonment of projects due to philosophical or technical differences. Even with successful projects, there can be problems. For example, Robert Thau who rewrote the Apache server was forced out of the Apache community a few years later. According to Østerlie, this was essentially because many members of the Apache community thought Thau was too much of an authority.[368] Besides the management issue, a second important factor is the extent of volunteer support. This is simply because the open source movement is dependent upon volunteers.[369] The lack of volunteer support can lead to "vaporware," which are open source projects that are never started.[370] The lack of support leaves many other projects in beta form, which is the equivalent of a rough draft. There are hundreds of open source projects languishing in beta form.[371]

B. Decision-Making Process

The decision-making process within legislative bodies involves a number of factors. For example, consider the difference in the representation of decision-makers in a town hall meeting versus the United States Congress. Moreover, in congress, the decision-makers are apportioned by two different methods, on the basis on statehood and population. Similarly, the criteria for a decision may vary from an emphasis on a constituent's welfare, the political party's welfare, to a broader concern for public welfare. Another important factor in the decision-making process is public comment. Public comment ensures governmental decision-makers consider public

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[366] *See* Bezroukov, *supra* note 274; Charles Connell, *Open Source Projects Manage Themselves? Dream On*, *available at* http://www.lotus.com/developers/devbase.nsf/articles/doc2000091200 (last visited Feb. 19, 2002) (arguing the open source projects need good managers).
[367] *See* Østerlie, *supra* note 179 (according to Bruce Perens ex-leader of the Debian GNU/Linux project).
[368] *Id.*
[369] *See supra* text accompanying notes 332-341 (noting the limitations of volunteers).
[370] Vaporware is a term for products that are announced but not available. *See* Webopedia, *Vaporware, available at* http://www.webopedia.com/TERM/V/vaporware.html (last visited Feb.5, 2002). *See infra* note 380 (noting the legal issues surrounding vaporware).
[371] Frauenheim, *supra* note 264 (describing the thousands of open source projects at SourceForge.net).

concerns.[372] Not surprisingly, all of these factors affect the decision-making process by the legislators of cyberspace.

The decision-making process for institutions includes decisions on what attributes to incorporate into the code as well as deciding when code is suitable for public release. An example of such a decision is whether to delay the release of code until a slight security flaw can be corrected. Some institutions may choose to release the code, while others may decide to wait.

This section begins by describing the decision-makers for each institution. Secondly, we discuss how the criteria for the decision-making process differ by institution. Some institutions are swayed by their membership, while others focus on what is profitable. A third important component concerns whether the decision-making process is open to public comment. The value of public input was demonstrated in our case study on cookies. As a result of public participation, the IETF's standards process quickly recognized the privacy and security flaws in cookies. We begin by discussing the decision-making process in universities, and then continue on to firms, consortia, and the open source movement.

1. Universities

In a university research project, the decision-maker is the developer or the head of a project. They ultimately decide what should be the final shape of the code. The criteria they follow are discretionary because of the autonomy and freedom within the university.[373] The autonomy fosters risk-taking in the development of code and is important for pushing the boundaries of knowledge and creating innovative products.[374] In our case study on the development of the web, it was Andreessen and Berners-Lee who decided what features to include in their browsers. They were the ones who announced the availability of the latest versions of their browsers on the Internet.[375] NCSA and CERN granted their researchers considerable autonomy in the decision-making process. Finally, the decision-making process

[372] The Administrative Procedure Act (APA) requires federal agencies to allow for public comment in either formal or informal rulemaking. 5 U.S.C. § 551-59 (1994).
[373] *See supra* text accompanying notes 285-287.
[374] This is supported by government funding agencies such as the National Science Foundation (NSF). According to Joseph Bordogna the NSF seeks innovative research that goes beyond current technology. "While everyone seems to be looking for merely the next technology, we are hoping they search for something that renders something obsolete." Joseph Bordogna, *Innovators Break the Rules. Trust Them*, *available at* http://knowledge.wharton.upenn.edu/articles.cfm?catid=14&articleid=334 (last visited May 28, 2001).
[375] *See supra* note 77 (noting Andreessen's announcement); *see supra* text accompanying note 51 (noting Berners-Lee's announcement).

within a university is not open to public comment. The researchers are under no obligation to consider public input. They make the decisions on whether the code is suitable for dissemination for either testing purposes or for widespread use.[376]

2. Firms

A firm's management engages in decision-making. They decide what features should be incorporated into the code. Profitability is a key criterion in the decision-making process.[377] This is why Netscape developed features supporting e-commerce, such as cookies. The profit motive also puts tremendous pressure on firms to introduce their code rapidly into the market to gain an advantage over competitors. Netscape quickly incorporated cookies despite the potential security and privacy issues. Netscape did not want to wait for the IETF to define a cookies standard. Instead, they rushed ahead to meet the market expectations. A few years later, Netscape decided to continue allowing third party cookies. This decision was made with full knowledge of the privacy and security risks, as well as the Internet community's disapproval of third party cookies. Netscape's motivation was its own financial interest. It sought to meet the needs of its paying customers who wanted advertising and not the privacy concerns of users of its free browsers.[378] This is a typical example of how firms operate. The consequence is that values that are deemed to be unprofitable are not factored into a firm's decision-making process.[379] Finally, the decision-making process is not open to public comment. In fact, the firms often conceal their activity, since there is no reason to provide information about potential code development activities to rivals.[380]

3. Consortia

The decision-makers in a consortium are determined by its membership. The number of decision-makers and the criteria they employ in the decision-making process may vary. For

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[376] Researchers typically publish their work, however this is an issue of dissemination and not public comment.
[377] *See supra* text accompanying notes 221-224.
[378] *See supra* text accompanying note 129. *See also supra* note 129 (providing one possible explanation why the browser vendors continued to allow third party cookies).
[379] *See infra* Part VI.F.2 (discussing why firms do not incorporate unprofitable values).
[380] Firms may provide information on their projects in a strategic way. Sometimes these announcements can be viewed as anticompetitive behavior in the case of vaporware. *See* Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CALIF. L. REV. 479, 504 (1998); Robert Prentice, *Vaporware: Imaginary High-Tech Products and Real Antitrust Liability in a Post-Chicago World*, 57 OHIO ST. L.J. 1163 (1996).

example, consider the differences between the W3C and the IETF. The W3C places its final decision-making power in the hands of its Director, currently Tim Berners-Lee.[381] Naturally, he is likely to make decisions that the members support because member support is vital for a consortium.[382] This can lead the Director to rubber stamp the choices of a few members.[383] The IETF is different. It bases its decisions on a rough consensus of the working group as well as the approval of the Internet Engineering Steering Group (IESG).[384] For example, consider the debate on the IETF's Multipurpose Internet Mail Extensions (MIME) standard. The debate included hundreds of people. And when Steve Jobs, then the founder of NeXT Software, appealed to Nathaniel Borenstein, the author of the MIME standard, seeking some changes, Borenstein refused. Borenstein believed it was absurd that "because that you were a famous executive that your opinion should outweigh the Internet community's reasoned debate."[385] This use of a general community consensus to determine Internet standards on basis of technical merit is the ideal of the IETF.[386] This explains why the IETF would not let the privacy and security flaws in the cookies technology pass unnoticed.[387]

The criteria for the decision-making process are up to its members. This is logical because a consortium develops standards and code for the benefit of its members. Consequently, these criteria can lead to the approval of standards that are ineffectual or never widely implemented, such as the W3C's PICS or the IETF's cookies standard. In contrast, a firm would not expend this level of effort in developing a product that was ineffectual or would not be

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[381] Rada, *supra* note 255, at 19 (describing the W3C's process for standards). The W3C's procedural guidelines are available to the public. *See* World Wide Web Consortium Process Document, *available at* http://www.w3.org/Consortium/Process/ (last modified July 19, 2001).

[382] If a member doesn't generally support a consortium's decisions, it will leave. For example, MCI WorldCom left the W3C because it didn't feel its concerns were being adequately addressed. *See* Gary H. Anthes, *W3C's Worldwide Power*, COMPUTERWORLD, Sept. 9, 1999.

[383] Rada, *supra* note 255, at 20.

[384] The IESG consists of volunteers who are voted to their position by the IETF's members. IESG administers the process and approves IETF standards. There are several works on how the IETF makes its decision. *See* Scott Bradner, *The Internet Standards Process*, RFC 2026, Oct. 1996, *available at* http://www.ietf.org/rfc/rfc2026.txt; David Crocker, *Making Standards the IETF Way,* STANDARDVIEW, Jan. 1993, at 1, *available at* http;//www.brandenburg/ietf/ietf-stds.html; Paul Hoffman, *A Novice's Guide to the IETF*, *available at* http://www.imc.org/novice-ietf.html (last visited Oct. 5, 2001).

[385] Interview with Nathaniel Bornstein, Author of MIME Standard, in Bloomington, Ill. (Sep. 17, 1999).

[386] The W3C is built upon the idea that too much input can be counterproductive. This is why the W3C places a large barrier for individual participation with its $5000 minimum fee. Other consortia charge a smaller fee. For example, the OASIS consortium, which develops XML standards, charges a $250 membership fee. This is often called the bozo membership fee, because it ensures that interested people participate and keeps bozos out. *See* St. Laurent Interview*, supra* note 324. Finally, the IETF has no membership fee. This shows how consortia vary in their barriers to third party participation.

adopted for widespread use. Nevertheless, these standards may be important. In the case of PICS, the W3C was attempting to fashion an industry-led technological solution to the problem of minors accessing indecent content.[388] In the case of the IETF's cookies standard, the IETF sought a precise technical standard for cookies and welcomed public discussion on the key privacy issues.[389]

Consortia can also vary on the consideration of public comments. Some consortia, such as the IETF, develop their standards with a full public process that emphasizes an ongoing public review. Other consortia, such as the W3C, may choose to develop a standard privately.[390] The reasons for a private process may include intellectual property issues, the avoidance of public scrutiny from the press and other third parties, and the ability to share sensitive information.[391] The W3C allows its working groups to choose a public or private decision-making process.[392] However, the final products of the W3C's working groups are subject to public comment.[393]

4. Open Source Movement

The decision-makers for an open source project vary from project to project and can range from the democratic to the authoritarian. In the case of Apache, there is a core group of people who make the decisions. This clique of developers determines the final form of Apache through a voting process.[394] In contrast, other successful open source projects are run in an authoritarian manner. For the Linux operating system, it is up to Linus Torvald whether to accept a patch.[395] While he usually accepts the recommendations of a core group of developers, he does have the discretionary power to do as he pleases. If problems occur between the

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[387] *See supra* text accompanying notes 120-127.
[388] *See supra* text accompanying notes 166-173 (discussing why PICS was ineffectual).
[389] *See supra* text accompanying notes 126-127 (noting that the IETF's cookies standard is not widely implemented).
[390] *See* MURPHY, *supra* note 227, at 144 (noting that when developing knowledge for competitive reasons total openness is not possible).
[391] According to Joseph Reagle, the avoidance of public discussion allows parties to change their position and allow issues to be resolved. *See* Reagle, *supra* note 359.
[392] World Wide Web Consortium, *Process Document,* § 4.2.2, 19 July 2001, *available at* http://www.w3.org/Consortium/Process-20010719/process.html.
[393] The W3C has a three month public comment period. *See* Rada, *supra* note 255, at 21-22.
[394] Bezroukov, *supra* note 274.
[395] Id.

decision-makers, the members of an open source project can always leave and start a competing project, thus creating a "fork" in the development process.[396]

The criteria for the decision-making process is not fixed; rather it depends on the discretion of the volunteer developers. In the case of Apache, the criteria concerns the addition of useful features and the removal of errors in the code. In other cases, the independence from economic or political influences can lead to the inclusion of features that are otherwise politically unpalatable or not in the economic interest of the Internet.[397] For example, the open source web browser Mozilla is capable of blocking the pop-up windows used for advertisements.[398] In a few cases, this independence has produced open source code that contravenes the law.[399] For instance, in the DeCSS case, the open source movement disseminated code that contained anti-circumvention attributes, in violation of the Digital Millennium Copyright Act.[400]

The open source movement is generally committed to a public development process. The code is always available to the public and the development of code is typically discussed in public forums. This public manner is evident in the development of Apache, which had over 3000 people submit reports on problems with the code.[401] However, it is possible to develop code without a public development process and then to release it as open source code. This happened with the NCSA Mosaic web server. Universities and government agencies often develop code that is later released to the open source movement.[402] In these cases, the decision-makers and criteria for the initial public release may be private. However, once released to the open source movement, the development process can then become public.

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[396] Bruce Kogut & Ana Metiu, *Open Source Software Development and Distributed Innovation*, 17 OXFORD REV. ECON. POL'Y 248 (2001). The ability to fork open source code and create rivals ensures that the development follows the wishes of the community and not one group of developers. FELLER & FITZGERALD, *supra* note 260, at 96.

[397] *See supra* text accompanying notes 343-348.

[398] *See supra* note 343.

[399] Lawrence Lessig, *The Limits in Open Code: Regulatory Standards and the Future of the Net*, 14 BERKELEY TECH. L.J. 759 (1999).

[400] Lisa Bowman, *Hollywood's War on Open Source*, ZDNET, Feb. 26, 2000, *available at* http://zdnet.com.com/2100-11-502010.html.

[401] *See supra* text accompanying note 189.

[402] The Open Channel Software Foundation facilitates the transfer of code to the open source movement. *See* Susan M., *NASA Releases Classic Software to Public Domain,* NEWBYTES, Oct. 25, 2001.

C. Dissemination of Code

Just as legislators must decide on the proper scope of a law, institutions must decide on how widely code should be disseminated. This issue concerns whether the code that is developed should be made freely available to the public or to only a few selected parties. This decision varies by institution, but is an important element in the development of code. This section discusses the proclivities of institutions regarding their decisions about how widely to disseminate new code. In later sections, we discuss the role of intellectual property protection and open standards on the dissemination of code.[403] We begin by discussing the dissemination decision for universities, and continue on to firms, consortia, and the open source movement.

The decision to disseminate code publicly may be an obvious choice within a university. This is consistent with the university's mission to expand knowledge.[404] Moreover, the norms within the university stress the need to publish research for claims of priority and public validation of the research.[405] Berners-Lee and Andreessen both released their code publicly through the Internet and sought feedback. They considered the public to be their customers.[406] However, as we shall discuss later, there is a recent and growing trend for universities to restrict the dissemination of code in order to gain much-needed compensation as well as control over the code.[407]

Firms tend to restrict the dissemination of code. Firms seek to disseminate code to potential customers and not the general public. Firms sometimes disseminate code freely to the public. However, this free dissemination serves a long-term strategic goal by utilizing economic phenomena such as, lock-in, switching costs, and network effects. Lock-in occurs when people have to buy multiple types of code specific to a system.[408] For example, once you buy a Sony Playstation video console, you have to continue to buy specific code, both hardware and software, for the Sony machine. Switching costs are the costs to overcome the lock-in. For

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[403] *See infra* Part VI.A. (open standards) and Part VI.B. (intellectual property).
[404] *See supra* text accompanying notes 202-205.
[405] *See supra* text accompanying notes 214-216.
[406] In February 1993, a message was posted congratulating Andreessen on NCSA Mosaic and asking him why he cared about what others thought, since they weren't customers of NCSA. Andreessen replied:
Well, you literally are our customer. But that's probably beside the point... we do care what you think simply because having the wonderful distributed beta team that we essentially have due to this group gives us the opportunity to make our product much better than it could be otherwise. We very much value constructive criticism from knowledgeable people. Marc Andreessen, *Xmosaic Experience,* WWW-TALK MAILING LIST, a*vailable at* http://www.webhistory.org/www.lists/www-talk.1993q1/0176.html (Feb. 25, 1993).
[407] *See infra* text accompanying notes 449-455.

example, the switching costs between a Windows system to a Unix based system can be high. A person may have to buy new hardware, software, have existing data converted to a new format, and retrain users. Not surprisingly, firms develop code to raise switching costs and keep customers. As a result, firms may disseminate demonstration code with less features or provide a free trial period in order to lock-in customers. A final reason firms may disseminate code freely is to take advantage of network effects. Network effects suggest that the larger the network the more powerful it is.[409] To take advantage of this, firms may disseminate their code for free to enlarge their market. For example, firms often release their instant messaging code for free in the hope of gaining more users. They understand that the more users they recruit, the larger their network, and hence, the more valuable it becomes.

Consortia develop code for the benefit of their members. Typically, the code is useful to an industry in general and is widely disseminated throughout that industry. However, a consortium may restrict the code to its members or charge third parties for access. In the case of the W3C and IETF, both consortia have taken the position that all code and standards that are developed will be disseminated to the public.[410]

The open source movement favors wide dissemination. This decision is consistent with the goal of the open source movement to create in creating freely available open source code. This decision is supported by copyright licenses that guarantee the right to redistribute the code freely.[411] Furthermore, one branch of the open source movement, the Free Software Foundation, uses intellectual property law to ensure code remains widely disseminated for subsequent innovation. This copyright license is known as the GNU General Public License and includes a condition that the code and any derivative code must be freely available.[412]

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[408] SHAPIRO & VARIAN, *supra* note 2, at 12.
[409] *See* SHAPIRO & VARIAN, *supra* note 2, at 174; Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. L. REV. 479, 550 (1998); Nicholas Economides, *The Economics of Networks*, 14 INT'L J. INDUS. ORG., 673 (1996), *available at* http://raven.stern.nyu.edu/networks/top.html. *See generally* Michael L. Katz & Carl Shapiro, *Systems Competition and Network Effects*, J. ECON. PERSP., Spring 1994, at 93.
[410] *See infra* text accompanying notes 437-438.
[411] *See infra* text accompanying notes 466-471.
[412] *See infra* text accompanying notes 466-469 (discussing the GNU General Public License).

VI. THE FINAL BILL: ATTRIBUTES OF THE FINAL IMPLEMENTATION

The previous parts focused on the structure, influences, and processes within different institutions. This part focuses on the results of these factors upon code. We show how institutional tendencies serve to shape various attributes of code.[413] The first attribute we discuss is open standards, which has consequences on interoperability between different code. Second, we focus on how institutions differ on the choice of intellectual property protection for code. This choice can provide either limitations or opportunities in the use of code. The third section focuses on the decision by institutions to open source their code. By open sourcing the code, it is possible to create a rich and vibrant foundation for further code development by the public. The fourth section discusses how institutions differ in developing high quality code that contains few flaws. The fifth section focuses on attributes that are not wholly technical, but are nevertheless important to users. These include attributes such as marketing, user-friendly code, documentation, and technical support. The last section focuses on non-technical attributes of code. These are the attributes that can affect fundamental societal concerns such as privacy and free speech.

A. Open Standards

An institution's decision whether to pursue and support open standards for code can have enormous ramifications on society and the marketplace. In studying Apache, we saw that Apache's support for open standards helped prevented an important part of the Internet, web servers, from becoming proprietary. Without Apache, Microsoft and Netscape could have implemented special features in their servers for use only with their browsers, thus fragmenting the Internet.[414] For example, we may well have ended up with web sites only accessible with Microsoft browsers and servers. But competition from Apache prevented a situation analogous to the browser war, and we avoided ending up with two web servers operational with two

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[413] This is not a one-way effect. These features also feedback and affect the development of code. For example, the choice of what sort of intellectual property protection to seek can influence the development process.

[414] This fear still exists because of Microsoft's monopoly of the desktop operating system. However, as a long Apache keeps a large portion of the server market, the web will be based on open standards. *See* Robert X. Cringely, *The Death of TCP/IP,* Pulpit, Aug. 2, 2001, *available at* http://www.pbs.org/cringely/pulpit/pulpit20010802.thml (arguing that Microsoft could eliminate the open standard for TCP/IP and replace it with a proprietary protocol).

different browsers.[415] After a short discussion on open standards, this section describes the tendencies of different institutions beginning with universities, and then continuing on to firms, consortia, and the open source movement.

Open standards can promote competition and consumer choice by providing for more than one vendor for any product.[416] Furthermore, consumers can be confident that the solution they purchase will be compatible with products from other vendors. Examples of open standards on the Internet include the transmission protocols such as FTP,[417] HTML, which serves as the language for web pages,[418] and the image format known as JPEG.[419] Open standards are defined by three elements. One, the standard is publicly available to everyone at a minimal cost. Second, no entity controls the standard or that the standard is licensed on "reasonable and nondiscriminatory terms".[420] Third, the development process in creating the standard involves public participation.[421]

Open standards typically emerge from consortia or Standard Developing Organizations (SDOs). Often a firm develops a standard, and then submits it to a consortium or SDO in the hope that it will become an open standard. However, open standards are not the norm in the computer industry.[422] The primary reason is that open standards take time to develop. This process can slow down the development and implementation of code. As a result, firms may not be able to quickly meet the demands of their customers.[423] A second reason is that open

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[415] MOODY, *supra* note 88, at 129.

[416] *See* Michael Goldenberg, *Standards, Public Welfare, and the Antitrust Law,* 42. BUS. LAW. 629 (1987) (arguing that standards may have an adverse effect on consumers because they can exclude the development of certain products that do not meet the standards).

[417] Developed by the IETF. *See* J. Postel & J. Reynolds, *File Transfer Protocol,* RFC 959, *available at* http://www.ietf.org/rfc/rfc959.txt (Oct. 1985).

[418] Developed by the W3C, the latest standard is World Wide Web Consortium, HTML 4.01 Specification, *available at* http://www.w3.org/TR/html4/ (Dec. 24, 1999).

[419] Developed by a joint ISO and ITU committee, for more information see http://www.jpeg.org/public/jpeghomepage.htm.

[420] The addition of licensing fees can have significant effects. The Internet was built upon freely available standards. There were no licensing fees for the essential standards such as FTP or HTTP. There are many that worry that the next generation of Internet standards, such as SOAP, WSDL, and UDDI will be controlled by a few firms. These firms will in effect place a toll booth on the Internet by collecting royalties on essential patents. *See* David Berlind, *IBM, Microsoft Plot Net Takeover*, ENTERPRISE, Apr. 11, 2002, *available at* http://www.zdnet.com.au/newstech/ebusiness/story/0,2000024981,20264614,00.htm.

[421] Crocker, *supra* note 384.

[422] IBM's control of the early computing industry led the industry to use IBM's proprietary standards instead of open standards. Marvin A. Sirbu & Laurence E. Zwimpfer, *Standard Setting for Computer Communication: The Case of X.25*, IEEE COMM. MAG., March 1985, at 35, 37.

[423] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, THE INTERNET'S COMING OF AGE 133 (2001) (discussing the use of open standards).

standards do not allow any party to control the standard. As we will discuss later, firms are very concerned about control of a standard.

Universities favor using and creating open standards because of their emphasis on creating and transferring knowledge to society. During the development of NCSA Mosaic, NCSA was committed to using open standards.[424] Additionally, the scarce resources at universities lead to a focus on creating and using open standards as building blocks for later work.[425] Finally, the importance of publication, as part of the commitment to knowledge creation, also spurs the creation and use of open standards. This was evident in Berners-Lee's emphasis on publishing open standards for the web.

A firm's decision on whether to choose open standards is based upon its control of the market. According to Shapiro and Varian, "a corporation will accept and use standards only if it believes it cannot control the market directly and that standards can."[426] So if a firm has control over a market, it will tend to use de facto standards.[427] But, if a firm cannot control the market, it may decide to support an open standard. This decision is based on the expectation that an open standard will increase the overall size of the market. A firm must decide if it is better off with a small share in a large market-based on open standards versus having total control of a small or nonexistent market-based on de facto standards.[428] A good example of this tradeoff is Apple's choice of a proprietary architecture and IBM's decision to create an open standard for the architecture of personal computers. Apple controls a small market, while IBM has a small share of a much larger market. Thus, open standards are favored when no firm is strong enough to dictate technology standards.

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[424] National Center for Supercomputing Applications, *Frequently Asked Questions about NCSA and the Software Development Group*, *available at* http://archive.ncsa.uiuc.edu/SDG/Software/Mosaic/Docs/mosaic-lic-faq.html (Oct. 1994); *Planet Internet,* TECH. REV., Mar. 2002, *available at* http://www.techreview.com/articles/qa0302.asp (interviewing Larry Smarr, the former director of NCSA, who notes the role of open standards for university research in creating commercial technologies).

[425] *See supra* text accompanying notes 291-293.

[426] CARGILL, *supra* note 233, at 42. *See also* PETER GRINDLEY, STANDARDS STRATEGY AND POLICY: CASES AND STORIES (1995) (discussing strategies firms should take towards standards). The choice of making your products compatible is another strategic choice firms must make. *See* Stanley M. Besen & Joseph Farrell, *Choosing How to Compete: Strategies and Tactics in Standardization*, 8 J. ECON. PERSP. 117 (1994).

[427] Some examples of firms with control over a market are Microsoft, Intel, TCI, and Visa. SHAPIRO & VARIAN, *supra* note 2, at 203.

[428] Firms sometimes create open standards in the hope of building enthusiasm and support for code. In contrast the Microsoft has often concealed the standards of Windows to gain a performance advantages for its own applications. Mary Jo Foley & Deborah Gage, *Will Microsoft 'Open Up'?*, EWEEK, June 25, 1999, *available at* http://www.zdnet.com/eweek/stories/general/0,11011,2283342,00.html.

The cookies case study illustrates the tension for firms in choosing between a de facto standard and an open standard. Initially, Netscape developed and implemented technologies, such as cookies and SSL, as de facto standards that it controlled.[429] It did this to gain an advantage over other competitors. Later, it supported turning these technologies into open standards. This decision was made to ensure that a larger market would adopt Netscape's technology. This tactic of going from a de facto to an open standard gave Netscape a head start over other competitors.[430] However, the downside of this tactic was Netscape's cookies standard was immature and contained privacy and security risks.[431]

The economic pressures on firms are so pervasive that they will tend to incorporate additional proprietary features into their products, which employ open standards, in order to raise switching costs for users.[432] For example, Cisco is adding proprietary features to its open standards-based routers. These new features can be used only with other Cisco routers.[433] Similarly, Netscape added proprietary features when implementing open standards resulting in not fully compatible implementations.[434] Netscape also incorporated proprietary tweaks to improve their products performance as compared to non-Netscape products.[435] The purpose of these changes was to keep its customers from switching to another product.[436]

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[429] *See supra* text accompanying notes 104-112 (cookies); *see supra* text accompanying note 100 (SSL).
[430] Netscape's strategy to beat Microsoft was to use open standards, but be the first to market the new protocols. *See* CUSUMANO & YOFFIE, *supra* note 355 at 135. However, to enlarge the market, there is an assumption that competitors will adopt the open standard.
[431] *See supra* text accompanying note 117.
[432] SHAPIRO & VARIAN, *supra* note 2, at 156; Robin Mansell, *Designing Electronic Commerce*, *in* COMMUNICATION BY DESIGN: THE POLITICS OF INFORMATION AND COMMUNICATION TECHNOLOGIES 103, 122 (Robin Mansell & Roger Silverstone eds., 1996) (noting how electronic trading systems are designed to gain competitive advantages through design features that limit competitors).
[433] SHAPIRO & VARIAN, *supra* note 2, at 200 (noting Cisco's use of proprietary features); Jeffrey Fritz, *Strategies & Issues: Shaping the Learning Curve*, NETWORK MAG., Dec. 5, 2000, *available at* http://www.networkmagazine.com/article/NMG20001130S0006/2 (noting how routing vendors, such as Cisco, offer proprietary features that lock a network into using a specific vendor's products).
[434] Netscape followed the "open, but not open" standard strategy. While every computer company claims to be open, they often all contain proprietary pieces in their code. For example, Netscape's implementation of Javascript embedded proprietary features to ensure its implementation varied from the standardized one. *See* CUSUMANO & YOFFIE, *supra* note 355 at 137.
[435] *Id.* A consequence of the incorporation of proprietary features into open standards is that it leads to more complexity and consequently problematic code. The lack of pressure to include these proprietary features allows the open source movement to develop higher quality programs, because they are simpler and more efficient without the resulting code bloat. Bezroukov, *supra* note 274.
[436] Another example is Microsoft's "embrace, extend and extinguish" strategy to existing open standards. Microsoft has added its own proprietary modifications to open standards such as HTML, Java, Real Audio, and QuickTime. The modifications have led to proprietary closed standards controlled by Microsoft. David Bollier, *The Power of Openness: Why Citizens, Education, Government and Business Should Care About the Coming Revolution in Open*

The basic mission of a consortium is to develop standards for the benefit of its members. These standards do not always meet the requirements of open standards for a number of reasons. A consortium may choose to restrict a distribution of a standard to only its members. Second, a consortium may charge a high price for access to the standard.[437] Finally, a consortium does not have to consider public input in its development process. The most important consortia for the Internet, the IETF and the W3C, develop open standards.[438] However, an open standard does not mean the implementation is free. It may still be necessary to license the necessary intellectual property to implement the standard.[439]

The open source movement supports open standards for several reasons. First, when creating open source code, you are in effect creating open standards. Access to the source code allows anyone to determine how to develop interoperable code. Second, the open source movement depends on its members building upon the efforts of earlier work. A crucial step to support this is open standards. Finally, the members of the open source movement believe in the value of open standards.[440]

The open source movement further supports a higher form of open standards, namely modularity. Modularity breaks down a large piece of code into smaller pieces or modules.[441] With modularity, it is possible to replace a module with a different module and the program as a whole would still operate as before. This style of design allows for considerable flexibility. For example, a developer unhappy with a certain module could replace only that module. This is much simpler than modifying the entire code. A second advantage of modularity is that it facilitates a decentralized development process.[442] People can independently work on different

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Source Code Software: A Critique and a Proposal for The H20 Project, *available at* http://www.openresources.com/documents/power-openness/main.html (Mar. 10, 1999).

[437] Roy Rada & John Berg, *Standards: Free or Sold*, COMM. ACM, Feb. 1995 (providing background on how various standard organizations charge for standards).

[438] *See supra* text accompanying note 249 (IETF); se*e supra* text accompanying note 254 (W3C).

[439] *See infra* text accompanying note 458.

[440] For example, during the Christmas of 1995, AOL performed minor upgrades of their web proxies. Consequently, the web pages served by Apache returned an error to AOL users. This led to a debate in the Apache community about whether to write a simple patch to fix the problem, or should the Apache community dig in their heels and force AOL to fix their web proxies to comply with existing web standards. The community decided it was more important to stay with open standards and in the end AOL fixed its web proxies. Østerlie, *supra* note 179.

[441] CARLISS Y. BALDWIN & KIM B. CLARK, DESIGN RULES: THE POWER OF MODULARITY (1999) (discussing the use of modularity in computer science); Kogut & Anca, *supra* note 396 (arguing that when a problem is modular the open source development process offers clear advantages to proprietary models of development).

[442] Modularity is used by other institutions under circumstances of decentralized management. For example, during the human genome project, the public consortium consisting of a number of universities designed their project in a modular fashion. This was a slower, but a much more accurate approach in sequencing the human genome. Tom

parts of the code. This feature of modularity is particularly popular in the open source movement.[443] Many open source projects, such as the Shambhala version of Apache, are designed using a modular architecture.[444]

B. Intellectual Property Protection

Just as institutions differ in considering open standards, they differ in their choice of intellectual property protection for code. This choice is important, because intellectual property protection strikes a balance between the rights of the producers and the rights of the users. Institutions balance these rights differently resulting in significant economic and social consequences. In this section, we discuss the approaches to intellectual property protection for code pursued by universities, firms, consortia, and the open source movement.

1. Universities

Universities historically developed knowledge for the public good. They favored wide dissemination of their knowledge by employing minimal intellectual property protection.[445] This allowed anyone to build upon this knowledge for public or private gain. This rationale is evident in CERN's decision to place libwww's source code in the public domain.[446] The public domain was chosen over other methods of dissemination because it was the least restrictive type of protection.[447] A more restrictive method could have led some entities to not develop code for the web.[448] Consequently, CERN's libwww code served as a building block for future code, including NCSA Mosaic and Apache. Quite simply, without CERN's code being available in the public domain, the web would not exist as we know it.

Paulson, *Mapping Human Genome Reaches the End of the Road*, SEATTLE POST-INTELLIGENCER, Feb. 12, 2001, *available at* http://seattlep-i.nwsource.com/local/geno12.shtml.

443 For example, the kernel for the Linux operating system has become more modular over time. *See* Kogut & Anca, *supra* note 396 (arguing that movement towards modularity reflects the governance structure of the open source community).

444 *See supra* text accompanying note 194.

445 *See supra* text accompanying notes 202-205.

446 *See supra* text accompanying note 60.

447 Code placed into the public domain code can be used free of charge without any royalty or constraints.

448 It was the licensing fees and conditions that led industry to abandon Gopher. *See supra* note 59.

In the 1980s, legislation was enacted in the United States allowing universities to seek intellectual property protection for the inventions of their researchers.[449] The rationale was that many government-subsidized inventions were languishing because of inadequate incentives for commercialization.[450] So the government gave universities the power to license and profit from their intellectual property. The resulting revenue, while concentrated in a few inventions, is over three hundred million dollars for the inventors and their universities.[451]

In our case study, the University of Illinois sought intellectual protection for the NCSA Mosaic browser. It then began licensing out the rights to the source code. NCSA licensed out the source code for commercial use with nonexclusive licenses to almost a dozen companies.[452] In all, these licenses and royalties earned the University of Illinois seven million dollars.[453] To put these licensing revenues into perspective, this about is about four percent of Netscape's browser based revenue in 1996.[454]

The decision by a university to seek intellectual property protection has significant ramifications. Most importantly, licensing places limits on the public's access to the code. The restrictions on access could encompass other academic researchers, the open source movement, and competitors to the licensee. Universities have a tremendous amount of discretion in these decisions. Later, we argue that there is a need for more definitive criteria to ensure that

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[449] The Bayh-Dole Act provides universities with the rights to inventions resulting from government-sponsored research at universities. This allows universities to profit from their inventions and creates an obligation for them to commercialize these technologies. Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3018 (1980) (codified as amended at 35 U.S.C. § 200-12 (1994).

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

[451] Xueshu Song, *University Technology Transfer and Commercialization: A Cost and Benefit Sharing Process*, *available at* http://einnovate1.inetu.net/tco/techtrans.htm (last visited Jan 27, 2002). The Bayh-Dole Act is one of several factors leading to higher amounts of university patenting and licensing since the 1980s. 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 (2001).

[452] *See supra* text accompanying notes 94-97. QUITTNER & SLATALLA, *supra* note 46, at 107 (claiming that NCSA charged $10,000 and a percentage on every copy); Wolfe, *supra* note 292 (claiming that NCSA charged an initial fee of $100,000 plus $5 for each copy).

[453] University of Illinois, Research & Technology Management Office, *Fiscal Year 1999 Annual Report*, *available at* http://www.otm.uiuc.edu/Publications/Annual Report/annreport.htm (Oct. 1999)

[454] Jeff Pelline, *Netscape playing catch-up to Yahoo*, CNET NEWS.COM, Mar. 30, 1998, *available at* http://news.cnet.com/news/0-1003-200-327902.html (citing the revenue). Clark later wrote that he understood the pressure on Smarr to profit from NCSA Mosaic. But Clark believes that the basic mission of a university is education, and not profitable products and services. He points out that Stanford recognizes this and this has led to hundreds of start-ups. CLARK, *supra* note 71, at 55. In the end, the University of Illinois gained a little licensing revenue, but lost many times over in alumni contributions by trying to cut out the student developers.

universities are acting not just in their own financial interest, but also being attentive to the public interest.[455]

2. Firms

Firms tend to favor maximum intellectual property protection because they seek to maximize the value of their property to their shareholders and not the general public at large. This is why Netscape patented cookies.[456] However, firms will sometimes accept less intellectual property protection in exchange for greater market share. This is why firms offer their intellectual property to consortia or the open source movement. Their hope is that they can offset their loss in intellectual property protection by gains in market share.

3. Consortia

Consortia vary in their rules for intellectual property protection. Consortia have to balance the intellectual property protection rights of participants against the more immediate goal of setting standards for the benefit of their members. As a result, the licensing terms for standards by consortia have a great deal of variation.[457] For example, the W3C and the IETF have different approaches towards intellectual property. The IETF requires "reasonable and nondiscriminatory licensing" (RAND), while the W3C has a policy of royalty free licensing.[458] On its face, this difference could lead a firm to choose the IETF over the W3C because of the potential for licensing revenue.

One issue that varies by consortia is the amount of necessary disclosure.[459] Consortia typically require participants to disclose any intellectual property rights that are the subject of a standard setting process.[460] This disclosure aids in preventing the "capture" of a standard through the opportunistic use of intellectual property rights. If intellectual property rights were

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[455] *See infra* Part VII.B.4.
[456] *See supra* note 105.
[457] Mark A. Lemley, *Intellectual Property Rights and Standard Setting Organizations* (forthcoming) (surveying the different intellectual property rules used by consortia).
[458] *Id.* The W3C created considerable controversy in the fall of 2001 when it considered changing to the RAND model. Many members of the Internet community felt the W3C should maintain royalty free licensing. Margaret Kane, Apple, *HP modify stance on patent plan*, CNET NEWS.COM, Oct. 12, 2001, *available at* http://news.cnet.com/news/0-1005-200-7506293.html.
[459] Lemley, *supra* note 457.
[460] *Id. (*providing a comprehensive discussion on the issue of disclosure on the basis on contractual, estoppel-based intellectual property, and tort theories).

not disclosed, one party could later control a standard, after the consortia agreed on a standard. Consortia vary on how they punish non-disclosure. Some consortia minimize the potential gain earned by firms from non-disclosure, while others penalize a firm's non-disclosure. Moreover, the FTC and courts may punish this behavior as anticompetitive.[461] In our case study on cookies, Netscape violated IETF rules by not disclosing their patent.[462] However, it is likely that Netscape will not be subject to legal action and will be estopped from enforcing its patent.[463] Nevertheless, Netscape's behavior is not anomalous, but a natural tendency.[464] Firms want to control and profit from their intellectual property rights, while also creating open standards within consortia to enlarge markets.

4. Open Source Movement

The open source movement has a nuanced approach towards intellectual property protection. The open source movement uses several types of intellectual property licenses. These licenses are the outgrowth of two major divisions in the open source movement. Each of these licenses reflects a different philosophical and practical view of what the open source movement should represent.[465]

Historically, the open source movement with its founding of the Free Software Foundation (FSF) has been committed to free software.[466] The initial goal of the FSF was to create a free Unix based operating system. The project's name was the recursive acronym GNU for GNU's Not Unix. With respect to intellectual property rights, the FSF argues that freedom should exist at three levels. First, one should have the freedom to study how the program operates and be able to adapt it to her own needs through access to the source code. Second, users should have the freedom to redistribute copies of the code. And third, users should be free to improve the program and release their improvements to the public for the benefit of the

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461 *Id. See also* Nicholas Varchaver, *Rambus: A Hot Stock's Dirty Secret*, FORBES, July 9, 2001.
462 *See supra* note 105.
463 Lemley, *supra* note 457 (discussing estoppel-based intellectual property liability and antitrust liability).
464 For example, firms have claimed patents on two ongoing IETF standards in 2001. Carolyn Duffy Marsan, *Patent Flap Slows Multilingual Domain Name Plan*, NETWORK WORLD FUSION, Mar. 26, 2001, *available at* http://www.nwfusion.com/news/2001/0326patent.html; Carolyn Duffy Marsan, *Adobe, Xerox Tiff Slows Internet Fax Standard*, NETWORK WORLD FUSION, Aug. 8, 2001, *available at* http://www.nwfusion.com/news/2001/0808adobexerox.html.
465 *See supra* text accompanying notes 265-267.
466 *See* Richard Stallman, *The GNU Project*, *in* OPEN SOURCES (Chris DeBona et al. eds., 1999) (providing a background on the free software movement), *available at* http://www.gnu.org/gnu/thegnuproject.html.

community of free software users.[467] To ensure that free software stays free, the FSF created the GNU General Public License (GPL).[468] The idea behind GPL is to grant everyone permission to run, copy, modify, and distribute the modified version of the program. To ensure that software stays free, the license requires that modified versions also be free. This prevents people from taking free software and incorporating it into proprietary or commercial programs. Thus, free software stays free. The downstream effect of the GPL on derivative software has led Microsoft, as a partisan commentator, to analogize the GPL to a virus that infects all the code it touches.[469]

Apache represents the other branch of the open source movement. This branch is not committed to the value of free code as free speech; instead they see the open source movement as a better method for developing high quality code. The Apache project did not use the GPL, and instead, favored a type of license most widely associated with BSD Unix.[470] This license requires that the source code be kept free. However, modifications to the source code are not required to be kept free.[471] This license does not have the viral nature of the GPL. It allows derivative or modified open source code to be incorporated into commercial products. For example, firms, such as IBM, Apple, and Microsoft, are allowed to incorporate open source code into their commercial products. Naturally, firms working with the open source movement generally favor this type of license.

C. Open Source Code

Open source code provides the public with access to the heart of a program. This allows people to build upon open source code, saving them the work of recreating code.[472] One important feature of open source code is its transparency. Because the source is open to inspection, it is easy to see what the source is capable of accomplishing, as well as what flaws it

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[467] *See* Free Software Foundation, *supra* note 265.
[468] Free Software Foundation, *GNU General Public License, available at* http://www.gnu.org/copyleft/gpl.html (last modified June 1991); David McGowan, *Legal Implications of Open-Source Software*, 2001 U. ILL. L. REV. 241 (discussing social, economic, and legal implication of open source software and the GPL).
[469] Stephen Shankland, *MS Lawyers Join Open-Source Fray*, ZDNET, June 22, 2001, *available at* http://www.zdnet.com/zdnn/stories/news/0,4586,5093151,00.html.
[470] BSD stands for the Berkeley Software Distribution version of Unix.
[471] Bruce Pernes, *The Open Source Definition*, *in* OPEN SOURCES (Chris DeBona et al. eds., 1999) (discussing the differences between public domain, GNU, and open source licenses); http://eon.law.harvard.edu/opencode/licenses/ (listing various open source licenses).
[472] *See supra* text accompanying notes 262-263.

may contain, while also making it impossible to incorporate hidden features.[473] This allows users a certain level of trust in open source code.[474] In this section, we discuss the approach of universities, firms, and consortia towards open source code. We do not discuss the open source movement, because they—by definition—support open source code.

The fundamental norms of a university support the sharing of research. So they are a natural source of open source code.[475] For example, CERN released its code to create a foundation for developing web browsers and servers. However, the recent trend allowing universities to seek intellectual property protection for code discourages the use of open source code. In our case study, the University of Illinois did not open source the NCSA Mosaic web browser for commercial use, and instead, licensed the code to a number of firms.[476] However, the source code for the NCSA Mosaic web server was available publicly.[477]

Firms tend to protect their investment in developing new code, and therefore, do not release their code as open source. This is to be expected. However, the success of the open source movement has prompted some firms to release their code as open source for potential financial gain.[478] For example, IBM has contributed open source code to the Apache project. IBM is not altruistic, rather, it believes it can make money by bundling an improved Apache with

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[473] An example of a hidden feature may be a backdoor or a password that allows any user to gain control over a program.

[474] Besides a level of trust through transparency, open source also provides users trust in the code's existence. Since the code is freely available, users do not have to worry about not having access to the code. In contrast, if a firm fails its code may effectively disappear leaving its customers to find a replacement.

[475] Some examples of government open source code can be found at the Open Channel Software Foundation. Another notable example is the work by the National Security Agency (NSA) on developing a secure version of open source operating system Linux. NSA complied with the open source license for Linux, the GPL, and is releasing its modifications to the public. P.J. Connolly, *U.S. Government Moves To Secure Linux*, INFOWORLD, Feb. 5, 2001, *available at* http://www.infoworld.com/articles/op/xml/01/02/05/010205opswatch.xml. However, this work has been criticized because its efforts aided everyone and not just American software firms. *See supra* text accompanying notes 990-991.

[476] *See supra* text accompanying notes 94-97.

[477] *See supra* text accompanying note 174.

[478] With slowing of growth in information technologies, companies may be more reluctant to use the unproven open source business model. Stephen Shankland, *Open Source Approach Fades in Touch Times*, CNET NEWS.COM, Nov. 20, 2001, *available at* http://news.cnet.com/news/0-1003-200-7926093.html. However, there is still a place for open source code. *Going Hybrid,* ECONOMIST, July 25, 2002. A classic example of a firm using the open source model is Netscape's decision in January 1998 to open source its proprietary web browser source code. In the press release Netscape argued that open sourcing the code, "will enable Netscape to harness the creative power of thousands of programmers on the Internet by incorporating their best enhancements into future versions of Netscape's software." By developing high-quality versions of Netscape Communicator through open source, Netscape hoped to then seed the market for Netscape's enterprise solutions and Netcenter business. Netscape Communications Inc., *Netscape Announces Plans to Make Next-Generation Communicator Source Code Available Free on the Net*, *available at* http://www.netscape.com/newsref/pr/newsrelease558.html (Jan. 22, 1998).

its proprietary software.[479] This bundling allows IBM to take advantage of Apache's high quality, while saving them the effort of developing their own web server.[480] However, releasing code as open source does not guarantee that open source developers will improve the code. Firms still need to ensure that developers are motivated to work on the code.[481]

Consortia are generally not concerned with open source code because they focus on standards and not the creation of code. Nevertheless, the decision to open source code rests with the consortium's members. The W3C has made a commitment to release its code as open source. The W3C's code is not intended for everyday use by consumers, rather it is for developers to test new standards. By using open source code, the W3C is inviting developers to assist in the development process for the benefit of the entire software developer community.[482]

D. Quality of Code

The quality of code refers to problems with code. Problems may develop as a result of software complexity, programming errors, or through software development tools.[483] The resulting errors may be trivial or a matter or life and death.[484] One estimate holds that defective code accounts for as much as forty five percent of computer-system downtime and cost U.S. companies one hundred billion dollars in lost productivity and repairs last year.[485] If these flaws

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[479] Niall McKay, *Apache-IBM Marriage Bears Children*, LINUX WORLD, *available at* http://www.linuxworld.com/linuxworld/expo/lw-apache.html (last visited Feb. 6, 2002).

[480] IBM has made a solid commitment to open source software. They believe that the open source development process can result in high quality software, because "innovation can be spurred through collaboration and the free exchange of ideas", according to Scott Handy, director of Linux solutions marketing for IBM. Interview at Slashdot, *Scott handy Tells What's Up with IBM and Linux*, *available at* http://slashdot.org/article.pl?sid=01/07/16/1326224 (July 16, 2001).

[481] For example, Apple has failed to generate interest in its open source code for Quicktime. Paul Festa, *Will Real Feast Where Apple Failed?,* CNET NEWS.COM, July 30, 2002, *available at* http://news.com.com/2100-1023-947094.html.

[482] All the W3C's open source projects can be found *at* http://www.w3.org/Status.

[483] EDWARD KIT, SOFTWARE TESTING IN THE REAL WORLD 7 (1995). *See also* Rick Hower, *Software QA and Testing Frequently-Asked-Questions*, *available at* http://www.softwareqatest.com/qatfaq1.html (last modified Jan. 30, 2002) (providing background material on issues with the quality of code).

[484] A classic case of bugs in code leading to deaths and serious injuries is the computerized radiation therapy machine called the Therac-25. Nancy Leveson & Clark S. Turner, *An Investigation of the Therac-25 Accidents*, IEEE COMPUTER, July 1993, at 18. The most expensive failure of code is the explosion of Ariane 5 rocket with $500 million in satellites. This failure was the result of a simple buffer overflow error. *ARIANE 5 Flight 501 Failure,* Report by the Inquiry Board, *available at* http://java.sun.com/people/jag/Ariane5.html (July 19, 1996); Jean-Marc Jézéquel & Bertrand Meyer, *Put it in the Contract: The Lessons of Ariane*, IEEE COMPUTER, Jan. 1997, at 129 (noting that this problem occurred because of the reuse of code).

[485] Aaron Ricadela, *The State of Software Quality*, INFORMATIONWEEK.COM, May 21, 2001, *available at* http://www.informationweek.com/838/quality.htm; *A Lemon Law for Software?*, ECONOMIST, Mar. 14, 2002. *See also* NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, THE ECONOMIC IMPACTS OF INADEQUATE

are not detected and fixed, code quickly becomes considered poor quality and can be abandoned. Quality is of such importance that more than half the development process is typically spent on testing the quality of code.[486] The testing of code is conducted in a variety of ways and usually extends to the documentation, specifications, and user manuals associated with code.[487] This section focuses on how institutions differ in creating high quality code. We begin by discussing universities, and continue on to firms, consortia, and the open source movement.

Universities do not emphasize high quality code for two reasons. First, they stress the creation of innovative, cutting-edge code. Their goal is not quality, rather they seek to bring to fruition a radical idea. Secondly, universities are subject to limited resources. They simply don't have the staff and resources to focus on developing high quality code. For example, during the development of NCSA Mosaic, the goal was to make the code work "most of the time." There was no pressure to develop a higher quality product. Instead, the pressure was on new features and platforms. According to John Mittelhauser, "we didn't really care about quality. We were just cranking out releases and putting in new features."[488] Their goal was not software quality but to develop innovative code and get people excited. According to Quittner, "the developers of NCSA Mosaic didn't care if the code was buggy [low quality], if 10 percent of the users couldn't operate the software because it crashed too much, then big deal. They weren't selling it after all."[489]

Firms generally produce higher quality code because they must acquire and retain their customers. To this end, firms test the quality of code. For example, the developers of NCSA Mosaic changed their attitude on software quality when they joined Netscape. They realized in order to sell their software, they needed to place an emphasis on the quality of software.[490] This

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INFRASTRUCTURE FOR SOFTWARE TESTING (2002) (calculating the costs of an inadequate infrastructure for software testing between $20 to $60 billion with over half of those costs borne by software users in the form of error avoidance and mitigation activities).

[486] KIT, *supra* note 483.

[487] *Id.*; GLENFORD J. MYERS, THE ART OF SOFTWARE TESTING (1979); CEM KANER ET AL., TESTING COMPUTER SOFTWARE (1999).

[488] CUSUMANO & YOFFIE, *supra* note 355 at 158.

[489] QUITTNER & SLATALLA, *supra* note 46, at 59; Similarly, in the case of the NCSA web server, NCSA didn't have the resources to maintain and fix all the reported bugs.

[490] CUSUMANO & YOFFIE, *supra* note 355 at 231.

led to a different development process, which included specific measures to improve the quality of code.[491]

Firms are already subject to regulation on code quality in some circumstances. For example, the Food and Drug Administration (FDA) and the Federal Aviation Administration (FAA) have regulations for code that is placed in medical devices or in airborne systems. These regulations do not require firms to use certain code, but instead, ensure that firms consider software quality throughout the development process.[492]

For unregulated businesses, numerous critics have pointed out the generally low quality and unreliability of code. The standard explanation is that consumers find lower quality code acceptable.[493] Especially, when the tradeoff for lower quality code is the incorporation of the latest innovative features.[494] Therefore, firms have little incentive to better develop and test code to ensure its high quality.[495] We saw this in the development of Netscape's web browser. Netscape wanted to be the first browser with the cookies technology. This rapid development led to flaws in Netscape's use of the cookies technology.[496] Some critics disagree with the standard explanation. Instead, they argue that the current business model for code encourages the development of poor quality code.[497] Others argue that the market will not solve this

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[491] *See* CUSUMANO & YOFFIE, *supra* note 355 at 265-297 (discussing the differences between Microsoft and Netscape in their quality assurance testing).

[492] The FCC has regulations concerning the development of code for aviation systems. *See* Leslie A. (Schad) Johnson, *DO-178B, Software Considerations in Airborne Systems and Equipment Certification*, CROSSTALK, Oct. 1998, *available at* http://www.stsc.hill.af.mil/crosstalk/1998/oct/schad.asp (focusing on DO-17B rules); George Romanski, The *Challenges of Software Certification*, CROSSTALK, Sep. 2001, *available at* http://www.stsc.hill.af.mil/crosstalk/2001/sep/romanski.asp (discussing how to ensure safe air transportation while using computer controlled systems). Similarly, the FDA also 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 the software will operate properly. Quality System Regulation, 21 C.F.R. § 820 (1999); FDA, *Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices*, *available at* http://www.fda.gov/cdrh/ode/57.html (May 29, 1998); John K. Suzuki, *Documenting the Software Validation of Computer-Controlled Devices and Manufacturing Processes: A Guide for Small Manufacturers*, MED. DEVICE & DIAGNOSTIC INDUSTRY MAG., Jan. 1996, *available at* http://www.devicelink.com/mddi/archive/96/01/023.html (providing an overview of the process).

[493] Charles C. Mann, *Why Software Is So Bad,* TECH. REV., July 2002 (quoting Microsoft's former chief technology officer Nathan Myhrvold, "software sucks because users demand it to"). *See also* Ed Foster, *Battling the Bugs,* INFOWORLD, Jun. 17, 2002, at 69 (remarking on a growing intolerance for low quality software).

[494] Peter Coffee, *Attacking the Quality Monster*, EWEEK, Dec. 14, 1998, *available at* http://techupdate.zdnet.com/techupdate/stories/main/0,14179,377690,00.html; Joel Garreau, *Thinking Outside the Box*, WASH. POST, Mar. 19, 2001 at C01; Ricadela, *supra* note 485.

[495] There are many steps firms can take to improve the quality of code including different programming techniques. Erik Sherman, *Taking Programming to the Extreme,* TECH. REV., July 19, 2002.

[496] *See supra* text accompanying notes 108-109.

[497] Some critics argue the current business model may encourage the development of poor quality code. This occurs because the incentives for customer acquisition favor releasing a low quality code over a finished high quality

problem of low quality code. They believe that either product liability lawsuits or government regulation will be needed in the future to improve code quality.[498]

Consortia typically develop standards, not code. Nevertheless, the quality of a standard is still important. A poor standard can lead to a number of problems from confusion in the marketplace to the abandonment of the standard. In our case studies, both the IETF and the W3C produced high quality standards. This was due to the efforts of the individuals participating in the development of these standards. One notable factor on quality was the role of a public process. This was evident in the development of the IETF's standard for cookies. The public process quickly found the problems with third party cookies that Netscape had overlooked.[499]

The open source movement is capable of producing high quality code. Instead of relying on paid personnel to test quality, the open source movement depends upon its public development process. If there are enough volunteers testing the code, then problems in the code will be found and corrected.[500] The quality of identification of problems and repair for a given project depends upon the number of people and their expertise.[501] A notable incentive for finding and fixing problems is that such work leads to an increase in reputational capital within the open source community. These factors have led to the Apache's high quality code.[502]

Firms are adopting a quasi-public development process through the use of volunteer software testers. Many firms routinely release pre-release or beta versions of code to allow for

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version. Often firms never fix the initial low quality version; instead they are busy releasing new versions of code every few years. Customers, who are often locked in, are then pressured to upgrade to new versions by vendors who refuse to support older versions of products. Moreover, the customer is usually subject to an annual maintenance fee for technical support. This is how the current business model encourages the development of low quality code that needs maintenance and continual upgrading. DONALD A. NORMAN, THE INVISIBLE COMPUTER 78-82 (1998) (discussing how the current business model leads to software of unnecessary complexity); Meridith Levinson, *Let's Stop Wasting $78 Billion a Year*, CIO MAG., Oct. 15, 2001 *available at* http://www.cio.com/archive/101501/wasting_content.html (noting the problems in the current software vendors business models and how companies are fighting back).

[498] Mann, *supra* note 493.

[499] *See supra* text accompanying notes 120-125.

[500] According to Raymond, if there are enough users looking at the code then the bugs will be found and corrected. Raymond, *supra* note 262. Or according to Linus Torvald, "Given enough eyeballs, all bugs are shallow."

[501] For example, during the development of Apache thousands of people contributed bug reports. *See supra* text accompanying note 189.

[502] *See* Mockus, *supra* note 187. Another popular example is the Linux operating system. It is considered more secure and bug free than code produced by Microsoft. The explanation is that the open source movement's public review process is much better and faster than that used by firms. However, the claim of the open source movement's high quality code is backed more by anecdotal evidence that empirical research.

public feedback.[503] Microsoft and Apple even charge their users to beta test their new operating systems.[504] The testing provides information on the quality of code before the final release.[505] However, this is different from the method used by the open source movement. Firms prefer to use a beta test near the final stages of development, while the open source movement allows continuous testing.

E. Marketing and Customer Support

This section focuses on attributes of code that are often viewed as "bells and whistles." These "extras" make code more desirable and usable by people, such as interfaces that are easy-to-use, well-written documentation, and technical support. The first part discusses how institutions market their code. The next section describes how institutions differ in their ability to create easy-to-use code. Third, the role of documentation is explained. Finally, we discuss how technical support varies by institution. In each section, we begin by discussing universities, and then continue on to firms, consortia, and the open source movement. We do not discuss consortia, except for marketing, because they rely on their members to develop a product with these attributes.

1. Marketing

Once an institution develops code, the next step is the "catching of the user." That is convincing a user to adopt code.[506] This involves marketing the code. For universities, their scarce resources limit the amount of marketing they can conduct. The traditional marketing method for universities is through publishing and word of mouth. NCSA Mosaic and Berners-

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[503] CUSUMANO & YOFFIE, *supra* note 355, at 283 (noting the role of Netscape's beta testing in allowing for a larger review group and rapid user feedback). Others have recommended that firms not rely on beta testers for seeking out security flaws, instead this should be done before releasing the product. *See* COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, CYBERSECURITY TODAY AND TOMORROW: PAY NOW OR PAY LATER (2002), *available at* http://books.nap.edu/html/cybersecurity/.

[504] Joe Wilcox & Ian Fried, *Apple peels open Mac OS X beta*, CNET NEWS.COM, Sep. 13, 2000, *available at* http://news.com.com/2100-1040-245652.html (noting that Apple released its beta version of OS X for $30); Joe Wilcox, *Microsoft stumbles with XP preview*, CNET NEWS.COM, July 9, 2001, *available at* http://news.cnet.com/news/0-1003-200-6528041.html (noting that people paid $10 for the Microsoft XP beta version).

[505] *See* Coffee, *supra* note 494 (noting that cost of fixing a software defect is much less in the beta stage).

[506] Quintas, *supra* note 337, at 93.

Lee's early web browser both relied on word of mouth through the Internet discussion groups such as www-talk to gain new users.[507]

Firms have an economic motivation to create, develop, and retain customers through marketing. This is why firm market their products. This is also why firms have marketing departments devoted to this task.[508] Their task is to persuade users to adopt their code. They accomplish this by identifying potential customers, developing promotional campaigns, and formulating pricing strategies. A marketing department also provides ideas for what features are important for the code. These can be fed back into the design of code.[509]

Consortia vary on how much marketing they may conduct. For example, the W3C does not concern itself with marketing its standards. The W3C feels that these tasks are outside its mission.[510] Instead, it is up to their members to adopt and promote the standards. In our case study, the W3C never marketed PICS to software firms and the end users of PICS.[511] Other consortia may market their standards. This can encompass developing usage guidelines, certification, and branding for standards. For example, the VoiceXML consortium is developing a certification program for compliant vendors.[512]

The open source movement ignores marketing as an unnecessary extra.[513] This is natural given the heavy emphasis placed on technical issues by the open source movement. The marketing that is done is largely informal and dependent upon word of mouth communication. Anything more is generally outside the activities of the open source movement. However, the commercial possibilities of open source code have led a number of companies, most notably

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[507] *See supra* note 77 (noting NCSA Mosaic's announcement); *see supra* text accompanying note 51 (noting Berners-Lee's announcement).

[508] A. PARASURAMAN & CHARLES L. COLBY, TECHNO-READY MARKETING: HOW AND WHY YOUR CUSTOMERS ADOPT TECHNOLOGY (2001) (discussing how firms can market code).

[509] CUSUMANO & YOFFIE, *supra* note 355 at 236-37. Marketing can affect the technical goals during the design of code. *See* Kieran McCarthy, *Geeks Declare War on Intel*, SALON, Mar. 2, 2001, *at* http://www.salon.com/tech/feature/2001/03/02/intel_netburst/index.html (describing the influence of Intel's marketing department on the development of code).

[510] Khare, *supra* note 251.

[511] *See supra* text accompanying notes 163-173 (noting the problems with the implementation and use of PICS).

[512] Gerald M. Karam and Kenneth G. Rehor, *Building the VoiceXML Forum Certification Program*, VOICEXML REV., Nov. 2001, *available at* http://www.voicexmlreview.org/Nov2001/features/certification.html.

[513] This is a weakness of the open source movement—focusing tightly on the source code—and forgetting the larger structure in which source code operates. Bezroukov, *supra* note 274 (noting the need for the open source movement to recognize and address the infrastructure and implicit knowledge that software depends upon).

IBM, to begin active marketing efforts.[514] These marketing efforts are led by firms seeking to profit through the open source movement.

2. User-Friendly Code

The user-friendly attribute focuses on the ease of use of particular code. This can include an intuitive interface or the availability of third party products for use with the code. Universities do not emphasize user-friendly code. Moreover, they don't have the resources to conduct usability testing.[515] Instead, they work on developing new and innovative code. In a few cases, the innovative code is also easy to use. This occurred during the development of NCSA Mosaic. Andreessen developed NCSA Mosaic in response to the complexity of existing software for the web that intimidated novice users. Andreessen listened and responded to people's concerns and continually shaped NCSA Mosaic so it would be easy to use.[516]

Firms have a direct interest in creating accessible and user-friendly products because their sale leads to improved market share and profits. A firm's emphasis on these issues is so great hat they conduct product usability testing to ensure that consumers can easily use their products.[517] A good example of the ability of firms to create user-friendly code is the development of operating systems. Apple's latest operating system, Mac OS X, is widely praised for its ease of use.[518] Apple built this operating system on top of BSD, an open source Unix operating system.[519] The resulting code has an aesthetically pleasing interface that is easy to use and is easily interoperable with a variety of code from third parties.

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[514] IBM has pledged to spend one billion dollars on developing and promoting Linux in 2001. Joe Wilcox*, IBM to Spend $1 Billion on Linux in 2001,* CNET NEWS.COM, Dec. 12, 2000, *available at* http://news.com.com/2100-1001-249750.html.

[515] Universities do not conduct usability testing, but they do conduct research into Human-Computer Interaction, such as what is the appropriate number of links for a web page or how should error messages be phrased. *See* BEN SHNEIDERMAN, DESIGNING THE USER INTERFACE: STRATEGIES FOR EFFECTIVE HUMAN-COMPUTER INTERACTION (1998).

[516] Earlier we noted how Andreessen felt the net was years behind the computer industry, because it was not easy to do simple things such as going to FTP archives. *See supra* text accompanying note 82. Andreessen also said that the "current users [of the Internet] had little interest in making it easier. In fact, there was a definite element of not wanting to make it easier, of actually wanting to keep the riffraff out." NAUGHTON, *supra* note 36, at 241.

[517] Rob Pegoraro, *Taking Software for a Test Drive,* WASH. POST, June 22, 2001, E1 (discussing Microsoft's usability testing center); Neil Randall, *Making Software Easier Through Usability Testing*, PC MAG., Oct. 6, 1998 *available at* http://www.zdnet.com/pcmag/pctech/content/17/17/tu1717.001.html (describing how software companies perform usability testing).

[518] Charles Haddad, *OS X for the Masses*, BUS. WK., July 25, 2001, *available at* http://www.businessweek.com/bwdaily/dnflash/jul2001/nf20010725_763.htm.

[519] Joe Wilcox, *Will OS X's Unix roots help Apple grow?*, CNET NEWS.COM, May 21, 2001, *available at* http://news.com.com/2100-1040-257982.html.

The open source movement's code is biased towards the needs of its sophisticated users.[520] Their notions of user-friendly code are quite different from that of a novice.[521] Their focus is on the operation of code, with little concern to polishing and refining code for novices.[522] For example, the open source movement has been unsuccessful in creating an easy-to-use, open source, Unix operating system. The flagship of the open source movement is Linux, an open source Unix operating system. However, Linux is notoriously difficult for new users. The operating system is designed for power users. No one took the time to make features easy to use and intuitive for novices.[523] Moreover, the open source movement lacks the resources to conduct product usability testing.[524]

3. Documentation

Documentation allows users to quickly understand how a product operates. High quality documentation is known to result in safer more reliable systems.[525] Universities tend not to emphasize documentation because of their scarce resources. The documentation they provide is often minimal. In contrast, firms usually provide good documentation. For example, Netscape provided generous documentation with its early web browsers.[526] However, the documentation

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[520] *See supra* text accompanying note 342. The typical attitude of the open source movement is reflected in this statement by Eric O'Dell, the director of information services at the Gadget Guru, who sees usability and flexibility as opposing goals, "Either usability suffers or flexibility does . . . Since the hackers maintain the system, there is obviously a certain reluctance to cripple the system just to satisfy end users, who are not held in very high esteem anyway." Andrew Leonard, *Linux for Dummies*, SALON, May 11, 1999, *at* http://www.salon.com/tech/review/1999/05/11/openlinux/. However, Apple's new operating system, Mac OS X, has succeeded in making an operating system that is both usable and flexible.

[521] For example, sophisticated users are likely to seek code that runs on sophisticated operating systems, such as Linux over Windows, and provide a considerable amount of flexibility, such as a command line interface over a graphical interface. *See* Nichols et al., *Usability and Open Source Software Development*, *in* Proceedings of the Symposium on Computer Human Interaction 49 (Kemp et al. eds., 2001), *available at* http://www.comp.lancs.ac.uk/computing/users/dmn/docs/oss.html.

[522] *Id.* (noting several forms of developer biases that affect usability). Similarly, the open source encryption project, GnuPG, also suffers from an interface that is not user friendly. Bill Lamb, *Pretty Geek Privacy,* SALON, Mar. 27, 2002, *at* http://www.salon.com/tech/feature/2002/03/27/gnupg/print.html.

[523] *See* Paul Fest, *Apple, AOL Veterans Making Linux Easy,* CNET NEWS.COM, Feb. 16, 2000, *available at* http://news.com.com/2100-1040-237031.html (acknowledging the difficultly of Linux for novice users). There is also very little academic research into the usability of open source software. *See* Nichols, *supra* note 521.

[524] Through cooperation with firms, the open source movement can conduct usability testing. Suzanna Smith et al., *GNOME Usability Study Report*, *available at* http://developer.gnome.org/projects/gup/ut1_report/ (July 2001) (reporting on usability testing conducted by Sun on the open source desktop environment GNOME).

[525] N. Levenson, *Software Safety: Why, What, and How*, COMPUTING SURV., Feb. 1986, at 125; D. Parnas et al., *Evaluation of Safety-Critical Software*, 33 COMM. ACM 636 (1990); Cem Kaner, *Liability for Defective Documentation*, SOFTWARE Q, *available at* http://www.badsoftware.com/baddocs.htm (1995).

[526] The original handbook is still online *at* http://home.mcom.com/home/online-manual.html or see the version 2.0 handbook *at* http://home.netscape.com/eng/mozilla/2.0/handbook/ (last visited Feb. 5, 2002).

was selectively written to overlook features such as cookies and the referrer technology that affected privacy.[527] Eventually, media and government pressure forced Netscape to include information about cookies and the related privacy issues into their documentation.[528]

The open source movement predominately relies on its users to develop documentation.[529] This can result in high quality to poor or no documentation.[530] There is considerable variation in the quality and depth of the documentation. However, once an open source project is sufficiently popular, commercial publishers may develop documentation.[531] This has led critics to argue that the best open source documentation is produced not by the open source movement, but by commercial publishers.[532]

4. Technical Support

Technical support provides users with assistance in the installation, maintenance, and use of code. The limited resources of a university often means that technical support is neglected. One of the atypical features of NCSA Mosaic, in comparison to other university browsers, was its early emphasis on technical support.[533] The NCSA Mosaic developers worked hard at providing technical support. But eventually, the developers couldn't provide the level of technical support that the users of NCSA Mosaic requested. Naughton notes that, "Mosaic's creators were thus experiencing many of the demands of working in a commercial company – providing 'customer' support, for example – but receiving none of the rewards which normally accompany such pressure."[534] The lack of rewards reflects the university's priorities in inventing code and not maintaining code.

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[527] *See supra* text accompanying notes 110-111. The referrer technology is a feature that provides a web site with information on your previous location. Thus a web site knows the URL from which you clicked. This can be useful for a web site to understand how visitors are finding and arriving at their web site.
[528] *See supra* text accompanying notes 128-131.
[529] For example, the Apache Documentation Project *at* http://httpd.apache.org/docs-project/. Linux has a similar volunteer led site devoted to publishing documentation *at* http://www.linuxdoc.org/.
[530] *See* Nichols, *supra* note 521 (finding in a case study that the lack of professional technical writers was obvious and consequently led to problems for users).
[531] O'Reilly Publishing is notable publisher of documentation and manuals for open source software such as Apache, Perl, and Linux.
[532] Bezroukov, *supra* note 274.
[533] *See supra* text accompanying notes 78-80. *See also supra* text accompanying note 175 (noting the technical support issues with NCSA Mosaic web server).
[534] NAUGHTON, *supra* note 36, at 247. As NCSA Mosaic grew in popularity, NCSA was receiving more and more calls requiring technical support. According to Chris Wilson, a member of the initial development team for NCSA Mosaic, "the [NCSA] center was just getting swamped. They were hiring people as quickly as they could and there was no way to get through the backlog." Wolfe, *supra* note 292.

Firms typically have a formal process for technical support, such as a technical support department. The department maintains code by continually fixing problems that occur. Firms emphasize technical support as part of customer retention, and customers clearly consider technical support when purchasing code.[535]

The open source movement relies upon its users to provide technical support. This often occurs though a myriad of online materials, discussion groups, and chat rooms.[536] With the growing commercial use of open source projects, a new wave of companies, such as IBM and Red Hat, are proving technical support for open source software. These commercial providers can assure firms that they will receive timely technical support and do not have to rely on the whims of online discussion groups.[537]

F. Social Values in Code

The previous sections focused on the technical attributes of code. This section focuses on other social values that code may contain.[538] For example, the case studies on cookies and PICS show that considerations of privacy and free speech can be embedded in code. This consideration of societal values in code is especially important in cases where policymakers are seeking to shape code to address societal concerns. In this section, we explain how institutions differ in their inclusion of social values. Policymakers can use this understanding to selectively support the development of code with an institution. This section begins by discussing universities, and continues on to firms, consortia, and the open source movement. The last part of this section provides an example of a social value, privacy, to show how institutions differ in the inclusion of a social value.

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[535] *See* Wendy Dittamore, *Apple Computer: Winner of ZDNet's Support Star Award*, ZDNET, Oct. 16, 2000, *available at* http://www.zdnet.com/special/stories/main/0,11415,2635820,00.html (noting that users would buy another Apple computer based upon the quality of the technical support); Paul Festa, *PC Customer Support Ranked* CNET NEWS.COM, October 22, 1997, *available at* http://news.com.com/2100-1001-204535.html (noting that consumers are taking into account technical support when buying a computer).

[536] Karim Lakhani & Eric von Hippel, *How Open Source Software Works: "Free" User-to-User Assistance*, May 2000 (providing an empirical study of the field support for open source software, which found that users were willing to help provide support for the Apache web server).

[537] For example, Covalent Technologies provides twenty four hour technical support for Apache. Stephen Shankland, *Apache Gets Big Boost: 24 Hour Service,* CNET NEWS.COM, Sep. 15, 1999, *available at* http://news.com.com/2100-1040-221335.html.

[538] We use the term social values to refer to interests to society that are affected by code.

1. Universities

A university provides its developers considerable autonomy.[539] As a result, academic developers largely determine the values in the code.[540] This allows social, economic, or political influences to affect code by reflecting the values of the individual developers. This allows for a wide variation in values, even in similar projects by different developers. This difference in similar projects is evident in the development of web browsers by Berners-Lee and Andreessen.

Berners-Lee developed a web browser that made it very easy for people to read and write pages. He envisioned the web as a place where it would be easy for people to find new information and contribute new information. He considered it important to develop tools to make it simple to publish material. Instead of browsers, he thought of the programs as browser/editors.[541] This value of publishing was incorporated in Berners-Lee's code. In contrast, Andreessen focused on making a "cool" web browser. He added visually enhancing features such as multimedia and the inclusion of online images.[542] He was not concerned with developing a web browser that allowed people to create content. Instead, his code valued the presentation of content.[543]

2. Firms

The goal of firms is to develop profitable code. To this end, they include attributes that are profitable. For example, firms profit from code that allows visually impaired people to use computers.[544] In this case, firms are producing code that supports societal values.[545] However, firms may not produce code that supports unprofitable but socially beneficial values. This is because firms seek to meet the needs of consumers and not society in general, a phenomenon

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[539] *See supra* text accompanying notes 286-289.

[540] Of course, universities and government can selectively fund different researchers' code, thus shaping the inclusion of societal values into code. *See* Sarah Stein, *The Media Production Model: An Alternative Approach to Intellectual Property Rights in Distributed Education*, EDUCAUSE REV., Jan/Feb 2001 (suggesting incentives to spur the development of code within universities).

[541] *See supra* text accompanying notes 84-87.

[542] *See supra* text accompanying notes 88-89.

[543] The reason for this difference is both developers are seeking recognition from different peer groups. *See supra* text accompanying notes 278-282.

[544] Lighthouse International*, Introduction to Adaptive Technologies, available at* http://www.lighthouse.org/resources_adaptive_tech.htm (last visited July 17, 2001) (providing an overview of adaptive technologies as well as a listing of manufacturers).

[545] *See* David Colker, *Giving Disabled A Voice,* L.A. TIMES, Apr. 8, 2002 (describing the role of firms in providing technologies for disabled people).

known as market failure.[546] This is not surprising and is a consequence of the structure and motivation of a firm.[547] This section discusses market failure from the perspective of economic efficiency as well as ethically based forms of market failure.

This part discusses four types of market failure from the perspective of economic efficiency. First, market failure occurs as a result of externalities. This transpires when the market price of a product does not reflect the costs that its use and production impose upon society.[548] The classic example is how industrial pollution is usually not accounted for in the manufacture of a product.[549] Similarly, security is an externality, which is a cost not accounted for in the production of code. The costs of security have reached trillions of dollars, and a single virus incident that affects Microsoft-based computers can cost over a billion dollars.[550] Commentators have argued that Microsoft ignores security as a deliberate business decision.[551] It believes that ease of use is more important than security.[552] However, the lack of security in Microsoft's products affects everyone by propagating viruses, reducing bandwidth across the Internet due to spurious traffic, and creating insecure machines that are then used to attack other machines across the Internet. Since Microsoft doesn't pay for this cost, this naturally leads to

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[546] Stephen Breyer, *Analyzing Regulatory Failure: Mismatches, Less Restrictive Alternatives, and Reform,* 92 HARV. L. REV. 549 (1979); JOE WALLIS & BRIAN DOLLERY, MARKET FAILURE, GOVERNMENT FAILURE, LEADERSHIP AND PUBLIC POLICY (1999); Robert McChesney, *The Internet and U.S. Communication Policy-Making in Historical and Critical Perspective*, 46 J. COMM. 98, 105-06 (1996) (noting the differences between citizens and consumers for communication technologies).

[547] *See supra* text accompanying note 308.

[548] Breyer, *supra* note 546, at 555; WALLIS & DOLLERY, *supra* note 546, at 17.

[549] An example of a positive externality is investment in research and development, which provides a benefit to the society that exceeds its cost.

[550] Lucy Sherriff, *Network Downtime Costs Planet $1.6 trillion*, REGISTER, Nov. 7, 2000, *available at* http://www.theregister.co.uk/content/6/11880.html; M.J. Zuckerman, *Feds Warn of Holiday Hackings*, USA TODAY, Dec. 14, 2000.

[551] Elinor Mills Abreu, *Microsoft: Bad security, or bad press?*, CNN, Sep. 28, 1999, *available at* http://www.cnn.com/TECH/computing/9909/28/ms.security.idg/ (noting several problems with security in Microsoft's products); Joseph Menn, *Security Flaws May be Pitfall for Microsoft*, L.A. TIMES, Jan. 14, 2002 (speculating that Microsoft's security woes may threaten its future).

[552] Robert X. Cringely, *The Death of TCP/IP: Why the Age of Internet Innocence is Over*, Aug. 2, 2001, *available at* http://www.pbs.org/cringely/pulpit/pulpit20010802.html; Paul Thurrott, *A Vulnerable Future for Windows XP Users*, WIN2000 MAG., July 26, 2001, *available at* http://www.win2000mag.com/Articles/Index.cfm?ArticleID=21939 (quoting Internet security expert Steve Gibson, "Microsoft is a marketing company, not a technology company. They're only going to sell what people want, and right now that's ease of use."); *Frontline: Hackers* (PBS television broadcast Feb. 13, 2001), *available at* http://www.pbs.org/wgbh/pages/frontline/shows/hackers/etc/script.html (according to Steven B. Lipner, a Microsoft Senior Security Analyst, "usability, flexibility, security are a set of trade-offs" and Microsoft has chosen convenience over security).

Microsoft's code overlooking the social value of security thereby imposing this negative externality on others.[553]

Second, market failure arises in the production of public goods.[554] Public goods are non-excludable and non-rivalrous in consumption. The classic examples of public goods are property rights, national defense, and infrastructure, such as highways. Similarly, there are code-based goods that have some characteristics of a public good such as standards,[555] open source code, [556] and code that addresses issues such as education and energy conservation.[557] These are examples of goods that will be underprovided or not provided for by firms.

Third, market failure occurs when markets are monopolistic or oligopolistic, instead of being competitive. With information technologies, there are two phenomena that can lead to uncompetitive markets. First, is the issue of lock-in and switching costs, which can lead to uncompetitive markets.[558] Government may have to intervene if switching costs are so high that they are acting as a barrier to entry for competitors. Second, network effects may lead some markets towards monopoly.[559] For example, communication networks become more valuable as they become large and that can result in a monopolistic market.[560]

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[553] Microsoft may be beginning to correct their security flaws. Recently, Bill Gates sent out an email declaring that security and privacy are instrumental and more important than new features in Microsoft's products. However, it is not clear whether this is merely lip service or whether substantial resources will be put forth to correct security flaws. *See* Robert Lemos & Margaret Kane, *Gates: Security is top priority*, CNET NEWS.COM, Jan. 17, 2002, *available at* http://news.cnet.com/news/0-1003-200-8509737.html (quoting Bill Gates, "When we face a choice between adding features and resolving security issues, we need to choose security. . . Our products should emphasize security right out of the box."). Microsoft did begin requiring programmers to attend half-day training sessions on writing secure software. *See* John Markoff, *Microsoft Programmers Focus on Secure Software,* N.Y. TIMES, Apr. 8, 2002.

[554] WALLIS & DOLLERY, *supra* note 546, at 18-19.

[555] Other goods, 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.
Cargill, *supra* note 228 (quoting OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, GLOBAL STANDARDS: BUILDING BLOCKS FOR THE FUTURE 14 n.23 (1992)).

[556] Open source code is available to everyone and one person's use does not affect another's use. *See* Lerner, *supra* note 273 (noting that open source code is a public good).

[557] Michael C. Lovell, *Sponsoring Public Goods: The Case of CAI on the PC,* 22 J. ECON. EDUC. 39 (1991) (arguing that the under supply of educational software occurs because it is a public good); *see infra* text accompanying note 921 (discussing the government's development of software to save energy).

[558] *See supra* note 408.

[559] *See supra* note 409.

[560] *See* 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, 152 (2001) (noting how network effects are pushing the Internet backbone towards monopoly).

Fourth, market failure can occur because of incomplete information or an asymmetrical allocation of information.[561] The classic example is the used car market, where the seller of used cars possesses much better information about the cars, and as a result, the lemons will crowd out the good used cars.[562] The history of cookies illustrates how consumers have less information than firms. Cookies are a technology that allows web sites to maintain information on their visitors. Netscape viewed the cookies technology as economically valuable.[563] Netscape then proceeded to incorporate the cookies technology and turn the feature on. However, Netscape never incorporated tools that would allow users to manage cookies in their browsers. Moreover, Netscape didn't notify users about the cookies technology.[564] They probably understood that if consumers knew about this feature, this could have led to a privacy backlash against cookies and lowered the adoption of the Netscape browser. This is an example of a firm exploiting the informational asymmetry between firms and consumers.

The second justification for market failures is not based on economic efficiency, but on ethical considerations. There are three types of market failures that can arise even when markets are efficient.[565] First, market failure occurs when redistribution of goods does not result in social standards of equity.[566] This is why there are programs such as universal service, which ensure that all citizens have access to telecommunications.[567] A second market failure occurs when people do not act in their own self-interest.[568] This calls for paternalism. An example of paternalism affecting code was the restriction on the transmission of indecent content to minors. A third market failure occurs when the market does not allow everyone equal opportunity for

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[561] Breyer, *supra* note 546, at 556; WALLIS & DOLLERY, *supra* note 546, at 19-20.
[562] George A. Akerlof, *The Market for "Lemons": Quality Uncertainty and the Market Mechanis*m, 84 Q.J. ECON. 488 (1970).
[563] If cookies were merely seen as a privacy hazard with no useful benefit they would have likely been eliminated. For example, Microsoft altered its software after it became public that Global Unique Identifiers for computers were being sent to Microsoft. Microsoft had little use for this information. This is not the usual case, since a lack of privacy usually results in useful information on consumer behavior that firms can use or sell. John Markoff, *Microsoft to Alter Software in Response to Privacy Concerns*, N.Y. TIMES, Mar. 7, 1999.
[564] Netscape never told users about cookies or provided any documentation on cookies and their privacy implications. *See supra* text accompanying notes 110-111.
[565] CHARLES WOLF, MARKETS OR GOVERNMENTS: CHOOSING BETWEEN IMPERFECT ALTERNATIVES (1988). *See also* CASS R. SUNSTEIN, AFTER THE RIGHTS REVOLUTION 55-73 (1990) (discussing non-market failure justifications for regulation).
[566] WALLIS & DOLLERY, *supra* note 546, at 22.
[567] Robert M. Frieden, *Universal Service: When Technologies Converge and Regulatory Models Diverge*, 13 HARV. J.L. & TECH. 395 (2000). *See also* Harmeet Sawhey, *Universal Service: Prosaic Motives and Great Ideals,* 38 J. BROADCASTING & ELECTRONIC MEDIA 375 (1994) (arguing that universal service is actually less about the goodness of the human heart and more about private groups advancing their own agendas).
[568] Breyer, *supra* note 546, at 559-60; WALLIS & DOLLERY, *supra* note 546, at 22.

fundamental rights.[569] This leads to government intervention to ensure that everyone has an equal opportunity, regardless of race, gender, ethnicity, or disability, in areas such as education and employment. For example, government intervention has required code to be capable of being accessed by disabled citizens.[570]

3. Consortia

A consortium's response to societal values is influenced by its structure. This section focuses on the how the goals, membership, and the development process within a consortia influence the incorporation of societal concerns. First, we note that consortia differ in their willingness to develop standards that address societal values. Second, we note the role of the development process on the inclusion of societal values. Finally, we note how the decision-making process can affect the societal values in code.

The PICS case study showed how a consortium setting allowed industry to cooperate in addressing a societal concern. This was a fitting purpose since firms individually would not support an unprofitable societal value. This led James Miller, a co-developer of PICS to state, "[I]ndustry has never demonstrated, and it continues with the privacy stuff to demonstrate that unless a very serious external threat is imposed it will not get together and unify with any speed to address any serious vital issue."[571]

The disadvantage of the consortium approach is that it may address a societal concern in a way that benefits the consortium's members over the general public. For example, PICS was designed by the W3C to address societal concerns about access to inappropriate material by minors. However, PICS failed to make a significant difference in children's access to inappropriate material because the solution produced by the W3C was more about avoiding threatened regulation than addressing the societal problem. Similar criticisms have been laid at the W3C's efforts on addressing privacy concerns.[572] Jason Catlett of Junkbusters believes that

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[569] WALLIS & DOLLERY, *supra* note 546, at 23.
[570] Examples of this include the Americans with Disability Act, closed captioning for television, and the text telephone (TTY). *See infra* note 601.
[571] Interview with James Miller, *supra* note 135.
[572] The W3C is working on a project to address privacy concerns through a technological measure titled the Platform for Privacy Preferences (P3P). Once again, a consortium appears a natural solution to political pressure and potential regulation. The W3C's members are trying to head off government regulation by claiming an industry solution or self-regulation for privacy. In the case of P3P, the W3C has worked with industry to ensure that P3P will be widely adopted by the software vendors, such as Microsoft. However, in doing so, they have neglected the end user and built a product that reflects the industry's view of privacy and not the expectations of most people. *See*

the real motive behind the W3C's efforts is not user privacy, but to stave off potential legislation on privacy.[573] So while a consortium may address societal concerns, it is biased by its reliance on its members' efforts and motivations.[574] As a result, a consortium's product may be of marginal value to society.

The development process can affect the inclusion of societal values in code for a consortium. Specifically, social concerns may be manifested to different degrees during the development process depending upon the consortium's membership. For example, by including a diverse pool of contributors, the IETF is more sensitive to societal concerns during the development process. The IETF's standard on cookies was more responsive to privacy due to the diversity of its participants. Koen Holtman, who participated in the discussion, had a distinctively different attitude towards privacy than most Americans because he was European. His different perspective led him to point out the privacy problems with cookies that others had disregarded.[575]

The decision-making process at a consortium can also affect the inclusion of societal values. A consortium can be structured to allow for public review during the decision-making process. For example, the IETF's open membership and emphasis on rough consensus affected the development of the cookies standard. Rough consensus allowed members of the IETF to

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Christopher D. Hunter, *Recoding the Architecture of Cyberspace Privacy: Why Self-Regulation and Technology Are Not Enough*, International Communication Association Convention, Acapulco, Mexico, *available at* http://www.asc.upenn.edu/usr/chunter/net_privacy_architecture.html (June 2000); Roger Clarke, *P3P Revisited*, *available at* http://www.anu.edu.au/people/Roger.Clarke/DV/P3PRev.html (Mar. 20, 2001) ("The key proponents of the P3P protocol have laboured long and hard in an endeavour to deliver a PET, but the interests of W3C's members have resulted in it being watered down to a mere pseudo-protection."); Electronic Privacy Information Center & Junkbusters, *Pretty Poor Privacy: An Assessment of P3P and Internet Privacy*, June 2000, *available at* http://www.epic.org/reports/prettypoorprivacy.html. A few supporters have argued that P3P is not the solution to privacy issues, but is a step in the right direction. Center for Democracy & Technology, *P3P and Privacy: An Update for the Privacy Community*, Mar. 28, 2000, *available at* http://www.cdt.org/privacy/pet/p3pprivacy.html. *See also* Lorrie Faith Cranor and Joseph Reagle, *Designing a Social Protocol: Lessons Learned From the Platform for Privacy Preference, in* TELEPHONY, THE INTERNET, AND THE MEDIA (Jeffrey K. MacKie-Mason & David Waterman eds., 1998) (providing a discussion of the technical and policy decisions for P3P); The W3C's web page with background info on P3P is *at* http://www.w3c.org/P3P/.

[573] Joab Jackson, *Suspicious Minds*, ALTERNET, July 5, 2000 *available at* http://www.alternet.org/story.html?StoryID=9409; Simson Garfinkel, *Can a Labeling System Protect Your Privacy,* SALON, July 11, 2000, *at* http://www.salon.com/tech/col/garf/2000/07/11/p3p.

[574] This reliance is evident in the move away from addressing social issues by the W3C. The initial agenda has been toned down and become more technically oriented. Khare, *supra* note 251 (describing the evolution of the Technology & Society Domain).

[575] According to Holtman, "Americans are much more willing to have others use and re-sell personal data . . . Such use and re-selling is common practice in the US, while [it is] bound to strict legal rules or outright forbidden in most European countries. These legal rules reflect the attitude of many Europeans, they are just not some laws which nobody cares about." Email from Koen Holtman, History of Cookies (Aug. 24, 1999) (on file with author).

consider a wider array of values other than merely profitable ones. David Kristol stated that he was under tremendous pressure to ignore the privacy and security problems of third party cookies.[576] But under the IETF's decision-making structure, he had enough freedom to resist these pressures. As a result, the IETF's standard for cookies addresses privacy and security concerns.

4. Open Source Movement

The open source movement consists of thousands of diverse developers. As a result, the open source movement is subject to a variety of influences. This is often manifested in the wide-ranging values of open source code that sometimes includes the marginal values of society. Our first point is that the open source movement is less subject to the dominant economic and political influences. Secondly, we note that the open source movement is biased by the societal concerns of its members. Our third point notes how the open source movement can be influenced by bottom-up social influences. Finally, we discuss how the open source movement's support of modularity can allow for the development of code that supports a mosaic of social values.

Developers within the open source movement have a considerable amount of autonomy. This international group of volunteer developers decides the code's values. As a result, the open source movement is less subject to the dominant economic and political influences. The inclusion of politically, economically, or socially unpalatable features can be seen in open source code, such as the open source web browser Mozilla and file sharing programs. Mozilla includes the ability to block images from third party web sites as well as pop-up advertising windows. File sharing programs, such as Gnutella, have facilitated widespread piracy.[577]

The open source movement is biased by the societal concerns of its members, which are not always representative of the public. Despite the diversity of open source developers, they often share similar beliefs about some issues.[578] For example, the open source movement has not addressed the issue of children's access to inappropriate material on the Internet. This is not surprising given the anti-censorship inclination of the open source movement. These similar beliefs can shape the development of open source code because of its dependence on volunteer

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[576] Kristol, *supra* note 113, at 23.
[577] *See supra* text accompanying notes 343-349.

developers. This shows how the development of code within the open source movement is shaped by its members' proclivities.

The open source development process also allows for bottom-up social influences. By allowing the public to comment and participate in the design, there is room for bottom-up pressure. This bottom-up pressure is not necessarily from programmers, but could involve others who participate and support open source projects in other ways.[579] One manifestation of bottom-up pressure is through the use of wish lists where the public can request new features.[580] This is under exploited, but it is useful to ensure that developers are cognizant of the needs of users.

The open source movement's use of modularity is capable of simultaneously supporting diverse social values.[581] Through modularity, users can choose the modules that best support their values. For example, consider the modular open source browser Mozilla. Modularity of the browser code means that it will be possible to customize the browser. For example, a browser could be constructed to only visit children-oriented sites, as rated by PICS. Or a browser could be modified to not accept third-party cookies. Or the browser's bookmarks could also be customized so as to contain a set of religious sites. The modularization of the open source code makes it possible to select values from a mosaic of code.[582]

5. Privacy as an Illustration of Institutional Differences

This section shows how code developed by different institutions can differentially affect a societal value. The value under consideration is informational privacy. This section begins by discussing how universities address privacy, and then continues on to firms, consortia and the open source movement.

Universities provide their developers with considerable autonomy. This allows them to focus on developing code without having to incorporate features that may compromise privacy.[583] There are researchers actively working to incorporate privacy technologies into code,

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[578] The culture of the open source movement is just beginning to be addressed. *See* MOODY, *supra* note 88.
[579] Members can provide material resources, other services such as documentation, or just watch over the process as an interested user.
[580] For example, Mozilla has a wish list that allows people to vote on features they think are important. This information is seen by developers as an aid to help them see what the users want. *See* http://mozilla.org/wishlist-faq.html.
[581] *See supra* text accompanying notes 441-442.
[582] LESSIG, *supra* note 1, at 225.
[583] For example, the cookies technology was not considered or developed within a university.

for example, by designing a web browser that is sensitive to issues of privacy.[584] Moreover, others argue that universities should lead by example by developing and using technologies in ways that are sensitive to privacy.[585]

Firms are likely to support privacy to the extent that it is profitable. As a result, there are a number of firms selling code that people can use to protect their privacy.[586] However, as a general matter, firms are not emphasizing privacy features in their code. This is due to market failures. Lessig argues that this market failure can be addressed by treating personal information as property.[587] Providing a legal entitlement over personal information could lead to the development of code that allows people to control this property. Other commentators argue that additional forms of market failures, which arise from information asymmetries and other factors, means that a property-based approach is insufficient to induce the development of code that considers privacy.[588] The result of this is that a firm "is eager to spy on us to create its marketing lists and profiles while, at the same time, seeking to keep this process opaque and refusing to grant basic fair information practices."[589] These market failures have led to the under production of code that embodies the basic value of privacy.[590]

Consortia may be structured to deal with societal issues such as privacy. For example, the W3C is working on a privacy project titled P3P, because it met the needs of its members.[591] In contrast, the W3C chose not to work on cookies. According to Roger Clarke, he raised this matter with Berners-Lee. According to Clarke, the "W3C avoided the matter entirely, reflecting the increasing constraints on its freedom of action arising from its desire to avoid upsetting its

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[584] Batya Friedman et al., *Informed Consent in the Mozilla Web Browser: Implementing Value-Sensitive Design,* Proceedings of the Thirty-Fifth Annual Hawaii International Conference on System Sciences (2002). The project page can be found at http://www.ischool.washington.edu/SecurityandValues/index.html.
[585] Dan Carnevale, *Logging in with Laura J. Gurak,* CHRON. HIGHER EDUC., Feb. 19, 2002, *available at* http://chronicle.com/free/2002/02/2002021901t.htm.
[586] Courtney Macavinta, *Net tools store info but stir concerns*, CNET NEWS.COM, October 8, 1999, *available at* http://news.cnet.com/news/0-1005-200-811310.html (discussing a number of privacy protection products, while also noting that consumer advocates warn that such programs do not always protect users' privacy and could wind up helping corporations collect even more data about customers).
[587] Lawrence Lessig, *Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 520 (1999). There are critics of this approach. *See* Paula Samuelson, *Privacy as Intellectual Property*, 52 STAN. L. REV. 1125 (2000); Jessica Litman*, Information Privacy/Information Property*, 52 STAN. L. REV. 1283 (2000).
[588] Paul M. Schwartz, *Beyond Lessig's Code for Internet Privacy: Cyberspace Filters, Privacy-Control, and Fair Information Practices*, 2000 WIS. L. REV. 743.
[589] Paul M. Schwartz, *Internet Privacy and the State*, 21 CONN. L. REV. 815, 853 (2000).
[590] Abreu, *supra* note 803 (noting that David Sobel, general counsel of the Washington, D.C.-based Electronic Privacy Information Center said that "I think it's generally true that most users are not going to pay for any (additional) services or features.").
[591] *See supra* text accompanying notes 572-574.

corporate sponsors."[592] Besides differences in deciding what projects to pursue, a consortium's membership and decision-making process can affect its consideration of societal concerns. For example, the IETF's public review process was concerned about the privacy risks with cookies.[593]

The open source movement is not as influenced by economic incentives to violate privacy. So we would expect the development of code to protect privacy. However, there is not a wide array or even a single good open source program to protect people's privacy. This is because there is no coordinated effort in the open source movement to develop tools to protect privacy. Moreover, there is little work on developing such code. For example, a search on the popular open source web site, SourceForge, finds only one working project that addresses problems with privacy and cookies.[594] Moreover, this program was originally created by a firm and then released to the open source movement. So while the open source movement has improved the code, it did not initiate its development.

There are two explanations for the lack of development of privacy tools for the general public. First, the open source community is technically sophisticated, and therefore, does not suffer from an informational asymmetry regarding privacy. That is, they understand the privacy risks with code as well as how to use code to limit privacy losses. A second more cynical explanation concerns the motivations of developers that seek peer recognition and prestige for career advancement. These developers abstain from working on privacy features because these privacy features are not desired by the firms that the developers are seeking to impress.

VII. Ensuring Public Accountability: How Society Can Shape Code

Thus far, this Article has focused on how the production of code is influenced by societal institutions. This part builds upon this and describes how society can shape these institutions in order to shape the development of code to meet specific societal concerns.[595] Simply put, society is not stuck with the legislators of cyberspace as they are, but can shape them. This allows

[592] Roger Clarke, *Cookies*, *available at* http://www.anu.edu.au/people/Roger.Clarke/II/Cookies.html (last modified, Jan. 13, 2001).
[593] *See supra* text accompanying notes 120-125.
[594] This program is Privoxy and provides filtering capabilities for protecting privacy, filtering web page content, managing cookies, controlling access, removing ads, and stopping pop-ups ads, *at* http://www.privoxy.org/.

society to shape code so it may address issues such as innovation, competition, or the general public welfare.

This part builds upon previous work by Reidenberg and others on how society can affect the production of code.[596] Our goal is to show the various tools available to policymakers to shape code. The first section focuses on how government can use its regulatory power to shape the development of code. Next, we focus on how government can use its fiscal power to influence the development of code. The final section discusses how public interest organizations can contribute to the development of socially beneficial code.

In each of these sections, society is acting differently to shape code. Government's regulatory power requires developers to modify code in particular ways. In contrast, the government's use of its fiscal power generally supports or favors a particular form of code over others. The shaping of code by public interest organizations can be manifested in many ways, but it is most importantly non-governmental action. Our case studies have shown us the importance of all three of these approaches in shaping code. Moreover, the findings in the case studies have led us to offer a few specific policy recommendations for how government ought to shape code. However, we do not attempt the immense task of determining the comparative efficiency of these different approaches to shaping code, because, in part, that analysis is a factually laden inquiry that depends on the specific characteristics and issues related to the code in question. Typically, when societal concerns are not being addressed in the marketplace, society uses a combination of these approaches to shape code.

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[595] MICHAEL E. PORTER, THE COMPETITIVE ADVANTAGE OF NATIONS 620 (1990) (explaining how government shapes the context and institutional structure of firms).

[596] Reidenberg explicitly addresses how public policy can change code. Joel Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553, 588-92 (1998). *See also* STUART BIEGEL, BEYOND OUR CONTROL? CONFRONTING THE LIMITS OF OUR LEGAL SYSTEM IN THE AGE OF CYBERSPACE (2001) (providing a broad framework for regulating cyberspace). *See generally* David M. Hart, *U.S. Technology Policy: New Tools for New Times*, NIRA REV., Summer 1998, at 3, *available at* http://www.nira.go.jp/publ/review/98summer/hart.html (providing a good summary of the various methods the government can use to shape the development of technologies); OFFICE OF TECHNOLOGY ASSESSMENT, GOVERNMENT INVOLVEMENT IN THE INNOVATION PROCESS (1978) (discussing various methods for government to shape technologies).

A. *Shaping Code Through Regulatory Methods*

The government can shape code with its regulatory power.[597] The government has many rationales for intervening in the design of code such as antitrust,[598] national security,[599] intellectual property rights,[600] and the public welfare.[601] For example, PICS was developed as a

[597] Considerable support has amassed for the principle that government has a role in regulating the Internet. LESSIG, *supra* note 1, at 201-02; Netanel, *supra* note 18; Reidenberg, *supra* note 596; Kesan & Shah, *supra* note 560; Jay P. Kesan & Andres A. Gallo, *Neither Bottom-Up Nor Top-Down: A Tacit Public Private Cooperative Solution for Internet Regulation* (forthcoming); Paul Schiff Berman, *Cyberspace and the State Action Debate: The Cultural Value of Applying Constitutional Norms to "Private Regulation",* 71 COLO. L. REV. 1263 (2000); Henry H. Peritt, *Towards a Hybrid Regulatory Scheme for the Internet*, 2001 U. CHI. LEGAL F. 215; Margaret Jane Radin & R. Polk Wagner, *The Myth of Private Ordering: Rediscovering Legal Realism in Cyberspace,* 73 CHI.-KENT L. REV. 1295 (1998). Even libertarians agree that the government may have a role in regulating the Internet. *See* David Post, *What Larry Doesn't Get: Code, Law, and Liberty in Cyberspace*, 52 STAN. L. REV. 1439 (2000).

[598] For example, in the Microsoft antitrust trial the government is attempting to restrain Microsoft from using its code for illegal competitive advantages. Microsoft has "commingled" the code of its Internet Explorer browser and the 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 consumers. The illegal commingling was upheld by the U.S. Court of Appeals for the District of Columbia. *See Appeals court rejects Microsoft, government requests*, ZDNET, Aug. 2, 2001, *available at* http://www.zdnet.com/eweek/stories/general/0,11011,2801117,00.html. *See also* Kesan & Shah, *supra* note 560, at 195 (noting how government modified code for competition during the privatization of the backbone network).

[599] For national security reasons, the government has restricted the sale of code. *See* Steven B. Winters & John A. Blomgren, *How the US Government Controls Technology,* 19 COMPUTER & INTERNET LAW. 1 (2002). The U.S. Government restricted the export of code containing strong encryption until 2000. This law led to companies, such as Netscape, having to market a weaker encryption version of their browser for download outside of the United States. In January 2000, a new encryption policy allowed the export of strong encryption in programs to most of the world. David E. Sanger & Jeri Clausing, *U.S. Removes More Limits on Encryption Technology*, N.Y. TIMES, Jan. 13, 2000, *available at* http://www.nytimes.com/library/tech/00/01/biztech/articles/13export.html. Relatedly, the government eased export restrictions on the fastest computers. John Markoff, *White House Eases Exports*, N.Y. TIMES, Jan. 11, 2001, *available at* http://www.nytimes.com/2001/01/11/technology/11EXPO.html. 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, *available at* http://www.wired.com/news/conflict/0,2100,47635,00.html.

[600] To protect intellectual property rights, the government uses both civil and criminal penalties. The government effectively shut down the music-trading program Napster for copyright violations. John Borland, *Database "upgrades" keep Napster down*, CNET NEWS.COM, July 6, 2001, *available at* http://news.cnet.com/news/0-1005-200-6443598.html. The government has begun prosecution of a programmer who wrote a program that circumvented Adobe's E-book format. Amy Harmon & Jennifer Lee, *Arrest Raises Stakes in Battle Over Copyright*, N.Y. TIMES, July 23, 2001; Roger Parloff, *Free Dmitry? Spare Me: Why the FBI Was Right to Arrest the Internet's Latest Martyr*, INSIDE.COM, Aug. 01, 2001, *available at* http://www.inside.com/product/Product.asp?pf_id=%7BE8EECFA3-CBD1-447E-952C-CC16283D266C%7D (providing an excellent review of the facts and circumstances around Dmitry Sklyarov's arrest).

[601] The government regulates the design of code for the public welfare. For example, the government has required television manufacturers to incorporate closed captioning for the hearing impaired. Closed Caption Decoder Requirements for Television Receivers, 47 C.F.R. § 15.119 (2002); The FCC page on closed captioning is *at* http://www.fcc.gov/cib/dro/caption.html. Similarly, the government has required television manufacturers to incorporate the "V-chip" which allows parents to block inappropriate television programs. Requirement for Manufacture of Televisions that Block Programs, 47 U.S.C. § 303(x) (2001); The FCC page on the V-Chip is *at* http://www.fcc.gov/vchip/legislation.html. Finally, the FAA and the FDA regulate the development of code for the safety of society. *See supra* note 492. A final example is the requirement that federal agencies must become

response to government regulation restricting online communications to minors.[602] Government regulation of code is analogous to the regulation of the architecture of our buildings and cities,[603] or the regulation of transportation,[604] the environment,[605] or biotechnology.[606] Regulations for code could focus on societal concerns such as security, privacy, and the protection of minors.

This section provides a framework of various regulatory tools and analyzes how they may be used to shape code. We do not attempt to formulate a simplistic model for how government should shape code. Instead, we attempt to provide a framework so as to highlight some of the critical issues that must be addressed in using any specific regulatory approach. This approach is preferable over a simplistic formulistic approach that is bound to fail because of numerous and varied factors that affect any attempted government regulation.[607]

This section discusses six ways the government may use its regulatory power to affect the development of code. The first four sections focus on how government can regulate a technology causing harm. First, government can prohibit or restrict the development or use of a technology. Second, the government can regulate code through the use of standards. This is often termed the command and control approach to regulation. Third, the government can shape code through market-based incentives regulation, such as taxes. Fourth, contract law and tort law can be used to prevent harm by changing liability. The fifth section details the use of mandated disclosure as an alternative to directly shaping code to address a societal harm. The sixth section discusses how government can shape code by redefining intellectual property rights. Finally, we urge the government to establish a coordinated strategy between governmental agencies for the regulation of code.

1. Prohibiting Code

One method of shaping code is through prohibition. Unlike regulation, which allows a certain level of a technology or activity, a prohibition holds there is no acceptable level within

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disability friendly. This has created demand for code that allows the development of accessible web sites. Carrie Johnson, *A More Accessible Web*, WASH. POST, Aug. 21, 2000, Page E01.

[602] *See supra* text accompanying notes 138-140.

[603] This literature encompasses urban planning through zoning and architecture through building codes. *See* JOHN LEVY, CONTEMPORARY URBAN PLANNING (1999); INTERNATIONAL BUILDING CODE (2000).

[604] ROBERT W. CRANDALL ET AL., REGULATING THE AUTOMOBILE 155-56 (1986).

[605] PETER S. MENELL & RICHARD B. STEWART, ENVIRONMENTAL LAW AND POLICY (1994).

[606] MICHAEL J. MALINOWSKI, BIOTECHNOLOGY: LAW, BUSINESS, AND REGULATION (1999)

[607] STEPHEN G. BREYER, REGULATION AND ITS REFORM 4-11 (1982) (discussing the rationale for using a framework approach in his work on government regulation).

society.[608] Prohibited technologies and activities can involve national security, public safety, and environmental concerns.[609] For example, in our case study of PICS, the government prohibited the transmission of indecent and obscene material to minors in the CDA. In this section, we first present the chief criticisms of the government's use of prohibition as a regulatory mechanism. The remaining section addresses these criticisms and shows how prohibitions can be used to shape code.

There are three major criticisms with the use of government prohibition. The first is that prohibition is an economically inefficient means of regulation because its cost is much higher than its benefit. The cost is high because a prohibition does not allow for potentially beneficial uses.[610] Critics suggest that a less costly approach is to use regulation with standards or require the use of product warnings. A second criticism concerns the high cost of enforcing a prohibition on code. The easy reproduction and transmission of code in a software format makes enforcement difficult. For example, in the DeCSS case, members of the hacker community distributed a program that deciphered the encryption used to protect DVDs.[611] In a short time, this code spread across the world and is still readily available despite the efforts of the movie industry to stifle its distribution. The final criticism concerns the negative effect of prohibition on innovation. By not allowing the development or sale of a technology, the government is closing off a path for future research and development. This is especially relevant in emerging areas of technological development. This argument is most pointedly made in the recent debate over the use of stem cells. Proponents of stem cell research argue that limiting research could stifle the development of important medical breakthroughs that would save lives.[612]

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[608] 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. For example, not allowing the baby Bells into the long distance market until they allow for competition in the local market. *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).

[609] For example, banning of predatory fish, such as the snakehead fish. Here the government is saying, that it is in the interest of society that people do not have access to these fish. The potential costs to society are too great. *See Snakehead Fish Found in Seven U.S. States,* CNN.COM, July 23, 2002 (discussing a forthcoming ban on snakehead fish).

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

[611] David M. Ewalt, *DeCSS Case Could Change Your IT Shop,* INFORMATIONWEEK, July 16, 2001, *available at* http://www.informationweek.com/story/IWK20010711S0010.

[612] Office of the Director, National Institutes of Health, *Stem Cells: A Primer*, *available at* http://www.nih.gov/news/stemcell/primer.htm (last visited Aug. 3, 2002).

Despite these criticisms, prohibitions can be an efficient means of regulation. For a prohibition to be efficient, it should only be employed when the costs of no prohibition to society so greatly outweighs the needs of some citizens.[613] In these cases, society cannot permit a balance between the needs of a small set of citizens and the overall costs to society.[614] Because regulations serve to provide an acceptable level of a technology or activity within society, when no such a balance is acceptable, prohibition becomes necessary. For example, the standard for banning a product by the Consumer Product Safety Commission is that if "no feasible consumer product safety standard . . . would adequately protect the public from the unreasonable risk of injury."[615] Examples of technologies that have been banned include polychlorinated biphenyls (PCBs),[616] chlorofluorocarbons (CFCs),[617] and, without suggesting an equivalence amongst these examples, anti-circumvention code.[618] These are all technologies that society has deemed unacceptable in any measure.

A prohibition's enforcement costs are generally much lower than other regulatory actions. It is much simpler to enforce a ban on all uses of a technology than trying to draw lines by limiting a product or activity. Once government allows some use, then enforcement costs rise because it is much more difficult to ensure a product is only being used or sold for its "permitted" uses. Another factor that can lower the cost of enforcement is the availability of substitutes. Substitutes that impose lower social costs can reduce demand for the prohibited product, thus easing enforcement of the prohibition. However, the lack of substitutes and continuing high demand for the prohibited product risks the creation of an illegal market. The ongoing drug war is a good example of this issue. The lack of substitutes for narcotics and the high demand has led to the formation of a vast illegal market. Thus, our analysis suggests that prohibitions are most efficient when enforced broadly across society and when users have access to substitute products.

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[613] The cost here is not purely economic cost, but social cost. There are many prohibitions based on moral grounds, such as human cloning. Many technologies associated with reproduction are prohibited or heavily regulated, for example stem cell research and cloning. *See* Vernon J. Ehlers, *The Case Against Human Cloning,* 27 HOFSTRA. L. REV. 523 (1999).

[614] *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 exceeds the social benefits).

[615] 15 U.S.C. § 2057 (1976). *See also* Richard A. Merrill, *CPSC Regulation of Cancer Risks in Consumer Products,* 67 VA. L. REV. 1261 (1981) (examining the Consumer Product Safety Commission's regulation of carcinogens).

[616] Toxic Substances Control Act, 15 U.S.C. § 2605 (e).

[617] Consumer Products Safety Commission, Regulations for Self-Pressurized Consumer Products Containing Chlorofluorocarbons, 16 C.F.R. § 1401.

Prohibitions on code can lead to high enforcement costs because of the ease of reproduction and transmission of code. However, this does not mean prohibitions on code are useless. A prohibition can still drastically limit the use of a technology, through its effect on law-abiding individuals and firms. While there may be an element of society that bypasses the prohibition, prohibition can still substantially reduce the social costs of an undesired technology. For example, to protect intellectual property rights, the government has made it illegal to develop anti-circumvention code.[619] As a result, there are no legitimate firms selling such code.[620] While this has not stopped the development of anti-circumvention code, the prohibition has severely limited distribution of this code out of concern for the potential liability exposure.[621]

Applying this analysis of enforcement costs to the government's restriction on the export of encryption technology, we find an unrealistic policy. The government historically restricted the export of encryption technology.[622] However, recently, the government relaxed its export regulations and began allowing the export of encryption technology.[623] The major exception is prohibitions against exports to Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.[624] Since this prohibition is a limited one, it increases enforcement costs.[625] A second reason for high enforcement costs is the availability of prohibited encryption technologies. Export regulations allow firms to publicly post their code on the web for download. According to the regulations, this is not considered a knowing export and is thus permissible, although anyone, including those

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[618] Digital Millennium Copyright Act, 17 U.S.C. § 1201(a)(1) (2001).
[619] *Id.*
[620] In the earlier days of personal computing, a popular genre was copy programs that circumvented 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 the software if the disk became unreadable. *See* Donald W. Larson, User Land Discussion Archive, *Tales of Woz's Genius, available at* http://static.userland.com/userLandDiscussArchive/msg018908.html (July 7, 2000).
[621] 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, *available at* http://news.com.com/2100-1040-931296.html; David Becker, *"Mod Chip" for Hacking Xbox Discontinued,* CNET NEWS.COM, June 26, 2002, *available at* http://news.com.com/2100-1040-939591.html.
[622] Peter H. Lewis, *Privacy For Computers? Clinton Sets the Stage For a Debate on Data Encryption*, N.Y. TIMES, Sep. 11, 1995.
[623] *See supra* note 599.
[624] Revisions and Clarifications to Encryption Controls in the Export Administration Regulations, 67 Fed. Reg. 38,855 (June 6, 2002).
[625] For example, this provision is found in the license of the Netscape browser. Netscape, *Netscape Browser Distribution Program License Agreement,* available at http://wp.netscape.com/bisdev/distribution/start.html (last visited Aug. 3, 2002).

in the prohibited countries, could download the code.[626] Third, the lack of substitutes drives up enforcement costs. The social cost of encryption technology is that terrorists and criminal organizations can conceal their communications. There are no substitutes or alternatives that would alleviate these social costs.[627] The government did attempt to create a compromise approach, the Clipper chip, but this effort failed.[628] All of these factors combine to create high enforcement costs, which suggests this policy is impractical.[629]

Prohibitions can provoke innovation and provide an impetus for research and development.[630] But, prohibiting technologies in emerging industries can reduce innovation.[631] Research has show that prohibitions have varying effects upon the development of substitutes by the existing "insider" firms within an industry. However, prohibitions can lead to new "outsider" firms developing technologically innovative substitutes.[632] One method of attenuating the impact upon innovation and encouraging the creation of substitutes is a gradual phasing out of the technology. For example, the government is slowly phasing out the production of CFCs so as to allow the development of alternatives.[633]

An example of a code-based prohibition that could have provoked technological change is the now unconstitutional part of the CDA, which banned the transmission of indecent content to minors over the Internet. Without challenging the correct First Amendment outcome of this case, this prohibition could have accelerated the development of verification technologies to identify minors and filtering programs that ensure that minors do not access indecent content. These technologies would have been developed because of the wealth of indecent content on the

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[626] Export Administration Regulations, 15 C.F.R. § 15.740.13(e)(6).

[627] While lesser strength encryption products are not prohibited, they are not adequate substitutes for terrorist or criminal organizations. This is 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.

[628] The Clipper chip was an encryption technology that left a "back door" for the government to eavesdrop on communications. However, 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).

[629] While this policy is ineffectual from the standpoint of enforcement costs, there are other reasons why it may still be necessary. In this case, this policy is part of the Wassenaar Arrangement, which seeks to regulate dual-use technologies. *See* Revisions and Clarifications to Encryption Controls in the Export Administration Regulations, *supra* note 624.

[630] Nicholas Ashford et al., *Using Regulation to Change the Market for Innovation*, 9 HARV. ENVIRON. L. REV. 419 (1985).

[631] OFFICE OF TECHNOLOGY ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE 100 (1995).

[632] Kurt A. Strasser, *Cleaner Technology, Pollution Prevention and Environmental Regulation,* 9 FORDHAM ENVTL. L.J. 1, 38-39 (1997) (discussing Ashford's research).

[633] OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 631, at 99-100.

Internet.[634] Web sites would have supported technologies that allowed them to continue to provide indecent material. Although there are no adequate substitutes for minors seeking indecent content, this would not appear to create a large illegal market because of the lack of economic resources by minors. Thus, the CDA could have served to shape the development of code. In sum, prohibitions are most effective in shaping code when they are enforced all across society and when substitutes are available.

2. Setting Standards: The Command and Control Approach

Government can shape the development of code through the use of standards. Under this approach, the government mandates technological requirements for code. This direct approach by the government has traditionally been known as the command and control approach. This term highlights how this regulatory approach depends upon government as the enforcer as well as the setter for standards. This approach is often contrasted with the use of market-based incentives, which are discussed in the following section.[635]

Standards in this regulatory approach have a much larger meaning than in our previous discussion on open standards. Open standards are one kind of a standard. They are in a class of standards that promote transactions, interconnection, and interoperability.[636] Many code-based standards are of this type, such as PICS and cookies. Other types of standards include product standards, which provide information about a product's characteristics.[637] For example, the U.S.

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[634] A new version of the CDA is now attempting to pass constitutional muster. Child Online Protection Act, Pub. L. No. 105-277, 112 Stat. 2681 (1998) (requiring sites that are harmful to minors to use an age verification barrier). It is being challenged. American Civil Liberties Union v. Reno, 217 F. 3d 162 (CA3 2000). *See* http://www.epic.org/free_speech/copa/ (providing further supporting documents).

[635] *See infra* Part VII.A.3.

[636] These types of standards are known as process standards. Process standards facilitate transactions, such as standards for bills of lading. *See* Office of Technology Assessment, *supra* note 637, at 100. An 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 560, 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 (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. Communications Assistance for Law Enforcement Act of 1994, Pub. L. No. 103-414, 108 Stat. 4279 (1994).

[637] Product standards contain information on the characteristics of the products. This information allows for product identification, interoperability, and quality control. *See* OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS, GLOBAL STANDARDS: BUILDING BLOCKS FOR THE FUTURE 99 (1992). Government mandated product standards are discussed in more detail in a later section on the disclosure of code's characteristics. *See infra* Part VII.A.5.

Department of Agriculture's (USDA) labeling system for food is a product standard.[638] A third type of standard protects against societal hazards or problems.[639] These safety-oriented standards are commonly used in environmental and transportation regulation.

This section begins by discussing how technologically forward-looking the government should be in its regulatory efforts. Next, we discuss the different methods government can use in mandating standards. Although, this section focuses on government-mandated standards, it should be noted that government is not the sole creator of these standards. Often standards are created by or with assistance from the private sector.[640] Moreover, the government does not mandate that the private sector use all government created standards. The government also creates standards for its own use, and sometimes, these standards spillover into wider use by society.[641]

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[638] U.S. DEPARTMENT OF AGRICULTURE, FOOD STANDARDS AND LABELING POLICY BOOK (1998).

[639] An example of a control standard is the quality requirements for automobile tires. *See* Federal Motor Vehicle Safety Standards, New Pneumatic Tires -- Passenger Cars manufactured after 1948, Part 571, Standard No. 109 (requiring every tire to have information encoded on the sidewall specifying temperature, speed, load, traction, and tread-life ratings). An example of a control standard for code is the requirement for televisions to incorporate closed captioning. Television Decoder Circuitry Act, Pub. L. No. 101-431, 104 Stat. 960 (codified at 47 U. S. C. § 303 (u), § 330 (b) (1990)) (regarding closed captioning); 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. Marketing of Radio-Frequency Devices, 47 C.F.R. § 2.801 (2001). *See also* Christopher Smallwood, *FCC Regulation of Computers*, COMPUTER LAW, March 1992, at 25. 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 492.

[640] The criteria for government participation in creating standards are when the work is in the public interest and compatible with an agency's mission. Office of Management and Budget, *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities*, No. A-119, Feb. 10, 1998. There are a number of agencies, most notably the National Institute of Standards and Technology (NIST), which actively works with other institutions, such as SDOs, firms, and consortia to develop standards. *See* Cargill, *supra* note 228 (arguing for stronger relationships between the government and consortia in developing standards).

[641] These voluntary standards can become widely used when mandated in the government procurement of code. *See infra* Part VII.B.2 (describing the government's procurement process). Two examples of voluntary standards are the Energy Star certification and government's choice of an encryption standard. The EPA developed the Energy Star certification for computers to increase energy efficiency. To meet the certification, a computer must be powered down to less than 30 watts when not in use. Environmental Protection Agency, *Computer Memorandum of Understanding*, *available at* http://yosemite1.epa.gov/estar/consumers.nsf/content/computers.htm (last visited Feb. 11, 2002). The government supported this standard with its procurement power. *See infra* text accompanying notes 909-914. As a result this voluntary standard has been widely adopted by industry. A second example is the government's choice of an encryption standard. NIST conducted a high profile international competition to evaluate and determine the optimal standard for encryption. While this standard is intended for government use, the private sector is likely to adopt it based on the government's evaluation. Thus the government's efforts in assessing and utilizing a standard can spill over for the benefit of the private sector. *See Commerce Secretary Announces New Standard for Global Information Security*, Dec. 4, 2001, *available at* http://www.nist.gov/public_affairs/releases/g01-111.htm. The name of the chosen encryption standard is the Advanced Encryption Standard and more information can be found *at* www.nist.gov/aes.

a. Technology-Forcing

An important issue in standard setting regulation is technology-forcing.[642] This refers to regulatory efforts that direct the development of technologies along specific paths. The intention of these standards is to force firms to either innovate or diffuse technologies. In the case of innovation, the government is attempting to force the creation of new technologies. In the case of diffusion, the government is forcing firms to incorporate existing technologies into their products. Government's use of technology-forcing regulation has varied by industry. For example, early automobile regulation used a significant amount of technology-forcing regulation, while building code regulations contain little technology-forcing aspects.[643]

The first part of this section focuses on how government can use technology-forcing regulation to shape the development of code, while acknowledging the limitations of technology-forcing regulation. The second section discusses code-based technology-forcing regulation and analyzes the Communications Decency Act from a technology-forcing perspective.

i. Regulatory Considerations

In using technology-forcing regulation, a regulator must consider a number of issues. This section first discusses criticisms with using technology-forcing regulation. The remaining part of the section addresses these criticisms so as to justify the use of technology-forcing regulation.

There are a number of criticisms with the use of technology-forcing regulations.[644] First, why is government directing the development of technologies in specific trajectories? Critics argue this approach is ineffective, and the government can use other methods, such as market

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[642] Jerry L. Mashaw & David L. Harfst, *Regulation and Legal Culture: The Case of Motor Vehicle Safety*, 4 YALE J. ON REG. 257, n. 18 (1987) (defining technology-forcing).

[643] Richard R. Nelson, *Government Stimulus of Technological Progress: Lessons from American History, in* GOVERNMENT AND TECHNICAL PROGRESS 451, 472 (Richard R. Nelson ed., 1982). *See also* Eric Lipton & James Glanz, *New York Plans Code Overhaul for High-Rises,* N.Y. TIMES, Aug. 2, 2002 (noting how building codes are slow to change and incorporate new technologies such as sprinkler systems).

[644] A number of commentators have criticized technology-forcing regulation. *See* STEPHEN G. BREYER, REGULATION AND ITS REFORM 106-07 (1982); Robert A. Leone, *Technology-Forcing Public Policies and the Automobile, in* ESSAYS IN TRANSPORTATION ECONOMICS AND POLITICS: A HANDBOOK IN HONOR OF JOHN R. MEYER 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); *see infra* note 685 (providing further criticisms on the use of technology-forcing for environmental standards. *But see infra* note 686 (providing a response from supporters of technology-forcing regulation).

incentives, to shape technologies. Second, how is government able to accurately set technology-forcing regulations? The development of technologies is unpredictable and unforeseen.[645] Additionally, government has even a harder task in ascertaining technical advances than firms because they are dependent upon firms sharing information with the government on the state-of-the-art. These firms have an incentive to withhold and mislead government to ensure that technology-forcing standards are lax and easily met. A final problem with technology-forcing regulation is compliance costs. The more radical a change, the higher the cost to industry, and the greater the incentive for firms to limit the regulations. This can lead to firms that try to reduce their costs by regulatory capture and litigation, instead of developing or diffusing new technologies.[646]

In addressing the above criticisms, a policymaker must first justify the use of a technology-forcing regulation. In deciding to use a technology-forcing regulation, a regulator is using a stick approach. A regulator is convinced that the carrot approach of market-based incentives will not be sufficient to change behavior.[647] Two reasons for favoring technology-forcing regulation is the inefficiency of market-based incentives and their politically infeasibility in some circumstances. First, technology-forcing regulations can be more efficient than market-based regulatory programs in two situations.[648] The first situation is when there are no existing technologies that address a societal concern. In this case, industry must be forced to develop new technologies.[649] For example, in passing the Clean Air Act, Congress was addressing public health concerns with little regard to technological or economic limitations.[650] A second situation

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[645] Nelson, *supra* note 643, at 454 (noting the uncertainty of technological advance based on a number of case studies); Robert W. Lucky, *Pondering the Unpredictability of the Sociotechnical System, in* ENGINEERING AS A SOCIAL ENTERPRISE 89 (Hedy E. Sladovich ed., 1991).
[646] Another problem is obsolete technology-forcing standards. Since Congress does not revise regulations periodically technology-forcing standards may become unfeasible or in need of revision. This then shifts the problem of setting and enforcing these regulations to courts. Carolyn McNiven, *Using Severability Clauses to Solve the Attainment Deadline Dilemma in Environmental Statutes*, 80 CALIF. L. REV. 1255 (1992) (suggesting courts be given the power through severability clauses to remove obsolete deadlines).
[647] Leone, *supra* note 644, at 303.
[648] *See infra* Part VII.A.3 (discussing market-based regulatory programs).
[649] "[F]or some pollutants in particular industries there may be no existing or theoretical control technology; the control of pollution will then require the development of entirely new control equipment or manufacturing processes-that is, it will be necessary to force major technological innovation." La Pierre, *supra* note 650, at 773 (1977).
[650] 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." 116 Cong.Rec. 32901-32902 (1970). *But see* D. Bruce La Pierre,

occurs when the technology exists, and the cost of the technology being mandated is low and the monitoring cost is high.[651] In this situation, these factors lead a technology-forcing regulation to be more efficient than a market-based regulatory program. Second, technology-forcing regulations can be justified based on political expediency. Technology-forcing regulations provide a clear objective, a direct method, and a tangible outcome for legislators.[652] In contrast, addressing market externalities with market incentives can be politically difficult. For example, economists argue that the best method of increasing automobile fuel efficiency is a gasoline tax. But no politician will support such a measure.[653] As a result, society has had to rely on technology-forcing regulations for improved fuel efficiency.[654]

A second issue is the setting of technology-forcing standards. This is a significant issue when the government requires firms to develop new technologies because of the unpredictability of technological advances.[655] In this case, standard setting is difficult because it is not clear what the cost to the firms will be for developing the technology.[656] For example, the Clean Air Act was not concerned about the current level of technological feasibility.[657] Its goal was to radically advance the state-of-the-art for reducing air pollution. Therefore, in setting technology-forcing regulation, it is necessary for regulators to garner the relevant expertise to gauge the state-of-the-

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Technology-Forcing and Federal Environmental Protection Statutes, 62 IOWA L. REV. 771, 837 (1977) (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* Bonine, *The Evolution of Technology Forcing In The Clean Air Act*, ENVIR. REP. (BNA) (Monograph No. 21) (1975); Russell V. Randle, *Forcing Technology: The Clean Air Act Experience*, 88 YALE L.J. 1713 (1979).

651 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 WISC. L. REV. 887, 937.

652 Leone, *supra* note 644, at 295.

653 In contrast, Europe has used taxes as a regulatory tool. *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, 167 (2000) (noting the popularity of taxes in other countries).

654 Technology-forcing standards can focus an industry's attention on a problem in a direct way. For example, in theory automakers historically have always had an interest in auto safety as a way differentiating their products and selling more cars. But in reality, it took Ralph Nader's *Unsafe at Any Speed* and subsequent legislation to focus the automakers on the issue of safety. *See* Leone, *supra* note 644, at 310, 302.

655 *See supra* note 645.

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

657 *See supra* note 650. The issue of technology-forcing regulation was recently visited by the Supreme Court. The Court held that the government is not required to consider financial impact when setting air quality standards. Justice Breyer's concurrence explicitly noted the validity of the technology-forcing nature of the Clean Air Act. Whitman v. American Trucking Associations Inc., 531 U.S. 457, 121 S.Ct. 903 (2001).

art as well as to understand the industry's history in technological innovation.[658] However, if a government agency cannot gather the necessary information or legislators are concerned about regulatory capture during the information gathering process then an alternative method of regulation may be necessary.[659]

A related issue is the need for government to have a clear understanding of the harm it is trying to prevent or the benefit it is trying to produce.[660] One of the problems with automotive safety regulation is that it has never been clear how much harm the National Highway Traffic Safety Administration (NHTSA) was supposed to prevent. For example, should an automobile survive a 30 m.p.h. head-on crash or a 50 m.p.h. crash?[661] These lessons are directly applicable to code. Thus, in order for code-based technology-forcing regulation to be successful, it must be clear what societal concerns are being addressed. Otherwise, an agency will soon run into problems persuading the public and firms that its regulations are creating societal benefits.

A third issue technology-forcing regulation must confront is compliance. Firms are motivated to avoid compliance in direct relation to the cost of the technology-forcing regulation. To ensure that firms comply and develop or diffuse the necessary technology requires a dogged regulator. Firms will try to delay or reduce technology-forcing regulation. After all, technology-forcing regulation relies upon a stick as opposed to a carrot approach. At times, delay may be prudent. However, if firms are generally successful in using this tactic, then this effectively neutralizes the use of technology-forcing regulation.

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[658] *See* Ashford, *supra* note 658, at 422.

[659] The probability of capture is higher because the government must closely interact with firms for information on their capabilities.

[660] In setting technology-forcing regulation, the regulator must consider the efficacy of the proposed regulation. The standard for efficacy depends upon whether the regulation is focused on forcing firms to create new technologies or incorporating existing technology into their products. In the first case, a regulator is trying to foster innovation. Therefore, the regulation should be focused on bottlenecks to technological development. For example, in the case of electric vehicles being pursued as a method of reducing pollution, Leone argues that technology-forcing regulations have revealed bottlenecks in power plant emission control, lead battery recycling, and consumer learning. Therefore, he believes that technology-forcing regulations for electric vehicles are wasteful. The issues are different when requiring firms to incorporate existing technologies into their products. In this case, the government is concerned with widely diffusing a technology. The success of this method hinges upon the cost of the technology that can be reduced over time. This requires firms to have either an incentive for continued innovation or economies of scale to reduce costs. Leone, *supra* note 644, at 320.

[661] Michael J. Trebilcock, *Requiem for Regulators: The Passing of a Counter-Culture?,* 8 Y. J. REG. 497, 505-06 (1991).

Technology-forcing regulation has led to numerous innovations,[662] including improved environmental quality,[663] safer automobiles,[664] cleaner automobile emissions,[665] and improved disclosure.[666] For example, the development of the automobile airbag was prompted by the development of standards for a "passive occupant restraint system". These standards began to be developed in the late 1960s by the NHTSA when no such technology existed. While industry fought this requirement, eventually such technology was developed and has since become standard equipment on automobiles.[667] However, the NHTSA has moved away from a technology-forcing regulatory approach towards a more reactive approach in automobile regulation.[668]

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[662] *See* Ashford et al. *supra* note 658 (providing a number of examples of how technology-forcing regulation led to innovation).

[663] *See* Nicholas A. Ashford, *An Innovation-Based Strategy for a Sustainable Environment, in* INNOVATION-ORIENTED ENVIRONMENTAL REGULATION 67, 85 (Kemmelskamp et al. eds., 2000).

[664] Technology-forcing regulation has led to many safety improvements including seat belts, air bags, and bumpers. These regulations have been acknowledged as successful, because the savings in safety outweighed the regulatory costs. *See* ROBERT W. CRANDALL ET. AL., REGULATING THE AUTOMOBILE 155-56 (1986).

[665] Technology-forcing regulations have led to internal combustion engines that emit ninety six percent less emissions. This type of reduction was thought to be infeasible when the regulations were first mandated. However, the overall assessment of this effort is mixed, because while there are lower automotive emissions, it is not clear whether this has led to clear improvements in public health. *See* CRANDALL, *supra* note 664, at 156-57 (arguing that the costs of emission regulation are higher than its benefits). Moreover, it is not clear whether there were other options, such as emissions fees, that could have led to the same technical advances. *See* Leone, *supra* note 644, at 292. For others, the development of new technologies such as catalytic exhaust treatment and low-emission vehicles show 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).

[666] The Securities and Exchange Commission mandates that companies file their documents electronically through EDGAR, the Electronic Data Gathering, Analysis, and Retrieval system. This system accelerates "the receipt, acceptance, dissemination, and analysis of time-sensitive corporate information filed with the agency." The goal is to "increase the efficiency and fairness of the securities market for the benefit of investors, corporations, and the economy." *Important Information About EDGAR*, *available at* http://www.sec.gov/edgar/aboutedgar.htm (last modified June 28, 1999). *See also* Joseph A. Grundfest, *The Future of United States Securities Regulation: An Essay on Regulation in an Age of Technological Uncertainty*, 75 ST. JOHN'S L. REV. 83 (2001) (arguing that EDGAR is an example of how the SEC is changing from a technology-forcing strategy to a reactive or obstructionist strategy because the SEC has not updated EDGAR).

[667] *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).

[668] A reason for the failure of technology-forcing regulation is the judicial system. The NHTSA began by using technology-forcing rulemaking. However, over time the NHTSA has moved towards a reactive strategy based largely around safety defects. It has been argued that this occurred largely because of judicial second-guessing. *See* Frank B. Cross, *Pragmatic Pathologies of Judicial Review of Administrative Rulemaking*, 78 N.C. L. REV. 1013, 1025 (2000). *See generally* 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); P. LORANG & L. LINDEN, AUTOMOBILE SAFETY REGULATION: TECHNOLOGICAL CHANGE AND THE REGULATORY PROCESS 149-54 (1977) (discussing NHTSA's difficulties with forcing manufacturers to develop new technologies).

ii. Code-Based, Technology-Forcing Regulation

There are numerous examples of code-based technology-forcing regulation including filtering software,[669] closed captioning,[670] v-chip,[671] accessibility,[672] enhanced 911,[673] and digital broadcasting.[674] This section first provides a cursory analysis of these code-based, technology-forcing regulations. The remaining part of this section analyzes the Communications Decency Act (CDA) as a technology-forcing regulation. This analysis provides insights into the failure of the CDA from a legal and technological standpoint.

While a thorough assessment of technology-forcing regulations for code is needed, a few lessons can be gleaned from a brief analysis of the examples noted above. First, in code-based regulation, it appears that technology-forcing regulation is often favored over market-based incentives. Government prefers to simply require manufacturers to modify their code. Second, regulations focused on preventing harm are easier to justify. Concerns about safety and violence led to clearer guidelines and more political support. Technology-forcing regulations that produce less clear benefits, such as accessibility and digital broadcasting, are much harder to justify. The issue of clear benefits becomes more important when we consider compliance costs.

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[669] *See infra* text accompanying note 687.

[670] The incorporation of closed captioning technology was similar to the incorporation of the ultrahigh frequency (UHF) tuner. Before government regulation, consumers were forced to buy an expensive stand-alone decoder. *See* DuBow, *supra* note 639 (providing a history of legislative process to require manufacturers to incorporate closed captioning).

[671] The V-chip was a relatively simply technology based on the modification of the closed captioning technology. *See* Kristen S. Burns, *Protecting the Child: The V-Chip Provisions of the Telecommunications Act of 1996,* 7 DEPAUL-LCA J. ART & ENT. L. & POL'Y 143 (1996); Lisa D. Cornacchia, *The V-Chip: A Little Thing But a Big Deal*, 25 SETON HALL LEGIS. J. 385 (2001).

[672] 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.

[673] 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 Mickle 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 industry to delay implementation, although it appears that industry will be able to comply); 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 we need to tighten the existing rules for enhanced 911 to foster the development of a seamless, ubiquitous, and reliable wireless communication network with 911). For background on Enhanced 911 *see* http://www.fcc.gov/911/enhanced/.

[674] 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. 105-33, 111 Stat. 251 §§3003 (1997); CONGRESSIONAL BUDGET OFFICE, COMPLETING THE TRANSITION TO DIGITAL TELEVISION (1999), *available at* http://www.cbo.gov/showdoc.cfm?index=1544&sequence=0&from=1.

The third lesson is that compliance costs matter, especially when firms are being forced to provide a vague benefit to the public, such as digital broadcasting. The high cost of compliance with digital broadcasting leads many to wonder if such technology-forcing regulation was needed in the first instance.[675] They urge that the market is superior in addressing such fuzzy public benefits.

Focusing on our case study of PICS, the government passed the CDA in 1996, which made it unlawful to transmit indecent or obscene material over the Internet to minors.[676] While this law was focused on prohibition, it served a technology-forcing purpose. Consequently, this law encouraged the development of technologies that would limit the transmission of indecent material to minors. PICS was developed as a direct result of this law.[677] In this sense, the law was technology-forcing. However, PICS has not solved the problem of minors accessing inappropriate content. So let us analyze the CDA as a technology-forcing regulation.

First, consider the justification for the CDA. The CDA clearly gave up on the market. While the market was not providing an adequate solution to the problem of the minors accessing inappropriate content, there was no reason to believe that the government could not create incentives to encourage the market to address this problem. The jump to a prohibition may have been rash. The second problem with the justification for the CDA was its efficacy. The CDA doesn't acknowledge that the technology existed to address the problem. At the time of the CDA, there were filtering products available that ensured minors did not access inappropriate content. If the technologies exist, then the rationale for a technology-forcing regulation should be promoting the diffusion of these technologies. Clearly, the CDA was not the best method to ensure a wide diffusion of filtering software. Instead, the government should have considered incentives or outright regulation mandating filtering software. In the end, the justification for the CDA seems to be more about political expediency than addressing a societal concern. In fact, the CDA was largely considered to be unconstitutional, and thus ineffective, from its very beginnings.[678]

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[675] Alan Murray, *Failed Policy on HDTV Illustrates Why Free Markets Can Be Trusted*, WALL ST. J., June 4, 2002.
[676] *See supra* text accompanying notes 136-137 (providing background on the CDA).
[677] *See supra* text accompanying notes 138-156 (providing background on the development of PICS).
[678] *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).

The second concern is whether the CDA was addressing a well-defined harm. The CDA regulated both obscene and indecent communications. While the harm from obscene communications was widely recognized, the harm from indecent communications was not agreed upon. In fact, the most vigorous debate over the CDA concerned the banning of indecent material that, in some cases, was useful for minors, such as sexual education material.[679] This illustrates the inappropriateness of technology-forcing regulation when government does not have a well-defined harm to address.

The final problem with the CDA is compliance. It was never clear how government would monitor and enforce the CDA on a worldwide medium.[680] While government could clearly make an impact, it seems reasonable that any significant impact would require international cooperation. The CDA did not consider this issue at all.

b. Methods of Standards Regulation

There are two general methods of regulating with standards, using a performance standard or a design standard. Performance standards do not specify a technology, but instead set forth guidelines for how a technology should operate.[681] This allows the market to create and shape a product as it sees fit. This is the principal advantage of performance standards. The flexibility of performance standards is the reason why firms prefer to develop technologies to meet performance standards.[682]

At the other extreme, we have regulations specifying design standards. 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. In contrast, the flexibility of a performance standard can lead to problems with enforceability because of the lack of specificity over the correct testing procedure to meet a performance standard.[683]

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[679] *Reno*, 521 U.S. at 877.
[680] David L. Sobel, *The Constitutionality of the Communications Decency Act: Censorship on the Internet*, 1 J. TECH. L. & POL'Y 2 (1996) (noting the problems with jurisdiction).
[681] BREYER, *supra* note 644, at 105. An example that Cargill provides is the EU Privacy Initiative, which 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. Cargill, *supra note* 228,at 5.
[682] BREYER, *supra* note 644, at 105.
[683] BREYER, *supra* note 644, at 105-06.

A middle ground between design standards and performance standards are the "best available technology" (BAT) regulations. These regulations are typically focused on gradually removing a harm based upon the available technology. Statutes are often worded to require the use of "reasonably available control technology" or the "lowest achievable emission rate."[684] The main use of BAT regulations has been to reduce pollution. The BAT standards have been criticized for not accounting for differences among users, imposing a large burden on agencies for enforcement and information gathering, and serving to slow technological innovation.[685] The counter to these criticisms is that the BAT approach provides a much simpler regulatory process that is even-handed and easily enforced.[686] Additionally, the BAT approach can adapt to changing circumstances because of its reliance on what is reasonably available rather than specifying a numerical value.

Recognizing their strengths and weaknesses, all three of these approaches can be used to shape code. Clearly, there are tradeoffs between these options. Performance standards provide a great deal of flexibility and allow for market-based solutions. For example, government legislation requires schools and libraries to use some type of "technology protection measure" for online material that is harmful to minors.[687] This performance standard allows schools and libraries to select the solution that best fits their own requirements. In contrast, design standards are fixed approaches, but allow the government to easily ensure compliance. If the government mandated the cookies technology or PICS, it would be using a design standard. Similarly, in the development of digital broadcasting, the Federal Communications Commission (FCC) has been criticized for using design standards in protecting users from interference.[688] Critics believe these regulations were too precise and instead industry should have been granted more freedom

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[684] OFFICE OF TECHNOLOGY ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE 90 (1995).
[685] *See* SUNSTEIN, *supra* note 565, at 88. *See also* Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985) (criticizing the Best Available Technology regulation strategy).
[686] *See* Howard Latin, *Ideal versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-Tuning' Regulatory Reforms,* 37 STAN. L. REV. 1267 (1985) (arguing that best available technology 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 (responding to Sunstein's criticisms); Wendy E. Wagner, *The Triumph of Technology-Based Standards*, 2000 U. ILL. L. REV. 83 (arguing that the best available technology approach is more expeditious, enforceable, even-handed, and adaptable).
[687] Children's Internet Protection Act, 47 U.S.C. § 254(h)(5)(A) (2001); Cole & Grossman, *supra* note 651.
[688] Advanced Television Systems Committee, *Transmission Measurement And Compliance For Digital Television, Revision A*, May 20, 2000 *available at* http://www.atsc.org/standards.html.

in dealing with interference problems.[689] Finally, the BAT approach encompasses standards that can change over time. An example of a hypothetical code-based BAT standard is requiring government agencies to use the "best available encryption technology in the storage of medical information." This standard would require government agencies to conduct a cost benefit analysis to determine what technology should be mandated. Unlike other standards, government agencies must update their systems as more effective technologies are developed.

3. Using Market-Based Regulation

Critics of standard setting or the command and control top-down approach often propose using market-based incentives as an alternative to direct rulemaking. Market-based incentives can be based upon a number of different economic instruments.[690] The general advantage of market-based incentives is that they are more efficient than standard setting. That is, the cost of regulating a harm with market-based incentives is generally less than with government mandated standard setting.

In this section, we focus on the use of taxes and marketable property rights for regulating code. Taxes can be used to penalize conduct or a particular technology. For example, consider the gas-guzzler tax on automobiles that are not fuel-efficient.[691] Marketable property rights utilize the market as an allocation mechanism to limit conduct or a technology. This allows firms to buy and sell their property rights to others. This regulatory scheme has been used to address a variety of societal concerns from congestion to pollution.

The choice between marketable property rights and taxes is largely between choosing between a price-based system or a quantity-based system. In using taxes, the government is increasing the price of undesirable behavior. In using marketable property rights, the government is fixing the amount of undesirable behavior that is acceptable to society. As a result, a tax-based system has an uncertain impact on the undesirable behavior, but the cost is

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[689] *See* Federal Communications Commission, *Economic Considerations for Alternative Digital Television Standards*, Nov. 1, 1996, *available at* http://www.fcc.gov/Reports/ec961101.txt, http://www.fcc.gov/Bureaus/Mass_Media/Orders/1996/fcc96493.txt (noting the design standards nature of the FCC's requirements by Bruce Owen); Federal Communications Commission, *Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service*, Dec. 24, 1996, *available at* http://www.fcc.gov/Bureaus/Mass_Media/Orders/1996/fcc96493.txt (noting comments by the National Cable and Telecommunications Association on the design standard aspect of ATSC standard).

[690] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, MANAGING THE ENVIRONMENT: THE ROLE OF ECONOMIC INSTRUMENTS (1994) (discussing various economic instruments).

[691] Gas Guzzler Tax, 26 USC § 4064.

known to firms. A marketable property rights scheme can have a fixed impact on the undesirable behavior, but the cost to firms is unknown. So a crucial decision for a regulator is whether they are concerned about setting a target for either reducing the undesirable behavior or for fixing the cost that is to be borne by firms.[692]

There are two principal criticisms of market-based approaches. The first is that the touted efficiency does not appear in the real world. Instead, the problems of monitoring and funding such programs leads to a higher cost for government than using standard setting regulation. The second criticism rests on moral or ethical grounds. In using a market-based incentive, society is saying that it is acceptable to engage in the socially undesirable behavior. For some critics, this is intolerable. As an extreme example, it is simply wrong for government to use a market-based approach to regulate murder. In this context then, individuals and firms should not be allowed to engage in murder by merely paying a "murder" tax. The following sections will address these criticisms and highlight the advantages of these methods in shaping and regulating code.

a. Taxes

Government's power of taxation is a powerful tool for shaping code. In using its power of taxation, the government can increase an individual's or firm's tax burden to encourage certain behavior. This section examines how taxes or fees can be used to penalize a particular activity or product.[693] For example, the gas-guzzler tax on automobiles is an alternative to regulation or classic standard setting.[694] In this section, we discuss when taxes are preferable to the use of regulation to deter socially undesirable behavior or undesirable products.

There are two approaches to using taxes, tax penalties or fees. A fee usually consists of a monetary penalty on a product or activity that is unrelated to the user's income. In general, a fee is more appropriate when users can be readily excluded from receiving the relevant service or

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[692] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, PUTTING MARKETS TO WORK: THE DESIGN AND USE OF MARKETABLE PERMITS AND OBLIGATIONS 26 (1997).
[693] *See* 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).
[694] BREYER, *supra* note 644, at 164 (standard setting); MARK KELMAN, STRATEGY OR PRINCIPLE? THE CHOICE BETWEEN REGULATION AND TAXATION 121 (1999) (providing a detailed discussion on the tradeoffs for using taxes as a substitute for regulation).

product.[695] This is the case with alcohol, the gas-guzzler tax, or fees on the sale of tires to finance cleanup of improper tire disposal sites.[696] The second type of tax penalty is based upon the income tax system. In this case, tax penalties are analogous to tax expenditures, but they serve to penalize rather than reward.[697] Throughout this section, we use the term taxes to refer to both fees and taxes based on the income tax.

There are several objections to using taxes as an alternative to regulation. The first questions the efficiency of taxes because of the difficulty of setting the right price for a tax. A tax will lead to some taxpayers changing their behavior, but other taxpayers may not change their behavior, and instead, just pay the tax. The critical issue is setting the right level for the tax.[698] If the tax is too high, the government will discourage too much of the activity. If the tax is too low, the government will not discourage enough of the activity. The second objection also considers the efficiency of this approach, but focuses instead on the administrative costs. In using a tax penalty, the government will be required to enforce, collect, and dispose the taxes. This is a weighty burden for government. 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 monetary penalties are paid. For critics of taxes, this is wrong. Those that have adequate financial resources are not then affected by the tax. Or if the penalty affects the income tax, it will not be a strong deterrent to those firms or individuals with low tax rates or who are not in tax-loss positions. In either situation, there is a class of individuals or firms that will continue to perform the socially undesirable activity, despite the tax.

The first issue that a regulator must address is the question of setting the tax accurately. This issue is not formidable. Just as with a regulation, 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, if the tax is too high or too low, it can be adjusted later to the level that society deems optimal.

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[695] KELMAN, *supra* note 694.
[696] *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 (noting sin taxes such as those on alcohol); Stephen M. Johnson, *Economics V. Equity: Do Market-Based Environmental Reforms Exacerbate Environmental Justice*, 56 WASH. LEE L. REV. 111 (noting taxes on pollution).
[697] Zolt, *supra* note 693, at 348-350 (defining tax penalties within the income tax system).
[698] BREYER, *supra* note 644, at 165 (noting the problem of setting regulatory taxes).

The second efficiency issue concerns administrative costs. When government seeks to reduce undesirable conduct, it will either use regulation or a market-based incentive such as a tax.[699] In both cases, the government will bear the administrative costs. In the case of regulations, the government is spending its resources on setting and enforcing regulations. In the case of taxes, the government is spending its resources on collecting, enforcing, and disposing the proceeds.[700] In fact, in certain circumstances taxes may be preferable to regulations because of low administrative costs. This is because the government already has an established tax system in place.[701] However, a critical issue for administrative costs and the success of a tax is whether the tax can be collected with minimal non-compliance.

The third objection to using taxes is on moral grounds. To address this concern, we believe taxes should be limited to those actions that society deems acceptable to condemn but nevertheless allow. In general, taxes are best used in circumstances when individuals and firms may be allowed to continue to engage in a socially undesirable activity at a low level. In other words, the cost of rooting out the activity is not outweighed by the benefits of the activity. This permits a certain degree of flexibility across a population or industry. As a result, this unevenness in the distribution of burden for taxes limits its use to particular cases. If an activity involves fundamental rights, such as worker safety or discrimination, taxes are generally inappropriate and clear-cut regulation is the preferred solution.[702] This is, at least in part, because we value equal treatment when it comes to individual rights.[703] Consequently, taxes are preferable in situations where society is not confronting basic rights and is comfortable with an unequal distribution of the desired activity across society.[704]

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[699] KELMAN, *supra* note 694.

[700] BREYER, *supra* note 644, at 170-71 (discussing the disposing of tax revenue proceeds).

[701] KELMAN, *supra* note 694, at 94-95 (noting various factors that affect the administrative cost). *But see* Zolt, *supra* note 693, at 374-76 (questioning the lost administrative costs of tax penalties).

[702] Kelman argues that there is a difference in regulation and taxes when it comes to rights. As Kelman put it "regulation, 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)." KELMAN, *supra* note 694, at 121-22.

[703] *See* Gloria E. Hefland, *Standards Versus Taxes in Pollution Control, in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 223, 245 (Jeroen C.J.M. van den Bergh ed., 1999) (arguing that although tax penalties are more efficient than standards, standards are the preferred solution by policymakers, because standards emphasize the antisocial nature of polluting).

[704] *See infra* text accompanying notes 724-725 (providing further discussion on the ethical issue of a market-based incentive permitting socially undesirable behavior).

Taxes are preferable to regulation when it is possible to influence consumer behavior.[705] In contrast to meeting regulatory standards, the cost of meeting taxes can be estimated. These costs can then be easily communicated to the consumer in the final cost of the product or through tax advisors. Consumers are thus aware of both the costs as well as the governmental policy disfavoring a specific activity or product. As a result, this influences consumers towards products and activities that are not subject to a tax. Similarly, firms have a continued incentive to innovate and improve their technologies to reduce their tax burden.

Taxes are preferable to tax expenditures or direct spending because they are not limited by budgetary constraints. 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 the subsidy of alternative fuels. However, while the subsidy is limited by the government's budget, the tax has no such limitation.[706]

There are two reasons why taxes aren't widespread despite their touted efficiency. The first is political. No one wants to raise taxes. Instead, a regulation is preferable. The second is that established firms prefer a standard setting regulation over a tax. This is because from the viewpoint of a firm, taxes cost more than regulation.[707]

Taxes on ozone-depleting chemicals as well as the gas-guzzler tax have served to shape technologies.[708] Other examples of taxes used to discourage certain activities include doing business with South Africa, engaging in greenmail transactions, and entering into golden parachute arrangements.[709] For example, Singapore has used tax surcharges on older cars and varying toll fees to cut congestion.[710] Similarly, taxes could be used to shape code.

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[705] 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* 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, 427 (1994).

[706] Chris Edwards et al., *Cool Code: Federal Tax Incentives to Mitigate Global Warming,* 51 NAT'L TAX J. 465, 475 (1998).

[707] *See* James M. Buchanan & Gordon Tullock, *Polluters' Profits and Political Response: Direct Controls versus Taxes,* 65 AMER. ECON. REV. 139; Thomas W. Merrill, *Explaining Market Mechanisms,* 2000 U. ILL. L. REV. 275, 288.

[708] 26 U.S.C. §§ 4681, 4682 (1988 ed., Supp. III) (ozone tax); 26 U.S.C. § 4064 (gas guzzler excise tax).

[709] *See* Zolt, *supra* note 693, at 344 (noting common examples of tax penalties).

[710] *Smart Card Taxes Singapore Drivers*, BBC NEWS, Apr. 14, 1998, *available at* http://news.bbc.co.uk/1/hi/world/asia-pacific/78172.stm.

One potential application for taxes on code is to address the problem of unsolicited bulk e-mail or spam. By placing a tax on each email message, the government would provide an incentive not to send an email message. This would also reduce email congestion. If this tax was small, say one message equals a penny, this would have a minimal impact upon most email users, while subjecting bulk e-mailers who may send out millions of e-mail messages to a significant tax burden. The major objection to this proposal is not about the proper setting of the tax or 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. As a result, it would be very difficult to ensure compliance with such a tax. In this case, a tax would not serve as an effective method for shaping code.

b. Marketable Property Rights

An alternative market-based regulatory mechanism is the use of a property based system. The core concept is that by creating property or a property right that can then be exchanged in the marketplace, the regulator is depending on the superior allocative efficiency of the market over government allocation.[711] For example, the government can either create property in 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, *e.g.*, to pollute through sulphur dioxide emissions. The resulting property right allows an individual to use the property as well as to sell the property as she sees fit. In some cases, the government may create a trading system for a property right to ensure its efficient transfer. This allows the use of prices as a signal and an incentive, which should theoretically lead to an efficient distribution of the property. Moreover, by limiting and reducing marketable property rights, the government can reduce or eliminate the conduct at issue. Thus, a marketable property right is an efficient method for the government to limit a harm or technology.

The creation of marketable property rights has been used for a variety of regulatory issues from congestion to pollution.[712] In the United States, marketable property rights have been created for eliminating lead in gasoline, reducing ozone-depleting gases in accordance with the

[711] 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, 2093-2097 (1993) (providing an overview of the use of marketable property rights as an alternative regulatory mechanism).

Montreal Protocol, reducing sulphur oxides, and reducing pollutants in the Los Angeles area.[713] In these cases, the government created a system by which these marketable property rights could be traded. By limiting and reducing the amount of marketable property rights, the government can control the extent of an activity.

There are several problems with using marketable property rights. The first is the inefficiencies due to high administrative costs in the creation and administration of marketable property rights. Government must define, allocate, sell, and monitor the use of these property rights. These high administrative costs suggest that marketable property rights are an inefficient solution compared to standards based regulation. The second problem concerns the strategic use of marketable property rights. In reality, there are no perfectly competitive markets. As a result, firms can distort the intent of marketable property rights to their advantage. Finally, the use of marketable property rights is also questioned on ethical grounds.

First, government must acknowledge that there are administrative costs in creating and administering marketable property rights.[714] Therefore, the government needs to evaluate these costs in considering whether to opt for standards based regulation or for a marketable property rights program. The first issue that the government must struggle with is defining the property. The metes and bounds of the property right is not a trivial issue as it will be contested.[715] Second, once a marketable right is established, how should the rights be allocated? For example, should they be auctioned?[716] Or should existing users get free marketable rights through grandfathering.[717] 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

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[712] ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, *supra* note 692.
[713] Tom Tietenberg, *Lessons From Using Transferable Permits to Control Air Pollution in the United States, in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 275, 275 (Jeroen C.J.M. van den Bergh ed., 1999).
[714] *See* OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 684, at 170 (providing background on the administrative issues); James T.B. Tripp & Daniel J. Dudek, *Institutional Guidelines for Designing Successful Transferable Rights Programs,* 7 YALE J. REG. 369, 374-377 (1989) (noting administrative issues in the use of marketable property rights).
[715] The defining of property rights is a continuing issue for government, because uncertainty can lead to inefficiencies. *See* Robert W. Hahn & Gordon L. Hester, *Where Did All The Markets Go? An Analysis of EPA's Emissions Trading Program,* 6 YALE J. REG. 109 (1989).
[716] *See* Paul Koustaal, *Tradeable Permits in Economic Theory*, *in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 265, 271-02 (Jeroen C.J.M. van den Bergh ed., 1999). *See also* Robert W. Hahn, *Market Power and Transferable Property Rights*, 99 Q.J. ECON. 753, 753-65 (1984) (noting how allocation can affect the efficiency of marketable property rights).
[717] Koustaal, *supra* note 716, at 268. *See also* Merrill, *supra* note 707, at 284 (noting the predominant use of grandfathering).

transactions costs for property transfer.[718] 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 specific property rights. In fact, low monitoring costs are necessary for a marketable property rights scheme to be successful.[719]

The second issue is the strategic use of property rights. In contrast to theory, a perfect market in which no actor has market power does not exist.[720] Hence, one expects firms to attempt to distort the market to their advantage. For example, firms could use their influence to collude to keep prices low or set pricing levels.[721] Or firms could buy up the marketable property to create a barrier for entry for new firms.[722] 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.[723]

The final issue to address is the moral argument against marketable property rights.[724] This issue is focused not on efficiency, but on ethical concerns. When government creates a property right, they are tacitly approving the behavior. Moreover, government is removing the stigma attached to the conduct by creating property rights. This is one of the reasons why people have been opposed to market-based approaches to minimize pollution. This is similar to concerns about inequality in using taxes.[725] Therefore, a regulator should try to avoid creating a marketable property right when society uniformly deems an activity to be morally wrong.

An advantage to using marketable property right is that they are generally more efficient than standard setting regulatory approaches.[726] In using marketable property rights, entities allocate the marketable property rights among themselves through a pricing mechanism. This approach is much more efficient than government mandating the allocations of property rights

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[718] BREYER, *supra* note 644, at 173; Koustaal, *supra* note 716, at 270-71 (noting transactions costs in trading).
[719] *See* Cole & Grossman, *supra* note 651, at 937; Koustaal, *supra* note 716, at 271; Youngsoo Oh, *Surveillance or Punishment? A Second-Best Theory of Pollution Regulation,* INTER. ECON. J., Autumn 1999, at 89.
[720] Koustaal, *supra* note 716, at 266.
[721] BREYER, *supra* note 644, at 173.
[722] *Id.*
[723] *Id.*
[724] *See* STEVEN KELMAN, WHAT PRICE INCENTIVES? (1981) (providing a thorough discussion of the moral basis argument).
[725] *See supra* text accompanying notes 702-704.
[726] *See* Ackerman & Stewart, *supra* note 685; Ruud A. de Mooij, *The Double Dividend of an Environmental Tax Reform, in* HANDBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 293, 302 (Jeroen C.J.M. van den Bergh ed., 1999) (noting the efficiency of market-based mechanisms through Coase's theorem).

for each entity. This is simply because it would be too expensive and onerous for the government to collect information on individual costs to make this allocation. Moreover, the pricing mechanism provides firms with flexibility because they can choose their own allocation of property rights. For example, they may decide to purchase additional property rights or they may choose to earn revenue by selling their property rights. This flexibility is in contrast to the uniformity of standard setting measures. As a result, theoretically, the marketable property right scheme is more efficient than standard setting regulatory approaches. However, in assessing whether to use marketable property rights, the government must consider the inefficiencies that emerge in administering property rights and the consequences of the lack of a perfectly competitive market. Nevertheless, marketable property rights, in some circumstances, such as those involving low monitoring costs, can save billions of dollars compared to standard setting regulatory approaches.[727]

A final advantage of marketable property rights is its support of continued technological innovation. Firms also have an incentive to innovate because technological innovations can allow them to sell off or use their marketable property rights more efficiently.[728] Compare this to a standard, where once the firm meets the set standard, they have little incentive for further innovation.

In the realm of code, the first notable creation of marketable property rights has been for the domain name system (DNS).[729] In this case, the government supported the creation of additional domain names for greater consumer choice, lower prices, and better service. To administer this process, the government turned over the management of the DNS to a private actor.[730] However, the government has maintained oversight to ensure the system is not used strategically for the benefit of a few.[731] This is necessary considering the persistent problems

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[727] Hahn & Hester, *supra* note 715, at 111.

[728] Ackerman & Stewart, *supra* note 685, at 1336.

[729] A number of commentators have considered whether a domain name is property. *See* 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).

[730] A few of the major works on the privatization of the DNS are as follows. 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*; Milton Mueller, *ICANN and Internet Governance: Sorting Through the Debris of 'Self-Regulation'*, 1 J. POL'Y, REG. & STRATEGY FOR TELECOMMS. INFO. & MEDIA 497 (1999); Jonathan Weinberg, *ICANN and the Problem of Legitimacy*, 50 DUKE L.J. 187 (2000); Kesan & Shah, *supra* note 560.

[731] Kesan & Shah, *supra* note 560, at 176-77 (noting actions taken by the government to ensure the governance of the DNS was transparent).

with the DNS privatization process. In fact, the government has advocated creating more property and lowering the cost for consumers.[732] The government's efforts to date have been focused on creating property rights for greater consumer choice, and not as a regulatory mechanism. However, one possible intervention is the government's interest in creating new top level domains such as .xxx, .adult, or .kids.[733] This intervention is not about limiting this behavior or allocating scarce resources, but is instead attempting to "fence off" or contain an activity to a specific piece of property. This use of property is more akin to zoning of real property than as an alternative for standard setting regulation.

The second use of marketable property rights for code could be in the privacy arena. Scholars have argued that the creation of a property right in privacy could correct market failures by providing people with control over their personal information.[734] The property right would lead to firms bargaining for a person's information, rather than the current system in which the incentives are for firms to disclose information without consent.[735] However, given the above discussion on marketable property rights, it is not clear whether this approach is warranted. First, it appears the creation of a privacy property right may not truly meet the needs of its proponents. The problems for most proponents is not the quantity of privacy, such as too much privacy or too little. Instead, the problem is the lack of negotiation and meaningful assent between parties during a transaction.[736] This is not a problem that marketable property rights can address. Marketable property rights work best to limit a quantity of harm and are not helpful in facilitating informed negotiations. Second, the purpose of property rights is to allow the market to allocate scare resources, and it is not clear how the market can allocate privacy property rights that are tied to individuals. Third, it is not clear how such a privacy property rights system will be administered.[737] Finally, there is the moral objection to allowing people to buy and sell

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[732] David McGuire, *Commerce Department Urges ICANN to Add More New Domains*, NEWSBYTES, May 25, 2001.
[733] Oscar S. Cisneros, *Surfers Need to Roam Porn-Free*, WIRED NEWS, Aug. 4, 2000, *available at* http://www.wired.com/news/politics/0,1283,37991,00.html (reporting on the consideration of an adult top level domain name by the Child Online Protection Act Commission); 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).
[734] *See supra* text accompanying notes 587-588.
[735] *See* Samuelson *supra* note 587, at 1127.
[736] *Id.* at 1134.
[737] *Id.* at 1138.

privacy.[738] In sum, the creation of a marketable property right in privacy is not a suitable alternative to regulation.

4. Modifying Liability

Changes in liability regimes can spur changes in code. Already, there are calls for additional liability to be placed on the developers of code. John Gilligan, chief information officer for the U.S. Air Force's computer network, wants software companies to be subject to legal action for failing to create and maintain secure products.[739] He believes that changing liability standards can improve product quality by requiring accountability from the developers of code. His call for accountability through liability is backed by a range of supporters from the National Academy of Sciences to the *Economist*.[740]

This section examines two different ways government can use liability to shape code. The first is through the law of torts, specifically product liability law. The second is through the law of contracts. We end by discussing how the relationship between increased liability and insurance companies can encourage the development of third party regulators. These private regulators, such as the Underwriters Laboratories, can serve to shape code to address societal concerns.

a. Product Liability Law

Product liability law can affect the development of code. Product liability law falls under the law of torts.[741] It depends not upon government agencies, but on persons who have been physically harmed seeking compensation in the courts.[742] One of the functions of product liability law is encourage firms to improve the safety of their products.[743] In this section, we

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[738] *Id.* at 1136.
[739] Alex Salkever, *A World Wide Web of Organized Crime,* BUS. WK., Mar. 13, 2001.
[740] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD*, supra* note 503; *A Lemon Law for Software?*, ECONOMIST, Mar. 14, 2002.
[741] 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).
[742] Susan Rose-Ackerman, *Tort Law in the Regulatory State, in* TORT LAW AND THE PUBLIC INTEREST 80 (Peter H. Schuck ed., 1991) (noting that product liability is a form of private law).
[743] MOORE & VISCUSI, *supra* note 741, at 8-9; 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).

argue that products liability law can serve as an alternative form of regulation to foster the development of safer code.[744]

Product liability law is a controversial area of the law to say the least.[745] Its impact has varied considerably by industry.[746] As of yet, product liability law has not had a substantial impact on code.[747] This is not surprising given that most losses from code are of an economic nature without physical injury.[748] Nevertheless, it is entirely foreseeable that as the use of code grows, code may increasingly be involved in physical injuries. As a result, product liability will grow in importance and will begin to shape code. However, the broadening of product liability to code may not become fully obvious because code is often contained within the systems of larger products that have traditionally been subject to product liability, such as automobiles or medical devices.[749]

One prominent example of product liability law shaping a technology is *Larsen v. General Motors Corp*.[750] General Motors argued that it had no duty to design a automobile that protects occupants in the event of a crash. Crashing an automobile was outside its intended use. However, the court disagreed. It held that the manufacturer of a vehicle has a duty to design

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[744] BREYER, *supra* note 644, 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 the developers of code. This would provide 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 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, *available at* http://www.acm.org/serving/se_policy/position.html (July 8, 1999). *See also* 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).

[745] Peter H. Schuck, *Introduction, in* TORT LAW AND THE PUBLIC INTEREST 17, 27-29 (Peter H. Schuck ed., 1991) (noting the politicization of law to limit liability).

[746] 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).

[747] There was potential for product liability due to the year 2000 problem with code. Industry was claiming potential liability losses of one trillion dollars. This led to the passage the Y2K Act which limited liability. Y2K Act, Pub. L. No. 106-37, 113 Stat. 185 (1999); John Wilen, *Report: Number of Y2K Lawsuits Dropping*, USA TODAY, Aug. 25, 1999.

[748] Thomas G. Wolpert, *Product Liability and Software Implicated in Personal Injury,* 60 DEF. CONS. J. 519, 519 (1993).

[749] *Id.* at 523.

[750] Larsen V. General Motors Corp., 391 F.2d 495 (8th Cir. 1968).

with reasonable care. This meant protecting occupants of the automobile in the event of a crash, even though crashing is not the intended use.[751]

There are several objections to using products liability law to shape technologies. First, critics argue that product liability law is inefficient. They urge that a more efficient method would be to allow consumers to select technologies based on their own evaluation of the risk and safety concerns. This would encourage the market to develop a wide range of technologies that are responsive to consumer needs. Thus, instead of using a stick approach of product liability law, they prefer the carrot approach of the market. This would also save firms substantial litigation costs.[752] Second, critics argue that the unpredictability of products liability law can lead to uneven results, since firms have difficulty predicting their liability exposure.[753] The third objection is that product liability law has a chilling effect upon innovation. The potential of product liability reduces innovation and keeps beneficial products off the market.[754]

First, while the market is theoretically more efficient, many of its assumptions are violated in the real world. As a result of market defects and transaction costs, product liability law can be more efficient than other alternatives. These defects can include buyers who are unaware of the risks or accorded inadequate opportunities to bargain for a safer and more expensive product.[755] 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 because they could best weigh the associated costs.[756] Through liability, a manufacturer would internalize the social costs into their products. This liability will raise costs for the manufacturer.[757] However, the benefits of these costs will be a safer product. Whether the costs of liability law are outweighed by its benefits is difficult to ascertain. This is because the deterrence aspect of product liability law provides a benefit to society that cannot be easily

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[751] John D. Graham, *Product Liability and Motor Vehicle Safety*, *in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 120, 121 (Peter W. Huber & Robert E. Litan eds., 1991).
[752] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, PRODUCT LIABILITY REFORM ACT OF 1997, S. REP. NO. 105-32, at 3-4 (1997).
[753] *Id.* at 5-6.
[754] *Id.* at 8-10.
[755] BREYER, *supra* note 644, at 175.
[756] *Id*.
[757] There is little evidence that product liability costs and insurance costs are too high. *See* MOORE & VISCUSI, *supra* note 741, at 13 (noting that in real terms insurance premiums have fallen between 1988 to 1998); COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 752, at 65.

measured.[758] It is also difficult to account for the gains to society from firms not releasing unsafe products. There is considerable evidence that product liability laws have led to safer products. For example, the change from a negligence to a strict liability standard has resulted in far less deadly accidents.[759] Some even argue that if product liability laws were more stringent, we would have even safer products.[760]

The second objection to product liability law is its unpredictability. The unpredictability typically refers to the use of punitive damages. Punitive damages often vary because they serve to punish defendants for their conduct. The awarding of punitive damages is rare. One study found that punitive damages were awarded less than five percent of the time in civil jury verdicts.[761] In fact, in product liability cases in state and federal courts between 1965 and 1990, punitive damages were only awarded 355 times over the entire twenty-five year period![762] The purpose of punitive damages is twofold. First, punitive damages express to a defendant that their conduct was intolerable.[763] Second, punitive damages serve a deterrent function because they reward plaintiffs subject to serious misconduct above their actual damages.[764] As a result, this provides firms with a strong incentive to ensure their products meet society's minimal standards for safety. As a deterrent, there is evidence that punitive damages can result in safer products.[765]

Third, there is not a simple direct relationship between increased liability and decreased innovation. One systematic study across several industries found that low levels of liability risk are associated with higher levels of research and development activity, and therefore, innovation. At high levels of liability, there is lower research and development activity, and thus, less innovation.[766] This means that a degree of product liability risk creates an incentive to develop safer products, but at extremely high-risk levels, there is a reduction in the development of new

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[758] Robert Litan, *The Liability Explosion and American Trade Performance: Myths and Realities, in* TORT LAW AND THE PUBLIC INTEREST 127, 135 (Peter H. Schuck ed., 1991).
[759] BREYER, *supra* note 644, at 175.
[760] Nicholas A. Ashford & Robert F. Stone, *Liability, Innovation, and Safety in the Chemical Industry, in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 367, 414 (Peter W. Huber & Robert E. Litan eds., 1991).
[761] Stephen Daniels and Joanne Martin, *Myth and Reality in Punitive Damages*, 75 MINN. L. REV. 1, 31 (analyzing 25,627 civil jury verdicts in forty-seven counties in eleven states for the years 1981-85).
[762] Michael Rustad & Thomas Koenig, *Punitive Damages in Products Liability: A Research Report,* 3 PROD. LIAB. L.J. 85, 89 (1992) (performing a comprehensive survey of punitive damages in product liability verdicts).
[763] Jane Mallor & Barry Roberts, *Punitive Damages: Towards a Principled Approach,* 31 HASTINGS L.J. 639, 648 (1980).
[764] *Id.* at 649-50.
[765] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 752, at 75.
[766] MOORE & VISCUSI, *supra* note 741, at 25.

products. This leads to the conclusion that there is a balancing point between increasing safety and the slowing of technological progress.[767] Thus, liability to a certain degree can actually increase innovation. Other research has found that notions of innovation and safety can't be separated and that liability affects both. Here, liability promotes safety and innovation of desirable products, while also discouraging the development of unsafe products that may be innovative.[768]

One advantage of product liability law is its public visibility.[769] The publicity of a product liability lawsuit can serve to stimulate safety through a variety of societal institutions.[770] Naturally, a products liability lawsuit will lead manufacturers to reexamine their practices. Moreover, the publicity can also spurn regulatory agencies to action as well as leading to consumer demand for safety. This was evident in several vehicle product liability suits such as the Ford Pinto, shoulder belts, and all-terrain vehicles.[771] Moreover, there is also evidence that product liability lawsuits provide firms with an incentive for developing safer products by affecting their wealth through the stock market.[772]

Product liability already plays a role in shaping the development of code. In industries where defective code can cause physical injury, such as aerospace and medicine, developers strive to develop safer code. There are many reasons, besides purely regulatory concerns, why firms avoid developing unsafe code. These include a loss of revenue, reputation, as well as product liability costs. As a result, firms developing code for aerospace applications and medical devices use a number of developmental strategies to ensure high quality code.[773]

Product liability can also play a role in shaping the future development of code. For example, one potential application is to hold firms liable for failing to properly secure their computer systems.[774] Firms that do not implement appropriate levels of security not only place

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[767] *See* MOORE & VISCUSI, *supra* note 741, at 26; W. Kip Viscusi & Michael J. Moore, *An Industrial Profile of the Links between Product Liability and Innovation, in* THE LIABILITY MAZE: THE IMPACT OF LIABILITY LAW ON SAFETY AND INNOVATION 81 (Peter W. Huber & Robert E. Litan eds., 1991). *See also* Litan, *supra* note 758, 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).
[768] COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION, *supra* note 752, at 77-78.
[769] Schuck, *supra* note 745, at 20-27.
[770] Graham, *supra* note 751, at 181-82.
[771] *Id.* at 181 (providing examples on the role of publicity from lawsuits).
[772] MOORE & VISCUSI, *supra* note 741, at 27.
[773] *See* RICHARD C. FRIES, RELIABLE DESIGN OF MEDICAL DEVICES (1997).
[774] Alan Charles Raul et al., *Liability for Computer Glitches and Online Security Lapses,* 6 BNA ELECTRONIC COM. L. REP. 849 (2001).

themselves at risk, but may also serve as unwitting pawns in attacks on other computer systems. Commentators have argued that one solution to this problem is the imposition of tort liability.[775] Such liability will motivate firms into adopting more secure code.

b. Contract Law

A second option for regulating with liability is through contract law. Typically, a transaction involving code falls under the Uniform Commercial Code (UCC), which has been virtually fully enacted by all fifty states.[776] The UCC contains default rules for contracts as well as rules that govern all contracts. For example, the UCC has default rules regarding warranties.[777]

Recently, there has been a movement to amend the UCC to better handle transactions with intellectual property and software. This was initially titled Article 2B. However, sharp differences emerged from the drafting process. Eventually, the American Law Institute withdrew from the process and eliminated Article 2B as an amendment to the UCC. However, supporters of Article 2B renamed the legislation as the Uniform Computer Information Transactions Act (UCITA).[778] UCITA has since been enacted in Virginia and Maryland and is being considered by other states.

UCITA is an ongoing example of how changes in liability affect code. The pro-UCITA movement is being led by the software industry and has led to two states adopting UCITA. However, a number of organizations have been fighting the adoption of UCITA. This has led a few states to pass anti-UCITA legislation, known as bomb-shelter legislation, which protects their residents against licensing provisions in contracts governed by UCITA.[779] Without addressing the merits of UCITA, we will highlight some provisions of UCITA that can affect the

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775 *Id.*
776 In dealing with code, there is often a question whether the sale of software is considered a good or a license under the UCC. Most courts have considered code a good and therefore a transaction falls under the UCC. *Computer Software as a Good Under the Uniform Commercial Code: Taking a Byte out of the Intangibility Myth,* 65 B.U. L. REV. 129 (1985); Douglas E. Phillips, *When Software Fails: Emerging Standards of Vendor Liability Under the Uniform Commercial Code*, 50 BUS. LAW. 151, 157-58 (1994).
777 For example, the default rule for contracts is for an Implied Warranty of Merchantability in the purchase of a good. U.C.C. § 2-314.
778 NATIONAL CONFERENCE OF COMMISSIONERS ON UNIFORM STATE LAWS, UNIFORM COMPUTER INFORMATION TRANSACTIONS ACT, *available at* http://www.law.upenn.edu/bll/ulc/ucita/ucita01.htm (2001).
779 Ed Foster, *Maryland Legislature Caves to UCITA, but Iowa May Offer a Safe Haven from Law*, INFOWORLD, Apr. 21, 2000, *available at* http://www.infoworld.com/articles/op/xml/00/04/24/000424opfoster.xml.

development of code. These examples highlight how changes in contractual liability can shape code.

UCITA allows developers to disclaim liability for damages caused by software.[780] According to Barbara Simons, "we know that it is almost impossible to write bug-free software. But UCITA will remove any legal incentives to develop trustworthy software, because there need be no liability."[781] As a result, it is widely considered in the software industry that UCITA will only lead to even lower quality standards for code.

A second criticism of UCITA is it would make enforceable provisions against reverse engineering. Reverse engineering is the process of analyzing code to determine how it operates. This is usually for the purpose of duplication and is done by competitors who wish to develop rival code. Reverse engineering is an accepted practice under copyright and trade secret law.[782] However, UCITA allows firms to prohibit reverse engineering of products. Undoubtedly, this provision will make it more difficult to develop competing products. While this provision may be difficult to enforce, it will still have a chilling effect upon the development of code.[783]

A third criticism of UCITA is that it allows developers to enforce contractual provisions against public criticisms of software. This would affect the writing of reviews, comparisons, and benchmark tests on code. These writings serve to inform consumers and create a more competitive marketplace.[784] While this provision may be found to be unenforceable on public policy grounds, it will still have a chilling effect upon the reviews of code.[785]

UCITA is an example of how changes in liability can shape code. Although, it is highly questionable that UCITA in its present form will be widely adopted, the issues behind UCITA are very relevant. They involve a balancing of various liabilities and conditions for the use of

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[780] Cem Kaner, *Software Engineering and UCTICA,* 18 J. MARSHALL J. COMPUTER & INFO. L. 435 (1999) (discussing how UCITA's provisions for limited accountability will serve as an incentive for the software industry to develop shoddier 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; Rochelle Cooper Dreyfuss, *Software as Commodity: International Licensing of Intellectual Property: Commentary: UCITA in the International Marketplace: Are We About to Export Bad Innovation Policy*?, 26 BROOK. J. INT'L L. 49 (2000).

[781] Barbara Simons, President of the Association of Computing Machinery, *Shrink-Wrapping Our Rights*, COMM. ACM, Aug. 2000, at 8, *available at* http://www.acm.org/usacm/copyright/ucita.cacm.htm.

[782] Cohen & Lemley, *supra* note 813, at 16-37 (arguing that the traditional right to reverse engineer software under copyright and trade secret law should be extended to patents).

[783] Kaner, *supra* note 780, at 473-74.

[784] The Institute of Electrical and Electronics Engineers, *Opposing Adoption of the Uniform Computer Information Transactions Act (UCITA)*, *available at* http://www.ieeeusa.org/forum/POSITIONS/ucita.html (Feb. 2000).

[785] Kaner, *supra* note 780, at 470.

code between developers and consumers. Whatever the outcome is, it will undoubtedly serve to shape the code that is developed in a post-UCITA world.

c. Insurance and Third Party Regulators

One of the consequences of liability is the development of institutions to lessen and spread the risk of liability. Insurance has long been a mechanism to spread the risk of liability from events such as fire or earthquakes.[786] More interesting 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.

In order to foster a similar regime, it is necessary to consider the factors that led to the growth of the Underwriters Laboratories (UL). The UL's history began with a rash of fires in major American cities in the 1890s. The culprit was electricity.[787] This led 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.[788] The laboratory would become the UL and provide rigorous unbiased testing of electrical devices for fire prevention. The UL maintains it is "testing for public safety. Our goal is to serve, not to profit."[789] Today, the UL works with over sixty thousand manufacturers. The UL label is present on over one hundred thousand products, which have each been evaluated for safety.[790] The success of the UL is the result of a close relationship with insurance companies and government regulators. This relationship ensures manufacturers follow UL's safety standards. As a result, products that have the UL label are considered safe. This approval is important for both the consumer and the manufacturer. The manufacturer of UL labeled products gains through lower insurance premiums.

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[786] Orna Raz and Mary Shaw, *Software Risk Management and Insurance*, Third International Workshop on Economics-Driven Software Engineering Research, Toronto, Canada, May 14-15, 2001, *available at* http://www.cs.virginia.edu/~sullivan/edser3/raz.pdf.
[787] NORM BEZANE, THIS INVENTIVE CENTURY: THE INCREDIBLE JOURNEY OF THE UNDERWRITERS LABORATORIES 6 (1994).
[788] *Id.* at 7.
[789] *Id.* at 6
[790] Underwriters Laboratories, *2001 Annual Report, available at* http://www.ul.com/annualreport01/index.html (last visited July 23, 2002).

As a result of recent concerns about security, the government is attempting to foster a similar regime for code.[791] It begins by companies purchasing insurance for cybersecurity. Consequently, insurance companies will provide discounts to firms with better security practices and those who use more reliable security products. Along the way, the insurance companies would encourage the creation of an analogous UL for testing code. Ideally, this 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 that used these approved pieces of code would have their premiums reduced. This would then increase demand for more secure code. As a result of this demand, developers would have an incentive to make sure their products met the standards of the code-based UL.

This approach is very compelling. It is largely based on private actors with government just promoting and using the tested products. The incentive structure for insurance companies, their insured, and developers appears to be very clear. Finally, this approach also addresses how to regulate code, which consists of a large number of products that change rapidly. While this scheme has proved successful for the UL and electrical products, there are significant issues with using insurance and third party regulators for code. We believe that there are three issues the government must consider 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 in situations when its price is largely independent of expenditures on self-protection.[792] For example, home owners demand insurance against fire and earthquakes because these are events that are largely independent of self-protection measures. 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. Consider the following examples for code. There is little a firm can do to protect itself from a major Internet outage. However, a firm can protect itself from a minor Internet outage through the use of redundant Internet service providers. Therefore, one would expect a demand for insurance against losses from a major Internet outage, but not from a minor Internet outage.

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[791] Brian Krebs, *White House Pushing Cybersecurity Insurance,* WASH. POST, June 27, 2002, *available at* http://www.washingtonpost.com/wp-dyn/articles/A55719-2002Jun27.html; Nancy Gohring, *Cyberinsurance May Cover Damages of Computer Woes,* SEATTLE TIMES, July 29, 2002.

The importance of self-protection for Internet security lessens the need for insurance. In the current state of the Internet, self-protection measures play an important role in reducing losses. This is evident in the vast industry devoted to developing and teaching self-protection skills to firms.[793] As a result of the importance of self-protection, the natural inclinations of the market will not foster the development of market insurance for security. Thus, government's encouragement will not be enough to foster the development of an insurance regime.

Without a viable insurance regime, there is little incentive for insurance companies to foster third party regulators for code. And creating third party regulators, which are not backed by insurance companies or some other entity that can force compliance, is bound to fail. 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.[794] There were no laws holding actors accountable for privacy violations. Therefore, TrustE could not meaningfully regulate their activity. Thus, without the support of insurance companies and the consequent threat of financial repercussions, there is little incentive for the growth of vigorous third party regulators for code.[795]

The second problem with insurance for code is the need for determinable damages. If losses cannot be estimated by insurance companies, they cannot provide market insurance that is priced in accordance with the risk.[796] The problem is that code-based damages are different than a loss from a fire or hazard, because damage from a fire is tangible, obvious, and irreplaceable. Code in the form of software, in databases, and the like is often intangible. Moreover, it is not obvious what the losses are when many code-based losses are reversible.[797] Examples of these

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

[793] One exemplary program is the SANS (System Administration, Networking and Security) Institute, which is devoted to defending computer systems and networks against the most dangerous threats. *See* http://www.sans.org/newlook/home.php.

[794] The use of private regulators such as TrustE has proven unsuccessful. TrustE is ineffective because it cannot force parties to comply. If a party does not comply with TrustE they lose slight reputational capital. There is little liability at stake. In contrast, not complying with standards set by Underwriters Laboratories can lead to problems in terms of lawsuits, loss of insurance coverage, and government oversight. Thus there are very real penalties for violating or ignoring the standards promulgated by Underwriters Laboratories. *See* Kesan & Gallo*, supra* note 597 (discussing the failure of third party institutions in regulating online privacy); Paul Boutin, *Just How Trusty is Truste?*, WIRED NEWS, Apr. 9, 2002, *available at* http://www.wired.com/news/print/0,1294,51624,00.html (noting the lack of an enforcement mechanism by TrustE).

[795] *See* Kesan & Gallo, *supra* note 597 (calling for government participation to spur the growth of third party institutions to regulate firms).

[796] *See* Raz & Shaw, *supra* note 786.

[797] Krebs, *supra* note 791 (noting the problem with assessing damage).

are computer viruses, hacker attacks, and the defacement of web pages. The remedy to many code-based security losses is that a firm's staff must perform activities such as removing viruses from computers and restoring backups. Therefore, predicting and assessing a firm's damages is difficult. Moreover, it may be that damages are so low that firms prefer to self-insure. This is another reason why firms have not sought cybersecurity insurance.

The third problem concerns the appropriate purchaser of insurance. In the government's efforts to improve security, they have focused on insurance for firms who use the Internet in their daily business. This may be the wrong buyer, if the goal is developing more secure products, because of the problems of self-protection and determination of damages. Instead, the government should focus on insurance for the developers of code. If these firms were subject to liability, then they and their insurers would have a tremendous incentive to address that liability.[798] This could lead to several outcomes. The developers could adopt voluntary "best practices" industry standards for security.[799] Their insurers could then require them to adopt these new practices. The insurers could also 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 their liability. All of these are ways that product liability and insurance can proactively shape code.

5. Requiring Disclosure

The government can shape the development of code by requiring disclosure. Disclosure requires firms to provide information about their products. This differs from educational campaigns funded by the government, which we discuss later.[800] Disclosure is intended to inform consumers, which then, allows markets to work more efficiently.[801] In many cases, the technical sophistication of code leads to few people understanding its true ramifications. For example, most users didn't understand the privacy risks of cookies until the media reported them. Moreover, many people still don't really understand how cookies operate and their privacy

[798] *Id.* (noting that security expert Bruce Schneier believes that firms aren't going to improve security until they face either product liability lawsuits or stringent standards).
[799] Dan Verton, *Consortium Created to Improve Software Reliability,* USA TODAY, May 22, 2002 (noting that the insurance industry can aid in promoting "positive behavior" among developers).
[800] *See infra* Part VII.B.5.
[801] BREYER, *supra* note 644, at 161. Disclosure can also be used to outlaw particular conduct, for example requiring the disclosure of large currency transactions aids in finding violations of tax and drug laws.

implications.[802] As a result of their limited knowledge, these people are not able to protect their privacy, and consequently, their personal information that is being collected.[803] These privacy problems can be substantially reduced if firms are required to meaningfully disclose the privacy risks of cookies.

According to Breyer, disclosure works most effectively when the following three conditions are met.[804] First, the public has to 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. After all, the disclosure is of no use if the public can't select a different alternative. Third, the public must find the information materially relevant. If the public finds no value in the disclosure, then there is little utility in requiring such disclosure. Based on this analysis, we offer several potential ways for government to regulate code with disclosure. These include the use of disclosure to set product standards, disclosure for certain products or activities, and industry-wide disclosure.

To provide the public with better information, the government can require firms to label their products with product standards.[805] For such a label to be successful, it must be able to convey information in a meaningful and concise manner. An example of a labeling standard is the United States Department of Agriculture's standards for food quality.[806]

Government can mandate disclosure to ensure consumers are adequately informed. This is a step beyond labeling and includes measures such as requiring firms to affirmatively provide information. For example, the Securities and Exchange Commission requires public companies to disclose meaningful financial and other information to the public. An example of a similar code-based disclosure policy is the Children's Online Privacy Protection Act. This law requires web sites to report what children's information it collects, uses, and discloses.[807] This information can allow parents to make an informed decision about what web sites their child can

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[802] Similarly, people have difficult understanding the complex privacy policies put forth by web sites. *See* Brian Krebs*, Standard, Plain-English Privacy Policies Wanted – Update,* NEWSBYTES, Dec. 3, 2001, *available at* http://www.newsbytes.com/news/01/172628.html.

[803] Elinor Mills Abreu, *CIA-Backed Web Privacy Firm Closes Service*, WASH. POST, Nov. 20, 2001, *available at* http://www.washtech.com/news/software/13778-1.html (noting that people don't understand privacy issues on the Internet).

[804] BREYER, *supra* note 644, at 163-64. *See also* WESLEY A. MAGAT, & W. KIP VISCUSI, INFORMATIONAL APPROACHES TO REGULATION (1992); SUSAN G. HADDEN, READ THE LABEL (1986).

[805] *See supra* text accompanying note 637.

[806] *See supra* note 638.

[807] Children's Online Privacy Protection Act, 16 U.S.C. § 6501 (2001).

visit. However, if parents do not find this information materially relevant, this regulation would be unnecessary.

A final method of disclosure is encouraging communication within an industry. In some circumstances, the public can benefit when firms share information. It is in the interest of government to support such collaboration. For example, the government-supported CERT Coordination Center collaborates with industry to disclose all known security incidents.[808] This communication benefits the public by allowing the developers of code to react quickly to potential security problems.[809] The concern here is that this creates room for some firms to behave opportunistically. For instance, some firms may be deliberately left out of the communication loop. Firms could also use these disclosure regulations to favor certain firms over others. This places a burden on the government to ensure that these regulations are not used to create an uneven competitive playing field.

6. Modifying Intellectual Property Rights

Government can use intellectual property rights, such as patents and copyright, to shape code. In the first section, we discuss how government may modify intellectual property rights to further innovation. The second section focuses on the use of patent pools and compulsory licensing to foster the dissemination of code or content.

a. Revising Intellectual Property Rights

Intellectual property rights differ from conventional property rights, such as land, in one key aspect. Society benefits from intellectual property that is not privatized. Free flowing information allows people to build upon the intellectual efforts of others. This is understood in the Constitution, which allows the limited protection of intellectual property rights in order to "to

[808] CERT Coordination Center was originally called the computer emergency response team.

[809] Elizabeth Hurt, *New Alliance Takes on Security: CERT Teams Up with Trade Group to Raise Awareness of Information Security Risks*, BUSINESS2.0, Apr. 19, 2001, *available at* http://www.business2.co.uk/articles/web/0,1653,15984,FF.html (discussing the collaboration between industry and government in disclosing security issues).

Promote the Progress of Science and Useful Arts."[810] Thus, the government's limited protection of intellectual property plays an important role in stimulating innovation.[811]

Intellectual property rights for code have historically been different for the hardware and software components. Patent law has traditionally protected the hardware components. Recently, patent law has joined copyright law for the protection of software. This change has occurred, not because of the actions of legislators, but because of judges.[812] Recent decisions by the Supreme Court and the Court of Appeals for the Federal Circuit, now allow the patenting of software.[813] However, it should be noted that copyright protection of code has not diminished. In fact, legislators have increased the duration of copyright protection with the Sonny Bono Copyright Term Extension Act of 1998.[814] This act retroactively extended the duration of copyright an additional twenty years.[815] Proponents argued that this extension would encourage investment in existing copyright works as well as encouraging the creation of new works, because of the longer exclusivity period.[816]

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[810] U.S. CONST. art.. I, § 8, cl. 8.

[811] Robert P. Merges, *Commercial Success and Patents Standards: Economic Perspectives on Innovation,* 76 CALIF. L. REV. 803 (1988) (noting how the patent system should directly reward innovation).

[812] The Supreme Court played a role in changing intellectual property rights for biotechnology. Diamond v. Chakrabarty, 447 U.S. 303 (1980) (allowing the patenting of genetically engineered life forms).

[813] Diamond v. Diehr, 450 U.S. 175 (1981) (finding that a software related invention was patentable); State St. Bank & Trust Co. v. Signature Fin. Group, Inc., 149 F.3d 1368, (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 CALIF. L. REV. 1, 8-11 (2001) (providing a brief history of software patents); Steven G. Steger, *The Long and Winding Road to Greater Certainty in Software Patents*, CBA RECORD, Apr. 2000, at 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 for the United States as well as European countries. The paper describes how patent protection for software has changed over time).

[814] *See* Sonny Bono Copyright Term Extension Act, Pub. L. No. 105-298, 112 Stat. 2827 (1998) (to be codified at 17 U.S.C. §§ 108, 203, 301-304).

[815] This ensured that no new copyright works, such as Walt Disney's Mickey Mouse character, would enter the public domain in the United States until 2019, when all works created in 1923 will enter into the public domain. Christina N. Gifford, *The Sonny Bono Copyright Term Extension Act*, 30 U. MEM. L. REV. 363, 385 (2000). This legislation is currently being challenged in Eldred v. Reno, 239 F.3d 372 (D.C. Cir. 2001), *cert. granted*, (U.S. Feb. 19, 2002) (No. 01-618). *See also* Lawrence Lessig, *Copyright's First Amendment*, 48 UCLA L. REV. 1057 (2001); Neil Weinstock Netanel, *Locating Copyright within the First Amendment Skein*, 54 STAN. L. REV. 1 (2001).

[816] Copyright Extension, *The Sonny Bono Copyright Term Extension Act, available at* http://www.copyrightextension.com/page01.html (last visited Jul. 16, 2002). Similarly, there have been calls for government to be allowed to copyright and grant partially exclusive and exclusive licenses for computer software by amending copyright law. *See* U.S GENERAL ACCOUNTING OFFICE, TECHNOLOGY TRANSFER: CONSTRAINTS PERCEIVED BY FEDERAL LABORATORY AND AGENCY OFFICIALS 37 (1988).

A number of scholars have argued that current intellectual property rights are too strong and actually discourage innovation.[817] They believe that intellectual property laws need to facilitate the sharing of information to further innovation. To further this goal, Lessig proposes limiting the duration of copyright protection. His proposal requires copyright holders to renew their registration every five years.[818] If the copyright is not renewed, the work falls into the public domain. He also proposes, in order to gain copyright protection for software, the author must provide the source code so it may enter the public domain upon expiration of the copyright.[819] The net effect would be to place more content and code into the public domain, which others could build upon.

Evaluating and justifying the revisement of intellectual property rights is difficult for two reasons. First, it is difficult to empirically ascertain whether intellectual property protection is too strong or too weak. Concepts such as innovation or a public commons for knowledge are difficult to compare as costs and benefits. Second, the modification of intellectual property rights affects a fundamental social and economic characteristic of society.[820] Individuals and firms rely on these notions and definitions of property in their actions. So any change undermines these assumptions.[821] Nevertheless, this has not slowed the long-term trend in copyright law towards more protection.[822]

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[817] 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); Neil Weinstock Netanel, *Copyright and a Democratic Civil Society*, 106 YALE L.J. 283 (1996).

[818] LESSIG, *supra* note 817, at 251. *See also* Mark A. Haynes, *Black Holes of Innovation in the Software Arts*, 14 BERKELEY TECH. L.J. 503 (1999) (arguing for limiting copyright protection, because it is slowing down innovation in code).

[819] 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 recreation, may allow for greater use of modularity in code. Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255 (1997).

[820] Carol M. Rose, *Property and Expropriation: Themes and Variations in American Law*, 2000 UTAH L. REV 1. (noting the traditional justifications for the stability of property).

[821] We reject the argument that copyright terms are meaningless. For example, Adkinson has argued that lengthening the terms of copyright is "unlikely to interfere with creativity or confer power over consumers. Recall 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, *Creativity & Control Part 2*, AM. SPECTATOR, May 2002, *available at* http://www.gilder.com/AmericanSpectatorArticles/AdkinsonMay-June.htm.

[822] JESSICA LITMAN, DIGITAL COPYRIGHT (2001) (noting the trend towards more protection).

b. Patent Pools and Compulsory Licensing

A second more tangible and immediate method of shaping code is through the use of patent pools and compulsory licensing. For instance, compulsory licensing allows the government to force a party to license out their copyright or patent. As a result, another party or the government can then make, use, and sell the affected content or technology. This allows government to widen the dissemination of the intellectual property. In the United States, the government has required compulsory licensing of copyright, but generally not patents.[823] The two prevailing justifications for the use of patent pools and/or compulsory licensing are high transactions costs, the public interest and the need to continue to promote downstream innovation.

These types of licensing schemes are used to reduce transactions costs.[824] In some industries, there are large numbers of intellectual property rights holders that must be contracted with to develop or use their property rights. The large numbers of parties result in high transaction costs and reduce the incentive to use this property. Government intervention seeks to address these high transaction costs through patent pools or compulsory licensing. Compulsory licensing reduces the costs of haggling over individual transactions as well as providing an administrative method to ensure the proper parties are compensated. For example, the government requires compulsory licensing of the retransmission of broadcast signals by cable. The rationale is that transaction costs would make it impractical for the cable company to pay royalties to each individual copyright owner of a broadcast signal.[825] Through compulsory licensing, the government reduces the transaction costs for all parties. This example also shows

[823] The 1976 Copyright Act provides for a number of compulsory licenses, such as for cable television, jukeboxes, and for public radio and public television. *See* 17 U.S.C. 111, 116, 118. Patents can also be the subject of compulsory licensing. *See* Joseph A. Yosick, *Compulsory Patent Licensing for Efficient Use of Inventions,* 2001 U. ILL. L. REV. 1275, 1277 (discussing the use of compulsory licensing for patents); Kenneth J. Nunnenkamp, *Compulsory Licensing of Critical Patents Under CERCLA,* 9 J. NAT'L RESOURCES & ENVTL. L. 397 (reviewing compulsory licensing of patents for cleanup of hazardous waste). *See also* Consumer Project on Technology, *Examples of Compulsory Licensing of Intellectual Property in the United States, available at* http://www.cptech.org/ip/health/cl/us-cl.html (last visited July 22, 2002).

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

[825] Cote, *supra* note 824, at 228-232.

how compulsory licensing can promote the growth of new technology by ensuring an adequate supply of content.[826]

The objection to using compulsory licensing rests largely on the costs of government action versus private action. Opponents of government mandated compulsory licensing prefer privately established organizations that lower transactions costs, such as the American Society of Composers, Authors, and Publishers (ASCAP).[827] They argue these private organizations have more flexibility in their licensing decisions.[828] Additionally, government action is subject to interested parties that may manipulate the rules for their own benefits.[829]

The second rationale for compulsory licensing is the public interest. There are technologies that are vital to the public interest. Examples of these interests include public safety, national defense, agriculture, environment, and antitrust.[830] The justification for compulsory licensing is that the public interests are so great that it is necessary to ensure public access to the products through compulsory licensing. The classic example is a life-saving drug that is sold at a high price.[831] For instance, a country may choose to use compulsory licensing to bring down the price of a drug.

The objection to this approach is that a compulsory license leads to a loss of monopoly power, which is an essential condition for an intellectual property right. As a consequence, this results in lower revenue for the producer. More generally, the government's use of this power will reduce the incentive to innovate by firms. If firms believe they will be subject to compulsory licensing for a product, they will not develop it.[832] So the overuse of this method could actually lead to fewer technologies that address various public interests.[833] A final objection for compulsory licensing is its administrative costs. The necessary legislative and

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[826] *Id.* at 242.
[827] Merges, *supra* note 824 (arguing that compulsory licensing is inferior to privately established collective rights organizations that address the problem of high transaction costs).
[828] *Id.* at 1295.
[829] *Id.*
[830] 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); Yosik, *supra* note 823, at 1279-84.
[831] 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 (2001).
[832] Fauver, *supra* note 830, at 676-77.
[833] *Id.* at 670-71. *See also* Theodore C. Bailey, *Innovation and Access: The Role of Compulsory Licensing in the Development and Distribution of HIV/AIDS Drugs,* 2001 J. L. TECH. & POL'Y 193, 210-14 (arguing that while compulsory licensing may reduce the level of innovation, the reduction may actually be the socially optimal level for research activity).

regulatory proceedings can take time. Government does not move nimbly. Moreover, in the area of code, technological development is rapid. As a result, compulsory licensing may reduce the incentive for firms to develop new business models that touch upon public interests because of the risk that they may be subject to compulsory licensing.[834]

There are a number of possible uses for compulsory licensing for code. For example, to reduce transactions costs and promote the growth of new digital music technologies, the government could require compulsory licensing of music in a digital format.[835] The critical issue would be whether government intervention is really needed because of the lack of private action in permitting transactions in digitally formatted music.

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 licensing of Microsoft Windows.[836] This licensing could be justified by the unique and important nature of the Windows operating system to society. Proponents would have to show how this licensing would increase innovation in the software industry. Another compelling reason for compulsory licensing would be for code that protects privacy, national security, or minors. In this case, a compulsory licensing scheme could be justified to ensure the product was widely disseminated. For example, a technology akin to PICS could be subject to a compulsory license to ensure it was placed on every computer in the nation. However, in using such a scheme, the government must consider the administrative costs as well as the potential adverse consequences on innovation. If firms are not adequately compensated by such licensing schemes, they may avoid developing code that addresses societal concerns.

7. Need for a Comprehensive Regulatory Strategy

A coherent and comprehensive regulation strategy for code has been inadequately considered by policymakers. The regulation of code is spread over a variety of agencies

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[834] Adkinson, *supra* note 821.
[835] *Lawrence Lessig: The "Dinosaurs" Are Taking Over*, BUS. WK., May 13, 2002, *available at* http://www.businessweek.com/magazine/content/02_19/b3782610.htm.
[836] James V. Grimaldi, *States Want Microsoft to Auction Off Windows Coding,* SEATTLE TIMES, Mar. 28, 1999, *available at* http://seattletimes.nwsource.com/news/local/html98/micx_19990328.html. *See generally* Consumer Project on Technology, *Compulsory Licensing as Remedy to Anticompetitive Practices, available at* http://www.cptech.org/ip/health/cl/us-at.html (last visited July 22, 2002).

including the FAA, FCC, FDA, FTC, and NHTSA.[837] There are no guiding principles or rationales for this regulatory approach. In contrast, the regulations for automobile technology and biotechnology have distinct rationales that guide the development of regulation.

In the case of automobile technology, the National Traffic and Motor Vehicle Safety Act required the government to develop safety standards for automobiles.[838] Previously, auto safety had been largely unregulated. Today, one agency, the NHTSA, is responsible for setting the safety standards that automobile manufacturers must meet.

In contrast, the regulation of biotechnology is not done by one federal agency, but instead relies upon a coordinated framework of federal agencies. This approach was recommended in a report by the Office of Science and Technology Policy (OSTP).[839] The OSTP found that the current laws in this area were largely adequate. This led to two principles for the regulatory activity. First, each agency would operate in an integrated and coordinated fashion with other agencies. Second, the responsibility for a product use would lie with a single agency. As a result, the USDA, EPA, and FDA are each responsible for different phases in the development of biotechnology products from research in laboratories to products in the marketplace.[840]

We believe that the approach taken in the regulation of biotechnology is appropriate for code. Code has many different uses and is created by a wide variety of parties. This diversity would lead to enormous difficulties for one agency to regulate all forms of code. Instead, regulatory authority should be given based on product use to a single agency. This is similar to the argument that the regulation of code should be application specific and not technology specific.[841] We see a movement in this direction with recent concerns over security, and the

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[837] The NHTSA is responsible for automobile safety and this now includes code. This is because computers are now used in motor vehicle systems such as pollution control, transmission, antilock brakes, electronic and mechanical systems, heating and air-conditioning, sound, and steering. For example, faulty electronic components and software flaws have caused problems with air bag deployment, powertrain controls, and ignition systems, and even led to deaths. Nedra Pickler, *GM to Recall Cadillac DeVilles for Faulty Air Bags*, DETROIT NEWS, Oct. 21, 2000, *available at* http://detnews.com/2000/autos/0010/22/autos-137213.htm (airbags); Justin Hyde, *Ford Recalls Explorers, Mountaineers,* DETROIT NEWS, Dec. 11, 2000, *available at* http://detnews.com/2000/autos/0012/11/-160923.htm (power train); Stephen LaBaton & Lowell Bergman, *Documents Indicate Ford Knew of Engine Defect but Was Silent,* N.Y. TIMES, Sep. 12, 2000 (ignition systems).

[838] National Traffic and Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 730.

[839] U.S. Office of Science and Technology Policy, Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23303 (1986).

[840] Linda Maher, *The Environment and the Domestic Regulatory Framework for Biotechnology,* 8 J. ENVTL. L. & LITIG. 133 (1993). *See also* Kurt Eichenwald et al., *Biotechnology Food: From the Lab to a Debacle,* N.Y. TIMES, Jan. 25, 2001 (providing a history of the industry's approach in courting and combating regulation).

[841] Timothy Wu, *Application v. Internet - An Introduction to Application Centered Internet Analysis*, 85 VA. L. REV. 1163 (1999).

government's efforts in attempting to unify coordination over code-based security.[842] Nevertheless, we believe government needs to develop a coordinated strategy for the regulation of code.[843]

B. Shaping Code Through Government Spending

Government can encourage the development and use of socially beneficial code through its fiscal power. This is analogous to government spending on supporting medical research, subsidizing agriculture, and building the interstate highway infrastructure. This section discusses five different ways the government's spending can influence the development of code. The first three sections focus on how government can use its fiscal power to shape code. The first section focuses on government funding of research and development. The next section explains how government can promote certain code through its power of procurement. The third section discusses how government can use tax expenditures or tax credits to shape code. The fourth section focuses on the appropriate policy for transferring government created code to the private sector. The government's approach in the transfer can have a significant impact on the development of code. The final section discusses how government spending on educational campaigns can affect the development of code.

1. Government Support of Research and Development

The government can support and shape the development of code by funding research and development activities directed at developing code.[844] Society's research and development expenditures totaled thirty six billion dollars in 2000 on just computers and electronics.[845] While the majority of this funding is from industry for industry, the federal government accounts for about six billion dollars spent on research and development for computers and electronics.[846] In

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[842] U.S. GENERAL ACCOUNTING OFFICE, CRITICAL INFRASTRUCTURE PROTECTION: SIGNIFICANT CHALLENGES IN SAFEGUARDING GOVERNMENT AND PRIVATELY CONTROLLED SYSTEMS FROM COMPUTER-BASED ATTACKS (2002); Ted Bridis, *U.S. Cyber-Security Efforts Faulted,* WASH. POST, July 22, 2002.
[843] The government has a history of coordinating research for code through the National Coordination Office for Information Technology Research and Development *at* http://www.hpcc.gov/.
[844] *See infra* note 959 (noting an alternative to government funding of research and development is the use of a tax expenditure to subsidize research).
[845] NATIONAL SCIENCE BOARD, *supra* note 11, at Table 4-3.
[846] *Id.* at Table 4-33.

spending money on research and development, the federal government can use two distinct approaches. We urge that while government support of basic, knowledge-seeking research is essential for innovation in the long run, we also believe that mission-oriented funding can address and shape code that meets societal concerns.

In discussing government support of research and development, we wish to avoid the common distinction between basic and applied research. Instead, we believe a better distinction is to view research as being either basic, knowledge-seeking or more mission-oriented.[847] Thus, in discussing the funding of these two types of research, we are focused on the motivations of the research and not on methods or outcomes.[848] Accordingly, we will use the terms basic research and mission-oriented research in our discussion.

a. Funding Basic Research

Basic research strives to understand how things work without specific applications in mind. This type of research has resulted in great innovations. For example, in our case studies the basic research at CERN, a particle physics laboratory, led to the birth of the World Wide Web. Similarly, the development of NCSA Mosaic occurred in a research center whose mission was to support supercomputing. In both of these cases, the link between the mission of the laboratory and the innovative activity was tenuous at best. But these examples show how government support of basic research can lead to unpredictable innovations in code.

The rationale for government funding is that the private sector will not perform an adequate amount of basic research. This market failure exists for a number of reasons. First,

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[847] Lewis M. Branscomb, *From Science Policy to Research Policy, in* INVESTING IN INNOVATION 112, 129-33 (Lewis M. Branscomb & James H. Keller eds., 1998).

[848] All too often research is divided into basic and applied. In this division, research with no clear application is basic research, while applied research is one with a practical application. Research conducted in academic laboratories is basic research, while research conducted in industry laboratories is applied research. Theoretical work is basic research, while experimental work is applied research. Science is produced by basic research, while technology comes from applied research. Moreover, implicit in this distinction is a linear model of development. This holds that basic research leads to applied research and that advances in science lead to advances in technology. We believe these divisions between what is being studied, the methods, outcome, and resulting linear model are an anachronism and lead to a poor understanding of technological development. Relying on this conception of technological development does not allow us to understand the development of code, especially in relation to government support of code. This is why more recent material ignores these divisions. *Id.* at 120. *See also* COMMITTEE ON CRITERIA FOR FEDERAL SUPPORT ON RESEARCH AND DEVELOPMENT, ALLOCATING FEDERAL FUNDS FOR SCIENCE AND TECHNOLOGY (1995), *available at* http://www.nap.edu/readingroom/books/fedfunds/part1/determining.html.

firms cannot predict the future economic value of basic research.[849] The core aspect of basic research is that it is unknown what application it may serve. Secondly, once the knowledge is produced, it is difficult to keep the knowledge from others.[850] The benefits of funding research and development cannot be entirely captured by a firm. Consequently, this leads rational-acting firms to concentrate their resources on applied problems whose benefits are better captured by the firm.[851]

The problem of under funding by the private sector led to calls for government funding. The most celebrated and influential supporter for government funding was Vannevar Bush.[852] Bush argued that researchers should be allowed to perform research without concerns about its practicality. He believed that such curiosity-driven research eventually leads to technological innovation. Therefore, if government wants to increase technological innovation, it follows that it should fund more basic research.[853]

This argument has been very persuasive and has resulted in substantial government funding for basic research and development. In the field of computer science the government spent almost $900 million on academic research in 1999.[854] Historically, this emphasis on basic research has led to the development of many technological innovations for code. Besides the development of the web, government's support has been instrumental for a number of other important computer innovations such as timesharing, computer networking, workstations, computer graphics, the mouse, the windows interface, VLSI circuit design, RISC computing, parallel computing, and digital libraries.[855] We have no doubt that such basic research will lead to further innovations in the future, and this is why we support government funding of basic research.

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[849] Nelson, *supra* note 205. Nelson's approach is referred to as the informational approach. Today, most scholars don't believe the knowledge produced is just information which can be easily transmitted. Instead, 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 is referred to as the evolutionary economic approach. *See* Ammon and Salter, *supra* note 203.

[850] Nelson, *supra* note 205. *See also* NATIONAL ACADEMY OF SCIENCES, *supra* note 40 (providing the economic rationale for government supported research and development).

[851] *See* Gregory Tassey, *R&D Trends in the U.S. Economy: Strategies and Policy Implications*, NIST Briefing Note, Apr. 1999, *available at* http://www.nist.gov/director/prog-ofc/R&DTrends.htm (providing additional arguments on why industry under invests in research and development).

[852] VANNEVAR BUSH, SCIENCE THE ENDLESS FRONTIER (1945).

[853] Crow & Bozeman, *supra* note 220 (finding that public institutions are best in carrying out basic research and development).

[854] NATIONAL SCIENCE BOARD, *supra* note 11, at Table 5-9.

A few critics argue that government funding of basic research is not needed. For them, government funding is simply wasteful and unneeded.[856] This position has been roundly criticized.[857] For example, Nelson found in a variety of industries that government support of research and development was valuable. Even in industries with a high level of private research and development, there was a substantial role for government supported research and development.[858]

The criticisms of government funding are largely about what research to conduct. In basic research, scientists decide what is important and not society. However, this research is funded by society. Society, quite rightly, wants to ensure that there are tangible, societal and economic benefits flowing from this research. Moreover, society believes certain areas of research demand higher priority. Recently, this has been manifested in a rapid increase for basic research in medicine, which has led to reduced funding in other areas such as energy and astronomy.[859] Since the basic research model cannot address immediate societal problems, another model for funding research and development merits consideration.

b. Supporting Mission-Oriented Funding

The mission-oriented approach seeks to force the development of scientific knowledge and technologies through increased funding on a specific subject.[860] This approach recognizes the need for basic research, but argues that we must also prioritize and allocate resources based on societal concerns. This approach is not concerned with learning about the world for the sake

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[855] COMMITTEE TO STUDY HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS, 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.
[856] *See* TERENCE KEALEY, THE ECONOMIC LAWS OF SCIENTIFIC RESEARCH (1996) (criticizing government funding for research).
[857] *See* 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).
[858] Nelson, *supra* note 643.
[859] Dan Vergano, *Medical Research Has Healthy Budget*, USA TODAY, Mar. 20, 2001, *available at* http://www.usatoday.com/news/health/2001-03-20-medical-research.htm. To protect against a pure politicization of research funding, agencies such as the NSF use peer review for the allocation of research funds.
[860] This approach can be phrased as a Jeffersonian approach with an emphasis on both traditional basic and applied research. *See* Gerald Holton & Gerhard Sonnert, *A Vision of Jeffersonian Science,* ISSUES SCI. & TECH, Fall 1999, *available at* http://www.nap.edu/issues/16.1/holton.htm; Lewis M. Branscomb, *The False Dichotomy: Scientific Creativity and Utility*, ISSUES 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).

of learning. Instead, it is concerned with problems that affect society. We believe that the mission-oriented approach permits society to shape code to address specific societal concerns, such as privacy or security.

While we support the use of mission-oriented funding, we also recognize that without funding basic research, this approach may lead to long-term problems. History has shown that advancement in any field depends upon advances in what may seem to be other irrelevant fields. For example, recent successes in medicine can be attributed to advances in high-energy physics, computing, and mathematics.[861] Another caveat from our case studies, as well as the literature on innovation, shows that technological innovation is often unpredictable.[862] Thus, the end result of mission-oriented research is unknowable and undetermined. This is an important point to recognize, because otherwise in the search for a technological solution to a problem, government may squander resources by paying too much for a solution or by not even developing a solution.

There are two different mission-oriented approaches that the government can use to shape code. The first approach is when the government is the predominant purchaser of a product, such as defense. In this case, the government has a legitimate interest in shaping the technology.[863] Moreover, the government's procurement interest allows it to define its technological needs with some expertise.[864] Without government funding, firms would not develop products because of the lack of a private market and the uncertainty of government procurement. Although the mechanics of the actual funding may be a procurement contract, in essence, this approach is focused on increasing the supply of technologies with the government funding the research and development of these technologies.[865]

Critics argue that this approach is too expensive and wasteful. There is ample evidence that some technology decisions made by the Department of Defense have been costly and wasteful.[866] This waste usually occurs because of the political dimensions of defense spending

[861] Vergano, *supra* note 859.
[862] *See supra* note 645.
[863] Nelson, *supra* note 643, at 460.
[864] *Id*.
[865] The government can finance the research and development in a variety of ways from funding basic research and development, supporting direct research and development support for a procurement contract, or hiding the cost of research and development within a procurement contract. Nelson, *supra* note 643, at 460.
[866] U.S. GENERAL ACCOUNTING OFFICE, HIGH-RISK SERIES - DEFENSE WEAPONS SYSTEMS ACQUISITION (1992) *available at* http://www.fas.org/man/gao/hr9307.htm.

as well as its sheer size.[867] However, this funding can affect society broadly through spillover effects. Spillover effects occur when the private sector finds a commercial application for a government supported technology.[868] These spillover effects mitigate the inherent inefficiencies in government funding of research and development for products that it will later purchase.[869]

The Defense Advanced Research Projects Agency (DARPA) is an example of an agency that funds mission-oriented research and basic research for the Department of Defense. Its achievements include the F-117 stealth fighter, the Joint Surveillance and Target Attack Radar System, and the precision guided munitions that were all used in Operation Desert Storm, the Persian Gulf War of 1990.[870] DARPA's achievements have spilled over beyond the military. For example, DARPA's funding of ARPANET, the precursor to the Internet, as well as the seed funding for the W3C are prominent examples of technology spillovers from defense to society at large.[871]

A second form of useful mission-oriented funding is pursued by government agencies with an agenda. By an agenda we mean an agency is supporting research and development that advances its own well-defined purposes.[872] It can then evaluate and selectively fund projects that further those interests. This is an effective way of supporting research that directly addresses societal concerns. A good example of such a government agency is the National Institute of Health, which supports research addressing specific diseases.

The criticism with this approach is the government's "picking" of winners. Critics would urge that there is a market for this research, and therefore, government funding is unnecessary. Additionally, they would argue that government funding essentially subsidizes a narrow class of winning firms that gain government support. There is ample historical evidence of the

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[867] William Hartung, *Corporate Welfare for Weapons Makers: The Hidden Costs of Spending on Defense and Foreign Aid, available at* http://www.cato.org/pubs/pas/pa350.pdf (Aug. 12, 1999).
[868] *Id*.
[869] CONGRESSIONAL BUDGET OFFICE, THE ECONOMIC EFFECTS OF FEDERAL SPENDING ON INFRASTRUCTURE AND OTHER INVESTMENT (1998) (concluding that justifying mission-oriented funding involves considering both its purpose as well as the spillover effects). *But cf.*, Frank R. Lichtenberg, *Economics of Defense R&D, in* HANDBOOK OF DEFENSE ECONOMICS 431, 447-48 (Keith Hartley & Todd Sandler eds., 1995) (finding a low rate of return for government research and development funding for defense).
[870] Defense Advanced Research Projects Agency, *Technology Transition*, Jan. 1997, *available at* http://www.darpa.mil/body/pdf/transition.pdf (describing how various DARPA technologies have been incorporated into the military capabilities for U.S. forces).
[871] *See* Charles Piller, *Funding the Impossible a Specialty for DARPA,* L.A. TIMES, Oct. 28, 2001, *available at* www.latimes.com/news/nationworld/nation/la-102801darpa.story; World Wide Web Consortium, *DARPA Support of the Web, available at* http://www.w3.org/Consortium/Prospectus/DARPA.html (last modified July 31, 2001).
[872] Nelson, *supra* note 643, at 460.

government's inadequacies in picking winners. As the argument goes, legislators and government bureaucrats shouldn't pick technologies, instead consumers should.[873]

We readily agree that government in general is no match for the market in picking winners. However, we believe that in certain instances, government can positively shape the development of technologies. We are limiting our support to areas where there are government agencies with concrete missions. This ensures that there are solid criteria and goals for the funding decisions as well as public support and accountability. Moreover, such an agency with a strong mission is likely to have the expertise available to make such funding decisions. Such expertise along with a funding policy that is based upon evaluation of competitive proposals by informed agency officials and/or peer review should aid in preventing wasteful expenditures.[874]

The mission-oriented funding of research and development is clearly relevant to code. Government could fund projects to advance the development of code to address societal concerns. For example, security has now become a major concern for code. The federal government is expected to drastically increase its spending on computer security to over four billion dollars a year.[875] This has led to calls for further government research and development on security issues with code.[876] However, there is not one government agency solely overseeing code development or even coordinating the development of code. Based on our analysis, we would recommend funding for an existing agency in which security issues related to code are part of its mission.[877] Otherwise, it is unlikely to have the expertise to fund projects

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[873] Mission-oriented funding approaches can lead to politicians picking technologies and not scientists. An example in medicine is 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. This meant NIH was forced to cut funding in other areas such as colon cancer to make up the shortfall. 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,* CONG. Q., May 8, 1999, *available at* http://ugsp.info.nih.gov/info_items/info22.htm.

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

[875] *Bush Gives $1.7 Billion Boost to Cybersecurity,* SILICONVALLEY.COM, May 23, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/news/332403.htm.

[876] COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, *supra* note 503; Carolyn Duffy Marsan, *Congress: Tighten IT Security,* NETWORK WORLD FUSION, Apr. 22, 2002, *available at* http://ww.nwfusion.com/news/2002/0422nist.html.

[877] Currently there are a number of agencies conduct researching into security aspects of code including the National Security Agency, National Science Foundation, and the National Institute of Standards and Technology.

judiciously.[878] An even better focus 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 this research is transferred to the private sector.[879]

Government funding should also consider government's role in creating and participating in the development of standards. Government has a strong justification for developing standards, because standards are considered impure public goods and will be under produced.[880] There are several different kinds of standards that the government can develop, including those promoting interconnection and interoperability as well as standards that benefit public health and safety.[881] For example, in response to concerns over computer security, the National Institute of Standards and Technology (NIST) is expanding its efforts in setting federal security standards.[882] This includes work on the "Common Criteria", a set of mandatory security standards for code used in national security systems.[883] Funding this type of research is another way government can shape to code to meet societal concerns.

2. Procuring Code

The government can use its powers of procurement to develop or support particular code.[884] Government's procurement power can create or grow the market for a particular product. This "power of the purse" focuses on the demand side of technology, in contrast to the

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[878] National Science Foundation, *Program Announcement: Trusted Computing*, NSF-01-160, Dec. 5, 2001, *available at* http://www.nsf.gov/pubs/2001/nsf01160/nsf01160.html. To further improve efficiency, the government should consider charging one agency, such as the National Institute of Standards and Technology with conducting research into code-based security issues. This would also help to prevent duplicative research as well as losing research results between various agencies.
[879] P.A. Geroski, *Procurement Policy as a Tool of Industrial Policy,* INTER. REV. APPLIED ECON., June 1990, at 182, 189 (noting value of users in the procurement process for the creation of innovative products).
[880] *See supra* note 555.
[881] *See supra* text accompanying notes 636-639.
[882] Marsan, *supra* note 876.
[883] 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, July 8, 2002, at 42; Common Criteria's web site is *at* http://www.commoncriteria.org/.
[884] We emphasize 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 (1999). Also 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 of the procurement mandates include preferences for disadvantaged businesses and women-owned businesses, the application of labor laws, environment, conservation, occupational safety, drug-free workplaces, domestic preferences, the Indian Incentive Program, and minority university institutions. Steven L. Schooner, *Fear of Oversight: The Fundamental Failure of Businesslike Government,* 50 AM. U. L. REV. 627, n.182-83 at 683-84 (2001).

supply side policies discussed previously. There is a long history of the use of procurement power from standardized clothing sizes during the Civil War to the U.S. Army's giving credibility to generic drugs.[885] This power follows from the immense amount of government expenditures. Federal government spending is expected to be over two trillion dollars in 2003, which is almost twenty percent of the Gross Domestic Product (GDP).[886] Of this, more than $200 billion will be spent on directly on procuring goods and services.[887]

This section seeks to show that the government's procurement power can also be effective in shaping information technologies.[888] The government is the largest single purchaser of code and will spend over fifty billion dollars on information technologies in 2003.[889] This includes almost nine billion dollars spent by state and federal governments on prepackaged software in 2001.[890] This is a small, but significant, part of the overall market for information technologies in the United States that was just over $800 billion in 2001.[891] This massive purchasing power can be used to influence the development of code by the private sector. Recently, the Consumer Project on Technology has called for the government to consider competition and security in its procurement decisions for code.[892]

The reasoning behind using government procurement to shape code is that new products take time to develop as innovators must create and grow a market. This process is risky and is

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885 This position would predict that the government requirement of filtering in libraries and school would enlarge the market for filtering software.

886 OFFICE OF MANAGEMENT AND BUDGET, BUDGET OF THE UNITED STATES GOVERNMENT: FISCAL YEAR 2003, *available at* http://www.whitehouse.gov/omb/budget/ (last visited Jun. 5, 2003).

887 This amount involves goods and services and not civil service or military personnel salaries, grants, foreign aid, etc. *See* Federal Procurement Data System (FPDS), *Federal Procurement Report*, *at* http://www.fpdc.gov/fpdc/FPR2000a.pdf (last visited June 5, 2002). *See also* Schooner, *supra* note 884, n.7 at 631 (noting the limitations of this procurement data).

888 A number of commentators have discussed government's procurement power. *See* C. Edquist and L. Hommen, *Public Technology Procurement and Innovation Theory*, *in* PUBLIC TECHNOLOGY PROCUREMENT AND INNOVATION (Charles Edquist et. al. eds., 2000); OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 596, at 37-38; Geroski, *supra* note 879.

889 *Bush Gives $1.7 Billion Boost to Cybersecurity,* SILICONVALLEY.COM, May 23, 2002, *available at* http://www.siliconvalley.com/mld/siliconvalley/news/332403.htm; Office of Management and Budget, *Report on Information Technology Spending for the Federal Government*, *available at* http://www.whitehouse.gov/omb/inforeg/final53.xls (April 9, 2001) (providing 2002 figures).

890 Bureau of Economic Analysis, Tables 1, 11, *available at* http://www.bea.doc.gov/bea/papers/tables.pdf (May 3, 2002), cited in David S. Evans & Bernard Reddy, *Government Preferences for Promoting Open-Source Software: A Solution in Search of a Problem,* n. 51, *available at* http://ssrn.com/abstract id=313202 (May 21, 2002). The total sales of prepackaged software was seventy four billion dollars.

891 WORLD INFORMATION AND TECHNOLOGY SERVICES ALLIANCE, DIGITAL PLANET 2002: THE GLOBAL INFORMATION ECONOMY (2002).

892 Ralph Nader and James Love, Consumer Project on Technology, *Procurement Policy and Competition Security in Software Markets,* June 4, 2002, *available at* http://www.cptech.org/at/ms/omb4jun02ms.html.

usually characterized by slow growth. But when government uses its purchasing power, it creates a much larger market. This grants producers economies of scale, lower units costs, and lower risks, thereby leading to the incorporation of new technologies and lower prices for the public in a shorter time.[893]

There are two major rationales for government's use of its procurement power to favor certain products. The first is an efficiency rationale that government should spend its resources wisely. This leads to a number of potential measures that the government can take including buying goods in volume to save money.[894] For instance, there are efforts to procure inexpensive products, such as generic medicines.[895] Another measure could require government purchasers to consider the total cost of ownership instead of just the initial cost.

This second rationale takes into account the effect of externalities. These are costs or benefits that are not contained in the price of a product. Government procurement has historically internalized environmental and other social externalities.[896] This means the government has affirmatively acted to ensure that these externalities are accounted for in the purchase of products. If government did not account for these externalities they are essentially saying they are not important by setting their price to zero.[897] Hence, by accounting for externalities the government strives to "set an example to the private sector, advance . . . [specific societal] goals, and best serve the public interest."[898]

There are three major criticisms with using government procurement to shape technologies. The first argument is that this is unnecessary meddling with the market. Government should act as a passive consumer and not attempt to influence the actions of private industry. The second criticism is that government "meddling" will be useless or may even

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893 Ralph Nader, *Shopping for Innovation: Government as a Smart Consumer*, AM. PROSPECT, Sep. 1, 1992, *available at* http://www.prospect.org/printer-friendly/print/V3/11/nader-r.html.

894 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*, *available at* http://www.gsa.gov/Portal/content/orgs_content.jsp?contentOID=22892&contentType=1005 (last modified Apr. 11, 2002).

895 Nader, *supra* note 893 (noting the role of the U.S. Army in establishing the credibility of generic drug products).

896 *See supra* note 884.

897 F. Paul Bland, *Problems of Price and Transportation: Two Proposals to Encourage Competition from Alternative Energy Resources*, 10 HARV. ENVTL. L. REV. 345, 386-87 (1986).

898 Nader, *supra* note 893.

partially backfire.[899] These critics argue that government support of a particular technology may not have much influence on the development of a 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, and therefore, raises administrative costs.

The government has a long and successful history of activism in shaping technologies that have no market such as high technology weapons. Similarly, the government can influence the development of commercial off-the-shelf products.[900] The rationale is that government must buy something, so why not buy products that offset certain externalities. Government can set an example for private industry by buying certain products or technologies that it sees as worthy. For example, the government has used procurement policies for energy efficient products since 1976.[901] Recently, the government has been active with environmentally friendly procurement measures, such as preferences for recycled products.[902] Instead of focusing on whether the government should be an active consumer, we think critics should instead focus on whether this approach has been successful.

We do agree that government procurement efforts can have a negligible impact upon the market. To address this concern, we suggest that government procurement efforts be focused. Typically, this involves using government procurement to provide the early demand for a product using new technologies.[903] It is at this crucial stage that government can most effectively shape the development of technologies for commercial use.[904]

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[899] Donald B. Marrow, *Buying Green: Government Procurement as an Instrument of Environmental Policy*, 25 PUB. FIN. REV. 285 (1997).

[900] 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 was widely disseminated across industry, 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 use procurement strategies to create competition and innovation. *See* Charles Edquist & Leiff Hommen, *Government Technology Procurement and Innovation Theory*, *available at* www.tema.liu.se/tema-t/sirp/pdf/322_1.pdf (1998) (discussing various procurement strategies the military uses).

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

[902] 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* ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, GREENER PUBLIC PURCHASING: ISSUES AND PRACTICAL SOLUTIONS (2000).

[903] PORTER, *supra* note 595, at 645-46. Government can also serve as a positive force to improve technologies and the competitiveness of producers through the following actions. The government can use stringent product specifications rather than just purchasing what domestic firms produce. These product requirements should also

Even in markets where government demand is influential, procurement efforts may fail.[905] Consider the scenario of two goods that are 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 a substitute for green goods. Thus, the net effect of the government's and private industry's actions would be offsetting.[906] Moreover, this could be seen as negatively impacting the development of new products or technologies 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. Moreover, if marginal costs are decreasing then government intervention can lower the price for green goods for all consumers through economies of scale. This analysis indicates that economies of scale are an important element in the success of government procurement for shaping technologies.[907]

Finally, we understand the criticisms 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.[908] For products groups without Energy Star labels, agencies are supposed to purchase products that rank in the top twenty-five percent for efficiency.[909] One report suggests that there is 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 have too

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consider international needs, as that is where future markets will lie. Government also must not be afraid to procure competitively. This provides domestic firms an incentive to innovate.

904 Another related criticism is that government efforts will be neutered by the lack of cooperation by private industry. There are a number of examples of private industry fighting procurement policies. *See* Nader, *supra* note 893 (noting how contractors have successfully fought off requirements that would hold construction companies liable for the quality of roads). McCadney, *supra* note 902, at 147 (discussing how Lexmark used contract conditions for toner cartridges that conflicted with the government's procurement efforts to recycle toner cartridges)

905 Marrow, *supra* note 899.

906 *Id.*

907 *Id.* Furthermore, this leads to the conclusion that government procurement can produce significant benefits if the government is a particularly large buyer of a specific product, supply is particularly elastic, and/or private demand is particularly inelastic.

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

909 *Id.*

many procurement requirements to consider.[910] However, there is no compelling reason to believe that these issues could not be addressed, if needed.[911]

An 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.[912] In 1999, it was estimated that the Energy Star requirements on computers and monitors saved over one billion dollars.[913] 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.[914] These savings are the result of a voluntary government standard supported by a procurement policy. This suggests that the EPA's Energy Star labeling and the federal procurement guidelines have led the private sector to purchase energy efficient equipment. Moreover, there is no evidence that the purchase of energy efficient products by the government has led the private industry to shift consumption towards inefficient products.

Another ongoing example of the government's procurement power is the requirement that the government comply with section 508 of the Rehabilitation Act. The Act states that any federal purchases of computers, software, and electronic equipment used to disseminate information, including telephones, copiers, and facsimile machines, must be accessible to persons with disabilities.[915] This has prompted firms such as Microsoft, Macromedia, and Adobe to modify their products to ensure they are capable of producing accessible web sites and content.[916] In the above examples, the government values societal concerns such as reducing carbon emissions and ensuring that disabled people have access to information technologies.

In both of these examples, critics would ask what is the cost of administering these programs? Moreover, what are the additional procurement costs to the government as a result of

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[910] ALLIANCE TO SAVE ENERGY & FEDERAL ENERGY PRODUCTIVITY TASK FORCE, LEADING BY EXAMPLE: IMPROVING ENERGY PRODUCTIVITY IN FEDERAL GOVERNMENT FACILITIES 18-19 (1998).

[911] 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-news.com/ens/aug2002/2002-08-08-06.asp.

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

[913] EPA Climate Protection Division, *The Power To Make a Difference: ENERGY STAR and Other Partnership Programs*, EPA 430-R-00-006, July 2000, at 12 (calculating 15 billion-kilowatt hours at $0.08 a kWh).

[914] *Id.*

[915] Section 504 of the Rehabilitation Act, 29 U.S.C. § 794d. *See also supra* note 672 (noting that the Telecommunications Act requires code to be accessible when it is easily achievable).

[916] Ann Moynihan, *Creating Web pages That Are Accessible To the Disabled Is Good Business*, BUSINESS REV., Mar. 29, 2002, *available at* http://www.bizjournals.com/albany/stories/2002/04/01/focus5.html.

these requirements? This is a much harder question. First, there is no clear data on how much extra, if any at all, the government has spent. Moreover, unless this data showed the government spent significantly more money, it would seem irrelevant. This is because the government's procurement decision is taking into account various externalities. This decision necessarily implies the government's willingness to pay more. The hope is that government efforts will prompt others to also take into account these values, and perhaps make it economically attractive for them to do so.

The above analysis leads to a number of recommendations for government procurement decisions regarding code. The efficiency rationale suggests that government should consider how to save money in making procurement decisions. For example, the U.S. General Services Administration (GSA) already buys information technology products in volume. This approach is a reasonable way to save government resources. The efficiency rationale also suggests the government should consider standards for product quality as well as open standards that promote interoperability. Both of these types of standards have the potential to reduce costs. For example, recently the United Kingdom's government put forth a policy seeking to use open standards that promote interoperability, while avoiding products that lock-in to proprietary code.[917] Finally, the efficiency rationale suggests that government should consider the total cost of ownership and not just the initial purchase price when purchasing products. This rationale could lead government to support open source code if there was evidence that its total cost of ownership was less than proprietary code. However, there is a need for more data on the costs of open source code compared to proprietary code before government can justify its use of open source code on efficiency grounds.

In procuring code, which is custom-made and not available off-the-shelf, the government should consider placing its source code into the public domain.[918] While this is not current practice, there is no reason why the government cannot bargain for the source code in its

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[917] Office of Government Commerce, *Open Source Software: Use Within UK Government,* July 15, 2002, *available at* http://www.ogc.gov.uk/index.asp?id=2190.

[918] 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 email and online shopping activities. *See* Federal Bureau of Investigation, *Carnivore Diagnostic Tool, available at* http://www.fbi.gov/hq/lab/carnivore/carnivore2.htm (last visited Mar. 16, 2002).

contracts.[919] Once government has access to the source code, duplication to the public is costless because source code is nonrivalrous.[920] The government's consumption of code does not affect anyone else. This nonrivalrous characteristic only applies to the software component of code. In contrast, if the government built a building, it could not simultaneously keep its offices there while allowing the public to use this building. However, software code is different, since it can be easily reproduced. For example, the Environmental Protection Agency (EPA) and the Department of Energy (DOE) developed software for the remote evaluation and control of energy conservation features of networked computers. Their goal was to save money on energy costs. But the nonrivalrous nature of code meant it was relatively costless to make this code publicly available in the interest of energy conservation.[921] The government may go farther by placing its source code into the public domain. Parties with access to the source code do not then have to "reinvent the wheel."

Critics would argue that this approach is wrong for two reasons. First, access to the source code could allow hackers to gain control of vital systems. We agree with this criticism and believe 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 accessible by anyone. Nevertheless, there may be portions of the code that could 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 just languishing. Instead, what is needed for further development is the ability for a party to have exclusive property rights. While this may be so in some instances, we do not think this is true in very many cases. In the later section on the transfer of intellectual property rights to the private sector, we argue that property rights are not necessarily required for further improvement of code.[922]

Government procurement decisions regarding code could also take into account certain externalities. Some externalities relevant to code are the support of innovation, protection of privacy, and ensuring security. The government could use its procurement decisions to favor certain products. In the case of innovation, the government can ensure that the products it buys

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[919] Typically when the government contracts out the development of code it does not have the right to distribute the code. U.S GENERAL ACCOUNTING OFFICE, *supra* note 816, at 27.

[920] The UK Government will consider placing the source code into the public domain for custom made code. *See* Office of Government Commerce, *supra* note 917.

[921] For more information on the EPA's Enabling Monitor Power Management software. *See* www.energystar.gov/powermanagement.

support open standards and modularity, which are keys to innovation for code. In the case of security, the government could ensure its products meet standards for security, such as the Common Criteria.[923] These decisions may be more costly, but can benefit the public in ways that are not captured by the market.

Relying on the rationales of efficiency and externalities have led to proposals that government use its procurement power to adopt open source code over commercial off-the-shelf products.[924] From the efficiency standpoint, it is well-established that the quality of open source code, such as Apache, can be comparable to that produced by private firms.[925] However, the cost of open source code is significantly lower, especially when the nonrivalrous nature of open source code is considered.[926]

From an externalities standpoint, there are several reasons for the government to prefer open source code over proprietary code. First, government use of open source code can lead to public benefits through 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 by the rest of government for free. Additionally, this code can be freely adopted by the general public. This freely available code would serve as an infrastructure, which others could use and build upon. A second externality to consider is the more innovative nature of open source code due to fewer restrictions on its use as compared to proprietary code.[927] Third, the open source movement's

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922 *See infra* Part VII.B.4.
923 *See supra* note 883.
924 President Information Technology Advisory Committee, *Developing Open Source Software to Advance High End Computing*, Oct. 2000, *available at* http://www.ccic.gov/ac/letters/pitac_ltr_sep11.html (encouraging the U.S. Government to use open source software in high end computing); Mitch Stoltz, *The Case for Government Promotion of Open Source Software*, NETACTION, *available at* http://www.netaction.org/opensrc/oss-whole.html (last visited Jan. 28, 2002); Shawn W. Potter, *Opening Up to Open Source*, 6 RICHMOND J. L. & TECH. 24 (2000) (arguing that besides procurement, the government needs to amend the UCC to enhance adoption of open source); *Should Public Policy Support Open-Source Software?*, AM. PROSPECT, *available at* http://www.prospect.org/controversy/open_source/ (organizing a debate on this issue); Bollier, *supra* note 436 (suggesting the use of government spending to support open source code). *Contra* David S. Evans & Bernard Reddy, *Government Preferences for Promoting Open-Source Software: A Solution in Search of a Problem, available at* http://ssrn.com/abstract id=313202 (May 21, 2002).
925 *See supra* text accompanying note 502.
926 From an efficiency standpoint, open source code can also lead to less red tape because of the lack of 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.
927 Steven Mann extends this idea by arguing that government should not let itself be subject to any proprietary code. Instead the government should only support code that is open. The rationale is that 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*

public development process allows for a plurality of influences because it is not dominated by any one firm or country.[928] Finally, open source code is transparent. Transparency allows government and society to easily examine code.[929] This "political" property of code is analogous to the transparency we require in government legislation.[930] For example, transparency in filtering software allows the public to determine the rules for excluding sites.[931]

Already, governments such as China, France, Germany, United Kingdom and the United States are beginning to adopt open source code.[932] For example, the ministries of culture, defense, and education in France are switching to Linux from Microsoft, Sun, and Lotus.[933] 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 their domestic software industry, national pride, and the well-known security flaws in Microsoft's products.

The objections to this proposal are largely that government is interfering in private markets and that government is taking money away from private industry. The criticisms are both legitimate, but society is better off if this code is freely provided than by purchasing the code. By providing this code, the government is creating an infrastructure that others can build upon, thereby creating new innovative forms of code. In the end, the government's effort will create more innovative applications, instead of perhaps wasting money on duplicative code.

Free Thought: Architecting Free Standards, FIRST MONDAY, Jan. 2000, *available at* http://www.firstmonday.dk/issues/issue5_1/mann/.

[928] The public development process can lead to new features that support societal values, which may not be present in commercial code. This includes values such as privacy, security, and support for multiple languages, which are all in the interest of government to promote.

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

[930] The public's expectations regarding transparency are also supported by the Freedom of Information Act (FOIA) and the Sunshine Act. The FOIA provides for a general right to examine government documents. 5 U.S.C. § 552 (1994). The Sunshine Act strives to provide the public with information on the decision-making processes of federal agencies. 5 U.S.C. § 552b (1994).

[931] 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,* B. GLOBE, July 26, 2002, *available at* http://www.globe.com/dailyglobe2/207/business/ACLU_sues_firm_over_its_filtering_software+.shtml; Benjamin Edelman, *Edelman v. N2H2, Inc. - Case Summary & Documents, available at* http://cyber.law.harvard.edu/people/edelman/edelman-v-n2h2/ (last modified Jul. 30, 2002).

[932] Paul Festa, *Governments Push Open-Source Software*, CNET NEWS.COM, Aug. 29, 2001, *available at* http://news.cnet.com/news/0-1003-200-6996393.html; Office of Government Commerce, *supra* note 917; Evans & Reddy, *supra* note 924 (providing a good summary of various governmental efforts in promoting open source code).

[933] Krane, *supra* note 932.

3. Using Tax Expenditures

The government's power of taxation is another tool for shaping code. In using its power of taxation, government can reduce or increase an individual's or firm's tax burden to incentivize certain behavior. The section discusses how a reduction of the tax burden through tax expenditures can induce certain behavior. As a result, government can support the development of code generally, as well as shaping 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 reduction in tax liability is in effect a substitute for government spending and is termed a tax expenditure.[934] The term tax expenditure highlights that the loss of tax revenue is equivalent to government spending.[935] Tax expenditures are commonly thought of as tax incentives or loopholes.[936] They can serve many purposes, but they are a popular method for addressing societal concerns.[937] The use of tax expenditures is substantial, total tax expenditures for fiscal year 2002 will be over six hundred billion dollars.[938]

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 tax expenditure also supports the establishment of a direct funded government program.[939] Commonly, this justification of government intervention is based on a form of market failure. However, there are several reasons why government may choose to use tax expenditures instead of direct spending to shape code for a particular purpose.

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[934] *See* STANLEY S. SURREY & PAUL R. MCDANIEL, TAX EXPENDITURES (1985) (providing the authoritative work on tax expenditures). *See also* TAX INSTITUTE OF AMERICA, TAX INCENTIVES (1971) (providing a number of articles on tax expenditures); Eric J. Toder, *Tax Incentives for Social Policy: The Only Game in Town?,* Burns Academy of Leadership, University of Maryland, *available at* http://www.academy.umd.edu/scholarship/DLS/WorkingPapers/Toder.pdf (last visited Jun. 28, 2002); Eric Toder, *Tax Cuts or Spending – Does it Make a Difference?,* Urban Institute, *available at* http://www.taxpolicycenter.org/research/author.cfm?PubID=410261 (June 8, 2000).

[935] 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 between 1998 to 2002. This is three times as much as budgeted federal spending on addressing climate change. Chris Edwards et al., *supra* note 706, at 467 (noting that funding for the Climate Change Technology Initiative was about $3.5 billion between 1998 to 2002).

[936] SURREY & MCDANIEL, *supra* note 934, at 1.

[937] *See* Eric J. Toder, *The Changing Composition of Tax Incentives: 1980-99*, National Tax Association Proceedings, *available at* http://www.urban.org/tax/austin/austin_toder.html (Mar. 1999) (documenting that tax expenditures have increasingly been used to promote social policy goals instead of business investment).

[938] *See* Office of Management and Budget, *Table 22-4. Tax Expenditures by Function, available at* http://www.whitehouse.gov/omb/budget/fy2002/bud22_4.html (last visited Jun. 27, 2002).

[939] SURREY & MCDANIEL, *supra* note 934, at 112.

First, there are jurisdictional differences between tax expenditures and direct spending. This refers to differences in the responsibility over the measure within the executive branch.[940] When a tax expenditure is used, the responsibility falls to the Treasury Department and the Internal Revenue Service for its administration.[941] In contrast, if direct spending is used, it requires an agency within the executive branch to administer the program. This suggests that tax expenditures are best used when the administrative costs of establishing and maintaining a spending program are high.[942] Administration of a program by the Treasury and IRS usually results in strict eligibility requirements because they tend to limit deductions.[943] Moreover, the Treasury and IRS usually do not have the expertise or the interest in the effectiveness of the program.[944] Therefore, a tax expenditure is appropriate when a program does not require continued administrative oversight and discretion.[945]

Secondly, there are psychological and political benefits to using tax expenditures. In contrast to a direct spending program, a tax expenditure has much lower visibility.[946] It is not represented by a government agency, rather it is hidden in the tax code. A tax expenditure is not viewed as government rewarding a few firms, but is instead seen as encouraging private decision-making.[947] As a result, many politicians who regard themselves as fiscally conservative would rather use a tax expenditure than support another "big government spending program". This is key to the popularity of tax expenditures.[948] Nevertheless, a tax expenditure is still government spending. Virtually any tax expenditure provision could be rewritten as a direct spending program.[949]

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940 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* SURREY & MCDANIEL, *supra* note 934, at 106-07.
941 SURREY & MCDANIEL, *supra* note 934, at 106.
942 Edwards, *supra* note 935, at 476.
943 SURREY & MCDANIEL, *supra* note 934, at 106.
944 *Id.*
945 One of the problems with the use of tax expenditures is that they may turn into tax shelters and lose their initial intent by subsidizing middlemen. In the 1970s many tax shelters were used by well off persons and not 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. SURREY & MCDANIEL, *supra* note 934, at 105.
946 SURREY & MCDANIEL, *supra* note 934, at 104-05.
947 *Id.* at 100.
948 *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 forces supporting direct spending programs).
949 *Id.* at 105.

There are several objections to using tax expenditures. First, critics argue that tax expenditures are inequitable. They are of little use to firms or individuals with low tax liability. A related objection is that the benefits of tax expenditures unfairly go to those with the highest tax liability.[950] First, there are individuals and firms with little tax liability or firms subject to the alternative minimum tax (AMT). In these cases, the tax expenditure would be of no value. However, in these cases, legislators can utilize a refundable, taxable credit.[951] A refundable tax credit is in effect a direct grant. Thus, this type of tax expenditure does not discriminate against those with little tax liability. This provision addresses concerns that tax expenditures have no effect on those with little tax liability. Secondly, the benefits of tax expenditures accrue to those with the highest tax liability.[952] In some cases, this can serve as a spur to change practices to gain the full benefit of the tax expenditure. However, if it is considered unfair that some beneficiaries with high tax liability are reaping the lion's share of the benefits then the tax expenditure program can be limited. Limits still provide incentives for behavior, but allow the government to ensure that a few taxpayers are not unjustly rewarded.

A second objection is that tax expenditures are inefficient. They are merely rewarding behavior that would have resulted anyway. Therefore, they act as an unneeded windfall.[953] This objection also strikes at direct spending, which is the alternative to a tax expenditure. However, it is possible to limit the windfall by making the tax expenditure incremental in structure. For example, by requiring that a taxpayer's activities exceed that of previous years to prevent a windfall, only marginal improvements would be rewarded.[954]

Third, critics argue that further tax expenditures will place too high of an administrative burden on the IRS.[955] However, it must be remembered that the IRS already handles hundreds of billions of dollars in tax expenditures involving numerous subjects such as energy, natural

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[950] *Id.* at 71-72 (noting that tax expenditures disproportionately favor those with high incomes).
[951] *Id.* at 109-11.
[952] *Id.* at 71-82 (noting that tax expenditures favored those with high incomes).
[953] *Id.* at 102.
[954] *Id.*
[955] Edwards, *supra* note 935, 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 transactional 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).

resources, agriculture, housing, and transportation to name but a few.[956] Moreover, tax expenditures are likely to result in a lower overall administrative cost by placing the burden on the IRS which already administers tax policy, instead of creating a new agency or department for a direct spending program.

The final objection is that the tax code should not be used for social policy even when it comes to supporting the creation of technologies. Instead, the government should look towards direct funding.[957] Stated alternatively, the tax code is about raising revenue and not about social policy. These incentives are only going to further complicate the code and lead people to lose faith in the tax code. While this is valid, the reality is that the tax code has long been an instrument of social policy. Moreover, society supports this approach.[958] In fact, according to Zelinsky, tax expenditures are a more useful way of communicating social policy to middle-income individuals or small businesses than direct spending. This occurs because the existing information networks of tax professionals will communicate information regarding the tax expenditure.[959] In contrast, the transactions costs are high for these individuals and firms who try to find and utilize direct spending programs set up by the government.

Tax expenditures have been used to support the development of technologies in general as well as to shape specific technologies.[960] For example, tax expenditures support alternative fuels, hazardous waste facilities, electric vehicles, and even research and development activities.[961] 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

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[956] *See supra* note 938 (providing a more complete listing of all tax expenditures).
[957] This is not new. *See* Bernard Wolfman, *Federal Tax Policy and the Support of Science*, 114 U. PA. L. REV. 171 (1965) (arguing that we need to question some of the favorable tax incentives given to encourage the development of technologies and ask whether they are needed or whether they are better off being direct subsidies).
[958] While tax scholars do not like the tax system used for social policy, economists see tax policy as an effective method to address societal concerns. Taxes are seen as a way to address externalities. *See* 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).
[959] Zelinsky, *supra* note 955, at 1036.
[960] The government's Research and Experimentation Tax Credit is one example of this. It costs the government billions of dollars, but subsidizes research and development by firms. *See* OFFICE OF TECHNOLOGY 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.
[961] *See* Internal Revenue Service, Qualified Electric Vehicle Credit, Form 8834 (providing a tax credit to purchasers of electric vehicles).

grants.[962] This intervention is justified because these rare diseases are deemed unprofitable by the pharmaceutical industry, and therefore, industry requires an incentive for research and development.[963] Moreover, direct grants are used to fund clinical testing programs for orphan drugs. The administration of this program is done by the FDA. In contrast, the tax expenditures allow a tax credit equal to fifty percent of the qualified clinical testing expenses for the taxable year.[964] However, the drug must first be designated an orphan drug by the FDA.[965] Thus in this case, the tax expenditure requires a modest amount of cooperation between the applicable federal agency with the expertise, the FDA, and the Treasury department to meet the goal of stimulating research.

The government could use tax expenditures to shape the development of code. For example, government could encourage the development of code to protect minors online. This code includes software, such as filtering software, which prevents minors from accessing inappropriate content. The government's intervention into the market is justified because the current products, including PICS, are expensive, difficult to use, and not very effective.[966] Moreover, there is a demand by parents for a code-based solution to the problem of minors accessing indecent material. The justification for tax expenditures over a direct spending program rests largely on three reasons. First, tax expenditures would not appear to be interfering in the market for the current products. Moreover, the problems of favoritism and picking "winners" for direct funding could be avoided. 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. The consequences of this proposal would be subsidizing vendors. This could

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[962] Orphan Drug Act of 1985, Pub. L. 97-414, 96 Stat. 2049 (2001). For more information see the FDA page *at* http://www.fda.gov/orphan/index.htm.

[963] 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 into rare diseases).

[964] Orphan Drug Act of 1985, Pub. L. 97-414.

[965] Orphan Drug Regulations, 21 C.F.R. PART § 316.20.

[966] Larry Buchanan, *Surfing in Shark-Infested Waters: Filtering Access to the Internet*, MULTIMEDIA SCH., March 1996, *available at* http://www.infotoday.com/MMSchools/MarMMS/networks3.html (noting the high prices of filtering software); COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, NATIONAL ACADEMY OF SCIENCES, 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,* ORANGE COUNTY REG., Sep. 27, 1998, *available at* http://archives.seattletimes.nwsource.com/cgi-bin/texis.cgi/web/vortex/display?slug=safe&date=19980927 (quoting Family PC's editor Joe Panepinto, "(Filters) are difficult to use, relatively expensive to maintain and difficult to configure").

overcome the current stalemate, where parents don't buy the code because it's overpriced, and developers cannot earn enough revenue to improve their code, because of their low acceptance. Thus, tax expenditures could lead to a reduction in cost for users while providing financial incentives for developers to improve their products.[967]

4. Transferring Intellectual Property to the Private Sector

The government is capable of creating very innovative code. However, government is generally not the ideal institution to provide technical support, maintenance, and further enhancement of code. The examples of the NCSA Mosaic web server and web browser showed why universities are inadequate in supporting code for use by the general public.[968] Instead, this activity is better accomplished by firms, consortia, or the open source movement. Therefore, for this code to become useful to society, it is often necessary to transfer code to the private sector.[969] As a result, there are a number of laws that require government and public universities to support the transfer of its technology to the private sector. In addition, federal agencies, such as the NSF, seek to have their sponsored research commercialized.[970]

To promote technology transfer, the government has enacted laws that allow for the transfer of intellectual property rights to the private sector.[971] The first notable law was the

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[967] Another example of the use of a tax expenditure to support code is to encourage the adoption of computers by individuals. Instead of operating a direct funded program to provide people with computers, the government could opt for a refundable tax credit. However, for a 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 the purchase of computers from garage sales or eBay whose prices would be lower. The tax expenditure would likely be a refundable tax credit to ensure that taxpayers with low tax liability can take advantage of this provision.

[968] *See supra* text accompanying note 534 (NCSA Mosaic web browser); *see supra* text accompanying note 176 (NCSA Mosaic web server).

[969] J.S. Metcalfe & L. Georghiou, *Equilibrium and Evolutionary Foundations of Technology Policy*, 22 SCI. TECH. & INDUS. REV. 75 (1998) (arguing that effective innovation is dependent upon knowledge transfers between universities and the private sector). This is known as a systemic approach in the study of innovation systems. *See* Jukka-Pekka Salmenkaita & Ahti A. Salo, *Rationales for Government Intervention in the Commercialization of New Technologies,* Systems Analysis Laboratory Research Report, Sep. 8, 2001.

[970] Rita R. Colwell, Director, National Science Foundation, *Remarks Before the Senate Appropriations Subcommittee on VA/HUD and Independent Agencies*, May 4, 2000, *available at* http://www.nsf.gov/od/lpa/congress/106/rc00504sapprop.htm ("This example is really just the latest in a string of NSF successes. The underlying technology for nearly all major search engines found on the web today - including Lycos, Excite, Infoseek, Inktomi and specialized search engines like Congress's own THOMAS - all were begun [and] created through NSF-funded research at universities.")

[971] Bhaven N. Sampat & Richard R. Nelson, *The Emergence and Standardization of University Technology Transfer Offices: A Case Study of Institutional Change*, ADVANCES STRATEGIC MGMT. (forthcoming) (providing a history of university patent policy).

Stevenson-Wylder Technology Innovation Act, which made technology transfer an integral activity for federal laboratories.[972] This was followed by the Bayh-Dole Act, which today allows universities and firms to patent and license the results of government-sponsored research.[973] These laws were a shift from public ownership of government-sponsored research towards private appropriation.[974] This change has meant that inventions that were previously in the public domain for anyone to use may now be patented, and arguably their use limited.[975]

The standard justification for technology transfer laws is to promote commercialization. These laws provide firms with the necessary intellectual property protection to support the eventual commercial development of a technology. Firms argue that technologies developed by the public sector or government are immature and in need of further refining and testing to meet the marketplace. However, this further development is risky. Therefore, firms need the protection of intellectual property rights through technology transfer laws to encourage them to embrace the risk in the development process.[976] And without intellectual property protection, firms urge that these government-sponsored technologies would languish in the public domain in their unrefined form.

Our case studies of the NCSA Mosaic web server and web browser highlighted two different approaches the government may take in transferring its technology. In one case, the government licensed out the technology to the private sector, and in the second case, the government placed the technology in the public domain. In the case of the NCSA Mosaic web browser, the University of Illinois licensed out the code for several million dollars.[977] The dominant web browser today, Microsoft's Internet Explorer, is built upon the NCSA Mosaic web browser source code.[978] The second method of technology transfer consisted of placing the NCSA Mosaic web server into the public domain. This method earned the university zero dollars. However, the most popular web server today is Apache, which had its origins in the

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[972] Stevenson-Wylder Technology Innovation Act of 1980, Pub. L. No. 96-480, 94 Stat. 2311-2320 (codified as amended at 15 U.S.C. §§ 3701-3714 (1994)).
[973] Bayh-Dole Act, Pub. L. No. 96-517, 94 Stat. 3018 (1980) (codified as amended at 35 U.S.C. § 200-12 (1994).
[974] *See* Rebecca 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).
[975] *Id*.
[976] Eisenberg, *supra* note 449, at 1669; U.S GENERAL ACCOUNTING OFFICE, *supra* note 816, at 14.
[977] *See supra* text accompanying notes 452-454.
[978] Netscape chose to forgo licensing and instead hired the NCSA programmers. They sought the knowledge of the developers of NCSA Mosaic, rather than the intellectual property rights.

NCSA Mosaic web server source code.[979] The Apache web server is available for free to the public.

Our case study on Apache challenges the prevailing view that intellectual property protection is needed to encourage the commercialization of government-sponsored research.[980] By placing the NCSA Mosaic web server into the public domain, the government encouraged the dissemination and continued innovation of the web server. Individuals and firms have incrementally and cumulatively improved the original source code created by NCSA. Generalizing and passing on the efficacy of placing all government-sponsored innovations in the public domain is unsupported by our two case studies. However, it is clear that definitive conclusions either for or against intellectual property protection for government-sponsored research are not possible at this juncture. Moreover, there is limited empirical evidence on this point.[981] It is clear which scenario benefits the University of Illinois. It is not as clear which scenario benefits society.[982] Perhaps, society would have been better off if the NCSA Mosaic web browser was placed into the public domain instead of being licensed.[983] This could have encouraged a wider circle of entities to build upon the NCSA Mosaic web browser.

The Apache case study also challenges the assumption that firms are the only entity capable of commercializing code. The prevailing logic for technology transfer laws assume that only firms are capable of turning government sponsored research into useful products. However, in the realm of code, there is another institution that is capable of producing useful code, the

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[979] *See supra* text accompanying note 174.

[980] *See* Colyvas et al., *How Do University Inventions Get Into Practice*, MGMT. SCI. (forthcoming 2002) (arguing on the basis of case studies that firms do not need the assurance of intellectual property protection to commercialize university technology).

[981] Mowery et al., *supra* note 451, at 117-18 (noting the lack of empirical evidence, but worried that the emphasis on patenting and licensing could hamper technological innovation, because it limits researchers access to technologies used in the process of conducting research); Sampat & Nelson, *supra* note 971 (commenting on the lack of evidence on the social benefits of existing technology transfer policy).

[982] *See* Eisenberg, *supra* note 449, at 1712 (arguing that intellectual property protection by universities is more likely to retard product development than promote development).

[983] There is evidence that the primary outcome technology managers and university administrators are interested in are revenues. While licensing revenues are easily quantifiable and a measure of success, they are not necessarily equivalent with the public interest. Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Tale of University Licensing*, NBER Working Paper 7 (1998) (conducting a survey of technology managers and university administrators on licensing). The public interest is to ensure that technologies are transferred to the private sector. In this manner other methods are just as important. These methods include publication, conferences, informal information channels, and consulting. Similarly, a report for the National Institute of Health pointed out that a university's principal obligation should not be maximization of revenues but the utilization of technologies, "technology transfer need not be a revenue source to be successful." Report of the National Institutes of Health

open source movement. The open source movement's reliance on both individual volunteers as well as firms to develop useful code has been validated in many projects including Apache. These products are not niche products, but products around which the computing industry is increasingly being based. The government's efforts at technology transfer must recognize the value and strength of the open source movement.

To further innovation and dissemination of code, the government should ensure the open source movement has access to government-sponsored code. We propose, as a general rule, that government funded research should place its code in the public domain.[984] Placing code in the public domain is the least restrictive method for both preserving access while permitting downstream intellectual property protection.[985] This allows both firms and the open source movement to build upon the government's code. Moreover, firms can still seek intellectual property protection for any code that they have spent efforts in improving or refining.[986] This policy is consistent with technology transfer laws, such as the Bayh-Dole Act, whose goals seek to further the utilization of government-sponsored research.[987]

An objection to this proposal is that this treats all parties equally, including foreign competitors to American companies. One use of intellectual property protection during technology transfer is to allow the government to provide preferential treatment to American firms. This is one of the many stated rationales for the Bayh-Dole Act.[988] In response, we argue

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(NIH) Working Group, *Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm.

[984] Our proposal focuses on the public domain, because it is much less restrictive than the GPL. The GPL requires any derivative code to be licensed under the GPL. While some people don't want their work privatized, this is largely a personal decision. Government should focus on creating the building blocks of code, no matter who the end users are. *See* Evans & Reddy, *supra* note 924 (arguing that the government should favor the public domain or BSD style of licenses over the GPL. *See also supra* text accompanying notes 466-469 (describing the GPL); Richard Stallman, President, Free Software Foundation, *Letter to the Editor: Public Money*, *Private Code*, SALON, Jan. 29, 2002, *at* http://www.salon.com/tech/letters/2002/01/29/stallman_on_universities/index.html (providing practical advice for university researchers on getting university code released with the GPL).

[985] To ensure that 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. An exception to government's encouragement and support of intellectual property rights during technology transfer would be needed for software.

[986] Firms would still have an incentive to make code user friendly, add documentation, and provide training because they could profit from these activities.

[987] 35 U.S.C. § 200 ("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 Report of the National Institutes of Health (NIH) Working Group on Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm (noting that technology transfer is not about financial returns to the government from licensing).

[988] 35 U.S.C. § 200 (2002) ("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; to encourage maximum

that preferential treatment is just one of the many underlying rationales for technology transfer. The main rationale behind technology transfer is to ensure the utilization of government research. Moreover, the rise of the open source movement, which is based upon volunteers around the world, complicates any preferential treatment for American firms. For example, the development of Apache relied on developers from around the world.[989] The effect of preferential treatment to American firms is to ensure code is not available to the open source movement. This is not merely a hypothetical issue.

The National Security Agency's (NSA) has decided to stop contributing to the open source movement.[990] NSA developed an enhanced version of the open source operating system Linux with military strength architectural improvements.[991] NSA released its code to the public in accordance with the licensing requirements of the Linux operating system. In response, the open source community applauded NSA's work and began utilizing their code. However, NSA was criticized for releasing the code to everyone and not just American companies. As a result, NSA is no longer working on creating more secure versions of open source software. We believe that curtailing such work is shortsighted and is a net loss to American industry and society as a whole.

The policy of placing code into the public domain may be difficult for universities to pursue. Licensing brings universities much needed revenue. It is difficult to turn away that money, and instead, place code into the public domain. For example, the University of Illinois had a number of companies seeking to license the NCSA Mosaic web browser. Foregoing that potential licensing opportunity would go against the nature and mission of a university technology transfer office. Thus, for this policy to become widely used, it will be necessary to

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participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities; to ensure that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area.").

[989] *See supra* text accompanying notes 186-189.

[990] Robert Lemos, *Linux Makes a Run for Government,* CNET NEWS.COM, Aug. 16, 2002, *available at* http://news.com.com/2100-1001-950083.html.

[991] Jim Krane, *World Governments Choosing Linux for National Security*, GOV'T TECH, Dec. 3, 2001, *available at* http://www.govtech.net/news/news.phtml?docid=2001.12.03-3030000000003951. *See also* Robert Lemos, *U.S. Helps Fund FreeBSD Security Project,* CNET NEWS.COM, July 9, 2001, *available at* http://news.com.com/2100-1001-269644.html (discussing the U.S. Department of Defense's work on improving the security of FreeBSD, an open source variant of Unix).

change the mindset in technology transfer offices.[992] Currently, universities are not "distinguishing between times when it's important to have a patent in place to get something disseminated and times when it's not. They're just looking to see if they can make money", according to Eisenberg.[993] As the NCSA Mosaic web server case study 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.[994]

Already, the government is slowly beginning to support the open source movement as an institution capable of developing code. While the open source movement has developed a significant amount of the code for the Internet, it also is playing a role in biotechnology.[995] This has led the National Institute of Health (NIH) to begin studying the appropriate level of intellectual property protection for its research tools. One important research tool is bioinformatics code. A working group by the NIH has recommended that the NIH should promote the free distribution of research tools.[996] Other researchers have been more aggressive. Harry Mangalam of tacg Informatics has called for the NIH to require research scientists who receive federal funding to make their code freely available for other researchers.[997]

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[992] 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. Press and Washburn, *supra* note 297.

[993] Benner, *supra* note 291. There are a few cases where is appears that technology transfer offices are placing a university's private gain over the benefits to the public. For example, Michigan State University is an example of a university that chose its own private profits over the public good. The 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 1996 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 and Washburn, *supra* note 297.

[994] Larry Smarr, former director of NCSA during the period when NCSA Mosaic was created and now a professor of computer science at U.C. San Diego does not believe that "universities should be in the money making 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 291.

[995] *See* Bruce Stewart, *Ewan Birney's Keynote: A Case for Open Source Bioinformatics*, *available at* http://www.oreillynet.com/lpt/a//network/2002/01/28/bioday1.html (Jan. 29, 2002); Bruce Stewart, *Lincoln Stein's Keynote: Building a Bioinformatics Nation*, *available at* http://www.oreillynet.com/pub/a/network/2002/01/29/bioday2.html (Jan. 30, 2002).

[996] *See Report of the National Institutes of Health (NIH) Working Group on Research Tools*, June 4, 1998, *available at* http://www.nih.gov/news/researchtools/index.htm.

[997] *Computer Scientists Push to Publish Code Powering Genetic Research*, SAN JOSE MERCURY NEWS, Nov. 24, 2001, *available at* http://www.siliconvalley.com/docs/news/svfront/015842.htm.

5. Funding Education and Training

The government can shape code through education or training campaigns. The purpose of government funding can vary from providing information about an activity or product to proactively attempting to change behavior. This intervention is justified because of the lack of information on the part of the general public. For example, the European Union partially funds the Internet Content Rating Association, which is educating parents and websites about using PICS.[998] In this section, we show how educational campaigns can shape code. After discussing the criticisms of funding educational campaigns, we show how government can shape code through educational campaigns. We focus on two sorts of campaigns. The first type of campaign is a by-product of government's employee training. The second approach involves direct funding of educational campaigns.

Criticisms of government funded educational campaigns largely focus on the effectiveness of these programs. Critics argue that millions of dollars are spent on educational programs that provide no tangible benefits.[999] One notable article on educational campaigns noted three problems with their effectiveness. First, not all behaviors can be corrected by educational campaigns. "Given human frailties, some accidents simply cannot be prevented."[1000] Second, campaigns should focus on one-time actions instead of trying to alter patterns of behavior. Third, changes come "slowly, modestly, and often expensively". Thus, campaigns take serious work and a campaign-of-the-month approach is ineffective. While these criticisms are valid, 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 to make it less costly. An example of this is the use of educational campaigns that are by-products of the government's efforts to educate its own employees.[1001] This occurs because of the ease of diffusing information through the Internet. The principal advantage is the low cost of the educational campaign. An excellent example of this is the web site usability.gov. Its original purpose was to assist people working

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[998] Internet Content Rating Association, *Internet Industry Leaders Gather for Launch of ICRAfilter*, *available at* http://www.icra.org/press/p19.shtml (Mar. 21, 2002).

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

[1000] *Id.* at 191.

[1001] For example, the government strives to ensure that its employees consider energy efficiency through educational campaigns. ALLIANCE TO SAVE ENERGY AND FEDERAL ENERGY PRODUCTIVITY TASK FORCE, *supra* note 910, at 31-34.

with the National Cancer Institute's (NCI) web pages. The web site provided a methodology for how to improve the design of web sites based on NCI's experience. NCI recognized that its web site was useful to people outside of NCI. They proceeded to make it available to other federal agencies as well as the general public. The cost of making this information available to others via the Internet is extremely low. As a result, usability.gov is now an important resource for web designers on how to make websites more usable, useful, and accessible. This example shows how effective educational campaigns can flow from the government's efforts to educate its employees.[1002]

The effectiveness of educational campaigns can vary depending upon whether the government is seeking to merely inform consumers about risks or attempting to change the behavior of people.[1003] While informing consumers is straightforward, changing behavior is much more difficult. After all firms have long tried to persuade consumers to purchase their products with mixed success. Nevertheless, there is ample evidence that educational campaigns can in fact change behavior, where other forms of regulation would fail.[1004]

Today's educational campaigns use much more sophisticated marketing techniques. The same principles and practices firms use for marketing are now being adapted to bring about social change, such as public health or safety. This approach is aptly named social marketing. It has been applied to a variety of social issues including health, education, safety, and the environment.[1005] 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 one time behavior. However, in some cases, social marketing has proven successful in changing behavior.[1006]

[1002] *See* http://usability.gov; Sanjay Koyani, *The Story Behind Usability.gov, available at* http://www.boxesandarrows.com/archives/002319.php (Apr. 1, 2002) (providing a history of usability.gov); William Matthews, *Dot-gov by Design*, FED. COMPUTER WK., Dec. 10, 2001 (discussing how usability.gov helps to improve government web sites).

[1003] Alan R. Andreasen, *Challenges for the Science and Practice of Social Marketing*, *in* SOCIAL MARKETING 3, 5 (Marvin E. Goldberg et al. eds, 1997).

[1004] PHILIP KOTLER & EDUARDO L. ROBERTO, SOCIAL MARKETING 8 (1989).

[1005] *Id.* at 6.

[1006] *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). A few other examples that Kotler and Roberto cite are as follows: M. T. O'Keefe, *The Anti-Smoking Commercials: A Study of Television's Impact on Behavior*, 35 PUB. OPINION Q. 242 (1972 (smoking); Harold Mendelsohn, *Some Reasons Why Information Campaigns Can Succeed,* 37 PUB. OPINION Q. 50 (1973) (drinking); R. I. Evans, *Planning Public Service Advertising Messages: An Application of the Fishbein Model and Path Analysis,* 7 J. ADVERTISING 28 (1979) (littering).

The government currently operates educational campaigns for code. These campaigns provide information to help with consumer decisions. The Federal Trade Commission (FTC) maintains information for consumers on e-commerce and the Internet. This includes information on buying low cost computers, protecting minors online, and the many types of online scams.[1007] One notable example is the Securities and Exchange Commission use of fake web sites to teach investors about potential scams.[1008] The fake web sites promoted 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!"[1009] The page also provides further information how to research investment offers and what to do if you are scammed. Another example of an educational campaign is the Energy Star specifications that allow consumers to identify energy-efficient products. This program has led to substantial purchases of energy efficient products.[1010]

An example of a potential code-based government education campaign to alter behavior is for security. A common technique for violating computer systems is the use of social engineering. This approach does not focus on the code, but instead gains information to bypass security from the users. This may involve tricking people into revealing passwords by pretending to be a technician. The best countermeasure here is education.[1011] Such an education campaign would likely require social marketing techniques. However, it could result in fewer security problems with code. Some examples of basic security precautions it could address include, using strong passwords with mix a mixture of alphabetic characters and numerals, changing passwords frequently, and educating employees about the risks of email attachments.[1012]

[1007] Federal Trade Commission, *Consumer Protection: E-Commerce & the Internet*, *available at* http://www.ftc.gov/bcp/menu-internet.htm (last modified Apr. 25, 2002).
[1008] Securities and Exchange Commission, *Regulators Launch Fake Scam Websites To Warn Investors About Fraud*, *available at* http://www.sec.gov/news/headlines/scamsites.htm (last modified Jan. 30, 2002).
[1009] *Id.*
[1010] Kevin Heslin, *EPA's Energy Star Program Pays Dividends*, ENERGY USER NEWS, Jan. 23, 2001, *available at* http://www.energyusernews.com/CDA/ArticleInformation/features/BNP__Features__Item/0,2584,19253,00.html.
[1011] *See* Malcolm Allen, *The Use of Social Engineering as a Means of Violating Computer Systems*, SANS Institute, *available at* http://rr.sans.org/social/violating.php (Oct. 12, 2001); Rick Nelson, *Methods of Hacking: Social Engineering*, *available at* http://www.isr.umd.edu/gemstone/infosec/ver2/papers/socialeng.html (last visited Mar. 26, 2001).
[1012] Cisco Systems, *10 Basic Cyber Security Tips for Small Businesses*, *available at* *http://www.cisco.com/warp/public/cc/so/neso/sqso/secsol/cybsc_ov.pdf* (Apr. 2000).

C. How Public Interest Organizations Can Shape Code

Government is not the only initiator and source that society can employ to shape code. Private groups can also shape code. The environmental movement and disability movement are examples of successful public interest organizations that have shaped the development of technologies. These groups were able to mobilize public support, which led to changes in the behavior of firms and government.[1013] In the same manner, public interest organizations and individuals can have a significant impact on code. Many of the recent changes to improve security and privacy for the Internet are the direct result of motivated individuals, rather than policymakers in government.[1014] This section discusses four measures that public interest organizations can take. First, public interest organizations can use political pressure to force changes in code. Second, public interest organizations can spur changes in code by informing the public about code. Third, public interest organizations can influence the development of code through participation in the development process. Fourth, public interest organizations can support the actual creation of code that addresses societal concerns.

1. Wielding Political Pressure

Public interest organizations can use political pressure to bring about changes in code. Through political pressure, public interest organizations can lead the government to use the bully pulpit as well as the threat of regulation to spur changes in code. The bully pulpit led the television industry to begin voluntarily rating its programs for the V-Chip.[1015] In our case studies, it was political pressure that led to improved cookie management tools in web browsers.[1016] The lesson is that public interest organizations can influence government into pressuring firms and consortia to modify their code.

This approach to changing code is limited because it depends upon voluntary efforts by developers. In the case of cookies and PICS, the developers sought to appease the government and produced code that did not fully address the underlying problem. However, the wielding of

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[1013] These groups can take advantage of the public participation components of US law. *See* Lewis Rosman, *Public Participation in International Pesticide Regulation: When the Codex Commission Decides, Who Will Listen?*, 12 VA. ENVTL. L.J. 329 (1993) (discussing the influence of public participation on U.S. regulatory agencies).
[1014] Richard Smith of the Privacy Foundation and Jason Catlett of Junkbusters are two dedicated individuals who have impacted privacy issues for the Internet.
[1015] Requirement for Manufacture of Televisions That Block Programs, 47 U.S.C. § 303(x) (2001).

political pressure is a good first step and a method of bringing attention to these issues. When possible, it is sensible to allow private industry to solve problems by itself before relying on government regulation.

2. Informing the Public

The development of code by firms can lead to a lack of concern for unprofitable social values.[1017] One reason this occurs is because consumers are subject to asymmetric allocation of information or incomplete information.[1018] A solution to this problem is to educate the public. By providing the public with information, it is possible to stimulate the development of code that addresses societal concerns.[1019] This role of education is an ideal role for public interest organizations. These organizations can serve as a forum and a resource for society's concerns about code.[1020] For example, users could be taught how to select code and use code in a responsible manner.[1021] Besides educating users, public interest organizations could educate the designers of code to consider the social implications of their work. This would further encourage the development of more socially conscious code.

3. Participating in the Development of Code

Public interest organizations can provide a voice for the public during the development of code within institutions such as firms and consortia. Our case studies have shown that firms and consortia will alter the development of code in response to public pressure.[1022] Public interest organizations can ensure that societal concerns are not overlooked during the development

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[1016] *See supra* text accompanying notes 128-131.
[1017] *See supra* Part VI.F.2.
[1018] *See supra* text accompanying notes 561-564.
[1019] The Pew Internet & American Life Project funds research on Internet related issues *see* http://www.pewinternet.org/.
[1020] Consumers Union has been funded by several foundations to educate the public on credibility of web sites. This will allow consumers to better understand the web sites they are using. Bob Tedeschi, *Consumers Union to Put Ratings System of Web Sites on the Web,* N.Y. TIMES, Apr. 15, 2002, *available at* http://www.nytimes.com/2002/04/15/technology/ebusiness/15ECOM.html.
[1021] Quoting security expert Richard Steele:
But the third and most important part is that the proprietors of the computers themselves must live up to a new standard of responsibility. You can't leave your computer connected to the world and not have firewalls. You can't send documents without encryption or other protection and expect them to remain private. So we ourselves have a responsibility. Frontline, *supra* note 551.
[1022] *See supra* text accompanying notes 310-312.

process.[1023] They can comment, evaluate, and serve as watchdogs to ensure that the development of code meets societal interests.[1024] For example, public interest groups led the fight against the unique serial numbers in Intel's Pentium III processor. Privacy advocates were concerned that these serial numbers could be used to identify and track a person's behavior across the Internet. As a result of this uproar, Intel decided not to include serial numbers in future processors.[1025]

A number of other public interest organizations, such as the American Civil Liberties Union, Electronic Frontier Foundation, and Electronic Privacy Information Center, have on occasion shaped the development of code. Recently, the Center for Democracy and Technology began the Internet Standards, Technology & Policy Project.[1026] A central goal of this project is to increase public interest input in the development of code. This project arose because of the recognition that technical decisions during the development of code can have a significant impact upon society.

4. Supporting the Development of Code

Public interest organizations can support the development of code to meet societal concerns. This support may be needed because firms will only support profitable societal concerns. This section discusses how public interest groups can support the development of code through direct funding or by coordinating the development of code. For both of these measures, the open source movement is usually the most effective means for developing code because of its use of volunteer labor.

Public interest organizations can fund the open source movement to create code that meets societal interests.[1027] The funding could overcome the biases within the open source

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[1023] *See supra* text accompanying notes 324-328.

[1024] *See* Steven Hetcher, *Norm Proselytizers Create a Privacy Entitlement in Cyberspace*, 16 BERKELEY TECH. L.J. 877 (2001) (explaining how these actors changed the norms for privacy in cyberspace).

[1025] Declan McCullagh, *Intel Nixes Chip-Tracking ID*, Apr. 27, 2000, WIRED NEWS, *available at* http://www.wired.com/news/politics/0,1283,35950,00.html.

[1026] This effort is funded by the Markle Foundation and the Ford Foundation. *See* http://www.cdt.org/standards/overview.shtml.

[1027] Bollier supplies a number of proposals for the private sector foundation community to support societal interests. Bollier, *supra* note 436. There is movement titled the "social source software" urging non-profit organizations to use and contribute to open source software for the benefit of all organizations. *See* Social Source Software, *Concept*, *available at* http://www.social-source.org/concept.htm (last modified Oct. 31, 2001).

movement towards creating code for the need of its developers.[1028] In essence, this would have public interest organizations acting as non-profit research groups such as the American Cancer Society or the International Maize and Wheat Improvement Center (CIMMYT).

Public interest organizations can encourage the development of code by lowering coordination costs for the open source movement. Benkler argues that the open source movement is a form of peer production where individuals are internally motivated. As a result, Benkler is suggesting that very little incentives are necessary to develop code if a project is well coordinated.[1029] This is because people will contribute their labor for free if it is a project they wish to pursue. Therefore, public interest organizations can encourage the development of open source projects by merely managing or overseeing the projects. So instead of directly paying a team of developers, a public interest organization could develop code by supporting a few people who would coordinate a much larger team of volunteer developers.

VIII. CONCLUSION

Much of the scholarly work on code focuses on how code regulates or shapes society. This Article has analyzed how society shapes code. Just as law is shaped by a variety of factors, code is similarly shaped by a variety of influences. Our goal was to provide an analysis of how code is shaped, which would be useful to policymakers. The first part of our Article studied the various societal institutions that develop code. These included universities, firms, consortia, and the open source movement. We examined how structural factors, different internal and external influences, and management decisions, which varied by institution, affected the development of code.

The second part of our Article, focused on how the varied tendencies of societal institutions resulted in different emphases on the social and technical attributes of code. This analysis should allow policymakers to understand how code develops and how to shape the

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[1028] This model of providing incentives to the open source movement was attempted for commercial development. It has not had much success. Andrew Leonard, *How Much Do I Hear For This Perl Script?,* SALON, May 14, 1999, *at* http://www.salon.com/tech/feature/1999/05/14/sourcexchange/index.html (describing Sourcexchange, a for profit clearinghouse for open source projects).
[1029] Yochai Benkler, *Coase's Penguin, or, Linux and the Nature of the Firm, available at* http://www.arxiv.org/abs/cs.CY/0109077 (last modified Oct. 23, 2001).

development of code to favor certain attributes such as open standards, quality of code, and other social values.

The final part of our Article provided recommendations for how society could shape code. To this end, we analyzed a number of different regulatory and fiscal actions government can take to shape code as well as how public interest organizations could act to shape code. Our analysis of how society can shape code led us to a number of policy recommendations. First, we criticize a number of existing government policies for shaping code. These include export prohibitions on encryption code,[1030] attempting to develop an insurance regime for cybersecurity,[1031] and the mandating of digital broadcasting technologies.[1032] Second, we offer a number of proposals that may be employed by the government to shape code. These include how government can shape code by funding its research and development.[1033] We also suggest that government should use its procurement power to favor open standards and open source code.[1034] To promote technology transfer, we argue that government should place its code into the public domain.[1035] Finally, we note that modification of liability regimes can result in more secure and safer code.[1036] In addition to government action, we recommend several measures that allow public interest organizations to shape code for the benefit of society.[1037] In sum, it is our hope that our analysis and recommendations will allow policymakers to anticipate and guide the development of code that contributes to our society.

[1030] *See supra* text accompanying notes 622-629.
[1031] *See supra* Part VII.A.4.C.
[1032] *See supra* text accompanying note 675.
[1033] *See supra* Part VII.B.1.
[1034] *See supra* Part VII.B.2.
[1035] *See supra* Part VII.B.4.
[1036] *See supra* Part VII.A.4.
[1037] *See supra* Part VII.C.