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# DECONSTRUCTING CODE

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*This Article deconstructs code using case studies and shows that code is not neutral and apolitical but instead embodies the values and motivations of the institutions and actors building it. The term "code," as we use it, consists of the hardware and software components of information technologies. Code is increasingly being sought as a regulatory mechanism in conjunction with or as an alternative to law for addressing societal concerns such as crime, privacy, intellectual property protection, and the revitalization of democratic discourse. Our analysis examines how societal institutions, such as universities, firms, consortia, and the open source movement, differentially influence the production of code. Relying on four case studies, we analyze how institutions differ in structure and motivation, and how they are affected by different social, political, economic, and legal influences. We then analyze how these societal institutions, which all approach code creation differently, influence the technical and social characteristics of the code that is developed by them. For example, code developed by a university is likely to contain different values and biases, regarding societal concerns such as privacy, than code developed by a firm. This analysis provides a crucial first step in understanding how society shapes these new technologies. Ultimately, this work may assist policymakers in proactively shaping the development of code to address societal concerns.*

## 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

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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

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] security,[8] protection of intellectual property,[9] and revitalizing democratic discourse.[10]

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informational economics); François Bar, *The Construction of Marketplace Architecture*, *in* TRACKING A TRANSFORMATION: E-COMMERCE AND THE TERMS OF COMPETITION IN INDUSTRIES 27 (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. MEDIA 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. 1039 (2002); TIMOTHY D. CROWE, CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (2d 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 architecture can support competition as well as provide 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. 1812 (2001) (arguing for P3P as a solution to privacy problems); *infra* note 575 (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, 699 (2001) (proposing the creation of a government search engine that only links to web sites that protect a user's privacy); Shawn C. 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. President's Critical Infrastructure Protection Board, *The National Strategy to Secure Cyberspace*, (Feb. 2002), *available at* http://www.whitehouse.gov/pcipb/ (suggesting a number of architectural solutions for improving security).

9. 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. Amy Harmon, *Hearings on Digital Movies and Privacy*, N.Y. TIMES, Mar. 2, 2002, *available at*

There is scant attention devoted to studying how architectural solutions are developed by society. This contrasts with the comprehensive efforts in understanding the development of legal solutions in fields such as legislation, administrative law, and public choice theory.[11] As a result, it is well understood how to address societal problems with legal solutions, but not with architectural solutions. This Article addresses this lacuna by deconstructing the development of information technologies through an examination of the various societal actors developing these technologies. This allows us to comprehend why information technologies differ in various social and technical aspects, such as the support for standards or the attention to privacy considerations.

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,[12] however, there were over five billion microprocessors sold in 1998.[13] These microprocessors are the code that governs many other technologies from aircraft and ships to refrigerators, lights, and smoke detectors.[14]

This Article 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 precedents, and legal customs. All of 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.[15] These

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http://www.nytimes.com/2002/03/01/technology/01DIGI.html.

10. *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).

11. 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).

12. NATIONAL SCIENCE BOARD, SCIENCE AND ENGINEERING INDICATORS – 2002 (2002).

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

14. *Id.*

15. We use the concept of legislators only in the descriptive sense and not in any normative sense. That is, we strive to understand who the rule makers for cyberspace are. We do not argue that the rule makers for cyberspace ought to act as

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 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.

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.[16] 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.[17] This Article contributes to this scholarship by explaining how society shapes the development of code. This work also recognizes the strengths and weaknesses of various societal institutions in developing code. This issue is a contentious one. Johnson and Post urge that government should allow consumers to choose code through the market.[18] For others, the significance of code is such that it should not be left solely to the market.[19] Our analysis highlights the strengths and weaknesses of relying upon firms to develop code. Moreover, we show how other institutions can develop code that addresses societal concerns which go unmet by the market.

Communications scholars have long recognized the power of code.[20] They emphasize how code, the medium of an information technology, affects how communications occurs.[21] For example,

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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.

16. 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.

17. Burk & Cohen, *supra* note 9.

18. David R. Johnson & David G. Post, *The New "Civic Virtue" of the Internet*, *in* THE EMERGING INTERNET 25 (C. Firestone ed., 1998).

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

20. 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., 1994) (providing an excellent overview of medium theory in communications).

21. 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

McLuhan argued that the medium of communication fundamentally affects our understanding of the world.[22] Communications scholars versed in political economy also study the development of code.[23] Their work typically documents how social, economic, political, and legal factors affect the design and implementation of code. 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 of thought. Moreover, this scholarship usually focuses on code developed by firms, with little attention given 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] Its 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, and social structures.[26] STS seeks to understand how

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unstable societies over a larger space, for example, the Roman Empire. HAROLD INNIS, EMPIRE AND COMMUNICATIONS (1950).

22. 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.

23. 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 in Information Science: 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).

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 & 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).

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

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 that are institutionally diverse 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 given by Winner 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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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 Artefacts?*, 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, at C8.

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 129 (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

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 consist of 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

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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 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 1, Spring 1999, *available at* http://dlis.gseis.ucla.edu/people/pagre/architecture.html (insisting 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. IN 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 is subject to institutional norms that that shape 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.

institutions outside academia.[36] The military-industrial complex would not have built a network without central control, one based on open standards that allow 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 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, universities, is 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]

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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 INFORMATION 167 (Vincent Mosco & Janet Wasko eds., 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 was 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

The second institution, the firm, is the leading developer and implementer of code. Firms spent over fifty billion dollars on research and development of new code in 1998.[41] Moreover, firms such as IBM, Hewlett-Packard, and Microsoft are the primary source of code for end users.

The third institution, the consortium, is an institution that arises from the cooperative efforts between firms or individuals. The majority of standards for 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, the open source movement, strives to keep the source code, 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

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INFORMATION TECHNOLOGY RESEARCH TO MEET SOCIETY'S NEEDS 88 (2000) [hereinafter COMPUTER SCIENCE AND TELECOMMUNICATIONS BOARD, MAKING IT BETTER]; *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, MAKING IT BETTER, *supra* note 40, at 64.

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); *infra* note 267 (providing further discussion on peer production).

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 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. This section analyzes 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.

## 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 (WWW or 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 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 project within CERN.[48] Over

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44. Conseil Europeen pour la Recherche Nucleaire (CERN), *All about CERN... in 7 questions!*, *available at* http://public.web.cern.ch/public/about/aboutCERN.html (last visited May. 3, 2004) (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.

48. *Id.* at 42.

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 were 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 academic community at large. In turn, the academic community sent 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]

Intending to encourage the development of the web, Berners-Lee asked his CERN-provided programmer to develop the individual pieces 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 them to be used with different computer operating systems.[56]

Available to the public as public domain software,[57] Berners-

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 268 (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.
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)

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 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

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(summarizing the announcement by CERN).

58. *Id.*; *see infra* text accompanying notes 467-470 (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.

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 began 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 that he found within the code.[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. In the end, Johnson did not want to collaborate with NCSA and he wrote Andreessen, "[w]ell, 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*, GQ, 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 manager, 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 the 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 its 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

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/news/alumni/win94/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 www-talk, which are 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)

Berners-Lee, what made NCSA Mosaic great was that Andreessen made "it very easy to install, and he supported it by fixing bugs via email any time night or day. 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] For example, 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 used 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,

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(announcing a new beta version of NCSA Mosaic by Andreessen).

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 & 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. GILLIES & CAILLIAU, supra note 45, 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.

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 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 it 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. Programmers would work late at night and talk over pizza. However, this changed as NCSA Mosaic's popularity grew.[90] 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, the programmers did not respect the management's decision-making capability. They 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 by the highly political academic environment.[92] This was highlighted when the *New York Times* featured NCSA Mosaic in an article in December 1993. Although 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

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.

of the management decisions there were getting harder to deal with. There were rebellions breaking out all over, evidenced by the fact that the 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 to 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. While the university continued 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

Netscape, a consortium, developed the cookies technology. In the following section, we discuss how Netscape's cookies technology led the Internet Engineering Task Force to develop a precise technical standard for cookies.

### 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 of the core developers of NCSA Mosaic to leave NCSA and to join him at Mosaic Communications Corp., which eventually become Netscape Communications.

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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.

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 Internet. This business decision led to an emphasis on security, commerce, and performance of both web servers and browsers.[99] This led Netscape to develop new technologies such as cookies, continuous document streaming, 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 named 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 are, what product you are asking for, or how many purchases you make. It has no memory. Statelessness on the web made commerce difficult. 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 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

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99. *Id.* at 109. One performance goal was that Netscape must load graphic images faster than NCSA Mosaic. MOODY, *supra* note 88, at 186; CLARK, *supra* note 71, at 151. The redesign 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, Sept. 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 Sept.t. 24, 2001).

ideas. This led to the idea state that the state data needs to be stored somewhere else other than the URL.[104] Lou Montulli and John Giannandrea refined their ideas into a solid working concept, Persistent Client State HTTP Cookies, over the next few weeks.[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]

The privacy risks of cookies are considerably higher when combined with referrer information. The referer [sic] field is part of the HTTP protocol advocated by Berners-Lee in 1992.[108] It provides a website with the previous URL visited by the person. Its intended purpose was to allow web sites to detect web sites that had linked to them with the hope that they would then add links back to the referring sites.[109] This would strengthen connections across the web. However, the combination of cookies and referrer information allows web sites to easily track a person's movement through their web sites. Web sites can then acquire considerable information about the long-term habits of their visitors. This ability to monitor and remember a user's 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. …

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

105. *Id; see* Netscape, *Persistent Client State HTTP Cookies*, *at* http://home.netscape.com/newsref/std/cookie_spec.html (last visited May 6, 2004) (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. Tim Berners-Lee, *Basic HTTP as Defined in 1992*, *at* http://www.w3.org/Protocols/HTTP/HTTP2.html (last visited Jan. 20, 2003).

109. Email from Phill Hallam-Baker, History of Referer (Jan. 21, 2003) (on file with author).

> 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.[110]

This pace left cookies as a technological kludge put together overnight.[111] This kludge was a natural consequence of the relentless pace at which Netscape was moving.

The rapid development cycle and the emphasis on commerce led to cookies being integrated into Netscape's first web browser in four ways. Netscape turned the feature on by default without notifying or asking the consent of users.[112] 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.[113]

While Netscape incorporated cookies into its web browsers released in 1994, 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.[114] The article immediately drew attention to cookies and resulted in a great uproar over the use of cookies. Over the next few years, cookies became one of the top Internet privacy issues.

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110. Interview by David K. Allison with Marc Andreessen, *supra* note 90; CLARK, *supra* note 71, at 148-49 (describing the relentless pace).

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

112. 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).

113. 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.

114. 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.

### 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.[115] The IETF, as the de facto Internet standards body, sought to ensure that 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.[116]

The first proposed standard was based on a technology different from cookies, which was more sensitive to privacy.[117] However, the IETF eventually switched to the Netscape cookies model.[118] 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.[119]

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

115. For further background on the IETF and the processes it uses to develop standards, *see* A. Michael Froomkin, *Habermas@Discourse.Net: Towards a Critical Theory of Cyberspace,* 116 HARV. L. REV. 749 (2003).

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

117. 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://www.kristol.org/cookie/draft-kristol-http-state-info-00.txt (Aug. 25, 1995).

118. Kristol, *supra* note 116, at 10.

119. *Id.* at 11.

management companies.[120]

Third party cookies can be used by online advertising companies to create detailed records of 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 its clients web sites; for example, 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.[121] This allows DoubleClick to aggregate the information about a person's web surfing from its client web sites. It can then create a detailed profile of a person's surfing habits. This has obvious and serious privacy implications.[122]

The IETF's cookies standard is critical of third party cookies and states that third party cookies must not be allowed. The standard does allow an exception if the program wants to give the user different options. However, the baseline default must be set to off.[123] It also requires the user be able to disable cookies, determine when a stateful session is in progress, and control the saving of cookies by web site. This last requirement is especially significant, because it allows users to manage what sites can and cannot place cookies.

The first IETF specification for state management was published in February 1997.[124] 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.[125] They insisted the standard address these issues. However, this standard quickly became inadequate because of compatibility problems in its implementation. This meant a revised

120. Schwartz, *supra* note 102.

121. *Id.* at 30.

122. Michael Gowan, *How It Works: Cookies*, PC WORLD, Feb. 22, 2000, *available at* http://www.pcworld.com/hereshow/article/0,aid,15352,00.asp.

123. 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.

124. D. Kristol & L. Montulli, *HTTP State Management Mechanism*, RFC 2109, Feb. 1997, *available at* ftp://ftp.isi.edu/in-notes/rfc2109.txt.

125. Kristol, *supra* note 116, at 11.

standard was necessary.[126]

It took the IETF three years to develop the revised standard. Again, the delay in the development of the standard was largely a result of privacy issues with third party cookies. After the initial standard, RFC 2109, the IETF found a new opposition force; 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.[127] The IESG insisted on developing strong guidelines for the use of cookies before a new cookies specification was approved.[128] The final standard for cookies, RFC 2965, was published 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 best technical standard, even if it will not be adopted in the near term.[129] Moreover, the process of developing the standard heightened public discussion on cookies.[130]

The public discussion on cookies was manifested in the media uproar over the privacy problems, and 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 it would follow the IETF's cookies standard and would not allow third party cookies.[131]

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126. *Id.* at 12.

127. *Id.* at 12-13.

128. Keith Moore & N. Freed, *Use of HTTP State Management*, RFC 2964, Oct. 2000, *available at* http://www.ietf.org/rfc/rfc2964.txt.

129. Kristol, *supra* note 116, at 29.

130. *Id.* at 22.

131. 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:

> 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

Netscape never fully followed the IETF standard for cookies and instead their browser by default allowed third party cookies.[132] The latest version of web browsers by Netscape and Microsoft still accept third party cookies by default to satisfy the advertising management companies.[133] Nevertheless, the government investigations pushed the browser makers to provide cookie management tools and improved documentation on cookies.[134]

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> 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 May 6, 2004) [hereinafter *FTC Privacy Hearings*].

132. 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 112. 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 116, at 21.

133. 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 (Sept. 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).

134. 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 Hearings*, supra note 131. 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.

### C. PLATFORM FOR INTERNET CONTENT SELECTION

The history of the Platform for Internet Content Selection (PICS) began with proposed legislation to regulate indecent speech on the Internet by Senator Exon in the summer of 1994.[135] By December 1994, the idea of a standard for labeling content on the Internet was discussed in an advisory committee meeting of the newly formed World Wide Web Consortium (W3C).[136] 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 "[s]omething has to be done . . . or children won't be given access to the Web."[137] AT&T joined IBM in proposing this project for the W3C.[138] However, no action was taken in response to their concerns.

Senator Exon reintroduced his legislation in February 1995 that would eventually become the Communications Decency Act (CDA).[139] 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 minors. This proposed legislation was followed by the now infamous Time cover story on cyberporn.[140] This combination of media and political pressure pushed the upstart Internet companies to action.

In June of 1995, the W3C began setting up a meeting to discuss technical solutions to limit content regulation of the Internet.[141] 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."[142] The members of the W3C realized that without an

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135. 140 CONG. REC. S. 9745 (daily ed. July 26, 1994) (including the amendment to S. 1882 by Senator Exon) *available at* http://www.eff.org/Censorship/Internet_censorship_bills/exon_s1822.amend.

136. Testimony of Dr. Albert Vezza in *American Civil Liberties Union v. Reno*, 929 F. Supp. 824 (E.D. Pa. 1996), *available at* http://www.ciec.org/transcripts/April_12_Vezza.html (last visited May 6, 2004).

137. BERNERS-LEE, *supra* note 46, at 112.

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

139. Communications Decency Act of 1995, S. 314, 104th Cong. (1995).

140. 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.

141. Interview with James Miller, *supra* note 138.

142. BERNERS-LEE, *supra* note 46, at 113.

industry solution, the government would regulate the industry.[143]

Microsoft, Netscape, and Progressive Networks created the Information Highway Parental Empowerment Group (IHPEG) in July 1995 to develop standards for labeling content.[144] IHPEG was chosen over the W3C because the members of IHPEG did not believe the W3C could act quickly enough.[145] 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 went beyond movie ratings of content 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.[146] The resulting project was the Platform for Internet Content Selection (PICS). According to Berners-Lee, "the 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 behavior of government."[147]

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; therefore, the IHPEG was necessary. Microsoft even attempted to persuade others such as IBM to join its coalition. IBM, however, supported the W3C. IBM's position was that "IBM does not join organizations founded by Microsoft, it forms them with Microsoft."[148] Microsoft capitulated and in September 1995, it was announced that PICS would be the result of a merger of the

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143. *Id.*

144. Press Release, 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).

145. Interview with James Miller, *supra* note 138.

146. *Id.*

147. Tim Berners-Lee, *Philosophy of the Web - Filtering and Censorship* (1997), *at* http://www.w3.org/DesignIssues/Filtering (last visited Sept. 19, 2001) (detailing Berners-Lee views on filtering and specifically PICS).

148. Interview with James Miller, *supra* note 138.

current efforts by the W3C and IHPEG.[149]

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 intense political pressure and the threat of regulation. These factors allowed the PICS team to rapidly push a standard on content selection through the W3C.[150] The PICS team also knew that working within the W3C, a consortium of important Internet companies, gave them another advantage.[151] 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.[152]

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.[153] Communication 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 was purely "a political decision" that was based on upcoming trial dates in December for the court challenge of the CDA.[154]

The final PICS specification limited access to indecent material in two ways.[155] First, web sites could self-rate their content by attaching labels indicating if content contained nudity or violence. Second, PICS supported 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, thereby allowing the filtering of web sites without relying on self-rating.

In 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

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149. Press Release, 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 (Sept. 11, 1995).

150. Interview with Paul Resnick, Designer for PICS, in Bloomington, Ill. (Aug. 10, 1999).

151. Interview with James Miller, *supra* note 138.

152. Interview with Paul Resnick, *supra* note 150.

153. Interview with James Miller, *supra* note 138.

154. *Id.*

155. For all the PICS technical specifications, see http://www.w3c.org/PICS/.

Wide Web. By February 1996, Microsystems put the first PICS ratings server on the Internet.[156] By March, a number of companies including Netscape and Microsoft had publicly committed to using PICS in their browsers.[157] By December 1996, the W3C made PICS an official "recommendation," the highest recognition a standard can receive by the W3C.[158] This recommendation, as is the norm in the W3C, was not patented and could be used royalty-free.[159]

The final version of the CDA was signed into law on February 8, 1996.[160] Immediately, a lawsuit was filed seeking to overturn the CDA.[161] Albert Vezza, Chairman of the W3C, testified at the trial. His testimony concerned the use of PICS as a method for content selection.[162] 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.[163] Judge Stewart Dalzell speculated that he could imagine a marketing advantage for implementing 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.[164] 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

156. Press Release, 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).

157. Press Release, W3C, PICS Picks Up Steam, *available at* http://www.w3.org/PICS/960314/steam.html (Mar. 14, 1996).

158. Press Release, W3C, W3C Issues PICS as a Recommendation, *available at* http://www.w3.org/Press/PICS-REC-PR.html (Dec. 3, 1996).

159. W3C, *W3C Software Notice and License, available at* http://www.w3.org/Consortium/Legal/copyright-software-19980720 (last modified Feb. 13, 2002).

160. 47 U.S.C.A. §223(a)(1)(B)(ii) (Supp. 1997).

161. 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.

162. Vezza, *supra* note 136.

163. Citizens Internet Empowerment Coalition, *Trial Update No. 9*, *at* http://www.ciec.org/bulletins/bulletin_9.html (Apr. 13, 1996).

164. Interview with Paul Resnick, *supra* note 150.

legitimate purposes."[165]

After the CDA was struck down, PICS went from a solution to the problem. People realized it could be more insidious than the CDA. On February 1997, *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."[166] During the summer, Lessig penned a story titled, "The Tyranny in the Infrastructure: The CDA Was Bad - but PICS May Be Worse."[167] Even the ACLU joined in and released a report on the dangers of content rating technologies such as PICS.[168]

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 required 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.[169] Similarly, search engines never limited their results to only PICS-labeled sites.[170] In the end, most sites refused to rate their sites with PICS compliant labels.[171] While there are a number of web

165. Reno v. American Civil Liberties Union, 521 U.S. 844 (1997).

166. Simson Garfinkel, *Good Clean PICS*, HOTWIRED, May 1997, *available at* http://www.hotwired.com/packet/garfinkel/97/05/index2a.html.

167. 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.

168. American Civil Liberties Union, Fahrenheit 451.2: Is Cyberspace Burning? How Rating and Blocking Proposals May Torch Free Speech on the Internet (1997), *available at* http://www.aclu.org/issues/cyber/burning.html (last visited May 6, 2004).

169. Tim Clark & Courtney Macavinta, *RSAC Shelves News Rating*, CNET NEWS.COM, Sept. 10, 1997, *available at* http://news.com.com/2100-1001-203141.html.

170. 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 138.

171. 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

sites that are rated with PICS compliant labels, they, at best, represent 0.4% of the web.[172]

The use of PICS for third party ratings never became viable. A system of third party labeling bureaus never emerged because of the absence of economic incentives and the necessary software tools.[173] Resnick saw a system of third party bureaus as the most realistic scenario through which PICS would become useful.[174] The existing filtering software companies, however, did not see any commercial option 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.[175] In

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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 138. 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 (last visited May 6, 2004).

172. 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).

173. 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 150.

174. Interview with Paul Resnick, *supra* note 150.

175. 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 running such a service. However, the idea never caught on. Interview with James Miller, *supra* note 138. 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*

addition to the lack of a business model 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 indicated that the only commercial server software was IBM's Internet Connection Server.[176] In sum, once the CDA was found unconstitutional by the Supreme Court, the development of software for PICS essentially stopped. The subsequent 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.[177] 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.[178]

When HTTPd was first released, the programmers at NCSA quickly patched any problems they discovered. But by 1995, the original team of programmers had left NCSA, and HTTPd was not updated in a timely manner.[179] This led individuals outside of NCSA to begin to "patch" problems that they discovered. This was possible because the source code was freely available in the public domain.[180]

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http://www.rsac.org/press/testimony.html (last visited Sept. 13, 2001).

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

177. 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.

178. *Id.*

179. *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.

180. 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, *NCSA HTTPd 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

An example of a patch was the addition of password authentication by Brian Behlendorf of the Hotwired web site. Other patches improved the security and performance of HTTPd.[181]

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 had to download the latest version of HTTPd and manually apply all the latest patches.[182] 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.[183]

Behlendorf began to contact other programmers,[184] and by February 1995 put together a mailing list called new-httpd and began circulating patches.[185] 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 was applied to NCSA's HTTPd 1.3. The resulting code became the first official release of Apache in April 1995.[186] The project was named Apache, a shortened version of "A PatCHy server."

The management structure for Apache is inspired by the IETF and its motto, "rough consensus and running code."[187] 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

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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*, 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).

181. MOODY, *supra* note 88, at 126. *See* Robert S. Thau, *Re: 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).

182. Thomas Østerlie, *Evolutionary Systems of Innovation*, *available at* http://www.idi.ntnu.no/~thomasos/thesis.pdf (last visited Mary. 17, 2004).

183. *Id*.

184. Leonard, *supra* note 179; *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).

185. MOODY, *supra* note 88, at 127.

186. *Id.* at 128.

187. *Id.*

members.[188]

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.[189] There are about fifteen core developers at any time.[190] The core developers create approximately 80% of the new functionality for Apache.[191] However, over 400 individuals have contributed code, and over 3000 people have contributed problem reports.[192]

During May and June of 1995, little work was done on Apache. The reason was described by Cliff Skolnick as, "[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."[193] Apache had stagnated as developers did not 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 was a rewrite of the server code.[194] Within a few months, the Shambhala code became the basis of the Apache server.[195] The new Shambhala code reignited discussion and work on the Apache server.[196]

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

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

189. McCool et al., *supra* note 180.

190. 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. A later study compared the development of Apache and the open source web browser Mozilla. A. Mockus et al., *Two Case Studies of Open Source Software Development: Apache and Mozilla,* 11 ACM TRANSACTIONS ON SOFTWARE ENGINEERING & METHODOLOGY 309 (2002).

191. Mockus et al., *supra* note 190.

192. *Id.*

193. Østerlie, *supra* note 182.

194. *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).

195. Robert S. Thau, *New Apache Server Beta Release*, WWW-TALK MAILING LIST, Aug. 7, 1995, *available at* http://impressive.net/archives/www-talk/9508071738.AA28471@volterra.

196. Østerlie, *supra* note 182.

development model.[197]

The failure of Netscape's and Microsoft's servers to meet the demands of the marketplace, specifically Internet Service Providers (ISPs), was one of the reasons for Apache's success. ISPs widely embraced Apache, because it allowed them to offer web hosting for corporate web 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.[198] ISPs, as well as other users, also chose 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.[199] 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 as a commercial, enterprise-level package.[200] IBM chose Apache over its own products, because Apache was the best server available.[201] IBM understood that there was little money to be made from selling server software. 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.[202] 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

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197. *Id.*; *see infra* text accompanying notes 443-444 (providing further discussion on the role of modularity).

198. *Id.*

199. MOODY, *supra* note 88, at 129.

200. *Id.* at 205.

201. IBM had its own experts ensure that the Apache web server was sufficiently high quality. *See* MOODY, *supra* note 88, at 208.

202. *See* McCool et al., *supra* note 180; William J. Holstein, *Big Blue Wages Open Warfare*, BUSINESS 2.0, Apr. 17, 2001 (discussing IBM's relationship with the open source movement).

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 section, in whole or in part, may be common knowledge to many readers and is intended to serve as background material. An 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.[203] This section begins by discussing the historic mission of the university in supporting basic research. We then discuss its institutional motivations and intended users.[204] 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.[205] Their role is to expand the frontiers of knowledge. This is an activity that private firms under-invest in, leading to public support of basic research.[206] Universities

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203. *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, Mar. 1998, 44 (acknowledging the role of university research in innovations in human computer interfaces).

204. 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.

205. 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).

206. *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.

contribute through the creation of knowledge, but also by disseminating knowledge and teaching future generations.[207] This benefits society by increasing innovation and lowering the cost of development for new technologies.[208]

In the pursuit of knowledge, universities support a wide variety of research. They realize innovation does not happen overnight. Rather, it is the result of the steady accumulation of knowledge across disciplines. This leads universities to support a variety of projects with little emphasis placed on individual projects.[209] For example, NCSA and CERN would not have been significantly affected if either Berners-Lee or Andreessen had failed.[210] Many of the projects universities support do not have an immediate impact on society. Occasionally, the research can have an immediate and significant effect on society such as with NCSA Mosaic.[211]

The motivation for research within a university is to build a reputation in the scientific community.[212] Reputation is derived from being the first to discover or develop new findings.[213] The emphasis on reputation-building can lead to problems when teamwork is required. The individualized reward system in a university setting leads

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207. Richard Florida, *The Role of the University: Leveraging Talent, Not Technology*, ISSUES SCI. & TECH. 363, Summer 1999 (arguing that the university's role is not only to produce technology but also to produce talent).

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

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

210. 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).

211. 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).

212. *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).

213. Dasgupta & David, *supra* note 209, at 499 (noting that "unlike tennis tournaments, science does not pay big rewards to runners-up").

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.[214] Eventually, the entire NCSA Mosaic programming team left the University of Illinois with bitterness.[215]

There are two reasons why the public should be considered the end user of the fruits of university research. 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.[216] Second, researchers have a personal interest in offering their knowledge to the public. Recognition is often given to those who were the first to create some particular knowledge.[217] The importance of priority has led to divisive debates in the academic world.[218] To this end, researchers widely disseminate their work for all users. This norm of wide dissemination is an important one, but is changing as the law concerning the intellectual property of universities is changing.[219]

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, researchers cannot depend upon a large technical support staff. Functions seen as extras, such as technical support and documentation, are not fully supported.[220] The lack of resources during

214. *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.

215. *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.

216. 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).

217. Dasgupta & David, *supra* note 209, at 500.

218. Katie Hafner, *A Paternity Dispute Divides Net Pioneers*, N.Y. TIMES, Nov. 8, 2001, at G1 (reporting on a tussle in the academic community over who invented packet switching technology).

219. *See infra* Part VI.B.1.

220. *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

the development process gives researchers the impetus to seek resources outside the university. This was evident during the development of the World Wide Web, when Berners-Lee began encouraging university students to develop web browsers.[221]

### B. FIRMS

In a capitalist system, the private sector develops the majority of code.[222] Firms such as IBM, Digital Equipment Corporation, and Microsoft have historically developed much of the code widely adopted in society. Our definition of a firm goes beyond the strict legal definition of a corporation and encompasses other constituent entities such as corporate research laboratories.[223] 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.[224] To make profits, firms must provide goods and services that

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continuing development of GateD. Hallgren & McAdams, *supra* note 211. 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.

221. *See supra* text accompanying notes 52-54.

222. 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).

223. 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, MAKING IT BETTER, *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?*, BUSINESS 2.0, 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).

224. *See* Nelson, *supra* note 208, at 299.

meet consumer demand.[225] Successful firms listen to their customers, provide them services they need and will need, and provide support when their customers have problems.[226] However, we should remember that the "goal of industry remains the satisfaction of shareholders by making a profit, not the advancement of science."[227]

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 dot com era, firms still maintained a management structure.[228] Simply put, firms provide financial compensation to 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 of 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 their knowledge

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225. 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).

226. 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.

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

228. *See* Dan Gebler, *End of the Dot-Com Cultural Revolution?*, E-COMMERCE TIMES, Sept. 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).

to other firms.[229]

### 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.[230] 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.[231] Their rationale is to develop research that is useful to all of them and would not otherwise be developed by a single entity.[232] 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.[233] By cooperating in a

229. Nancy Gallini & Suzanne Scotchmer, *Intellectual Property: When Is It the Best Incentive System?, in* 2 INNOVATION POLICY AND THE ECONOMY 51 (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 Costs and Benefits of Patents,* 32 J. ECON. ISSUES 1031 (1998) (noting several economic theories for patents).

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

231. Cargill, *supra* note 42 (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. POL'Y 159, 164 (1999) (reviewing the structure and origins of consortia).

232. S*ee* Nelson *supra* note 208, 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).

233. 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 230, 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

consortium, the participants can collectively work towards a common solution.[234]

This section begins by discussing standards and the role of consortia as compared to Standard Developing Organizations.[235] 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.[236] 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 quantifiable, multiple code developments can be based on a single standard. In fact, many firms have developed products based on the standards for cookies and PICS.

Consortia are the primary developers of voluntary consensus standards for information technologies. Unlike other fields, there is little activity in developing information technology standards within Standard Developing Organizations (SDOs), such as the International Organization for Standardization (ISO).[237] The standardization efforts of consortia occupy a middle ground between the de facto standards set by firms and the de jure standards of SDOs.[238] Consortia also differ from SDOs in that standard setting is only one aspect of a consortium's activities.[239] Consortia can also foster the implementation

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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.

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

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

236. 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.

237. Cargill, *supra* note 42, at 4.

238. Updegrove, *supra* note 234, at 144; *see* Paul A. David & Mark Shurmer, *Formal Standards-Setting for Global Telecommunications and Information Services*, 20 TELECOMM. POL'Y 789 (1996) (reviewing the nature and economic significance of the activities of formal standardization bodies); CARGILL, *supra* note 236, at 125 (discussing the characteristics of some international SDOs).

239. Hawkins, *supra note* 234. Other significant differences between

and adoption of standards. For example, they may require members to sign contracts to ensure compliance with standards.

The motivations for using a consortium emerged 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 all voices are heard. Any party directly or materially affected is allowed to participate in the standardization process.[240] The groups involved "represent personal, professional, national, disciplinary, and industry goals."[241] The diversity of the participants' goals typically leads to a longer time to reach consensus on a standard.[242] In contrast, a consortium can self-select its members to ensure a group of like-minded participants.[243] 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.[244] Second, SDOs have strict rules to ensure they are open and accountable organizations.[245] These rules often lengthen the development time. For example, an SDO standard may require several formal reviews, which can each take a minimum of six months.[246] This leads to a longer standardization process. For example, it typically

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*, BUSINESS 2.0, Oct. 2000 (summarizing the differences between consortia and SDOs for code).

240. CARGILL, *supra* note 236, at 168.

241. *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).

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

243. Cargill, *supra note* 42*,* at 4.

244. 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).

245. Cargill points out that traditional standards setting 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 239.

246. Cargill, *supra* note 42, at 19.

takes seven years for an international SDO to develop a standard.[247] A consortium can develop standards more quickly, because it is not subject to the same procedural rules as SDOs.[248]

Both its end users and its structure exert a large influence on the consortium. First, and foremost, the end users of a consortium vary. Although a consortium can choose to restrict its standards to its members, it may also 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.[249] Second, the structural features of a consortium affect the development of code. These 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.[250]

The IETF's origins date from the early days of the Arpanet, the precursor to the Internet. The IETF developed many of the standards that form the basis for the Internet. The IETF is considered a "gray" standard body, because its standards are initiated and driven by implementers.[251] 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,

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247. Paul A. David & Mark Shurmer, *Formal Standard-Setting for Global Telecommunications and Information Services*, 20 TELECOMM. POL'Y 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).

248. Cargill, *supra* note 42, at 5.

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

250. 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).

251. 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" standards, in comparison to a hypothetical and more complex approach a more formal standard organization may might support.

mailing lists, and standards are available for free on the Internet.[252] Finally, the IETF requires "reasonable and nondiscriminatory" licensing of any intellectual property covering a standard.[253]

Originally, the W3C supplied a place for the producers of web-related software to develop standards.[254] Now, the W3C's members are largely private firms.[255] Annual membership costs are between five thousand and 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.[256] While the final standards are public, typically only members participate in the development of standards.[257] The W3C's structure permits the rapid development of standards, sometimes in as little as seven months.[258] Historically, the W3C has adopted a policy of royalty-free licensing of any intellectual property covering a standard.[259]

An important feature of the W3C is its commitment to address societal issues. The W3C is developing technologies that affect social

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

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

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

255. 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 Jan. 12, 2003) (containing frequently asked questions about the W3C).

256. 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 254.

257. 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).

258. *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).

259. The W3C considered revising this policy, but public pressure led them to maintain the requirement of royalty free licensing. *See* W3C, ROYALTY-FREE PATENT POLICY, *available at* http://www.w3.org/TR/2002/WD-patent-policy-20021114/ (last modified Nov. 14, 2002); Margaret Kane, *W3C Bows to Royalty-Free Pressure*, CNET NEWS.COM, Nov. 14, 2002, *available at* http://news.com.com/2100-1001-965863.html; W3C, *Royalty-Free Patent Policy*, *available at* http://www.w3.org/TR/2002/WD-patent-policy-20021114/ (last modified Nov. 14, 2002).

values with its Technology and Society Domain.[260] The W3C has focused on issues of security, content filtering and labeling, security, electronic commerce, accessibility, and privacy.[261] Naturally, the issues chosen by the W3C are those that are of interest to 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, the scripting language PERL, and the popular email server Sendmail.[262] The defining characteristic of the open source movement is the public availability of the source code.[263] The source code is the instructions for software that can be read and modified by programmers.[264] By keeping the source code publicly available, developers can build upon others' earlier work to create more complex and higher quality code.[265] In contrast, proprietary software usually does not include the source code, which limits reuse and forces developers to re-create the code for

260. W3C, THE TECHNOLOGY & SOCIETY DOMAIN, *available at* http://www.w3.org/TandS/ (last visited May 5, 2004).

261. Khare, *supra* note 254 (describing the evolution of the Technology & Society Domain).

262. *Tour de Source*, WIRED, May 1999, *at* http://www.wired.com/wired/archive/7.05/tour.html.

263. 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); Charles M. Schweik & Andrei Semenov, *The Institutional Design of Open Source Programming: Implications for Addressing Complex Public Policy and Management Problems*, FIRST MONDAY, Jan. 2003, *available at* http://firstmonday.org/issues/issue8_1/schweik.

264. *See supra* text accompanying note 177 (defining source code); *see also* Cargill, *supra* note 231 (arguing that the open source movement's licenses define this institution).

265. 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).

minor changes.[266] The public nature of open source code leads to a cooperative development process. Not surprisingly, many of the same issues associated with consortia are seen in the open source movement.[267] 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 Software Foundation (FSF). It maintains that source code should be free, allowing a user to "run, copy, distribute, study, change, and improve the software."[268] The FSF believes that there is a moral, social, and civic value 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 distribution of code based upon 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.[269] This allows firms, such as Apple and Microsoft, to incorporate open source software into the software they sell.[270] For this branch, the value of open source code is

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266. Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255, 259 (1997).

267. Scholars have argued that the ease of communication through modern technologies has led to a new form of production. They term this it "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 of production compared to manufacturing-ed 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 193-194.

268. Free Software Foundation, *The Free Software Definition, available at* http://www.gnu.org/philosophy/free-sw.html (last modified Oct. 17, 2001).

269. 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).

270. 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

its openness, which allows for a technically superior development process. Thus, a principal difference between these two branches concerns whether open source code can be distributed after being commingled with proprietary code.

The motivations of the open source movement are varied.[271] There are a small number of paid participants as well as private firms.[272] 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, the potential motivations are fourfold.[273] First, they develop code that they themselves need. This occurs because there is no alternative in the marketplace or the alternative is costly.[274] Second, many developers find enjoyment in developing code as a creative endeavor.[275] Third, they seek recognition from their peers by contributing to the development of innovative code.[276] Finally, there is a political motivation that sees open source as superior to

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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.

271. *See* FELLER & FITZGERALD, *supra* note 263, at 137-54 (discussing the various motivations for the open source movement).

272. *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 May 5, 2004) (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.").

273. 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).

274. Raymond, *supra* note 265.

275. 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 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).

276. Josh Lerner & Jean Tirole, *The Simple Economics of Open Source*, 50 J. INDUS. ECON. 197 (2002), *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).

proprietary software.[277] This is often manifested as an anti-Microsoft attitude. These differing motivations affect the choice of intellectual property protection for the source code.[278]

The end users of open source software are, by definition, the public. The goal 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.[279] 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.[280] By understanding these influences, we can begin to predict the resulting institutional tendencies that shape code. This section discusses these influences on each institution, beginning with the university, and continuing on to firms, consortia, and the open source movement.

### A. UNIVERSITIES

The NCSA Mosaic case study identified a number of influences that shape the development of code in a university. These influences

277. 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/.

278. *See infra* Part VI.B.

279. 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) (on file with Author).

280. 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).

affected not only NCSA but also CERN. We treat CERN as a university-style 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 of the university's membership for peer recognition. 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 the 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.[281] For researchers, the criterion for excellence is peer recognition.[282] 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 diminished motivation for potential economic gain when developing code within a university.[283]

The influence of peer recognition manifested during the development of NCSA Mosaic. The student developers of 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.[284] 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 dictated by what looked cool.[285] This example shows the influence of peer recognition and also its lack of uniformity based on the peer group being addressed.

The desire for peer recognition extends to the institutional level. This is unusual because 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.[286] The University

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281. *See supra* text accompanying notes 212-213.
282. *See* Mats Benner & Ulf Sandstrom, *Institutionalizing the Triple Helix: Research Funding and Norms in the Academic System*, 29 RES. POL'Y 291 (2000).
283. *See supra* note 61.
284. *See supra* notes 88-89.
285. NAUGHTON, *supra* note 36, at 244-45.
286. CS ALUMNI NEWS, *supra* note 72. Similarly, recognition from the

of Illinois also began touting the accomplishments of NCSA Mosaic. It used the prestige of NCSA Mosaic to enhance its own status.[287] Thus, the desire for peer recognition affects both researchers and their institutions.

The second influence is the autonomy given to developers within the university.[288] Universities provide the autonomy, the freedom to pursue self-directed research, necessary to develop code because innovation and the creation of new ideas are the central goals of research at universities.[289] Autonomy means 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 primitive theories 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.[290]

The case studies show that NCSA and CERN allowed their researchers considerable freedom. At CERN, researchers developed new software for everything from running the soda machine to conducting physics experiments.[291] Within this institutional environment, Berners-Lee was allowed to work on his radical proposal for the web, and pursue his project as he saw fit.[292]

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outside led the University of Minnesota to understand the significance of the Gopher program developed at the university.

287. *See* UNIVERSITY OF ILLINOIS, FACTS 2001, *available at* http://www.admin.uiuc.edu/pubaff/facts96.html (last visited May 5, 2004) (highlighting the role of Mosaic in a background statement about the university).

288. Dasgupta & David, *supra* note 209, 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).

289. 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).

291. BERNERS-LEE, *supra* note 46, at 43.

292. 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).

Research autonomy is the result of legislation in the 1980s which allowed universities to acquire intellectual property protection for the inventions of its researchers.[293] As result, universities can now profit handsomely by licensing the rights to code to the private sector.[294] This legislation does not appear to directly shape the development of code within universities. It plays a significant role in the transfer of code to the private sector.[295] For example, universities are supporting research in profitable biotechnological pest control in lieu of less profitable but still effective methods of pest control.[296] In selected fields, the potential for an economic windfall has led universities to support certain research topics in lieu of others.[297]

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.[298] 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.[299] Berners-Lee used this strategy during the

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293. *See infra* text accompanying note 451 (discussing the Bayh Dole Act).

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

295. *Id.* (analyzing how the Bayh Dole Act affects the attributes of code).

296. 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).

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 233, 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. *See supra* text accompanying notes 220-221.

299. *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,*

development of the web. He lacked the resources to develop web browsers for all the major computing platforms, which 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).[300] These reusable blocks of code were known as libwww and became the basis for future web browsers and servers.[301]

### B. FIRMS

Firms produce goods and services for the market. An important consideration is the anticipation of consumer needs. In short, economic concerns are the primary motivator of firms, and serve to shape the development of code for firms.[302] 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.

Anticipated consumer demand is the major influence on a firm's code. Firms strive to ensure that code meets and creates consumer demand. Therefore, if code does not generate revenue, it will be abandoned. Netscape was created to meet such an anticipated demand. In order to meet its demand for new browsers and Internet servers, Netscape focused on selling its software to "large companies with deep pockets."[303] To accomplish this, Netscape developed and incorporated technologies to support commerce, such as cookies and the Secure Sockets Layer.[304] These technologies were crucial to the

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*Private Code*, SALON, Jan. 4, 2002, *at* http://salon.com/tech/feature/2002/01/04/university_open_source/print.html.

300. 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).

301. *See supra* text accompanying notes 55-60.

302. 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).

303. QUITTNER & SLATALLA, *supra* note 46, at 97.

304. *See supra* text accompanying notes 99-101.

early success of Netscape's web browsers and servers.[305]

Focusing on consumer demand can result in firms missing innovative changes in technology.[306] 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.[307] 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 with this new approach.[308] 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, upon which the Internet would later be based.[309]

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.[310] This neglect of unprofitable societal concerns by firms is understandable.[311] However, there are steps, such as regulation, that society can take to ensure that firms address unprofitable, but socially desirable, concerns.

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305. 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).

306. CLAYTON M. CHRISTENSEN, INNOVATOR'S DILEMMA: WHEN NEW TECHNOLOGIES CAUSE GREAT FIRMS TO FAIL (1997) (finding that firms that listen to their customers may miss innovative changes, because of the development of disruptive technologies).

307. S*ee* Nelson *supra* note 208.

308. *See supra* notes 47-48.

309. 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, Sept. 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).

310. *See supra* text accompanying notes 112-113.

311. *See infra* Part VI.F.2.

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.[312] 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 using basic cookie management tools and improving the documentation on cookies.[313] 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.[314]

### C. CONSORTIA

A consortium's members are the primary influence on the development of code. This is not surprising since consortia are structured to meet the demands of their members. 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.

A consortium's members set the agenda and decide what projects to pursue and the appropriate level of resources.[315] This was

312. 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/.

313. *See supra* note 134 and accompanying text.

314. *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).

315. Cargill, *supra* note 231, 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 May 5, 2004) (noting that membership benefits of the GateD consortium include participating in developing features and goal setting, although the code is available for free of

evident in the PICS case study. The W3C chose to work on PICS in response to their members' concerns.[316] Because PICS was seen as a technical solution to prevent government regulation of the Internet, the W3C placed PICS on a rapid development cycle to ensure that it would be completed for the upcoming constitutional challenge to the CDA.[317]

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.[318] The W3C used a closed private process during the development of PICS.[319] This was because firms, such as Microsoft and IBM, agreed to work within the W3C only if PICS was developed rapidly.[320] The W3C relied upon a dozen people during the entire developmental process.[321] 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. By the end of 1995, the W3C had a draft specification for PICS, while the IETF had not made any progress.[322] This led the IETF to abandon its efforts and rely on the

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charge); Hallgren & McAdams, *supra* note 211 (describing GateD project).

316. According to James Miller, co-chairman 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 it's 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 138; *see also* text accompanying notes 135-143 (providing background on the history of PICS).

317. Joshua Michael Marshall, *The Trouble with PICS*, FEED MAG., Sept. 1997, *available at* http://www.feedmag.com/html/feedline/97.09marshall/97.09marshall.html (on file with Author.)

318. *See supra* text accompanying notes 250-260.

319. 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.

320. *See supra* text accompanying notes 148-149.

321. *See supra* text accompanying note 153.

322. According to the W3C, the IETF is only effective for generating and criticizing ideas, while the W3C's structure is better at producing timely specifications for its members' benefit. The W3C is more effective in 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

W3C.[323] In this case, the W3C's structure favored a much more rapid development process than the IETF's public process.[324]

Consortia may ignore or overlook outside social influences and third parties during the development process.[325] 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 consider their mission to be 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.[326] This can result in ineffective or technically poor solutions.[327] For instance, the PICS specification is of little use to firms selling filtering software to libraries and parents. This is because the needs of end users and the commercial filtering firms were not addressed in the PICS development process.[328] Since PICS, the W3C has established a

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members to develop the standards and push them forward. *See* World Wide Web Consortium, *Process Document*, *Section 8.4,* W3C, W3C AND THE INTERNET ENGINEERING TASK FORCE (IETF), Nov. 11, 1999, *available at* http://www.w3.org/Consortium/Process/Process-19991111/appendix.html; W3C, FREQUENTLY ASKED QUESTIONS, *available at* http://www.w3.org/Consortium/Prospectus/FAQ.html (last visited May 5, 2004).

323. 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).

324. Another example is the development of HTML. The popularity of HTML led to over a hundred people being actively involved with the IETF 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 the private arena of the W3C).

325. 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.

326. 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, Author of *XML: A Primer*, in Bloomington, Ill. (Dec. 7, 2001).

327. 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 who have felt that the W3C's approach to XML is far too complicated and too vendor- oriented. They are creating alternative lightweight solutions. *See* Roberta Holland, *XML Schema Catches Heat,* EWEEK, Apr. 22, 2001, *available at* http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2710691,00.html.

328. *See supra* text accompanying notes 173-176. Similarly, the Platform

more formal standardization process that incorporates public comments.[329] This guarantees that standards are subject to public scrutiny, but does not address the problem of overlooking third parties in the development process.[330]

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.[331] These potential stakeholders were affected by the cookies standard, but never participated in the development process.[332] Consequently, there were numerous problems with software compatibility and privacy issues that ultimately delayed and marginalized the final standard.[333]

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for Privacy Preferences (P3P) project ofby the W3C, has been criticized for producing a solution that meets the needs of industry over consumers. *See infra* note 575. 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.

329. The W3C process has evolved towards a more formal process. World Wide Web Consortium, *supra* note 257.

330. 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, consortium members 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 326; 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).

331. 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 116, at 19.

332. 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.

333. Another example of a consortium overlooking third parties is the IETF's almost unanimous resistance to developing standards with a built- in ability to support wiretapping. The IETF's rejection reflects its membership's libertarian leanings. Its behavior stands in 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.

### 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 argue that political and economic influences provide little influence on the development of code. At times, the open source movement even counters dominant political and 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.[334] 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. According to 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.[335]

The limits of volunteerism also extend to the subject of the project. Volunteers wish to work on interesting tasks.[336] 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

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).

334. *See supra* text accompanying notes 273-277.

335. Pair Networks, *An Interview with Jordan Hubbard*, WORKINGMAC, Aug. 16, 2001, *available at* http://www.workingmac.com/article/32.wm.

336. 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 265.

> 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.[337]

This biases open source code towards the needs of its volunteer member developers. Code then addresses the needs and purposes of sophisticated developers and not ordinary users.[338] Projects are often those that developers think are interesting or useful, such as a C compiler or an mp3 player.[339] As a result, volunteer members may not work on code that is in greater demand or more socially beneficial.[340] For example, the development of the early web browsers, such as NCSA Mosaic and Erwise, relied on volunteer programmers all across the world.[341] 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."[342] Berners-Lee wanted the developers to focus on a much more substantive issue—the addition of

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337. Bezroukov, *supra* note 277.

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

339. 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 includes both computer professionals and 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 (last visited May 5, 2004).

340. The limitations of volunteerism are evident from the period between Apache's first official release and 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 182.

341. *See supra* notes 52-54.

342. BERNERS-LEE, *supra* note 46, at 71.

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 believed that the reason people focused on browsing over writing and editing features was that it just wasn't fun to create an editor.[343] 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 complaint is that open source code is designed for use by sophisticated developers, and therefore, difficult for novice users to use.[344]

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 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.[345] 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.[346]

At times, the code developed by the open source movement can run counter to conventional economic and political influences. For example, consider the development of the Gnutella file-sharing program. Gnutella was developed by AOL subsidiary Nullsoft, which

343. *See supra* notes 84-88 and accompanying text.

344. *See infra* text accompanying note 520.

345. *See Sneak Peek: 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).

346. When the image-blocking feature was removed in an early version, there was a concomitant uproar. There were concerns that AOL- Time Warner (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 Mozilla Junkbuster-like Feature Removed*, SLASHDOT, *available at* http://www.slashdot.org/articles/00/05/09/1410222.shtml (May 9, 2000).

also developed the popular Winamp digital music player.[347] 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 from accessing the file sharing network. Nullsoft didn't intend to sell the program, but created it as a "labor of love."[348] AOL quashed Nullsoft's distribution of Gnutella in one day, but it was too late. The open source movement had begun to refine and distribute Gnutella.[349] 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 for governments to track down users or remove information.[350] The motivations for this defiant behavior result largely from the libertarian views of the open source developers.[351] These developers get a special satisfaction from code that complicates life for government. This motivation 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 developing code have different legislative processes, because of their differing structures and susceptibility to different influences. This section discusses three management decisions during the legislative process for code that serve to shape code. First, institutions differ in the speed of the

347. 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.

348. *Id.*

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

350. John Markoff, *The Concept of Copyright Fights for Internet Survival*, N.Y. TIMES, May 10, 2000 (discussing the Freenet project).

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

development process for code. Second, institutions differ in their processes for deciding what attributes should be included in their 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 code is disseminated. Some institutions favor making their code widely available, while other institutions 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 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 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. This, however, is not always the case. We begin by discussing the speed of development in universities; we then continue on to firms, consortia, and the open source movement.

According to Bruce Maggs, a former vice-president for research and development at Akamai Technologies, who has recently returned to academia, the typical norms for university research favor a slower, more thorough, approach over a rapid development process.[352] The additional time allows researchers to ensure the accuracy of their results, ponder interesting results, and consider new research trajectories.[353] 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.[354]

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352. 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.

353. *See* SUBCOMM. ON BASIC RESEARCH OF THE COMM. ON SCIENCE, 106TH CONG., VIEWS AND ESTIMATES OF THE COMM. ON SCIENCE FOR FISCAL YEAR 2000, *available at* http://www.house.gov/science/viewsfy2000.htm (discussing why the government should focus on long term research) (last visited May 5, 2004).

354. *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

Firms are under pressure to develop code rapidly. It is well established that the first competitor in a market has a distinct advantage.[355] Netscape emphasized a rapid development process, because it understood that its success depended on being the first commercial web browser.[356] 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."[357] The emphasis on speed leads to a tradeoff in the quality of the code.[358] In the case of Netscape, the rapid development process led to the incorporation of an immature technology that contained security and privacy holes such as third party cookies.[359]

Consortia are chosen because of their rapid speed in developing standards as compared to Standard Developing Organizations (SDOs).[360] 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.[361] 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.[362] However, consortium work is not always completed rapidly. For example, the Secure Digital Music Initiative (SDMI) consortium made little progress over the last few years.[363] Additionally, the speed

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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.

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

356. *See supra* text accompanying note 110.

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

358. 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).

359. *See supra* text accompanying note 120.

360. *See supra* text accompanying notes 240-248.

361. Gary H. Anthes, *W3C's Worldwide Power,* COMPUTERWORLD, Sept. 9, 1999, *available at* http://www2.cnn.com/TECH/computing/9909/09/w3c.idg/; Khare, *supra* note 254; 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).

362. *See supra* text accompanying notes 324-329.

363. 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,

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.[364] 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.[365] Only after a standard was developed within the VoiceXML Forum was it submitted to the W3C.[366] Thus, as the W3C has slowed, other consortia have materialized to provide a rapid development process.[367]

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.[368] 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.[369] 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.[370] 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.[371] A lack of volunteer support can lead to "vaporware" – open source projects that are never

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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, Sept. 23, 1999, *available at* http://content.techweb.com/wire/story/TWB19990923S0027.

364. S*ee supra* text accompanying note 329.

365. Grant DuBois, *W3C Accepts VoiceXML 1.0 Spec*, EWEEK, May 22, 2000. Another similar example is the creation of the Wireless Application Protocol (WAP) Forum.

366. *Id*.

367. 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.

368. *See* Bezroukov, *supra* note 277; 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 that open source projects need good managers).

369. *See* Østerlie, *supra* note 182 (according to Bruce Perens, ex-leader of the Debian GNU/Linux project).

370. *Id.*

371. *See supra* text accompanying notes 334-343 (noting the limitations of volunteers).

started.[372] 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.[373]

## B. DECISION-MAKING PROCESS

The decision-making process within legislative bodies is complex. The criteria for a decision may vary, ranging from an emphasis on constituents' or a political party's welfare, to that of a broader concern for the public's welfare. Another important factor in the decision-making process is public comment, which ensures governmental decision-makers consider public concerns.[374] Not surprisingly, all of these factors affect the decision-making process of the legislators of cyberspace. Similarly, the decision-making process for institutions includes decisions on what attributes to incorporate into the code as well as decisions on 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 which 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 for universities, and then continue on to firms, consortia, and the open source movement.

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372. 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 modified May 19, 1998). *See infra* note 382 (noting the legal issues surrounding vaporware).

373. Frauenheim, *supra* note 267 (describing the thousands of open source projects at SourceForge.net).

374. 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).

### 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 their autonomy and freedom within the university.[375] Autonomy fosters risk-taking in the development of code and is important for pushing the boundaries of knowledge and creating innovative products.[376] In our case study on the development of the web, Andreessen and Berners-Lee 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.[377] NCSA and CERN granted their researchers considerable autonomy in the decision-making process. Finally, the decision-making process 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 their code is suitable for dissemination, either for testing purposes or for widespread use.[378]

### 2. FIRMS

A firm's managers decide which features should be incorporated into the firm's code, and profitability is a key criterion in their decision-making process.[379] 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 their potential security and privacy issues. Netscape did not want to wait for the IETF to define a standard for cookies. Instead, they rushed ahead to meet market expectations. A few years later, Netscape made a similar decision to continue allowing third party cookies. This decision was made with full knowledge of the privacy and security risks, as well as the Internet

375. *See supra* text accompanying notes 288-290.

376. 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." *Trusting Innovators Who Break the Rules*, CNET NEWS.COM, Apr. 17, 2001, *at* http://news.com.com/2009-1033-255906.html?legacy=cnet (last visited Sept. 12, 2004).

377. *See supra* note 77 (noting Andreessen's announcement); *see supra* text accompanying note 51 (noting Berners-Lee's announcement).

378. Researchers typically publish their work; however, this is an issue of dissemination and not public comment.

379. *See supra* text accompanying notes 224-227.

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 rather than meet the privacy needs of users of its free browsers.[380] This is a typical example of how firms operate. Values that are deemed to be unprofitable are not factored into a firm's decision-making process.[381] Finally, as with universities, the decision-making process is not open to public comment. In fact, firms often conceal their activity, because there is no reason to provide information to rivals about potential code development activities.[382]

### 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 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.[383] Naturally, he is likely to make decisions that the members support because member support is vital for a consortium.[384] This can lead the Director to rubber stamp the choices of a few influential members.[385] 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).[386]

380. *See supra* text accompanying note 132. *See also supra* note 132 (providing one possible explanation why the browser vendors continued to allow third party cookies).

381. *See infra* Part VI.F.2 (discussing why firms do not incorporate unprofitable values).

382. Firms may provide information on their projects strategically. False announcements regarding vaporware could be viewed as anticompetitive behavior. *See* Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. 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).

383. Rada, *supra* note 258, 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, *at* http://www.w3.org/Consortium/Process/ (February 5, 2004).

384. Generally, if a member does not support a consortium's decisions, it will leave. For example, MCI WorldCom left the W3C because it did not feel its concerns were being adequately addressed. *See* Anthes, *supra* note 361.

385. Rada, *supra* note 258, at 20.

386. 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 decisions. *See* Scott Bradner, *The Internet Standards Process – Revision 3*, *at* http://www.ietf.org/rfc/rfc2026.txt (Oct. 1996); David Crocker, *Making Standards the IETF Way,* STANDARDVIEW, Jan. 1993,

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 to budge. Borenstein believed it was absurd that "because you were a famous executive … your opinion should outweigh the Internet community's reasoned debate."[387] This use of a general community consensus to determine Internet standards on basis of technical merit is the ideal of the IETF.[388] This explains why the IETF would not let the privacy and security flaws in cookie technology pass unnoticed.[389]

The criteria for a consortium's 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. A firm, on the other hand, would not expend this level of effort in developing a product that was ineffectual or would not be adopted for widespread use. Nevertheless, such standards may be important. In the case of PICS, the W3C was attempting to fashion an industry-wide technological solution to the problem of minors gaining access to indecent content.[390] In the case of the IETF's cookies standard, the IETF sought a precise technical standard for cookies and welcomed public discussion on key privacy issues.[391]

Consortia vary on the consideration of public comments. Some consortia, such as the IETF, develop their standards with a fully public process that emphasizes ongoing public review. Other consortia, such

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at 1, *available at* http://www.brandenburg.com/ietf/ietf-stds.html (last visited May 5, 2004); Paul Hoffman, *A Novice's Guide to the IETF*, *at* http://www.imc.org/novice-ietf.html (last visited May 5, 2004).

387. Interview with Nathaniel Bornstein, Author of MIME Standard, in Bloomington, Ill. (Sept. 17, 1999).

388. The W3C is built upon the idea that too much input can be counterproductive. This is why the W3C enforces a large barrier for individual participation via its $5000 minimum fee. Most other consortia charge a much smaller fee. For example, the OASIS consortium, which develops XML standards, charges a $250 membership fee. This is often called a "bozo" membership fee, because it ensures that interested people are able to participate but keeps "bozos" out. *See* St. Laurent Interview*, supra* note 326. The IETF, on the other hand, has no membership fee. This is illustrative of how consortia vary in their barriers to third party participation.

389. *See supra* text accompanying notes 123-130.

390. *See supra* text accompanying notes 169-176 (discussing why PICS was ineffectual).

391. *See supra* text accompanying notes 129-130 (noting that the IETF's cookies standard is not widely implemented).

as the W3C, may choose to develop standards privately.[392] 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.[393] The W3C allows its working groups to choose a public or private decision-making process.[394] However, the final products of the W3C's working groups are subject to public comment.[395]

### 4. OPEN SOURCE MOVEMENT

The decision-makers for an open source project may differ in philosophy from the democratic to the authoritarian. In the case of Apache, there is a core group of people who make the decisions. This group of developers determines the final form of Apache through a voting process.[396] In contrast, other successful open source projects are run in a more authoritarian manner. For the Linux operating system, it is up to Linus Torvald whether to accept a patch.[397] While he usually accepts the recommendations of his core group of developers, he does have the discretionary power to do as he pleases. However, if problems occur between the decision-makers, the members of an open source project may leave and start a competing project.[398]

The criteria for the decision-making process are not fixed; rather they depend on the discretion of the volunteer developers. In the case of Apache, the criteria concerned the addition of useful features and the removal of errors in the code. In other cases, independence from economic or political influences can lead to the inclusion of features that are otherwise politically unpalatable or not in the

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392. *See* MURPHY, *supra* note 230, at 144 (noting that when developing knowledge for competitive reasons total openness is not possible).

393. According to Joseph Reagle, the avoidance of public discussion allows parties to change their position and allows issues to be more easily resolved. *See* Reagle, *supra* note 361.

394. *World Wide Web Consortium Process Document,* § 4.2.2, *at* http://www.w3.org/Consortium/Process-20010719/process.html (July 19, 2001).

395. The W3C has a three month public comment period. *See* Rada, *supra* note 258, at 21-22.

396. Bezroukov, *supra* note 277.

397. *Id.*

398. Bruce Kogut & Anca Metiu, *Open Source Software Development and Distributed Innovation*, 17 OXFORD REV. ECON. POL'Y 248 (2001), available at http://jonescenter.wharton.upenn.edu/papers/2001/wp01-08.pdf (last visited May 5, 2004). 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 263, at 96.

economic interest of the Internet.[399] For example, the open source web browser Mozilla is capable of blocking the pop-up windows used for advertisements.[400] In a few cases, this independence has even produced open source code that contravenes the law.[401] 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.[402]

The open source movement is generally committed to a public development process. Code is always made 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.[403] However, it is possible to develop code without a public development process and then release it as open source code. This happened with the NCSA Mosaic web server. Universities and government agencies also often develop code that is later released to the open source movement.[404] 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.

### 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. They must decide whether the code 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 this decision. In later sections, we discuss the role of intellectual property protection and open standards on the dissemination of code.[405] We begin by discussing the dissemination decision for universities, and

399. *See supra* text accompanying notes 350-355.

400. *See supra* note 350.

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

402. Lisa Bowman, *Hollywood's War on Open Source*, ZDNET NEWS, *available at* http://zdnet.com.com/2100-11-502010.html?legacy=zdnn (Feb. 26, 2000).

403. *See supra* text accompanying note 192.

404. 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,* NEWSBYTES, Oct. 25, 2001.

405. *See infra* Part VI.A. (open standards) and Part VI.B. (intellectual property).

continue on to firms, consortia, and the open source movement.

The decision to disseminate code publicly may be an obvious choice for a university. This is consistent with the university's mission to expand knowledge.[406] Moreover, the norms within the university stress the need to publish research for claims of priority and public validation of the research.[407] Berners-Lee and Andreessen both released their code publicly through the Internet and sought feedback. They considered the public to be their customers.[408] There is, however, a recent and growing trend for universities to restrict the dissemination of code in order to gain much-needed compensation, as well as to retain control over the code.[409]

Firms typically seek to disseminate code to potential customers and not the general public. Firms do, however, sometimes disseminate code freely to the public. This free dissemination, however, normally 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 future code specific to a system.[410] For example, once you buy a Sony Playstation video console, you have to continue to buy code, both hardware and software, that is specific to the Sony machine. Switching costs are the costs required to overcome this lock-in. For example, the switching costs between a Windows system and a Unix-based system can be high. A person may have to buy new hardware and software, have existing data converted to a new format, and retrain users. Not surprisingly, firms often design code to raise switching costs and keep customers. Along these lines, firms may disseminate demonstration code with fewer 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.[411] To take advantage of this, firms may disseminate their code for

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408. In February 1993, a message was posted congratulating Andreessen on NCSA Mosaic and asking him why he cared about what others thought, since they were not 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).

409. *See infra* text accompanying notes 451-453.

410. SHAPIRO & VARIAN, *supra* note 2, at 12.

411. *See* SHAPIRO & VARIAN, *supra* note 2, at 174; Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. L. REV. 479,

free to enlarge their market. For example, firms have released 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.[412]

The open source movement favors wide dissemination. This decision is consistent with the goal of the open source movement to create freely available open source code. This decision is supported by copyright licenses that guarantee the right to redistribute the code freely.[413] 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.[414]

## 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 impact of these factors upon code. We show how institutional tendencies serve to shape various attributes of code.[415] The first attribute we discuss, open standards, 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 on or opportunities for the use of code. The

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 (last visited May 5, 2004). *See generally* Michael L. Katz & Carl Shapiro, *Systems Competition and Network Effects*, J. ECON. PERSP., Spring 1994, at 93.

412. *See infra* text accompanying notes 440-441.

413. *See infra* text accompanying notes 467-472.

414. *See infra* text accompanying notes 467-470 (discussing the GNU General Public License).

415. 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.

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 their approaches to 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

The open source movement supports open standards for several reasons. First, when creating open source code, they are 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 the adoption of open standards. Finally, the members of the open source movement usually believe inherently in the value of open standards.[416]

An institution's decision on 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 prevent 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.[417] This situation would have resulted in web sites only accessible with Microsoft browsers and servers. But competition from

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416. For example, during the Christmas holiday in 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 they should write a simple patch to fix the problem or 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 182.

417. This fear still exists because of Microsoft's monopoly over 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: Why the Age of Internet Innocence is Over,* PULPIT, Aug. 2, 2001, *available at* http://www.pbs.org/cringely/pulpit/pulpit20010802.html (arguing that Microsoft could eliminate the open standard for TCP/IP and replace it with a proprietary protocol).

Apache prevented a situation analogous to the browser war, with two different web servers operational only with their corresponding browsers.[418] 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.[419] 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,[420] HTML, which serves as the language for web pages,[421] and the image format known as JPEG.[422] Open standards are defined by three characteristics. First, the standard is publicly available to everyone at a minimal cost. Second, no entity controls the standard, or the standard is licensed on "reasonable and nondiscriminatory terms."[423] Third, the development process for creating the standard involves public participation.[424]

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.[425] The primary reason is that open standards

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418. MOODY, *supra* note 88, at 129.

419. *See* Michael Goldenberg, *Standards, Public Welfare Defenses, and the Antitrust Laws,* 42. BUS. LAW. 629 (1987) (arguing that standards may have an adverse effect on consumers because they can hinder the development of innovative and inexpensive products that do not meet the standards).

420. Developed by the IETF. *See* J. Postel & J. Reynolds, *File Transfer Protocol (FTP)*, *at* http://www.ietf.org/rfc/rfc959.txt (Oct. 1985).

421. Developed by the W3C. For the latest standard, see *HTML 4.01 Specification*, *at* http://www.w3.org/TR/html4/ (December 24, 1999).

422. Developed by a joint ISO and ITU committee. For more information, see http://www.jpeg.org/committee.html (last visited May 5, 2004).

423. 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 tollbooth 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 (last visited May 5, 2004).

424. Crocker, *supra* note 386.

425. 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, *Standards Setting for Computer Communication: The Case of X.25*, IEEE COMM. MAG., March 1985, at 35, 37.

take time to develop. This process can slow down the development and implementation of code, and, as a result, firms may not be able to quickly meet the demands of their customers.[426] A second reason is that open standards do not allow any party to control the standard. As we will discuss later, firms are very concerned about the control of their standards.

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.[427] Additionally, the scarce resources lead to a focus on creating and using open standards as building blocks for later work.[428] Finally, the importance of publication, as part of universities' 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."[429] So if a firm has control over a market, it will tend to use its own de facto standards,[430] but if it 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 having a small share in a large market based on open standards or having total control of a small or nonexistent market based on de facto standards.[431] A good example of this tradeoff is

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

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

428. *See supra* text accompanying notes 299-301.

429. CARGILL, *supra* note 236, 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).

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

431. 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 performance advantages for its own applications. Matt Hines & Dawn Kawamoto, *EU Report Takes Microsoft to Task*, CNET NEWS.COM,

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.

The cookies case study illustrates the difficulty 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.[432] 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 their competitors.[433] However, the downside of this tactic was that Netscape's cookies standard was immature and contained privacy and security flaws.[434]

The economic pressures on firms are so pervasive that they tend to incorporate additional proprietary features into their products employing open standards, in order to raise switching costs for users.[435] For example, Cisco is adding proprietary features to its open standards-based routers. These new features can be used only with other Cisco routers.[436] Similarly, when Netscape added proprietary features while taking advantage of open standards, it resulted in implementations that were not fully compatible.[437] Netscape also

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Apr. 22, 2004, *at* http://news.com.com/2100-1016_3-5197411.html.

432. *See supra* text accompanying notes 104-114 (cookies); *see supra* text accompanying note 100 (SSL).

433. 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 357, at 135. However, in order to enlarge the market, competitors must adopt the open standard.

434. *See supra* text accompanying note 120.

435. 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).

436. 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).

437. 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).

incorporated proprietary tweaks to improve their products' performance as compared to non-Netscape products.[438] The purpose of these changes was to keep its customers from switching to another product.[439]

A consortium's standards do not always meet the requirements of open standards because its basic mission is developing standards for the benefit of its members. For example, a consortium may choose to restrict distribution of a standard to only its members. Also, a consortium may charge a high price for access to the standard.[440] Finally, a consortium does not have to consider public input in its development process. However, the most important consortia for the Internet, the IETF and the W3C, do develop open standards.[441] An open standard does not mean the implementation is free. Users may still be required to license the intellectual property necessary to implement the standard.[442]

The open source movement also supports a higher form of open standards, modularity, which breaks down a large piece of code into smaller pieces or modules.[443] With modularity, it is possible to replace a module without disrupting the operation of the program as a whole. This style of design allows for considerable flexibility. For example, a developer unhappy with a certain module can replace only that module, which is much simpler than modifying the entire code. A second advantage of modularity is that it facilitates a decentralized

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438. Netscape followed the "open, but not open" standard strategy. While every computer company claims to be open, they often 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 357, at 137.

439. 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 Source Code Software*, *at* http://cyber.law.harvard.edu/home/1999-02 (Apr. 1999).

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

441. *See supra* text accompanying note 252 (IETF); *see supra* text accompanying note 257 (W3C).

442. *See infra* text accompanying note 459.

443. CARLISS Y. BALDWIN & KIM B. CLARK, DESIGN RULES: THE POWER OF MODULARITY (2000) (discussing the use of modularity in computer science); Kogut & Anca, *supra* note 398 (arguing that when a problem is modular the open source development process offers clear advantages to proprietary models of development).

development process.[444] People can independently work on different parts of the code. This feature of modularity is particularly popular in the open source movement.[445] Many open source projects, such as the Shambhala version of Apache, are designed using a modular architecture.[446]

### B. INTELLECTUAL PROPERTY PROTECTION

Just as institutions differ in their consideration of open standards, they also 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 have historically developed knowledge for the public good. They have therefore favored wide dissemination of their knowledge by employing minimal intellectual property protection.[447] 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.[448] The public domain was chosen over other methods of dissemination because it required the least restrictive type of protection.[449] A more restrictive method could have led some entities to not develop code for the web.[450] Consequently,

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444. 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 to sequencing the human genome. Tom Paulson, *Mapping Human Genome Reaches the End of the Road*, SEATTLE POST-INTELLIGENCER REPORTER, Feb. 12, 2001, *available at* http://seattlep-i.nwsource.com/local/geno12.shtml (last visited May 6, 2004).

445. For example, the kernel for the Linux operating system has become more modular over time. *See* Kogut & Anca, *supra* note 398 (arguing that movement towards modularity reflects the governance structure of the open source community).

446. *See supra* text accompanying note 197.

447. *See supra* text accompanying notes 205-208.

448. *See supra* text accompanying note 60.

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

450. It was the licensing fees and conditions that led industry to abandon

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.

In the 1980s, legislation was enacted in the United States that allowed, and even encouraged, universities to seek intellectual property protection for the inventions of their researchers.[451] The rationale was that many government-subsidized inventions were languishing because of inadequate incentives for commercialization;[452] the government therefore gave universities the power to license and profit from their intellectual property. The resulting revenue, while concentrated in a few inventions, was over three hundred million dollars for the inventors and their universities.[453]

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, for commercial use with nonexclusive licenses to almost a dozen companies.[454] In all, these licenses and royalties earned the University of Illinois seven million dollars.[455] To put these licensing revenues into perspective, this accounts for about four percent of Netscape's browser-based revenue in 1996.[456]

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Gopher. *See supra* note 59.

451. 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).

452. *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).

453. Xueshu Song, *University Technology Transfer and Commercialization: A Cost and Benefit Sharing Process*, *available at* http://einnovate1.inetu.net/tco/techtrans.htm (last visited May 5, 2004). 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).

454. *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 300 (claiming that NCSA charged an initial fee of $100,000 plus $5 for each copy).

455. University of Illinois, Research & Technology Management Office, *Fiscal Year 1999 Annual Report*, *available at* http://www.vpted.uillinois.edu/Reports_and_References/?bch=1 (Oct. 1999).

456. 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

A 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 affect other academic researchers, the open source movement, and competitors of the licensee. Universities have a tremendous amount of discretion in these decisions. We believe that there is a need for more definitive guidelines to ensure that universities are acting not just in their own financial interest, but also in the public interest.

### 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 to the general public at large. This is why Netscape patented cookies.[457] However, firms will sometimes accept less intellectual property protection in exchange for greater market share in order to capitalize on the influence of network externalities. This is why firms sometimes 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 because they must 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 produced by consortia have a great deal of variation.[458] The approaches of the W3C and the IETF toward intellectual property illustrate these variations. The IETF requires "reasonable and nondiscriminatory licensing" (RAND), while the W3C simply has a policy of royalty-free licensing.[459] On its face, this difference could lead

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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.

457. *See supra* note 105.

458. Mark A. Lemley, *Intellectual Property Rights and Standard Setting Organizations* (forthcoming) (surveying the different intellectual property rules used by consortia).

459. *Id.* The W3C created considerable controversy in the fall of 2001

a firm to choose the IETF over the W3C because of the potential for licensing revenue.

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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 (last visited May 5, 2004). Eventually the W3C decided to continue to require royalty free licensing of all proposed standards. Margaret Kane, *W3C Bows to Royalty-Free Pressure*, CNET NEWS.COM, Nov. 14, 2002, *available at* http://news.com.com/2100-1001-965863.html (last visited May 5, 2004).

The amount of disclosure that is necessary varies in different consortia.[460] Typically, consortia require participants to disclose any intellectual property rights that are the subject of a standard setting process. This disclosure actually prevents the "capture" of a standard through the opportunistic use of intellectual property rights. [461] If intellectual property rights are not disclosed, one party might later control a standard after the consortia agreed upon that 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.[462] In our case study on cookies, Netscape violated IETF rules by not disclosing their patent.[463] However, it is unlikely that Netscape will be subject to legal action and estopped from enforcing its patent.[464] Nevertheless, Netscape's behavior is not anomalous and appears to be a natural tendency.[465] 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 uses several types of intellectual property licenses that are the outgrowth of two major divisions in the open source movement; each division reflects a different philosophical and practical view of what the open source movement should represent.[466]

Historically, the open source movement has been committed to free software.[467] The initial goal of the FSF was to create a free Unix-

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460. Lemley, *supra* note 458.

461. *Id. (*providing a comprehensive discussion on the issue of disclosure on the basis on contractual, estoppel-based intellectual property, and tort theories).

462. *Id. See also* Nicholas Varchaver, *Rambus: A Hot Stock's Dirty Secret*, FORTUNE, July 9, 2001.

463. *See supra* note 105.

464. Lemley, *supra* note 458 (discussing estoppel-based intellectual property liability and antitrust liability).

465. 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 (last visited May 5, 2004); 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 (last visited May 5, 2004).

466. *See supra* text accompanying notes 268-270.

467. *See* Richard Stallman, *The GNU Project*, *in* OPEN SOURCES (Chris

based operating system. The FSF intellectual property rights freedom should exist at three levels. First, one should have the freedom to study how a 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 source code. Third, users should be free to improve the program and release their improvements to the public for the benefit of the community of free software users.[468]

The FSF created the GNU General Public License (GPL) to help ensure that software remains free of cost.[469] The GPL grants everyone permission to run, copy, modify, and distribute the modified version of the program. To ensure that software stays free, the license requires that distribution of modified versions also be free. This prevents people from taking free software, incorporating it into proprietary or commercial programs, and then selling the software. 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.[470]

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.[471] This license also requires that source code be kept free, but modifications to the source code are not required to be kept free.[472] This license therefore 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 and Apple, are allowed to incorporate Apache's open source code into their commercial products. Naturally, commercial firms working with the open source movement generally favor this type of

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DeBona et al. eds., 1999) (providing a background on the free software movement), *available at* http://www.gnu.org/gnu/thegnuproject.html (last visited May 5, 2004).

468. *See* Free Software Foundation, *supra* note 268.

469. 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).

470. Stephen Shankland, *MS Lawyers Join Open-Source Fray*, ZDNET, June 22, 2001, *available at* http://www.linuxdevices.com/news/NS2292440348.html (last visited May 6, 2004).

471. BSD stands for the Berkeley Software Distribution version of Unix.

472. 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://cyber.law.harvard.edu/home/ossummary (listing various open source licenses).

license.

### C. OPEN SOURCE CODE

Open source code provides public access to a program's core, thereby allowing people to build upon an existing platform and saving them the work of recreating code.[473] 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 may contain, while also making it impossible to incorporate hidden features.[474] This allows users a certain level of trust in programs running open source code.[475] 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.

As we have made clear already, the fundamental norms of a university support the sharing of research, so they are a natural source of open source code.[476] As an example, CERN was released to create a foundation for developing web browsers and servers. However, the recent trend of universities seeking 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.[477] However, the source code for the NCSA Mosaic

473. *See supra* text accompanying notes 265-266.

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

475. 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.

476. 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; Will NSA's Efforts Shape the Future of Security?*, INFOWORLD, Feb. 5, 2001, *available at* http://www.infoworld.com/articles/op/xml/01/02/05/010205opswatch.xml (last visited May 6, 2004). However, this work has been criticized because its efforts aided everyone and not just American software firms. Robert Lemos, *Linux Makes a Run for Government,* CNET NEWS.COM, Aug. 16, 2002, *available at* http://news.com.com/2100-1001-950083.html (last visited May 6, 2004).

477. *See supra* text accompanying notes 94-97.

web server was available publicly.[478]

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.[479] 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 its proprietary software.[480] This bundling allows IBM to take advantage of Apache's high quality, while saving them the effort of developing their own web server.[481] 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.[482]

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

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478. *See supra* text accompanying note 177.

479. 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).

480. 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).

481. IBM has made a solid commitment to open source software. It believes 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 with Scott Handy, *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).

482. 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), *at* http://news.com.com/2100-1023-947094.html.

using open source code, the W3C is inviting developers to assist in the development process for the benefit of the entire developer community.[483]

### D. QUALITY OF CODE

Problems with code may develop as a result of software complexity, programming errors, or through software development tools.[484] The resulting errors may be trivial or a matter of life and death.[485] One estimate suggests 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.[486] If these flaws are not detected and fixed, code quickly becomes considered poor quality and may be abandoned. Quality of code is of such importance that more than half of the development process is typically spent on testing. [487] The testing of code is conducted in a variety of ways and usually extends to the documentation, specifications, and user manuals associated with code.[488] This section explores institutional differences in the quality of

483. All of the W3C's open source projects can be found at http://www.w3.org/Status (last visited April 28, 2003).

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

485. A classic case of bugs in code leading to deaths and serious injuries is the computerized radiation therapy machine called the Therac-25. *See* Nancy Leveson & Clark S. Turner, *An Investigation of the Therac-25 Accidents*, COMPUTER, July 1993, at 18. The most expensive failure of code is the explosion of the Ariane 5 rocket with $500 million in satellites. This failure was the result of a simple buffer overflow error. *See* INQUIRY BOARD, EUROPEAN SPACE AGENCY, ARIANE 5 FLIGHT 501 FAILURE: REPORT BY THE INQUIRY BOARD (July 19, 1996), *available at* http://ravel.esrin.esa.it/docs/esa-x-1819eng.pdf; Jean-Marc Jézéquel & Bertrand Meyer, *Design by Contract: The Lessons of Ariane*, COMPUTER, Jan. 1997, at 130 (noting that this problem occurred because of the reuse of code).

486. Aaron Ricadela, *The State of Software: QUALITY*, INFORMATIONWEEK, May 21, 2001, at 43, *available at* http://www.informationweek.com/838/quality.htm; *see also* NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, THE ECONOMIC IMPACTS OF INADEQUATE INFRASTRUCTURE FOR SOFTWARE TESTING, at ES-3 (2002) (calculating the costs of an inadequate infrastructure for software testing to be between $22.2 and $59.5 billion, with over half of those costs borne by software users in the form of error avoidance and mitigation activities), *available at* www.nist.gov/director/prog-ofc/report02-3.pdf; Aaron Ricadela, *A Lemon Law for Software?*, ECONOMIST, Mar. 16, 2002, at 3 (describing pervasive irresponsibility within the software industry).

487. KIT, *supra* note 484.

488. *Id.*; *see also* CEM KANER ET AL., TESTING COMPUTER SOFTWARE (1999); GLENFORD J. MYERS, THE ART OF SOFTWARE TESTING (1979).

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, the production of quality code is not their primary goal. Instead, universities encourage the creation of innovative, cutting-edge code, with the aim of creating a radical idea. Second, universities lack the staff and resources necessary to create code that is both unique and error-free. 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 to develop 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."[489] Their goal was not to produce quality software but rather to develop innovative code and to get people excited. According to Quittner, "the developers of NCSA Mosaic didn't care if the code was buggy [of 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."[490]

Conversely, firms generally produce code of relatively high quality because, in contrast to universities, they must acquire and retain customers. To this end, firms test their code. For example, the developers of NCSA Mosaic changed their attitude on software quality when they joined Netscape. They realized that in order to sell their software, they needed to place an emphasis on producing a quality product.[491] This led them to add specific quality control measures to the development process.[492]

In some industries, government regulation further compels the production of relatively error-free code. For example, the Food and Drug Administration (FDA) and the Federal Aviation Administration (FAA) regulate code placed in medical devices and in airborne systems, respectively. These regulations do not mandate the use of specific code, but rather require firms to pay attention to the quality of their code throughout the development process.[493] Nevertheless, as

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489. CUSUMANO & YOFFIE, *supra* note 357 at 158.

490. 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 of the reported bugs.

491. CUSUMANO & YOFFIE, *supra* note 357 at 231.

492. *See* CUSUMANO & YOFFIE, *supra* note 357 at 265-297 (discussing the differences between Microsoft and Netscape in their quality assurance testing).

493. 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/1998/10/schad.asp (focusing on DO-17B

numerous critics have pointed out, unregulated businesses generally produce lower quality, less reliable code. The standard explanation is that consumers find lower quality code acceptable[494]--especially when the offsetting benefit is the incorporation of the latest innovative features.[495] Therefore, some firms have little incentive to better develop and test code to ensure its high quality.[496] We saw this in the development of Netscape's web browser. Netscape wanted to be the first browser with the cookies technology, and the ensuing rapid development led to the release of a flawed product.[497] Some critics disagree with the standard explanation, arguing instead that the current business model for code encourages the development of poor quality code.[498] Others argue that the market will not solve this

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rules); George Romanski, *The Challenges of Software Certification*, CROSSTALK, Sept. 2001, *available at* http://www.stsc.hill.af.mil/crosstalk/2001/09/romanski.pdf (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 that the software will operate properly. *See* Quality System Regulation, 21 C.F.R. § 820 (1999); FDA, GUIDANCE FOR FDA REVIEWERS AND INDUSTRY GUIDANCE FOR THE CONTENT OF PREMARKET SUBMISSIONS FOR SOFTWARE CONTAINED IN MEDICAL DEVICES (May 29, 1998), *available at* http://www.fda.gov/cdrh/ode/57.html; 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 (providing an overview of the process), *available at* http://www.devicelink.com/mddi/archive/96/01/023.html.

494. Charles C. Mann, Why Software Is So Bad, Tech. Rev., July/Aug. 2002, at 36 ("'Software sucks because users demand it to.'" (quoting Microsoft's former chief technology officer Nathan Myhrvold)) . See also Ed Foster, Battling the Bugs, InfoWorld, Jun. 17, 2002, at 69 (remarking on a growing intolerance for low quality software) available at http://www.infoworld.com/article/02/06/14/020617opgripe_1.html.

495. Peter Coffee, *Attacking the Quality Monster*, PCWEEK, Dec. 14, 1998, *at* 18; Joel Garreau, *Thinking Outside the Box*, WASH. POST, Mar. 19, 2001, at C01; Ricadela, *supra* note 486, at 43.

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

497. *See supra* text accompanying notes 110-111.

498. Some critics argue that 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 version. Often, firms never fix the initial low quality version, because they are busy releasing new versions of code every few years. Vendors who refuse to support older versions of products pressure customers, who are often locked in, to upgrade to new versions. 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. *See* 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, at pages 79-83 (noting the problems in the current software vendors business models and how

problem of low quality code. They believe that either product liability lawsuits or government regulation is needed to improve code quality.[499]

Consortia typically develop standards, not code, but the standard's quality is still important. A poor standard can lead to a number of problems, ranging from confusion in the marketplace to the abandonment of the standard. In our case studies, we found that both the IETF and the W3C produced high quality standards, due to the efforts of the individuals participating in their development. In addition, the role of a public process can notably influence quality, as the development of the IETF's standard for cookies made clear. There, a public process quickly found problems with third party cookies that Netscape had overlooked.[500]

The benefits of public involvement also underlie the capability of the open source movement to produce high quality code. Instead of entrusting quality control to a limited number of paid personnel, this movement relies upon a potentially unlimited pool of volunteers. The notion is simply that if enough people test the code, problems in it will be discovered and corrected.[501] Naturally, the movement's success in identifying and repairing problems depends upon the number of people and their collective expertise.[502] Although the volunteers are not directly compensated for their work, they nonetheless possess a notable incentive for finding and fixing problems: an increase in their reputational capital within the open source community. These factors have spurred the development of Apache's high quality code.[503]

Firms are adopting a quasi-public development process by using volunteer software testers. Many firms routinely release pre-release or beta versions of code to allow for public feedback.[504]

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companies are fighting back) *available at* http://www.cio.com/archive/101501/wasting_content.html.

499. Mann, *supra* note 494.

500. *See supra* text accompanying notes 123-128.

501. *See* Raymond, *supra* note 265 (arguing that if there are enough users looking at the code, then the bugs will be found and corrected and quoting Linus Torvald, "'Given enough eyeballs, all bugs are shallow.'"

502. For example, during the development of Apache thousands of people contributed bug reports. *See supra* text accompanying note 192.

503. *See* Mockus, *supra* note 190. Another popular example is the Linux operating system, which is considered to be 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 the process used by firms. However, the claim of the open source movement's high quality code is backed more by anecdotal evidence that empirical research.

504. CUSUMANO & YOFFIE, *supra* note 357, at 283 (noting the role of Netscape's beta testing in allowing for a larger review group and rapid user

Microsoft and Apple even charge their users to beta test their new operating systems.[505] The testing provides information on the quality of code before the final release.[506] 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 characterized as "bells and whistles." These "extras" make code more desirable and usable by people, and include interfaces that are easy-to-use, documentation that is well-written, and technical support that is ample and helpful. Here we explore the following topics: how institutions market their code; how institutions differ in their abilities to create easy-to-use code; and the role played by documentation and institutional variations in the level and quality of technical support. 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 specific attributes.

#### 1. MARKETING

Once an institution develops code, the next step is convincing a user to adopt the code.[507] This requires an institution to think seriously about how best to market its product. For universities, scarce resources restrict their marketing efforts to relatively low cost approaches such as publishing and "word of mouth" advertising. In order to get new users, both NCSA Mosaic and Berners-Lee's early web browser relied on

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feedback). Others have recommended that firms not rely on beta testers for seeking out security flaws, because this should be done before releasing the product. *See* COMPUTER SCI. & TELECOMMS. BD., CYBERSECURITY TODAY AND TOMORROW: PAY NOW OR PAY LATER (2002), *available at* http://books.nap.edu/html/cybersecurity/.

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

506. *See* Coffee, *supra* note 495 (noting that the cost of fixing a software defect is much less in the beta stage than after final release).

507. Quintas, *supra* note 339, at 92-94.

recommendations in Internet discussion groups such as www-talk.[508]

As compared to universities, firms have a stronger economic motivation to create, develop, and retain customers through marketing. Profit is, after all, the raison d'etre of most firms, and consequently, firms devote entire departments to the task of persuading users to adopt their code. [509] They accomplish this by identifying potential customers, developing promotional campaigns, and formulating pricing strategies. In the process, a marketing department learns how what customers are looking for, providing feedback that is critical to developers in the design and continued development of code.[510]

Consortia vary on how much marketing they may conduct, and it is up to their members to adopt and promote the standards. For example, the W3C does not concern itself with marketing its standards, believing that these tasks are outside its mission.[511] Indeed, in our case study, the W3C never marketed PICS to software firms and end users of PICS.[512] However, other consortia may choose to 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.[513]

Finally, the open source movement ignores marketing as an unnecessary extra.[514] 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

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

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

510. *See* CUSUMANO & YOFFIE, *supra* note 357, at 236-37 (describing how marketing can affect the technical goals during the design of code; Kieran McCarthy, *Geeks Declare War on Intel*, SALON, Mar. 2, 2001, (describing the influence of Intel's marketing department on the development of code), *at* http://www.salon.com/tech/feature/2001/03/02/intel_netburst/index.html.

511. Khare, *supra* note 254.

512. *See supra* text accompanying notes 166-176 (noting the problems with the implementation and use of PICS).

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

514. This is a weakness of the open source movement, which tends to focus tightly on the source code while forgetting the larger structure in which source code operates. *See* Bezroukov, *supra* note 277 (noting the need for the open source movement to recognize and address the infrastructure and implicit knowledge that software depends upon).

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 IBM, to begin active marketing efforts.[515] These marketing efforts are led by firms seeking to profit from the open source movement.

### 2. USER-FRIENDLY CODE

The phrase "user-friendly" describes code that is relatively easy to use. User friendly code has both an intuitive interface and compatibility with third party products. Universities do not emphasize user-friendly code. Moreover, they don't have the resources to conduct usability testing.[516] 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 web software that intimidated novice users. Andreessen listened and responded to people's concerns and continually shaped NCSA Mosaic so that it would be easy to use.[517]

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 that it conducts product usability testing to ensure that consumers can easily use its products.[518] 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

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515. 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, *at* http://news.com.com/2100-1001-249750.html.

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

517. Earlier we noted how Andreessen felt that 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 (citation omitted).

518. *See* Rob Pegoraro, *Taking Software for a Test Drive,* WASH. POST, June 22, 2001, at E1 (discussing Microsoft's usability testing center); Neil Randall, *Making Software Easier Through Usability Testing*, PC MAG., Oct. 6, 1998, at 285 (describing how software companies perform usability testing).

use.[519] Apple built this operating system on top of BSD, an open source UNIX operating system.[520] The resulting code has an aesthetically pleasing interface that is both easy to use and easily interoperable with a variety of third party code.

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

520. Joe Wilcox, *Will OS X's Unix Roots Help Apple Grow?*, CNET NEWS.COM, May 21, 2001, *at* http://news.com.com/2100-1040-257982.html.

The open source movement's code is biased towards the needs of its sophisticated users.[521] Its notions of user-friendly code are quite different from those of a novice.[522] Its focus is on the operation of code, with little concern for polishing and refining code for novices.[523] 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 advanced users. No one took the time to make features easy to use and intuitive for novices.[524] Moreover, the open source movement lacks the resources to conduct product usability testing.[525]

### 3. DOCUMENTATION

Documentation allows users to quickly understand how a product operates. High quality documentation is known to result in

521. *See supra* text accompanying note 344. The typical attitude of the open source movement is reflected in a 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.

522. 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* David M. Nichols et al., *Usability and Open-Source Software Development*, *in* PROCEEDINGS OF THE SYMPOSIUM ON COMPUTER HUMAN INTERACTION 49 (Elizabeth Kemp et al. eds., 2001), *available at* http://www.comp.lancs.ac.uk/computing/users/dmn/docs/oss.html.

523. *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. *See* Bill Lamb, *Pretty Geek Privacy,* SALON, Mar. 27, 2002, *at* http://www.salon.com/tech/feature/2002/03/27/gnupg/print.html.

524. *See* Paul Fest, *Apple, AOL Veterans Making Linux Easy,* CNET NEWS.COM, Feb. 16, 2000, *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 2; David M. Nichols & Michael B. Twidale, *The Usability of Open Source Software*, FIRST MONDAY, Jan. 2003, *at* http://firstmonday.org/issues/issue8_1/nichols.

525. 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).

safer, more reliable systems.[526] Because of their scarce resources, universities tend not to emphasize documentation. Firms, in contrast, usually provide good documentation. For example, Netscape provided generous documentation with its early web browsers.[527] However, the documentation was selectively written to overlook features such as cookies and the referrer technology that affected privacy.[528] Eventually, media and government pressure forced Netscape to include information about cookies and the related privacy issues in its documentation.[529]

The open source movement relies predominately on its users to develop documentation.[530] This can result in documentation that varies greatly in both quality and quantity.[531] However, once an open source project is sufficiently popular, commercial publishers may develop documentation.[532] This has led critics to argue that the best open source documentation is produced not by the open source movement, but by commercial publishers.[533]

### 4. TECHNICAL SUPPORT

Technical support provides users with assistance in the installation, maintenance, and use of code. The limited resources of a university often mean that technical support is neglected. One of the

526. Nancy G. Leveson, *Software Safety: Why, What, and How*, 18 COMPUTING SURV. 125 (1986); David L. Parnas et al., *Evaluation of Safety-Critical Software*, 33 COMM. ACM 636 (1990); Cem Kaner, *Liability for Defective Documentation*, SOFTWARE QA, 1995, at 8, *available at* http://www.badsoftware.com/pdfs/baddocs.pdf.

527. The original handbook is still online at http://home.mcom.com/home/online-manual.html (last visited May 2, 2004). The version 2.0 handbook may be accessed *at* http://home.netscape.com/eng/mozilla/2.0/handbook/ (last visited May 2, 2004).

528. *See supra* text accompanying notes 112-113. 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.

529. *See supra* text accompanying notes 131-134.

530. See, for example, the Apache Documentation Project at http://httpd.apache.org/docs-project/ (last visited May 5, 2004). Linux has a similar volunteer led site devoted to publishing documentation at http://www.linuxdoc.org/ (last modified May 5, 2004).

531. *See* Nichols, *supra* note 522 (finding in a case study that the lack of professional technical writers was obvious and consequently led to problems for users).

532. O'Reilly Publishing is a notable publisher of documentation and manuals for open source software such as Apache, Perl, and Linux.

533. *See* Bezroukov, *supra* note 277.

atypical features of NCSA Mosaic, in comparison with other university browsers, was its early emphasis on technical support.[534] Eventually, however, 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."[535] The lack of rewards reflects the university's priorities, namely inventing code but not maintaining it.

Firms typically have a formal process for technical support, such as by contacting their technical support departments. These departments maintain code by continually fixing problems that occur. Firms recognize the importance of technical support in maintaining customers, and customers clearly consider technical support when purchasing code.[536] However, as firms develop newer products, they often limit support for older ones.[537]

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.[538] With the growing commercial use of open source projects, a new wave of companies, such as IBM and Red Hat, are providing 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.[539]

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534. *See supra* text accompanying notes 78-80. *See also supra* text accompanying note 178 (noting the technical support issues with NCSA Mosaic web server).

535. 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 300.

536. *See* Paul Festa, *PC Customer Support Ranked*, CNET NEWS.COM, October 22, 1997(noting that consumers are taking into account technical support when buying a computer), *available at* http://news.com.com/2100-1001-204535.html.

537. *See* John Fontana, *Microsoft Sets Five-Year Limit on Support*, NETWORKWORLD, Oct. 21, 2002, at 10.

538. Karim R. Lakhani & Eric von Hippel, *How Open Source Software Works: "Free" User-to-User Assistance*, 32 RESEARCH POLICY 923 (2003) (conducting 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).

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

### 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 reflect.[540] For example, the case studies on cookies and PICS show that considerations of privacy and free speech can be embedded in code. In this section, we explain how institutions differ in their incorporation 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.

#### 1. UNIVERSITIES

A university provides its developers with considerable autonomy.[541] As a result, academic developers largely determine the values in the code.[542] This allows social, economic, or political influences to affect code by reflecting the values of the individual developers. Consequently, code written by different developers may reflect a wide variation in values, even though the projects are similar. This 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 both to find and to 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.[543] This value was incorporated in Berners-Lee's code. In contrast, Andreessen focused on making an aesthetically contemporary ("cool") web browser. He added visually enhancing features such as multimedia and the inclusion of online

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

541. *See supra* text accompanying notes 289-292.

542. Of course, universities and government can selectively fund different researchers' codes, 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 at 27 (suggesting incentives to spur the development of code within universities), *available at* http://www.educause.edu/ir/library/pdf/erm0111.pdf.

543. *See supra* text accompanying notes 84-87.

images.[544] He was not concerned with developing a web browser that allowed people to create content. Instead, his code reflected the value that he placed on the presentation of content.[545]

### 2. FIRMS

The goal of firms is to develop profitable code, and to this end, they include attributes that are profitable. For example, firms profit from code allowing visually impaired people to use computers.[546] In this case, firms are producing code that supports societal values.[547] However, firms may choose not to produce code that supports unprofitable, though socially beneficial, values. This is because firms seek to meet the needs of consumers and not those of society in general, a phenomenon known as market failure.[548] This is not surprising and is a consequence of the structure and motivation of a firm.[549] This section first discusses market failure from the perspective of economic efficiency and then addresses ethically based forms of market failure.

There are four types of market failure from the perspective of economic efficiency. First, market failure occurs as a result of externalities. This occurs when the market price of a product does not reflect the costs that its use and production impose upon society.[550] The classic example is how industrial pollution is usually not accounted for in the manufacture of a product.[551] Similarly, security is an externality,

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544. *See supra* text accompanying notes 88-89.

545. The reason for this difference is both developers are seeking recognition from different peer groups. *See supra* text accompanying notes 281-285.

546. LIGHTHOUSE INTERNATIONAL, INTRODUCTION TO ADAPTIVE TECHNOLOGIES (providing an overview of adaptive technologies as well as a listing of manufacturers), *available at* http://www.lighthouse.org/download/fact_sheets/assistive_technology.pdf (last visited April 29, 2004).

547. *See* David Colker, *Giving Disabled a Voice,* L.A. TIMES, Apr. 8, 2002, pt. 3, at 1 (describing the role of firms in providing technologies for disabled people).

548. *See* JOE WALLIS & BRIAN DOLLERY, MARKET FAILURE, GOVERNMENT FAILURE, LEADERSHIP AND PUBLIC POLICY (1999); Stephen Breyer, *Analyzing Regulatory Failure: Mismatches, Less Restrictive Alternatives, and Reform,* 92 HARV. L. REV. 549 (1979); Robert W. 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).

549. *See supra* text accompanying note 311.

550. Breyer, *supra* note 548, at 555; WALLIS & DOLLERY, *supra* note 548, at 17.

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

which is a cost not accounted for in the production of code.[552] 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.[553] Commentators have argued that Microsoft believes that ease of use is more important than security,[554] and that it therefore makes a strategic business decision to ignore security concerns.[555] The lack of security in Microsoft's products, however, 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. Because Microsoft doesn't pay for this cost, this naturally leads to Microsoft's code overlooking the social value of security thereby imposing this negative externality on others.[556]

Second, market failure arises in the production of public

552. Jean Camp & Catherine Wolfram, *Pricing Security*, *in* 2000 PROCEEDINGS OF THE CERT INFORMATION SURVIVABILITY WORKSHOP 31.

553. Lucy Sherriff, *Network Downtime Costs Planet $1.6 Trillion*, REGISTER, Nov. 7, 2000, *at* http://www.theregister.co.uk/content/6/11880.html; M.J. Zuckerman, *Feds Warn of Holiday Hackings*, USA TODAY, Dec. 14, 2000, at 3D

554. *See* Robert X. Cringely, *The Death of TCP/IP: Why the Age of Internet Innocence is Over* (Aug. 2, 2001), *at* http://www.pbs.org/cringely/pulpit/pulpit20010802.html; Peter Judge, *Microsoft: Does It Pay To Be Safe?*, CNET NEWS.COM, Oct. 9, 2002 (noting Microsoft's traditional approach to making security less of a priority); Paul Thurrott, *A Vulnerable Future for Windows XP Users*, WINDOWS & .NET MAG., July 26, 2001 (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."), *at* http://www.win2000mag.com/Articles/Index.cfm?ArticleID=21939; *Frontline: Hackers* (PBS television broadcast, Feb. 13, 2001) (according to Steven B. Lipner, a Microsoft Senior Security Analyst, "usability, flexibility, [and] security are a set of trade-offs" and Microsoft has chosen convenience over security), *available at* http://www.pbs.org/wgbh/pages/frontline/shows/hackers/etc/script.html.

555. Elinor Mills Abreu, *Microsoft: Bad Security, or Bad Press?*, CNN.com, Sept. 28, 1999 (noting several problems with security in Microsoft's products), *available at* http://www.cnn.com/TECH/computing/9909/28/ms.security.idg/; Joseph Menn, *Security Flaws May be Pitfall for Microsoft*, L.A. TIMES, Jan. 14, 2002, pt. 3, at 1 (speculating that Microsoft's security woes may threaten its future).

556. Microsoft may be beginning to correct its 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 (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.'"), *at* http://news.cnet.com/news/0-1003-200-8509737.html. Microsoft did begin requiring programmers to attend half-day training sessions on writing secure software. *See* John Markoff, *Microsoft Programmers Hit the Books in a New Focus on Secure Software,* N.Y. TIMES, Apr. 8, 2002, at C4.

goods.[557] 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,[558] open source code, [559] and code addressing issues such as education and energy conservation.[560] 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, rather than competitive. With information technologies, there are two phenomena that can lead to uncompetitive markets. First, is the issue of lock-in and switching costs.[561] Indeed, government may have to intervene if switching costs are so high that they act as a barrier to entry for competitors. Second, network effects may lead some markets towards monopoly.[562] For example, communication networks become more valuable as they become large, and that can result in a monopolistic market.[563]

Fourth, market failure can occur because of incomplete information or an asymmetrical allocation of information.[564] 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.[565] 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

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557. WALLIS & DOLLERY, *supra* note 548, at 18-19.

558. Other goods, such as 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. *See* Cargill, *supra* note 42.

559. Open source code is available to everyone and one person's use does not affect another's use. *See* Lerner, *supra* note 276 (noting that open source code is a public good).

560. 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).

561. *See supra* note 410.

562. *See supra* note 411.

563. *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).

564. Breyer, *supra* note 548, at 556; WALLIS & DOLLERY, *supra* note 548, at 19-20.

565. George A. Akerlof, *The Market for "Lemons": Quality Uncertainty and the Market Mechanis*m, 84 Q.J. ECON. 488 (1970).

valuable.[566] Netscape then proceeded to incorporate the cookies technology and turn the feature on. However, Netscape never incorporated tools that allowed users to manage cookies in their browsers. Moreover, Netscape didn't notify users about the cookies technology.[567] They probably understood that if consumers knew about this feature, this could have led to a privacy backlash against cookies and hampered 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.[568] First, market failure occurs when redistribution of goods does not result in social standards of equity.[569] This is why there are programs such as universal service, which ensure that all citizens have access to telecommunications.[570] A second market failure occurs when people do not act in their own self-interest.[571] This calls for paternalism. An example of paternalism affecting code is 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 fundamental rights.[572] 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

566. If cookies were seen merely as a privacy hazard with no useful benefit, they would probably have been eliminated. For example, Microsoft altered its software after the public became aware 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 Will Alter its Software in Response to Privacy Concerns*, N.Y. TIMES, Mar. 7, 1999, § 1, at 1.

567. Netscape never told users about cookies or provided any documentation on cookies and their privacy implications. *See supra* text accompanying notes 112-113.

568. *See* 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).

569. WALLIS & DOLLERY, *supra* note 548, at 22.

570. 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 than it is about private groups advancing their own agendas).

571. *See* WALLIS & DOLLERY, *supra* note 548, at 22; Breyer, *supra* note 548, at 559-60.

572. WALLIS & DOLLERY, *supra* note 548, at 23.

requires code to be accessible by disabled citizens.[573]

### 3. CONSORTIA

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

The PICS case study showed how formation of a consortium facilitated industry cooperation in addressing a social concern. 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."[574]

The disadvantage of the consortium approach is that it may address a social concern in a way that benefits the consortium's members over the general public. For example, PICS was designed by the W3C to address social 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 social problem. Similar criticisms have been leveled at the W3C's efforts to address privacy concerns.[575] Jason

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573. Examples of this include the Americans with Disability Act, closed captioning for television, and the text telephone (TTY). *See* Telecommunications Act of 1996, 47 U.S.C. 255; Closed Caption Decoder Requirements for Television Receivers, 47 C.F.R. § 15.119 (2002); Carrie Johnson, *A More Accessible Web*, WASH. POST, Aug. 21, 2000, at E01.

574. Interview with James Miller, *supra* note 138.

575. 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 to be 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* Christopher D. Hunter, Recoding the Architecture of Cyberspace Privacy: Why Self-Regulation and Technology Are Not Enough, Presented at the International Communication Association Convention, Acapulco, Mexico, June 2000, *available at*

Catlett of Junkbusters believes that the real motivation behind the W3C's efforts is not user privacy, but to stave off potential legislation on privacy.[576] So while a consortium may address social concerns, it is biased by its reliance on its members' efforts and motivations.[577] As a result, a consortium's product may be of marginal value to society.

The development process also affects the extent to which social values are reflected in its code. For example, by including a diverse pool of contributors, the IETF is rather sensitive to social concerns during the development process. Due to this diversity, the IETF's standard on cookies was singularly responsive to privacy concerns. Koen Holtman, a European who participated in the discussion, had a distinctively different attitude towards privacy from that of most Americans, and was thereby able to easily identify privacy problems with cookies that others had disregarded.[578]

The decision-making process at a consortium can also affect the inclusion of social values. A consortium can be structured to allow for

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http://www.asc.upenn.edu/usr/chunter/net_privacy_architecture.html; *see also* ELEC. PRIVACY INFO. CTR. & JUNKBUSTERS, PRETTY POOR PRIVACY: AN ASSESSMENT OF P3P AND INTERNET PRIVACY, June 2000, *available at* http://www.epic.org/reports/prettypoorprivacy.html; Roger Clarke, *P3P Revisited*, ("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.") *at* http://www.anu.edu.au/people/Roger.Clarke/DV/P3PRev.html (last modified Mar. 20, 2001).A few supporters have argued that P3P is not the solution to privacy issues, but is a step in the right direction. *See, e.g.*, CENTER FOR DEMOCRACY & TECHNOLOGY & INFORMATION AND PRIVACY COMMISSIONER (ONTARIO), *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/.

576. *See* 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.

577. 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 254 (describing the evolution of the Technology & Society Domain).

578. 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." E-mail from Koen Holtman, Aug. 24, 1999) (regarding the history of cookies) (on file with author).

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 consider a wider array of values than merely profitable ones. Kristol stated that he was under tremendous pressure to ignore the privacy and security problems of third party cookies.[579] 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. Second, we note that the open source movement is biased by the social 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 considerable autonomy. This international group of volunteer-developers decides the code's values. As a result, the open source movement is less subject than it might otherwise be to insular 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.[580]

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.[581] For example, the open source movement has not

579. Kristol, *supra* note 116, at 22.

580. *See supra* text accompanying notes 346-351.

581. The culture of the open source movement is just beginning to be addressed. *See* MOODY, *supra* note 88.

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 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 on and participate in the design, there is bottom-up pressure. This pressure is not necessarily from programmers, but could involve others who participate and support open source projects in other ways.[582] One manifestation of bottom-up pressure is through the use of wish lists where the public can request new features.[583] This under-exploited feedback mechanism is useful to ensure that developers are cognizant of users' needs.

The open source movement's use of modularity is capable of simultaneously supporting diverse social values.[584] 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 visit only child-oriented sites, as rated by PICS. Likewise, a browser could be modified not to accept third-party cookies—or the browser's bookmarks could be customized to contain a set of religious sites. The modularization of open source code makes it possible to select values from a mosaic of code.[585]

### 5. PRIVACY AS AN ILLUSTRATION OF INSTITUTIONAL DIFFERENCES

This section shows how code developed by different institutions can differentially affect a social value, namely informational privacy.

582. Members can provide material resources, other services such as documentation, or just watch over the process as an interested user.

583. 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 (last modified Feb. 18, 2004). Similarly, the developers of the open source Virtual Network Computing (VNC) maintained a web page suggesting features that they would like others to develop. *See* AT&T LABORATORIES CAMBRIDGE, WANT TO HELP? – PROJECT SUGGESTIONS, *available at* http://www.uk.research.att.com/archive/vnc/help.html.

584. *See supra* text accompanying notes 443-444.

585. LESSIG, *supra* note 1, at 225.

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.[586] There are researchers actively working to incorporate privacy technologies into code, for example, by designing a web browser that is sensitive to issues of privacy.[587] Moreover, others argue that universities should lead by example by developing and using technologies in ways that are sensitive to privacy.[588]

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.[589] 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.[590] 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, mean that a property-based approach is insufficient to induce the development of code that considers privacy.[591] 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

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586. For example, the cookies technology was not considered or developed within a university.

587. Batya Friedman et al., *Informed Consent in the Mozilla Web Browser: Implementing Value-Sensitive Design, in* PROCEEDINGS OF THE THIRTY-FIFTH ANNUAL HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES , January 7-10, 2002, Los Alamitos. The project page can be found at http://www.ischool.washington.edu/SecurityandValues/index.html.

588. Dan Carnevale, *Logging in with Laura J. Gurak,* CHRON. HIGHER EDUC., Feb. 19, 2002, *at* http://chronicle.com/free/2002/02/2002021901t.htm.

589. Courtney Macavinta, *Net Tools Store Info But Stir Concerns*, CNET NEWS.COM, October 8, 1999 (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), *available at* http://news.cnet.com/news/0-1005-200-811310.html.

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

591. Paul M. Schwartz, *Beyond Lessig's Code for Internet Privacy: Cyberspace Filters, Privacy Control, and Fair Information Practices*, 2000 WIS. L. REV. 743.

fair information practices."[592] These market failures have led to the under-production of code that embodies the basic value of privacy.[593]

Consortia may be structured to deal with social issues such as privacy. For example, the W3C is working on a privacy project titled P3P, because it met the needs of its members.[594] In contrast, the W3C chose not to work on cookies. Roger Clarke raised this matter with Berners-Lee and the "W3C avoided the matter entirely, reflecting the increasing constraints on its freedom of action arising from its desire to avoid upsetting its corporate sponsors."[595] 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.[596]

Compared with consortia, the open source movement is relatively uninfluenced by economic incentives to violate privacy. Thus, we might even expect the open source movement to develop code that protects privacy, but this is not the case In fact, there has been no coordinated effort in the open source movement to develop such tools. Likewise, there have been surprisingly few individual efforts to develop 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.[597] 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

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592. Paul M. Schwartz, *Internet Privacy and the State*, 32 CONN. L. REV. 815, 853 (2000).

593. Elinor Mills Abreu, *CIA-Backed Web Privacy Firm Closes Service*, WASH. POST, Nov. 20, 2001 (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").

594. *See supra* text accompanying notes 575-577.

595. Roger Clarke, *Cookies*, *available at* http://www.anu.edu.au/people/Roger.Clarke/II/Cookies.html (last modified Jan. 13, 2001).

596. *See supra* text accompanying notes 123-128.

597. This program is named 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/ (last visited May 5, 2004).

the privacy risks with code as well as how to use code to limit privacy losses. As a result, they do not need new privacy tools. 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. CONCLUSION

This Article extends our understanding of code by deconstructing its development. We found that code is shaped by a variety of influences in several social institutions. Specifically, structural factors, various internal and external influences, and management decisions shape the development of code within universities, firms, consortia, and the open source movement. This shaping process results in different emphases within societal institutions on the social and technical attributes of code.

The deconstruction of the development process permits an analysis of institutional competencies and allows policymakers to understand how each institution serves to shape code. We briefly highlight a few of these findings. Our examination of universities found that they were a significant contributor to innovative development of code. In order to ensure continued innovation, our findings suggest that policymakers need to continue to fund research while allowing researchers a measure of autonomy. After all, if researchers were not free to pursue self-directed research, the World Wide Web would not exist.[598]

As a result of our examination of firms, we found the most significant observation to be the firms' lack of willingness to incorporate unprofitable social values in code.[599] As we point out, this lack of willingness is perfectly rational and not surprising. It is important, however, to recognize this when considering how social values can be addressed by code. An unexpected finding was the extent to which consortia are beholden to their members and their consequent disregard of social concerns.[600] Our findings in the PICS case study show the limitations of consortia in addressing public policy concerns. Finally, the open source movement appears to be an emerging source of code that is useful to society, especially with its focus on open standards, open source code, and modularity. However,

598. *See supra* notes 288-292.
599. *See supra* Part VI.F.2.
600. *See supra* Part IV.C.

this movement is not a panacea, and it suffers from several endemic problems including the limits of volunteerism.[601] Nevertheless, it is becoming clear that the open source movement offers a new vista for the development of code.

Our analysis shows how the choice of an institution can affect the development process, speed of the development process, the dissemination of code, and the qualities of the code. These choices are not trivial. For example, society encourages research within universities on the premise that such knowledge will be widely disseminated. Similarly, the choice of an institution affects the attributes of code. Our analysis shows how the choice of a firm affects open standards, quality of code, and the incorporation of societal values into code.

Policymakers can now begin to shape the development of code to favor certain attributes. This can be done in two ways. First, society can influence the development of code through the choice of which institution to support. Our analysis has shown how institutional differences are manifested with different emphasis on the social and technical attributes of code. For example, should society rely on code by firms to protect privacy or should we encourage the open source movement to develop privacy enhancing code? Policymakers can now begin by analyzing whether a firm is likely to incorporate a specific societal concern into code. If not, policymakers may seek the aid of universities, open source movement, or consortia. For example, to encourage the open source movement, policymakers may provide it with code it can build upon and refine.

Secondly, policymakers can shape the development of code by modifying the existing structures of institutions. Our analysis has shown how the existing structures of institutions shape code. Some institutions, like consortia are created entirely out of legislation to meet societal needs. Government could also encourage the development of code by the open source movement by modifying its technology transfer policy to favor the open source movement over firms. To encourage university researchers to examine a specific problem, the government could provide specific research funds. Similarly, the government could use a contrary approach to provide researchers with greater autonomy in the hopes of creating more innovative code. These approaches all shape code differently by influencing its institutional origins. 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.

601. *See supra* notes 334-343.