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DNA Rules: Legal and Conceptual Implications of Biological "Lock-Out" Systems

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Recent advances in genetic engineering now allow biological inventions to be programmed in a fashion resembling the restrictive programming of digital media. These biological "lock-out" systems restrict unauthorized use of genetically engineered seeds in much the same way that digital rights management (DRM) systems restrict the use of digital media. Indeed, these new genetic use restriction technologies, known as "GURTs," raise many of the same policy issues that have been identified with DRM. In both cases, the substitution of technological protection for legal protection allows private parties to displace the public policy balance of ownership and control that is inherent in intellectual property law.

The proliferation of restrictive technologies such as DRM and GURTs poses a challenge not only to the traditional balance of control over intellectual property, but also to our understanding of legal doctrines related to ownership and control. In particular, the ability to embed contractual

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terms in restrictive technologies requires a re-examination of the concepts of disclosure and consent in licensing transactions involving such technologies, as well as a reconsideration of commonly employed notions of property and contract. As restrictive technologies blur the distinctions between property, contract, and physical products, these categories may be redefined in light of the interplay between law and the values that restrictive technologies embed in the design of physical products.

INTRODUCTION

Human artifacts embody the values of their creators, bearing the indelible stamp of the mind and culture that produced them; this is the fundamental assumption behind archaeology, anthropology, and the study of the humanities. This principle holds true for technology as well as for more palpably cultural objects. Whether artifacts are technological or cultural, they include among their attributes certain assumptions as to their proper or intended use. Scholars of technology refer to limitations embedded in artifacts as "prescriptions"[1] or "affordances"[2]: the design constraints that delimit what can or cannot be done with a particular artifact.

More than any other human artifact, information technology embodies within its design rules for its own use, due to the grammatical quality of such technologies that allows for explicit inscription of discourse within their design.[3] Computer software, for example, comprises a technological artifact that can be programmed or scripted to "behave," that is, to perform complex functions specified by a programmer.[4] The inscription of software artifacts may include specified constraints on the program's behavior, such as denial of access to a file without proper authorization.

Biotechnology as well has now arrived as information technology, permitting technological constraints to be purposefully programmed into genetic code.[5] The recent development of genetic use restriction technologies (GURTs) that allow seeds to be genetically programmed not to germinate presages the inscription of other genetic programs in biological artifacts. The emerging ability to program genetic code in this fashion blurs the linc between law and artifact, and promises to challenge long-held

1. Bruno Latour (a.k.a. Jim Johnson), *Mixing Humans and Non-Humans Together: The Sociology of a Door Closer*, 35 SOC. PROBS. 298, 306 (1988).

2. *See, e.g.*, Bryan Pfaffenberger, *Technological Dramas*, 17 SCI. TECH. & HUM. VALUES 282, 284 (1992).

3. *See* Phil Agre, *Internet Research: For and Against*, *in* 1 INTERNET RESEARCH ANNUAL: SELECTED PAPERS FROM THE ASSOCIATION OF INTERNET RESEARCHERS CONFERENCES 2000-2002, at 25, 27 (Mia Consalvo et al. eds., 2004).

4. *See* Pamela Samuelson et al., *A Manifesto Concerning the Legal Protection of Computer Programs*, 94 COLUM. L. REV. 2308 (1994) (describing software as a text that "behaves").

5. *See infra* notes 20-22 and accompanying text.

assumptions in the legal regime of ownership and control over such biological creations.

In this Article I hope to illuminate these emerging issues by drawing upon parallel discussions regarding digital technology, recognizing that those discussions are themselves in their infancy and may need to be enhanced or extended for my purposes here. Recent commentary regarding digital technology shows how technological constraints may sometimes substitute for law, and that such technological substitution raises the same policy concerns raised by equivalent legal regulation. I show that embedding behavioral scripts in either digital or biological information technologies challenges our ability to implement policies worked out in the context of legal regulation. In particular, I highlight the problem of distinguishing coded constraints that we might treat as equivalent to law from other types of technologically embedded values. In doing so, I touch upon the broader questions as to whether long-standing discussions of contract law can be effectively applied to technological constraints.

I shall begin by describing the recent advances in genetic design that allow constraints on the use of plants or other transgenic organisms to be programmed into the organism itself. I then show that this development parallels that of other programmable information technologies, and that current trends in the analysis of electronic digital technologies may be properly applied to biological technologies. In particular, the development of programmable biological code implicates a series of difficult policy questions regarding the market power of commodity producers, the autonomous choices of commodity users, and the proper role of the state in regulating programmed constraints. I discuss how behavioral scripts substitute for and complement contracts, but show that contract law is ill-equipped to accommodate such programmed products. I conclude with a discussion of how the merger of product with contract challenges our notions of both contract and property, and explain that by looking beyond such classifications, we may develop a methodology for setting public policy regarding programmable artifacts.

I
DEPLOYING CODED CONSTRAINTS

Gene splicing techniques have enabled the creation of many types of sexually reproducing plants with commercially attractive characteristics: increased nutritional value, resistance to drought and pests, herbicide resistance, and medicinal properties, to name only a few.[6] The economic

6. *See* ECONOMIC RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, ECONOMIC ISSUES IN AGRICULTURAL BIOTECHNOLOGY (Robbin Shoemaker et al. eds., 2001) [hereinafter ECONOMIC ISSUES]; *see also* UNITED STATES CONGRESS, OFFICE OF TECHNOLOGY

challenge to the development of such plant varieties is that new varieties of plant may be relatively expensive to create, but are often trivially inexpensive to propagate once they are in existence—indeed, they may propagate even when intended not to do so. Plants reproduce and multiply, as living organisms are wont to do, even without human intervention. Planting a single seed leads to a harvest of many seeds. This reproductive strategy of the plant forms the basis for human agricultural activity; the farmer reaps an excess of seed for food or other uses, typically including the seed needed for the next year's planting.

As a consequence of their natural tendency to proliferate, plants routinely provide the purchaser with year after year of free seed, alleviating the need to pay for future seeds. This results in a public goods problem, as the marginal cost of distribution is close to zero.[7] Such public goods concerns are also common in other areas of innovation, even where the subject matter does not reproduce itself.[8] Ideas, books, music, inventions, and other valuable creative or inventive works may be costly to create, but nearly costless to propagate. Conventional economic wisdom suggests that such items may be underproduced, as the efficient price of distribution for such a good leaves no room for a creator to secure any profit on the investment made to produce the good.[9]

Legal prohibitions have been the typical solution to this problem, although technological solutions have also been employed. Intellectual property law allows the rights holder an exclusive right to the protected good, permitting an artificial inflation of price to recoup the investment made in creating the good—essentially giving the public good legal status as a private good. Private good characteristics may additionally or alternatively be imposed on public goods through technological solutions ranging from padlocks and fences to sophisticated encryption algorithms, all of which allow the owner to physically exclude potential users from the good.[10] In the case of genetically engineered plants, both technological and legal strategies may now be employed, although with important and unusual consequences not seen in previous incarnations of the public goods problem.

ASSESSMENT, A NEW TECHNOLOGICAL ERA FOR AMERICAN AGRICULTURE (1992), *available at* http://govinfo.library.unt.edu/ota/Ota%5f1/DATA/1992/9201.pdf.

7. *See* ROBERT S. PINDYCK & DANIEL L. RUBINFELD, MICROECONOMICS 663-65 (2d ed. 1992) [hereinafter PINDYCK & RUBINFELD]. "Public goods" are generally defined as those goods which are non-rivalrous and non-exclusive; that is, which may be enjoyed by more than one consumer at a time, and which consumers cannot be prevented from enjoying. *See id.*

8. *See* William M. Landes & Richard A. Posner, *An Economic Analysis of Copyright Law*, 18 J. LEGAL STUD. 325 (1989).

9. *See* PINDYCK & RUBINFELD, *supra* note 7.

10. *See* Dan L. Burk, *Muddy Rules for Cyberspace*, 21 CARDOZO L. REV. 121, 170-71 (1999).

A. Anti-Germination Technology

Until recently, society has tended to rely solely upon legal rules to govern the exclusive use of biological inventions.[11] For example, in the United States, at least three distinct regimes of intellectual property protection govern the use of novel plant varieties. First, a special variation on patent protection, the plant patent, prevents unauthorized propagation of asexually reproducing plant varieties.[12] Second, since the United States Supreme Court declared in the landmark case of *Diamond v. Chakrabarty* that utility patents cover "anything under the sun that is made by man,"[13] the statute authorizing utility patents has been interpreted to cover transgenic plant inventions. This interpretation has been explicitly endorsed by the Supreme Court in a more recent decision, *J.E.M. AG Supply, Inc. v. Pioneer Hi-Bred International, Inc.*, where the court held that overlapping coverage by utility patents and other forms of plant-specific intellectual property protection is permissible.[14]

Finally, a *sui generis* form of intellectual property, established under the Plant Variety Protection Act (PVPA), encourages the development of new varieties of sexually reproducing plants by granting developers broad control over the growth, use, importation, and sale of new plants.[15] This U.S. statute implements an international plant variety protection treaty, the International Union for the Protection of New Varieties of Plants (UPOV).[16] The PVPA differs from utility patent protection in its length and scope of coverage. Unlike patents, but as permitted under the UPOV, the PVPA includes some important exceptions to a seed developer's control, such as a "farmer's exemption" allowing farmers to save seed from a proprietary crop, and a research exemption permitting agricultural research involving the plant.[17]

Plant variety owners may prefer that their control over the variety not be subject to such exceptions, and so, as a condition of access to their seeds, they routinely require that farmers contractually waive their rights

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11. *See* Keith Aoki, *Weeds, Seeds, & Deeds: Recent Skirmishes in the Seed Wars*, 11 CARDOZO J. INT'L & COMP. L. 247 (2003) (describing propertization of plant varieties).

12. 35 U.S.C. § 161 (2000).

13. 447 U.S. 303, 309 (1980).

14. 534 U.S. 124 (2001).

15. 7 U.S.C. § 2402 (2000).

16. *See generally* Andre Heitz, *History of the UPOV Convention and the Rationale for Plant Breeder's Rights*, *in* International Union for the Proteetion of New Varieties of Plants (UPOV), UPOV Seminar on the Nature of and Rationale for the Protection of Plant Varieties Under the UPOV Convention 19-42, UPOV Doc. No. 697[E] (1991); Barry Greengrass, *The 1991 Act of the UPOV Convention*, 13 EUR. INTELL. PROP. REV. 466 (1991).

17. International Convention for the Protection of New Varieties of Plants, Dec. 2. 1961, 33 U.S.T. 2703, 815 U.N.T.S. 89 (revised March 19, 1991), *available at* http://www/upov.int/en/publications/conventions/index.html.

under the PVPA to save seed or engage in other legally permissible uses.[18] Often the terms of this contract are printed on or attached to the bag of seed. The contractual fine print purports that the farmer has agreed to the terms if the farmer uses the seed.[19] However, it is difficult to police the use of seed and to enforce the terms of such "seed-wrap" licenses. To do so, seed developers must send agents out into farmers' fields to sample crops, looking for unlicensed uses of proprietary seed. When such uses are found, costly legal procedures may be necessary in order to halt the use, force acceptance of a license, or recover unpaid royalties.

The problems of detection and enforcement might be lessened if seed could be designed to be "self-policing," that is, if it were unsuitable for use without the developer's permission. Newly available transgenic technologies, dubbed "GURTs," allow for the creation of such self-policing seed.[20] These technologies function by introducing into the plant variety genetic elements that produce a toxin late in seed maturation.[21] The toxin kills the seeds after the plant has matured, producing a crop for the farmer, but forcing him to return to the seed producer for new seed each year because the seeds produced in growing the crop are not viable for replanting. Thus, even in the absence of a contractual obligation not to save seed, the technology makes it impossible to save seed for replanting. The genetically altered seed in essence carries within its own makeup a "lock-out" prohibition on unlicensed use.

Indeed, if the genetic alteration of the seed is thought of as equivalent to a license prohibition, the terms of usage embedded in the genetic "license" may be quite sophisticated. In one embodiment of the technology, for example, it is possible to introduce into the seed a genetic "switch" that will repress, or turn off, the toxin production when the seed is exposed to a particular chemical. This in effect supplies a chemical password to

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18. *See* Neil D. Hamilton, *Legal Issues Shaping Society's Acceptance of Biotechnology and Genetically Modified Organisms*, 6 DRAKE J. AGRIC. L. 81 (2001).

19. *See* Mark D. Janis & Jay P. Kesan, *Intellcctual Property Protection for Plant Innovation: Unresolved Issues after* J.E.M. v. Pioneer, 20 NATURE BIOTECHNOLOGY 1161 (2002).

20. Keith Aoki, *Neocolonialism, AntiCommons Property, and Biopiracy in the (Not-So-Brave) New World Order of International Intellectual Property Protection*, 6 IND. J. GLOBAL LEGAL STUD. 11, 54 (1998). The most widely publicized embodiment of this technology, known officially as the technology protection system (TPS), has been dubbed by its detractors as the "terminator" gene. ECONOMIC ISSUES, *supra* note 6, at 42. I have chosen to avoid this nomenclature, in part because it has assumed certain rhetorical implications that are unhelpful to serious analysis of the technology's impact, and in part because I wish to avoid confusion: in molecular biology, the term "terminator" refers to a specific type of genetic control sequence that is not employed in GURTs. *See* JAMES D. WATSON ET AL., MOLECULAR BIOLOGY OF THE GENE 377-78 (4th ed. 1987) (describing RNA terminator control sequences).

21. *See* U.S. Patent No. 5,723,765 (issued Mar. 3, 1998); *see also* MARTHA L. CROUCH, EDMONDS INST., HOW THE TERMINATOR TERMINATES: AN EXPLANATION FOR THE NON-SCIENTIST OF A REMARKABLE PATENT FOR KILLING SECOND GENERATION SEEDS OF CROP PLANTS (1998), *available at* http://www.edmonds-institute.org/crouch.html.

activate seed germination, which can be used to control the terms of seed usage from year to year. Yearly application of the control chemical, obtained from the seed owner for payment, would allow the owner to activate or deactivate seeds. One can easily envision other types of switches sensitive to temperature, precipitation, soil alkalinity, or other environmental factors, that could limit use of the seed to certain geographical regions or seasonal applications. Indeed, plants could be engineered for various desirable properties—pest resistance, drought resistance, superior yield, and so on—and particular attributes activated or deactivated depending on the price paid by the purchaser.[22]

Although the patent on this technology is directed to control plant development, similar genetic control elements are known in other organisms, and there seems to be no particular reason that such technology need be confined to plants. Since the advent of genetically engineered animals, beginning with the "Harvard Oncomouse,"[23] the ability of an animal to reproduce has posed a challenge to the owners of proprietary rights in the organism: does the purchase of a patented animal confer the right to breed or use subsequent generations of the animal, and, if not, how can the patent holder control subsequent generations?[24] Similar to the case of genetically altered seed, this problem has been largely handled via licenses that either include or exclude the right to breed the animal.[25] However, once again, due to policing and enforcement problems, as well as the opportunity for price discrimination, the availability of a genetic system to activate or deactivate a genetically engineered trait might be highly attractive to the creators of such animals.

The prospect of germ-line alteration of human subjects[26] has been even more controversial, although for somewhat different reasons, primarily relating to the ethical controversy of altering traits in future generations, which have had no opportunity to consent to such alterations.[27] A full exploration of this issue is impossible within the scope of this Article, but I note that some of the ethical objections to germ-line therapy might be

22. GURT systems that inactivate a specific, usually recombinant, trait are know as "trait-specific" or "T-GURTs"; those that entirely prevent germination of the seed have been dubbed "variety-level" or "V-GURTs." *See* ECONOMIC ISSUES, *supra* note 6, at 42.

23. UNITED STATES CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT, NEW DEVELOPMENTS IN BIOTECHNOLOGY: PATENTING LIFE (1989) [hereinafter PATENTING LIFE] (describing the Harvard "Oncomouse," the first transgenic animal for which a patent was issued).

24. *See* Rebecca Dresser, *Ethical and Legal Issues in Patenting New Animal Life*, 28 JURIMETRICS J. 399 (1988); PATENTING LIFE, *supra* note 23, at 121.

25. *See* Robert P. Merges, *Intellectual Property in Higher Life Forms: The Patent System and Controversial Technologies*, 47 MD. L. REV. 1051 (1988).

26. Germ-line therapies are those that would affect reproductive cells. *See* UNITED STATES CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT, HUMAN GENE THERAPY: BACKGROUND PAPER 6-8 (1984) [hereinafter HUMAN GENE THERAPY] (defining germ-line genetic alteration).

27. *See* LEROY WALTERS & JULIE GAGE PALMER, THE ETHICS OF HUMAN GENE THERAPY (1997).

addressed by a control system that could deactivate the traits conferred by germ-line therapies on future generations, or activated if those inheriting the altered gene desired the benefit of the recombinant trait.

A more likely, but no less troublesome, application of the technology might be found in somatic cell therapies, targeted at non-reproductive cells.[28] Genetic regulatory elements analogous to those in plant applications could be added to the transgenic DNA "cassettes" contemplated for human gene therapy, placing recombinant genes in human cells under similar proprietary control. One can easily envision proprietary control of future genetic therapies for certain diseases, such as diabetes or hemophilia, which are caused by the failure of a particular gene in the body to produce a particular protein.[29] A recombinant genetic cassette containing a healthy copy of the defective gene, along with genetic insertion and control elements, could be introduced into the patient's cells in order to supply the missing protein.[30] The cassette could include regulatory elements allowing the gene to be activated or deactivated by administration of a proprietary pharmaceutical; so long as the patient were supplied with the pharmaceutical, the gene would continue to prevent the disease.

Such a system might perhaps allow the recipient to pay for the therapy over an extended period of time, rather than all at once. The supplier of the treatment could exercise self-help to deactivate the gene if payment were not forthcoming. Of course, under the current system, the supplier would presumably have legal recourse for non-payment, but for the reasons described above, self-help might be a more attractive form of recourse. While these applications of GURTs are speculative at present, they demonstrate that it is possible to envision the eventual application of GURTs technologies to a wide range of biotechnological products. The application of GURTs to seeds may be only the first instance of programmable biological products, and forms part of a broader movement toward "lock-out" technologies in general.

B. Content Management Technology

The appearance of GURTs in biotechnology is not the first instance of a programmable use restriction technology; for example, the description of seed licensing offered above bears an uncanny resemblance to the history of content licensing in digital media.[31] Digital technology offers

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28. *See* HUMAN GENE THERAPY, *supra* note 26 (distinguishing germ-line therapies, which are directed at gametes, from somatic cell therapies, which are not).

29. *See* LUBERT STRYER, BIOCHEMISTRY 253-54 (3d ed. 1988).

30. P.D. Robbins, *Retroviral Vectors*, *in* GENE THERAPY: PRINCIPLES AND APPLICATIONS 13, 18 (Thomas Blankenstein ed., 1999).

31. William W. Fisher, *The Impact of Terminator Gene Technologies on Developing Countries: A Legal Analysis*, *in* BIOTECHNOLOGY, AGRICULTURE, AND THE DEVELOPING WORLD: THE DISTRIBUTIONAL IMPLICATIONS OF TECHNOLOGICAL CHANGE 137, 142 (Timothy Swanson ed., 2002).

inexpensive and widespread access to the means of reproducing and distributing copyrighted materials. Much as the PVPA provides legal protection for seeds, copyright law affords the owners of digital content some recourse against many unauthorized uses of their material. However, copyright is subject to a host of uses that require no authorization from the copyright holder.[32]

Owners of digital content, much like developers of plant varieties, have long wished to escape the consumer privileges afforded by copyright law. They have done so through the fiction of the "shrink-wrap" license, which purports to restrict a purchaser's use of the accompanying product.[33] The license takes its name from the legal fiction that the purchaser demonstrates agreement to the license terms by breaking the shrink-wrap cellophane on the product package. More recently, a different implementation of such licenses has taken on the nomenclature of "click-wrap" from computerized presentation of a license to which the user can assent by using the computer mouse to click on a graphic labeled "I agree."[34]

The road to legal acceptance for click- and shrink-wrap licenses has been long and tortuous. Such licenses raise concerns of both consumer consent and intellectual property policy. Courts in the United States have in many cases been reluctant to enforce such agreements because in the shrink-wrap situation, the purchaser may have no opportunity to review the license prior to opening the package. Proponents of mass market licenses for software have complained that similar mass market agreements have long since been accepted in most other areas of commerce.[35] This observation is true, so far as it goes, but a car rental agreement, for example, provides at least a nominal opportunity to read the agreement before the rental occurs. In the case of shrink-wrap licenses, even the fiction of a pre-transaction opportunity to review is absent. Click-wrap agreements similarly often involve after-market agreements to use software pre-installed on a computer the consumer has already purchased. The situation is exacerbated by the advent of electronic commerce; proposed uniform rules for information licensing would permit a merchant to change the terms of the agreement by posting the new terms somewhere on the Internet or by

32. *See, e.g.*, 17 U.S.C. §§ 107-112 (2000) (detailing numerous and varied exceptions to the exclusive rights of the copyright holder, such as the right to perform non-dramatic musical works at agricultural fairs or in the classroom).

33. *See* Deborah Kemp, *Mass Marketed Software: The Legality of the Form License Agreement*, 48 LA. L. REV. 87 (1987); David W. Maher, *The Shrink-Wrap License: Old Problems in a New Wrapper*, 34 J. COPYRIGHT SOC'Y 292 (1987).

34. Mark A. Lemley, *Shrinkwraps in Cyberspace*, 35 JURIMETRICS J. 311 (1995).

35. *See* Rohert W. Gomulkiewicz & Mary L. Williamson, *A Brief Defense of Mass Market Software License Agreements*, 22 RUTGERS COMPUTER & TECH. L.J. 335 (1996); Holly K. Towle, *Mass Market Transactions in the Uniform Computer Information Transactions Act*, 38 DUQ. L. REV. 371 (2000).

sending the purchaser an e-mail message that would be considered effective even if the purchaser never actually received the message.[36]

In some circumstances, such licenses may be limited by contract doctrines of unconscionability or preempted by federal policy governing the rights the contract seeks to allocate.[37] Preemption may occur, for example, where the contract would frustrate the movement of intellectual property into the public domain as intended by Congress or mandated by the Constitution. Some commentators suggest that overreaching attempts to limit access to uncopyrighted portions of a work governed by the contract or to limit fair use of the work could run afoul of federal copyright or patent policy.[38] This is in part due to the mass market nature of such provisions[39]; proponents of such licenses protest that, unlike property rights which are good against the world, contracts bind only the parties to the agreement.[40] But when every user of a product is required to acquiesce to the same agreement, the contract begins to resemble an effective property right, one which has different and potentially conflicting bounds from those set by Congress. To the extent that such a blanket contract provision frustrates federal policy, the Supremacy Clause dictates that the state law contract must give way.

At the same time, such licenses have become increasingly enforceable and increasingly regarded as legitimate. In the face of uncertain enforcement by the courts, software vendors sought to legitimate these contracts by promulgation of the Uniform Computer Information Transaction Act (UCITA), which was adopted in two states, although rejected in several others.[41] This Act began life as a proposed addition to the Uniform Commercial Code, but engendered such controversy that it was instead promulgated as a separate uniform act.[42] UCITA purports to be neutral on the question of preemption,[43] as well as on the question of

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36. UNIF. COMPUTER INFO. TRANSACTION ACT § 214(a) (2002).

37. *See* Maureen O'Rourke, *Drawing the Boundary Between Copyright and Contract: Copyright Preemption of Software Licensing Terms*, 45 DUKE L.J. 479 (1995); David A. Rice, *Public Goods, Private Contract and Public Policy: Federal Preemption of Software License Prohibitions Against Reverse Engineering*, 53 U. PITT. L. REV. 543, 544-45 (1992).

38. *See* David Nimmer et al., *The Metamorphosis of Contract into Expand*, 87 CALIF. L. REV. 17, 67 (1999).

39. *See id.*

40. *See, e.g.*, Raymond T. Nimmer, *Breaking Barriers: The Relation Between Contract and Intellectual Property Law*, 13 BERKELEY TECH. L.J. 827, 849 (1998).

41. So-called "bomb shelter" provisions have been enacted in several states, attempting to statutorily disallow application of other states' UCITA provisions to transborder transactions. *See* IOWA CODE ANN. § 554D.104(4) (West 2001 & Supp. 2003); N.C. GEN. STAT. ANN. § 66-329 (2003); W. VA. CODE ANN. § 55-8-15 (Michie 2000 & Supp. 2003).

42. *See* Jean Braucher, *When Your Refrigerator Orders Groceries Online and Your Car Dials 911 After an Accident: Do We Really Need New Law for the World of Smart Goods?*, 8 WASH. U. J.L. & POL'Y 241, 242 (2002).

43. UNIF. COMPUTER INFO. TRANSACTION ACT § 105(a) cmts 2, 3 (2002).

unconscionability[44]; however it is clearly intended to legitimate the formation of standardized, non-negotiated information licenses. Thus, legitimation comes via promulgation of licenses containing choice of law provisions that contemplate the laws of Maryland or Virginia, which have enacted versions of the UCITA.[45] Alternatively, several recent cases seem to indicate a trend toward legitimation of such licenses through adaptation of general contract law.[46]

Yet, even if such licenses become more frequently enforceable, it is still extremely difficult for copyright holders to police such agreements, perhaps even more so than in the case of "seedwrap" liceneses discussed above. Consequently, copyright owners have begun deploying sophisticated software lock-out systems that prevent access to digitized content except on the terms dictated by the owner.[47] Such content management software, sometimes called digital rights management (DRM) systems, may govern a wide range of user behaviors, such as the number of times a work may be accessed, the duration of access, the ability to reproduce or transmit the work, and the payment schedule for additional access.[48]

For example, the DRM system might be programmed to permit only one playback of a work or allow only one copy of a work to be printed. Users may be able to pay for different levels of access and use if they wish to make additional copies or engage in additional playback of the work. Technological protection may also be combined with legal mechanisms; for example, access to technologically controlled content may be provisioned on agreement to a click-wrap-type license that purports to restrict the permissible uses of the work.[49] Similarly, the content management system may permit the owner to shut off the software remotely if the user fails to make the required payment in a timely manner; a controversial provision of UCITA would have made agreement to such self-help a valid term of computer information licenses.[50]

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44. *Id.* § 105(b), cmt 3.

45. *See* MD. CODE ANN., COM. LAW. §§ 22-101 to -816 (2002); VA. CODE ANN. §§ 59.1-501.1 to -509.2 (Michie 2001).

46. *See* Hill v. Gateway 2000, Inc., 105 F.3d 1147 (7th Cir. 1997); ProCD, Inc. v. Zeidenberg, 86 F.3d 1447 (7th Cir. 1996); M.A. Mortenson Co. v. Timberline Software Corp., 998 P.2d 305 (Wash. 2000).

47. *See* Julie E. Cohen, *Some Reflections on Copyright Management Systems and Laws Designed to Protect Them*, 12 BERKELEY TECH. L.J. 161 (1997); Kenneth W. Dam, *Self-Help in the Digital Jungle*, 28 J. LEGAL STUD. 393 (1999).

48. *See* Mark Stefik, *Shifting the Possible: How Trusted Systems and Digital Property Rights Challenge Us to Rethink Digital Publishing*, 12 BERKELEY TECH. L.J. 137 (1997).

49. *See* Michael J. Madison, *Legal-Ware: Contract and Copyright in the Digital Age*, 67 FORDHAM L. REV. 1025 (1998).

50. *See, e.g.*, UNIF. COMPUTER INFO. TRANSACTIONS ACT § 816 (Draft of Oct. 15, 1999) (allowing electronic self-help upon a separate manifestation of assent); UNIF. COMPUTER INFO. TRANSACTIONS ACT § 816 (Final Act 2000) (restricting electronic self-help in non mass market licensing), *available at* http://www.law.upenn.edu/bll/ulc/ulc_frame.htm. This provision proved so

In this environment, where technology provides the first line of defense against unauthorized uses of content, the legal protection preferred by content owners may be not so much a deterrent against violation of copyright or similar proprietary rights, as a deterrent against circumvention of technological protections.[51] In the United States, content owners have gained such protection in the form of the Digital Millennium Copyright Act (DMCA), which prohibits circumvention of technical protection measures and trafficking in technology that would facilitate such circumvention.[52] This statute effectively provides content owners with a new right of technological access, independent of any intellectual property right. Language promulgating similar legal measures has appeared in a recent European Union Copyright directive.[53]

The implications of the development of lock-out technology are striking: by implementing technical constraints on access to and use of digital information, a copyright owner can effectively supersede the rules of intellectual property law.[54] For example, as described above, the copyright owner may decide that the technological controls will not permit any copying of the controlled content, whether or not the copying would be permissible under a statutory user exemption such as fair use. If the integrity of the controls is backed by the state, as it is under the DMCA's anti-circumvention provisions, the result is to shift enforcement of the rights-holder's interest from penalties for unauthorized infringement to penalties for unauthorized access, deterring otherwise legitimate uses of the protected content. When combined with statutory enactments such as the UCITA or judicial decisions favoring the licensing terms promulgated by information producers, these developments dramatically alter the balance of ownership and control of new digital technologies.[55]

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controversial that the final draft excluded such provisions. *See* UNIF. COMPUTER INFO. TRANSACTIONS ACT § 816 (2002).

51. *See* Eric Schlachter, *The Intellectual Property Renaissance in Cyberspace: Why Copyright Law Could Be Unimportant on the Internet*, 12 BERKELEY TECH. L.J. 15 (1997).

52. Digital Millennium Copyright Act, Pub. L. No. 105-304, 112 Stat. 2860 (1998) (codified as amended in scattered sections of 17 U.S.C.).

53. Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the Harmonization of Certain Aspects of Copyright and Related Rights in the Information Society, 2001 O.J. (L 167) 10.

54. *See* Glynn S. Lunney, Jr., *The Death of Copyright: Digital Technology, Private Copying, and the Digital Millennium Copyright Act*, 87 VA. L. REV. 813 (2001).

55. *See* Niva Elkin Koren, *A Public-Regarding Approach to Contracting Over Copyrights*, *in* EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 191 (Rochelle Cooper Dreyfuss et al. eds., 2001).

II
LEGAL CONSTRAINTS ON CODE

The design of technical protection in genetic products may equally dramatically alter the balance of ownership and control in biological technologies, due to the constraints or values embedded in designs that limit the ability of consumers to exercise choice regarding the use of those products. Where either biological or digital technological constraints substitute for legal constraints, control over the design of information rights is shifted into the hands of private parties who may or may not honor the public policies that animate public access doctrines such as copyright fair use or the PVPA "farmer's exemption." Rights holders can effectively write their own intellectual property statutes in either software or DNA. This shift to private control challenges the traditional role of the state in determining the limits of property and contract, as well as the accepted philosophical assumptions underlying these legal institutions.

A. Legal Rules and Technological Rules

The development of digital content management systems constitutes a graphic demonstration of the power of technology to regulate behavior. As both Larry Lessig[56] and Joel Reidenberg[57] have pointed out, technical standards are within the control of the designer and so confer upon the designer the power to govern behavior with regard to that system.[58] Once constraints on behavior are built into the technical standards governing a technology, the technical standards effectively become a new method for governing use of that technology—in essence, the technical standards, or "code," become a type of law. These technical rule sets may supplement or even supplant the legal rule sets designed to govern the same behavior.

Scholars studying the social effects of technology have long observed that "social shaping" is routinely accomplished through design that recruits the end user into a particular social role.[59] Consider, for example, the case

56. LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE (1999); *see also* Daniel A. Farber, *The Dead Hand of the Architect*, 19 HARV. J.L. & PUB. POL'Y 245 (1996) (observing how architectural design dictates academic social interaction); Neal Kumar Katyal, *Architecture as Crime Control*, 111 YALE L.J. 1039 (2002) (discussing building and neighborhood design to channel behavior).

57. *See* Joel Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules Through Technology*, 76 TEX. L. REV. 553 (1998).

58. *See* Mark A. Lemley, *Intellectual Property Rights and Standard Setting Organizations*, 90 CALIF. L. REV. 1889, 1896 (2002) (defining standards broadly as "any set of technical specifications that either provides or is intended to provide a common design for a product or process").

59. *See, e.g.*, Stephen R. Barley, *The Alignment of Technology and Structure Through Roles and Networks*, 35 ADMIN. SCI. Q. 61 (1990); Hugh MacKay et. al, *Reconfiguring the User: Using Rapid Application Development*, 30 SOC. STUD. SCI. 737 (2000); Steve Woolgar, *Configuring the User: The Case of Usability Trials*, *in* A SOCIOLOGY OF MONSTERS: ESSAYS ON POWER, TECHNOLOGY, AND DOMINATION 57 (John Law ed., 1991). Under this view of technology, known as "actor-network theory," or "ANT," both humans and artifacts play out roles that have been scripted for them by a

suggested by Bruno Latour, in which the state wishes to enforce safety standards by requiring all automobile drivers to use seat belts.[60] One method to produce the desired behavior is to pass laws penalizing the failure to use such harnesses. However, an alternative method to produce the desired behavior is to fit automobiles with seat belt interlocks that prevent the car's ignition from functioning unless the seat belt is fastened to complete an electronic circuit. Either method controls the behavior of drivers, penalizing the failure to buckle up: in the first instance by means of a fine, and in the second by disabling the operation of the automobile. Thus, the government may choose to employ or enforce technical standards to achieve goals that might otherwise be achieved by legal rulemaking.

The use of technological rules to govern behavior has been dubbed by Joel Reidenberg as "lex informatica."[61] Reidenberg has examined in particular detail the complex set of interactions through which governmental action can shape technological standards into a substitute for legal controls. The state may implement the technological alternative through a variety of regulatory mechanisms from a variety of sources. Most directly, the state might simply require automobile manufacturers to install seat belt interlocks on all cars produced.[62] Alternatively, courts, or legislatures acting through courts, could impose liability for deaths or injuries on manufacturers who fail to install seat belt interlocks, creating an incentive to include the feature in cars. Similar liability could be imposed on car drivers or owners, creating a consumer demand for manufacturers to install the devices. Ancillary social actors, such as insurers, may also be mobilized to ensure installation of the technological feature. For example, if liability is imposed on drivers who fail to adopt the technology, insurance payments for such drivers will likely increase. Insurers will presumably decrease premiums for drivers who lessen their liability by adopting the technology, partially subsidizing the cost of adoption. The network of incentives that produces a given technological "script" is therefore complex, and private actors may be directly or indirectly mobilized by governmental initiatives.

1. The Limits of Private Lawmaking

The design of technological rule sets, however, is not the sole provenance of the state; indeed, it is more often left in the hands of private parties. In the case of DRM systems, copyright owners, with the tacit approval of the state, have already begun to determine the rules that are embedded

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complex web of social relations. *See* John Law, *After ANT: Complexity, Naming, and Topology*, *in* ACTOR NETWORK THEORY AND AFTER 4 (John Law & John Hassard eds., 1999).

60. Bruno Latour, *Where are the Missing Masses? The Sociology of a Few Mundane Artifacts*, *in* SHAPING TECHNOLOGY/BUILDING SOCIETY: STUDIES IN SOCIOTECHNICAL CHANGE 225 (Weibe E. Bijker & John Law eds., 1992).

61. *See* Reidenberg, *supra* note 57.

62. *See* JERRY L. MASHAW & DAVID L. HARFST, THE STRUGGLE FOR AUTO SAFETY (1990).

into the technological controls. These embedded rules effectively supplant statutory copyright rules, as choices such as fair use that might be permitted under the statute become physically impossible.[63] Moreover, to the extent that the DMCA appears to legitimate technological controls over copyrighted works without regard to their effect on public policy, the statute effectively grants rubber-stamp approval to such private "legislation."[64]

Although there exists at present no similar anti-circumvention statute sanctioning technological controls for genotechnology, other private property statutes might be used to produce the same result. For example, prior to passage of the DMCA, copyright owners made attempts to characterize the circumvention of DRM technologies as violations of the copyright or patent in the DRM software itself.[65] Similarly, given that the anti-germination technology described here is patented, attempts to tamper with or reverse engineer it could constitute patent infringement. When so employed, the patent in the anti-germination technology essentially becomes a form of anti-circumvention law.

The development of such technological controls over use, whether in software or transgenic corn, should raise concern because it substitutes private technological rules for the public statutory rules declared by Congress in the Copyright Act or the PVPA. Producers who employ such lock-out technology may in essence become private legislatures, imposing rules of usage without regard to the broader public interest that informs democratic rule making.[66] This problem has been well explored with regard to digital technology, but its application to genetic engineering has yet to be fully considered.[67] The instantiation of a proprietary rule in genetic code, which following Reidenberg, we might call "lex genetica," is the first example of regulation through genetic code, but it is unlikely to be the last.

2. *Public Policy Limitations*

Of course, the promulgation of technologically embedded rule sets is not the first situation in which private allocation of rights in information has been encouraged and enforced by public institutions. Most notably, the

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63. *See* Dan L. Burk & Julie E. Cohen, *Fair Use Infrastructure for Rights Management Systems*, 15 HARV. J.L. & TECH. 41 (2001).

64. *See* Niva Elkin-Koren, *The Privitazation of Information Policy*, 2 ETHICS & INFO. TECH. 201 (2000); Charles R. McManis, *The Privatization (or "Shrink-Wrapping") of American Copyright Law*, 87 CALIF. L. REV. 173 (1999).

65. *See* Atari Games Corp. v. Nintendo of Am., Inc., 975 F.2d 832 (Fed. Cir. 1992).

66. *See* W. David Slawson, *Standard Form Contracts and Democratic Control of Lawmaking Power*, 84 HARV. L. REV. 529, 530-31 (1971) (characterizing promulgation of form contracts as private lawmaking); *see also* David V. Snyder, *Private Lawmaking*, 64 OHIO ST. L.J. 371 (2003) (characterizing private regulatory activity as private lawmaking).

67. *See* J.H. Reichman & Jonathan A. Franklin, *Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract With Public Good Uses of Information*, 147 U. PA. L. REV. 875 (1999).

coercive power of the state is routincly brought to bear in the case of contractual agreements, including confidentiality agreements and intellectual property licenses. Since technical controls can impose conditions that formerly might have been the subject of a detailed license agreement, such controls might be viewed as equivalent to a sort of licensing regime. Then, extending the analogy, penalties for circumvention of the technological constraints simply stand in for the private law of contract, which penalizes breach of a contractual agreement.

The comparison to contract by no means justifies employment of technical controls that contravene established public policy. Where traditional contracts are at issue, carte blanche enforcement of private agreements has never becn the rule in Anglo-American law. As discussed above, such agreements are held unenforceable whencver they are found to be illegal, unconscionable, or simply in violation of public policy.[68] Because contract law is state law, a similar result also may be reached on grounds of federalism: where enforcement of a state law contract would violate the public policy inherent in the federal intellectual property scheme or embedded in the Constitution itself, the contractual provision is preempted.[69] An attempt to leverage the right beyond the limits set by federal policy similarly constitutes grounds for voiding the contract.

To the extent that programmable computer or biological code confronts us with behavioral constraints that are analogous to contractual provisions enforced by legal action, we face much the same dilemma we have previously faced with regard to contractual constraints. This point has perhaps been argued most forcefully by Julie Cohen, although not in precisely these terms, when she opines on the potential for constitutional preemption of certain technological content management constraints.[70] Cohen suggests that the coercive power of the state should be extended in support of technological content management constraints no farther than it may be extended to enforce statutory or contractual constraints. This conjecture, which Lessig has dubbed the "Cohen Theorem,"[71] might be applied in either private or public law settings to restrain the implementation of technological constraints by, respectively, either individuals or the state.[72]

Under the Cohen Theorem, technological analogs to contracts should not be privileged more than the contracts themselves. When rights

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68. *See* RESTATEMENT (SECOND) OF CONTRACTS § 178 (1979).

69. *See, e.g.*, Lear, Inc. v. Adkins, 395 U.S. 653 (1969); Brulotte v. Thys Co., 379 U.S. 29 (1964); Vault Corp. v. Quaid Software, Ltd., 775 F.2d 638 (5th Cir. 1985).

70. Julie E. Cohen, *Copyright and the Jurisprudence of Self-Help*, 13 BERKELEY TECH. L.J. 1089 (1998).

71. *See* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 257 (2001).

72. *See also* Snyder, *supra* note 66, at 357 (calling for application of public policy limits to private lawmaking).

management systems attempt to impose restrictions on access to or use of informational content that would be improper in a contractual agreement, the restrictions should be viewed as equally repugnant to public policy and equally void. Stated differently, where the Constitution imposes limits on the government's creation and recognition of property rights in intellectual goods, those limits should apply equally to both legally and technologically delineated property. This might occur, for example, where statutorily protected technological controls curb free speech in excess of the balance struck in the Copyright Act. In some instances of overreaching via technological controls, the Constitution may even demand a limited self-help right, or "right to hack," to surmount privately erected technological barriers to information that the Constitution requires be publicly accessible.

One would expect a similar result with regard to parallel provisions in seed-wrap licenses. For example, federal policy granting a research or farmer's exemption under the PVPA might abrogate seed-wrap terms that would frustrate the intent of such statutory provisions. A similar situation may result in the wake of the Supreme Court's *J.E.M.* decision, which indicates that utility patents may also be the basis for some seed licensing.[73] Although these patents lack meaningful research or farmer's exemptions, overreaching patent licensing might constitute misuse of the patent or an antitrust violation in excess of the rights intended by the statutory grant.[74] In past cases where such misconduct has occurred, courts have declined to enforce the overreaching license, and overreaching seed-wrap licenses based on patent rights might be void on such grounds.

Yet, even assuming the preemption of some seed-wrap terms, it is less clear what rights might form the jurisprudential basis for a right to hack technological lock-out measures outside the context of digital technology. The tension between free speech and copyright has been judicially recognized[75] and academically explored,[76] and the limits upon congressional power have been the subject of long scrutiny. Technological controls over creative works are only the most recent chapter in that policy discussion. Biological controls, however, appear to lack any similar policy precedent. Unlike content management systems, anti-germination systems do not implicate a fundamental human right to receive information. No court has

73. *See* Janis & Kesan, *supra* note 19, at 1163-64.

74. *Cf.* Julie E. Cohen, *Reverse Engineering and the Rise of Electronic Vigilantism: Intellectual Property Implications of "Lock-Out" Programs*, 68 S. CAL. L. REV. 1091, 1190 (1995) (discussing patent protection for digital rights management as misuse).

75. Harper & Row, Publishers, Inc. v. Nation Enters., 471 U.S. 539, 558 (1985).

76. *See* L. Ray Patterson, *Free Speech, Copyright, and Fair Use*, 40 VAND. L. REV. 1, 3 (1987); Harry N. Rosenfield, *The Constitutional Dimensions of "Fair Use" in Copyright Law*, 50 NOTRE DAME LAW. 790, 796-98 (1975); Lionel S. Sobel, *Copyright and the First Amendment: A Gathering Storm?*, 19 COPYRIGHT L. SYMP. (ASCAP) 43, 66 (1971); *see also* Robert C. Denicola, *Copyright and Free Speech: Constitutional Limitations on the Protection of Expression*, 67 CALIF. L. REV. 283, 289-99 (1979); Melville B. Nimmer, *Does Copyright Abridge the First Amendment Guarantees of Free Speech and Press?*, 17 UCLA L. REV. 1180, 1190 (1970).

plicate a fundamental human right to receive information. No court has ever recognized a constitutional right to save seed or to engage in agricultural research. Some commentators have argued in favor of a general First Amendment right to engage in scientific research,[77] but the legitimacy of such arguments is unsettled and their application to proprietary organisms uncertain.[78]

However, a variety of international commentators, particularly those concerned with the development of poorer nations, have raised objections to GURTs as a threat to adequate food supplies.[79] The concentration of seed technology in a very few firms, when accompanied by legal or technological exclusivity, could make needed agricultural technology inaccessible to poorer nations. The production of adequate food implicates a human right that in many quarters would be viewed as more fundamental, or at any rate more pressing, than the right to free expression. International human rights conventions list access to adequate food as a fundamental right,[80] although it is unclear what this might mean in the context of U.S. law. No serious jurisprudence has developed in the United States concerning this right, and the incorporation of international economic obligations into American law is a topic well beyond the scope of this article.[81] Nonetheless, the primacy of this right in international treaties suggests the possibility of looking beyond the U.S. Constitution for a compelling public policy interest that may in some ways parallel the speech interest in analyses of digital content.

In some instances, a right to hack anti-germination technology might be inferred from the constitutional jurisprudence of supremacy. To the extent that anti-germination technology interferes with federal policy embodied in the PVPA, it might be treated as equivalent to the state law contract

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77. Richard Delgado & David R. Millen, *God, Galileo, and Government: Toward Constitutional Protection for Scientific Inquiry*, 53 WASH. L. REV. 349 (1978); Harold P. Green, *Constitutional Implications of Federal Restrictions on Scientific Research and Communication*, 60 UMKC L. REV. 619 (1992); John A. Robertson, *The Scientist's Right to Research: A Constitutional Analysis*, 51 S. CAL. L. REV. 1203 (1977).

78. *See* Dan L. Burk, *Patenting Speech*, 79 TEX. L. REV. 99 (2000).

79. RICHARD A. JEFFERSON, UNITED NATIONS ENVIRONMENTAL PROGRAMME, TECHNICAL ASSESSMENT OF THE SET OF NEW TECHNOLOGIES WHICH STERILIZE OR REDUCE THE AGRONOMIC VALUE OF SECOND GENERATION SEED, AS EXEMPLIFIED BY U.S. PATENT NO. 5,723,765 AND WO 94/03619, 151-55 (1999), *available at* http://www.cambia.org.au/downloads/CBDAnnex%20RAJ.pdf.

80. *See* G.A. Res. 217, U.N. Doc. A/810, at 76 (1948) ("Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food, clothing, housing, and medical care . . . ."); G.A. Res. 2200, 21 U.N. GAOR, 21st Sess., Supp. No. 16, at 49, U.N. Doc. A/6316 (1966).

81. *See* Robert L. Bard, *The Right to Food*, 70 IOWA L. REV. 1279, 1289 (1985); Barbara Stark, *Economic Rights in the United States and International Human Rights Law: Toward an "Entirely New Strategy"*, 44 HASTINGS L.J. 79 (1992). The current administration has taken the position that "the U.S. understands the right of access to food to mean the *opportunity* to secure food, and not a guaranteed entitlement." U.S. Mission to the U.N. Food and Agriculture Organization, *Annex II: Explanatory Notes/Reservation*, *in* REPORT OF THE WORLD FOOD SUMMIT: FIVE YEARS LATER (2002).

that it supplants: both the contract and the technological lock-out system must give way before federal policy. Such preemptive policies might include the federally promulgated right to save seed or the right to use protected varieties to conduct research. However, this argument has less force where the contract, or its technological equivalent, sound in patent rights that do not provide for such user privileges. Patents that overlap PVPA rights appear under the *J.E.M.* analysis to eradicate the exemptions in the PVPA.[82] Either contracts or technological constraints arising from such patents might be seen to do the same.

Nevertheless, there remain a number of instances in which the technological equivalent to a patent license might be seen as overreaching in the same manner as a patent license, giving rise to a user right to circumvent the technological control.[83] This might be the case, for example, in situations equivalent to patent misuse, such as where a technological restriction extends beyond the term of the underlying patent right. It is important to note that no explicit anti-circumvention statute currently prohibits the hacking of GURTs biological controls. However, because restriction technology is patented, direct and contributory patent infringement may preclude circumvention of GURTs. Thus, under the Cohen Theorem, enforcement of the patent that precludes GURTs hacking might be denied if enforcement of the patent creates a result equivalent to overreaching.

However, recognizing a right to hack GURTs presents certain practical problems. Even if a sound legal basis for the right to circumvent technological protections can be found, the practical implementation of a right to hack may be problematic outside the context of digital technology. Few ordinary consumers have the personal knowledge and skill necessary to reverse engineer and circumvent technical protections. In the case of DRM circumvention, one of the primary concerns addressed by the DMCA was the widespread provision of user-friendly circumvention "tools" to the general public by technically sophisticated hackers.[84] There appears to be no comparable community of biological hackers who might either personally have the skill to circumvent biological lock-out coding or supply users with the tools to circumvent such code. Unless such tools are available, it is unclear how effective a right to circumvent GURTs would be.

B. Regulating Technological Scripts

While the Cohen Theorem suggests some limits to the permissible effects of technical controls, embedding such controls in digital or biological systems nonetheless challenges the existing order of control and ownership of technology. These embedded controls move product usage

82. *See* Monsanto Co. v. McFarling, 302 F.3d 1291, 1299 (Fed. Cir. 2002).

83. *Cf.* Dan L. Burk, *Anticircumvention Misuse*, 50 UCLA L. REV. 1095 (2003).

84. *See* 17 U.S.C. § 1201 (a)(2) (2000) (prohibiting trafficking in anticircumvention devices).

discretion away from users and toward producers and concomitantly moving control decisions away from *ex post* enforcement and toward *ex ante* design decisions. The resulting re-configuration of power between producer and user is in many ways dramatic. However, the drama of this shift may be more a matter of degree than of kind. The substitution of technological controls for legal controls may be viewed as a subset of a more general phenomenon. The use of technological constraints to channel behavior predates programmable artifacts, and the idea that technology embodies rules is not new. I have noted that Bruno Latour identified the scripted nature of different artifacts, pointing out, for example, that automobile seat belts with ignition interlocks embody a type of "script," or rule, requiring a driver to take the particular action of fastening the seat belt before driving.[85] Similarly, a locked door effectively embodies a script against unauthorized entry. Speed bumps, which Latour dubs "sleeping policemen" may be placed in a road, implementing a traffic regulation script to drive slowly.[86] These artifacts are not programmable in the sense that software or DNA may be programmed with a wide range of attributes, but nonetheless the physical construction of the door enforces its particular prohibition, just as the electromechanical script of the ignition interlock enforces its particular prohibition.

In digital media, a similar physical design script might be illustrated by the recent production of DVDs that, much like the anonymous directive audio tapes in the old *Mission: Impossible* television show, self-destruct after use. The DVDs are formed of a substance that degrades after the packaging is opened, limiting the life of the product after purchase.[87] The discs are composed of a polymer that begins to darken when exposed to air; when the reaction reaches a certain degree of opacity, the data on the disc can no longer be read by the laser in a playback machine. The polymer can be formulated so that the darkening process takes twenty-four, forty-eight, or some other specified number of hours, so that the consumer essentially pays for a set period of access to the content. The process can reportedly be slowed by refrigeration, but eventual illegibility is an irreversible characteristic of the product's physical structure.

The composition of such DVDs provides a relatively simple design script; DRM and GURTs systems may embody more complex scripts. Thus, although programmability certainly increases the range and complexity of artifactual scripts, this may represent a difference of degree, rather than a difference of kind. Myriad user constraints are routinely built

85. *See* Latour, *supra* note 60, at 225-26; *see also* Madeleine Akrich, *The De-Scription of Technical Objects*, *in* SHAPING TECHNOLOGY/BUILDING SOCIETY: STUDIES IN SOCIOTECHNICAL CHANGE 205 (Weibe E. Bijker & John Law eds., 1992).

86. *See* Latour, *supra* note 60.

87. Eric A. Taub, *DVDs Meant for Buying but Not for Keeping*, N.Y. TIMES, July 21, 2003, at C1.

into all kinds of artifacts, and all of them will entail some set of values: the hinge design causes the door to swing in a particular direction, the doorknob is set at a particular height and requires a certain degree of manipulation to open, and so on. Many of these constraints go unnoticed as part of the artifactual backdrop of society, while other constraints implicate important social values, either supporting or frustrating such values. Such effects may be intentional or unintentional; the door may be unintentionally difficulty for physically disabled persons to open, or may be intentionally difficult for small children to open, or may even unintentionally frustrate use by the physically disabled precisely because it was designed to retard use by small children.

The creation of such artifactual scripts may be influenced by state action. As suggested by the seat belt example above, technological design may be either directly or indirectly determined by a range of regulatory interventions.[88] But in market-based economies, such intervention is typically limited to design features that have a noticeable effect on public health or safety, or to extraordinary regulation, such as removal of architectural barriers that hamper the activities of the disabled.[89] On rare occasions, courts have also penalized, as antitrust violations, certain "predatory" design choices that are technological attempts to tie together interoperable products, effectively excluding consumer adoption of products produced by competitors because of technological incompatibility.[90]

But outside such unusual regulatory interventions, the vast majority of technological choices go largely unregulated, as we primarily entrust to market forces the task of weeding out over time the most inefficient or unusable designs. Indeed, the gravamen of the "predatory design" case is that a dominant producer has attempted to improperly skew this market-sorting process. Although it is understood that such markets may be subject to network effects,[91] incomplete information, and a wide range of market failures that could in fact hamper the efficient development of such designs,

88. MASHAW & HARFST, *supra* note 62.

89. 42 U.S.C. §§ 12182 (b)(2)(A)(iv), 12183 (a)(1)- (2) (2000).

90. *See* 1 HERBERT HOVENKAMP ET AL., IP AND ANTITRUST § 12.3c (2002). At least, in theory:

> In some instances, two products might be illegally tied through the technological relationship between them. If, for example, the systems software was designed to only be compatible with a specific hardware configuration, and that specific hardware configuration, because it is based on information held only by the seller, is only available from that seller, then a violation might be found. But such a violation must be limited to those instances where the technological factor tying the hardware to the software has been designed for the purpose of tying the products, rather than to achieve some technologically beneficial result.

Response of Carolina, Inc. v. Leasco Response, Inc., 537 F.2d 1307, 1330 (5th Cir. 1976).

91. Such effects occur when adoption of a certain product incrementally affects the value of the product to other users. *See generally* Michael L. Katz & Carl Shapiro, *Network Externalities, Competition, and Compatibility*, 75 AM. ECON. REV. 424 (1985) (describing the economics of network effects); Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CALIF. L. REV. 479, 551 (1998) (analyzing the importance of network effects in a variety of legal settings).

the market approach is assumed on the whole to operate more ably than command-and-control intervention by the state.

This market approach itself undoubtedly imbues the resulting artifacts with particular embedded values, and users of any given technology will for the most part be unaware of the values embedded in that technological system. Indeed, this is one of Reidenberg's key objections to a wholly free market approach to information technology development: unknown to the general populace, the approach is not "free" at all, but cedes to technologists choices that may later dictate the freedom of or constraints upon users.[92] Reidenberg's preferred solution appears to be one of governmental oversight or involvement, at least in democratic states. Governmental bodies may exercise such oversight through a variety of channels, including direct regulation, standard setting, procurement, criminal or civil penalties, and so on.[93] Reidenberg reasons that involvement by elected officials, or at least by bureaucrats answering to elected officials, better reflects and implements the will of the majority than does independent design by unelected technocrats.

But, as detailed above, explicit legal or regulatory intervention into technological design is relatively rare, and for good reason. Unless we are willing to countenance wholesale state oversight of every routine design decision, we must somehow separate out those design constraints that implicate public policy from those that we have previously treated as innocuous, or at least as commonplace. This separation has long been taken for granted; in a conventional transaction involving the use or exchange of an artifact, we have typically separated the values embedded in the artifact from the legal values governing the transaction. For example, when a consumer purchases an automobile featuring seat belt interlocks, we could conceptualize as a term of the transaction, embedded in the artifact, "the purchaser will be required to fasten her seat belt prior to driving." We have not done so, however, and in fact tend to separate even a public legal requirement to use seat belts from the terms of the private transaction; no promise to use seat belts is written into automobile sales contracts or leases, despite laws requiring seat belt use.

To be sure, some regulatory intervention may occur at the point of legal transaction if the nexus between the two seems sufficiently close. The licensing of the vehicle or transfer of the license may be incorporated into the transaction, if for no other reason than it provides a convenient control point for the state to ensure that such licensing occurs. But a conceptual nexus for such incorporation has been relatively rare. Returning to the case of the automobile, other regulatory interventions, such as the requirement

92. *See* Reidenberg, *supra* note 57, at 586.
93. *Id.* at 588-92.

that the driver be licensed or carry proper accident insurance, appear to have an insufficient nexus with the sale of the vehicle.

In much the same way, explicit legal or regulatory intervention into "private lawmaking" via contract is relatively rare. If our past experience with law in fact maps onto the territory of technological constraints, we would expect only a subset of such constraints to trigger legal safeguards, as the Cohen Theorem advocates. The vast majority of both private and public lawmaking goes relatively unremarked, routinely functioning without the application of extraordinary judicial or constitutional remedies. Only a small number of contracts are struck down as unconscionable or void for public policy, just as few statutes are struck down as unconstitutional. Presumably an equally small or smaller number of design choices would embody void or objectionable scripts equivalent to an impermissible private bargain.

The antitrust predatory design cases alluded to above are relatively rare for precisely this reason: it is enormously difficult to determine when a product has been designed to lack compatibility with competing products for predatory, anticompetitive purposes and when it has been so designed for rather routine technical reasons.[94] Distinguishing routine technical design decisions from those violating constitutional or social policies is bound to be equally difficult. Yet the current literature analyzing technological constraints gives no clear guidance on where routine or garden variety design choices begin to shade over into legally cognizable constraints or which legally cognizable constraints should be abrogated as contrary to existing public policy.

III
TAKING CODE SERIOUSLY

Summing up to this point, I have argued that the advent of programmable technical constraints creates two intertwined difficulties: first, determining where legally cognizable technology choices leave off and where routine, if sometimes troubling, technological design choices begin; and second, once legally relevant technology choices have been identified, determining how social policy choices that have been implemented in law will be implemented in its technological analogs. The lines drawn in each case may differ according to the technology involved. To date, much of the literature discusses these issues in the context of digital media. However, the advent of biological code requires extension and perhaps amendment of

94. *See In re* IBM Peripheral EDP Devices Antitrust Litig., 481 F. Supp. 965, 1003 (N.D. Cal. 1979) *aff'd sub nom.* Transamerica Computer Co. v. Int'l Bus. Machs. Corp., 698 F.2d 1377 (9th Cir. 1983) ("[U]sually [in product design] many results are intended, and if only one, even the predominating, intent is illegal, and thus punished, legitimate incentives will be imperiled."); 1 HOVENKAMP ET AL., *supra* note 90, at § 12.3c.

the conclusions developed in the digital context. Although digital and biological lock-out systems bear many analytical similarities, they arise in different milieux. Both pose challenges to traditional principles of contract and property law, but the theoretical and practical challenges may differ according to the technology involved. Consequently, in this final section, I examine certain implications of previous arguments asserted regarding digital code as they apply more generally to technological controls, particularly the logical results of arguments equating code with contract law.

A. Code and Consent

The development of technological protections is closely tied to the development of standardized mass market contracts for licensing intellectual property. Whether shrink-wrap associated with software or seed-wrap associated with transgenic plants, such contracts may serve as an adjunct to technological protections, setting the terms for authorized access or use. Contracts and technological protections may also serve to some degree as substitutes for each other, although the latter form of protection is, as a practical matter, more stringent, lacking not only the monitoring and enforcement costs, but also the flexibility of its legal counterpart.

However, if the emergence of technological protections has stirred controversy, so too has the emergence of its legal equivalent, the form contract.[95] As I have briefly indicated above, the development of the standardized form contract has challenged the traditional notion of contract as an informed exchange of legally binding promises.[96] Despite their proliferation in many areas of commerce, such contracts certainly are not read or understood by the majority of those individuals they purport to bind, and though they are quite routinely upheld, it cannot be on the basis of conscious agreement. As Todd Rakoff famously observed, the terms of such standardized agreements tend to become "invisible" to consumers, who will remain rationally ignorant of their provisions unless and until they are surprised by some term to which they have supposedly agreed.[97] Agreement to such contractual terms, as agreement is generally understood, cannot credibly even rise to the level of a legal fiction.

Noting this problem, commentators have sought to rehabilitate the mass market contract as agreement premised on a different kind of consensus between buyer and seller.[98] This view shifts the agreement to bargains on the basis of consent—under this theory, the purchaser, rather than agreeing to certain terms, consents to be legally bound. The supposed

95. *See* Arthur Allen Leff, *Contract as Thing*, 19 AM. U. L. REV. 131 (1970).

96. *See supra* notes 35-36 and accompanying text; *see also* Robert A. Hillman & Jeffrey J. Rachlinski, *Standard-Form Contracting in the Electronic Age*, 77 N.Y.U. L. REV. 429 (2002).

97. Todd D. Rakoff, *Contracts of Adhesion: An Essay in Reconstruction*, 96 HARV. L. REV. 1173, 1250-54 (1983).

98. *See* Randy E. Barnett, *Consenting to Form Contracts*, 71 FORDHAM L. REV. 627 (2002).

consent in such a bargain is not necessarily what would be colloquially considered consent, but rather is a type of generalized, rationally ignorant, blanket consent to be bound by a legal obligation of some sort, even if the purchaser is quite unaware of what sort of obligation she is undertaking.[99] Unfortunately, this rationalization for such contracts proves equally unsatisfactory, as wholesale enforcement of "consent" to unknown contract terms may prompt the drafter to include the most outrageous terms possible, and the consumer cannot seriously be regarded as acquiescing to such terms. Admittedly, a court may declare the most outrageous terms void or unconscionable after the fact, but this leaves the consumer alternately at the mercy of the vendor or the mercy of the judge—an odd and tortured form of consent.

Given the difficulty of explaining form contracts as any sort of agreement, whether actual or implied, the explanation of standardized contracts has increasingly shifted to a theory of contract as product.[100] Under this view, the contract itself is the product being purchased, or at least a feature of the product being purchased.[101] Setting aside the opportunity for contractual breach, the consumer regards purchasing a movie disc that self-destructs after forty-eight hours as economically equivalent to purchasing a movie disc that she is contractually obligated to cease viewing after forty-eight hours—the consumer receives two days' worth of entertainment value in either case. Similarly, the farmer views seeds that will not reproduce and seeds accompanied by a contract forbidding reuse in the same fashion. The provisions of the mass market contract become "take it or leave it" terms, just like the characteristics of any other off-the-shelf mass market product.

It is this last conceptual shift to "take it or leave it" that presages the introduction of technological protections into seeds or into software and provides the framework for considering the substitution of technology for contract.[102] Scripted or programmable artifacts take this rationale to its ultimate conclusion, by which the contract becomes in fact not merely an *economic* feature of the product, but an embedded *physical* feature as well. The contract need no longer be considered a conceptual feature adjunct to the product, but rather an actual feature of the product. Rakoff's classic distinction between visible and invisible terms thus becomes quite literal; the terms of the contract disappear into the structure of the object.

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99. Rakoff, *supra* note 97, at 1199-1200.

100. *See* Margaret Jane Radin, *Humans, Computers, and Binding Commitment*, 75 IND. L.J. 1125, 1126 (2000) (discussing shift to contract as product).

101. *See* Robert W. Gomulkiewicz, *The License is the Product: Comments on the Promise of Article 2B for Software and Information Licensing*, 13 BERKELEY TECH. L.J. 891 (1998); Nimmer, *supra* note 40, at 841.

102. *See* Radin, *supra* note 100, at 1126; Margaret Jane Radin, *Online Standardization and the Integration of Text and Machine*, 70 FORDHAM L. REV. 1125 (2002).

But the actual integration of contract into product poses both practical and theoretical problems for the functionality of private bargaining. Each of the successive conceptions of contract outlined above depends to a greater or lesser extent upon the informed choice of the consumer. Even the model of contract as product assumes a knowing purchase by the consumer for a smoothly functioning market. According to some commentators, particularly in the bargain or assent camp, the justification of contract rests fundamentally upon promotion of individual choice or autonomy.[103] According to others, particularly those employing an economic analysis, individual choice plays a central role in implementing the decentralized allocation of resources; by encouraging self-interested activity with minimal outside interference, resources are moved to their optimal use.[104] Thus, in this second set of theories, choice functions within an economic framework as a means to an end, rather than as an end in itself. At the same time, some apologists for an economic approach have melded the two theories, turning the relationship between autonomy and efficiency around to argue that a market-based approach to contract is desirable because it promotes autonomy.[105]

Under any of these approaches, excessive governmental intervention into the bargain may be decried as paternalism or interference with the autonomy of the contracting parties.[106] But the focus on autonomy in private bargaining creates a potential paradox regarding state intervention or paternalism. State intervention may in fact be necessary to preserve the autonomy or contractual freedom of certain parties, particularly when one party stands in a position of overwhelming power or influence. Typically, such asymmetrical bargaining positions are perceived to occur when one party has far more information than the other or when one party's range of choices are highly constrained due to lack of competitive alternatives.

In such situations, the terms of the agreement may be imposed by the stronger party, without the free consent of the other. The classic case for such asymmetrical bargains are consumer transactions, when a large corporate entity may have access to far more information about a product than the typical consumer or when the consumer's bargaining choices may be limited to few, or even one, vendors. Either situation may be understood in an economic framework as a form of market failure; were the market to

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103. Randy E. Barnett, *A Consent Theory of Contract*, 86 COLUM. L. REV. 269 (1986). *But see* Richard Craswell, *Remedies When Contracts Lack Consent: Autonomy and Institutional Competence*, 33 OSGOODE HALL L.J. 209 (1995) (outlining situations in which autonomy may be enhanced by enforcing contracts without consent).

104. RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 110 (5th ed. 1998).

105. Richard A. Posner, *The Ethical and Political Basis of the Efficiency Norm in Common Law Adjudication*, 8 HOFSTRA L. REV. 487 (1980); Richard A. Posner, *Utilitarianism, Economics, and Legal Theory*, 8 J. LEGAL STUD. 103 (1979).

106. *See* Anthony T. Kronman, *Paternalism and the Law of Contracts*, 92 YALE L.J. 763 (1983); Cass R. Sunstein, *Legal Interference with Private Preferences*, 53 U. CHI. L. REV. 1129 (1986).

operate perfectly, market forces would act to discipline contractual overreaching as informed consumers sought vendors offering better terms, forcing all vendors to offer similar terms. Similarly, in a well-functioning market, consumer objections to technological control might drive such controls from the market; if there is broad consumer demand for uncontrolled products, a producer who offers such uncontrolled products will rapidly capture a broad swath of the market and force other producers to abandon the controls as well to remain competitive.

The likelihood that consumers will compete technological controls out of the marketplace seems dimmed by the observation that the legal analog to such controls, mass market contracts, have neither disappeared, nor become more consumer friendly over time. This could of course be due to informed consumer approval of such contracts, as consumers freely and cheerfully consent to them. Alternatively, it may mean that market failure has left consumers with little choice other than to acquiesce to such contracts. Market failure of this type may in fact be very common; however, where the social system puts its faith in markets, the law assumes that these market failures will be rare.

The tradition in Anglo-American law has been that, for the most part, the state avoids intervention into particular terms of the contract. Courts classically refuse to inquire, for example, into the adequacy of consideration.[107] The state may withhold its coercive power in those rare cases where a party falls into a category clearly classified as lacking legally cognizable autonomy, such as that of minors or the mentally incompetent.[108] Equally rarely, a court may invoke a doctrine such as unconscionability to protect otherwise competent parties, especially individual consumers, from exploitation by more powerful or better informed parties.[109] Autonomy may also be promoted in unusual situations by other doctrines, such as rescission,[110] misrepresentation,[111] or mistake,[112] that might be viewed as designed to nullify agreements a party has entered into without full information, which may be to say without full autonomy.[113]

However, such doctrines are invoked rarely and with some reluctance because of their potential to supersede freedom of contract.[114] Judges are reluctant to override terms that may have been the preference of the

107. RESTATEMENT (SECOND) OF CONTRACTS § 79 (1979); E. ALLAN FARNSWORTH, FARNSWORTH ON CONTRACTS § 2.11 (2d ed. 1998 & Supp. 2000).

108. RESTATEMENT (SECOND) OF CONTRACTS § 12 (1979).

109. FARNSWORTH, supra note 107, at §4.28.

110. RESTATEMENT (SECOND) OF CONTRACTS § 283 (1979).

111. *Id.* § 164.

112. *Id.* § 153.

113. *See* Anthony T. Kronman, *Mistake, Disclosure, Information and the Law of Contracts*, 7 J. LEGAL STUD. 1 (1978).

114. *See* Mark Petit, Jr., *Freedom, Freedom of Contract, and the "Rise and Fall,"* 79 B.U. L. REV. 263 (1999).

contracting parties. Libertarian analysts denounce the doctrines for introducing the heavy hand of the state into private bargaining.[115] Economic analysts decry the potential for inefficiency.[116] Even analysts outside the free market economics tradition may be wary of such doctrines because they assume that certain classes of individuals cannot understand contractual terms or cannot formulate a legally recognizable desire to be bound by contractual terms. The historical inclusion of women together with children and mentally handicapped individuals as legal incompetents amply illustrates the danger of judicial preferences not merely to the success of a particular bargain, but to individual autonomy.[117] The melding of contract and product complicates the question of consensual bargain, but the history of contract law suggests that the state is unlikely to sort the question out.

B. Disclosure and Design

Consequently, although the state may forbid or invalidate certain contractual terms, it will more often mandate disclosure of terms.[118] For example, certain key terms to a mass market contract must be "conspicuous," which typically means printed in a larger, bolder, or more prominent typeface than terms considered less important or less potentially troublesome.[119] Such "paternalism lite" is intended to secure autonomous decision making by ensuring that information deemed important to a decision is available, without necessarily dictating the decision itself.[120] Of course, this approach assumes that the recipient of the information has the circumstantial latitude to act freely on the information provided. More interventionist doctrines may be invoked in those unusual occasions where the law may assume such latitude is lacking.

Instances of asymmetric information in contracts between consumer and seller may be common, even ubiquitous, due to the likelihood that consumers will not read or understand the fine print—if indeed there is even an opportunity to see it. In the mass market cases, courts have shown some reluctance to enforce written shrink-wrap licenses where information material to the transaction is disclosed subsequent to the transaction.[121] Freedom of contract in such situations may be little more than a sham and resistance to state intervention little more than an excuse to give the more powerful party in the transaction unrestrained latitude to impose oppressive or overreaching terms. The problem could in theory be ameliorated if the terms

115. Richard Epstein, *Unconscionability: A Critical Reappraisal*, 28 J.L. & ECON. 293 (1975).

116. *See* Posner, *Utilitarianism, Economics, and Legal Theory*, *supra* note 105, at 116.

117. *See* Petit, *supra* note 114, at 292, 306-12.

118. *See* Sunstein, *supra* note 106, at 1167.

119. *See* U.C.C. § 1-210(10) (2001) (defining "conspicuous").

120. *See* Donald H. Regan, *Justifications for Paternalism*, *in* THE LIMITS OF THE LAW: NOMOS XV 189, 190-91 (J. Roland Pennock & John W. Chapman eds., 1974).

121. *See, e.g.*, Specht v. Netscape Comm. Corp., 306 F.3d 17, 28-30 (2d Cir. 2002).

were sufficiently plain and consumers could be induced to read them. But where contract becomes product, the potential arises for a more persistent asymmetry of information. Although some features of the product may be apparent upon inspection, many features—especially those implementing contract-like scripts—will not be. The potential for abuse is far greater when the information material to the transaction is never disclosed, but remains embedded in the product.

Some movement toward disclosure of product characteristics has become evident in the case of copy-protected CDs, where consumers have sued manufacturers on grounds of products liability and deceptive practices, arguing that the product was defective or misleading to consumers since it would not perform as expected—that is, music could not be copied from the CD, as consumers have come to expect.[122] A suit of this kind in the United States was resolved by notices on the outside of the product, warning consumers that the disc would not play on CD-ROM drives or permit downloads to MP3 players.[123] Similar issues of consumer confusion or displeasure have led to objections by the owners of compact disc technology that music discs outfitted with technical protections are not properly labeled "CD."[124] As a result, publishers of copy-protected discs have treated them as a different product, not called or labeled "CDs."[125]

Such notice problems may well be presented by technologically protected seeds if disclosure is not mandated. If present, a seed-wrap license could serve as some notice of the product characteristics. But as technical protections replace written contracts, that form of notice may become diminished. Moreover, although the purchaser of seed may have the opportunity to read the agreement on the side of the bag, he has no ability to examine the programming of a seed, and cannot determine its constraints by examining the product, any more than a consumer has the opportunity to run chemical analysis on a drug before purchase. This is of course primarily a problem with initial encounters; as the farmer knows what to expect from certain types or brands of seed, GURTs constraints may appear more and more a normal feature of the product. But as the types of GURT constraints proliferate, the possibility for surprise from hidden characteristics, much like surprise from unexpected contractual terms, multiplies as well.

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122. *See* Jim Hu, *Lawsuit Targets Copy Protection*, CNET News.com, *at* http://news.com.com/2100-1023_3-272784.html?tag=rn (last modified Sept. 7, 2001); *see also* Reuters, *Consumer Group Sues Over Copy-Protected CDs*, CNET News.com, *at* http://news.com.com/2100-1027_3-5134830.html (last modified Jan. 5, 2004) (Belgian consumer lawsuit).

123. *See* Lisa M. Bowman, *Consumer Claims Victory in CD Lawsuit*, CNET News.com, *at* http://news.com.com/2100-1023-843114.html (last modified Feb. 2, 2002).

124. *See* Evan Hansen, *Dion Disc Could Bring PCs to a Standstill*, CNET News.com, at http://news.com.com/2100-1023-876055.html (last modified Apr. 4, 2002).

125. *Id.*

This suggests a need to equalize the informational disparity regarding scripted products. However, if the traditional solution of disclosure is to be the mechanism for equalization, the precise contours of the needed disclosure remain problematic. In the contractual setting, there is typically no disclosure requirement surrounding transactions,[126] although in the sale of goods there may be a duty to disclose material *defects* known to the seller.[127] Design choices or embedded technological values are certainly integral to the function of a product, but are not necessarily defects. The rare instances where design choices are the subject of disclosure tend to arise in the area of products liability, where an industrial product is found to have dangerous characteristics not apparent upon consumer examination,[128] leading to the proliferation of consumer warning labels on every conceivable product from hair dryers to mattresses. Disclosure of the potential danger allows the manufacturer of the product to avoid liability for injury by virtue of the consumer's voluntary acceptance of the danger. But non-dangerous design choices are typically mandated by neither contract nor tort theories. Courts do not require that an automobile seller reveal, for example, that a car was designed on the assumption that exhaust manifolds would need replacement every ten years, that gasoline prices would remain at $1.35 per gallon, that automobile factory workers' wages would remain stable, or that Americans in the next decade would value mobility over ecology.

Indeed, the law has been somewhat hostile to mandating disclosure when technologies render products that are morally, but not materially, different. In those rare instances where consumers have displayed an interest in knowing, for example, where particular meats originated, or whether recombinant gene products were used in the production of milk or vegetable products, both courts and legislatures have been resistant to imposing a legal disclosure requirement.[129] In some of these cases, market demand has prompted producers to provide products carrying the desired disclosures, obviating the need for legal or political intervention.[130] But where a market for the information has not developed, there has, to date, been little state intervention to solve the market failure or to force disclosure merely for the sake of informed consent, rather than for a palpable health or safety purpose. This history indicates a jurisprudential dearth of analytical tools that could be used to determine what scripted product features might constitute

126. *See generally* ARTHUR L. CORBIN, CORBIN ON CONTRACTS § 28.20 (1993 & Supp. 2003).

127. U.C.C. § 2-314, official cmt. 3 (2001).

128. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2(c) (1998).

129. Dan L. Burk, *The Milk-Free Zone: Federal and Local Interests in Regulating Recombinant bST*, 22 COLUM. J. ENVTL. L. 227 (1997).

130. This has occurred, for example, in the case of milk from cows treated with recombinant bovine somatotropin (rBST), to which some consumers may have social or moral objections. The producers have responded by supplying milk from untreated herds at a higher price. *Id.*

material features that ought to be disclosed to the purchaser and what features are merely routine design features that the law will ignore.

C. *Product and Property*

Thus, current contract jurisprudence appears ill-equipped to facilitate disclosure, let alone prohibition, of legally relevant product features when product and contract merge. But the problem of contract as product leads to a second, related theoretical problem with long-term practical ramifications. The merger of contract into product is conceptually intertwined with recent debates over the definitional separation between legal notions of property and contract. Much of this dialogue centers on recent scholarship by Thomas Merrill and Henry Smith, addressing the "numerus clausus" problem, that is, thc constraints upon the number of legally recognized forms of property.[131] Merrill and Smith adopt as definitional the standard maxim that property constitutes a legal regime functioning *in rem*, or "against the world," whereas contract constitutes a legal regime functioning *in personam*, or between particular parties. From these axioms, they derive the conclusion that the forms of property should be limited and new forms of property discouraged, because of the costs the public at large will bear in keeping track of myriad public entitlements. By contrast, they view contract as properly infinitely malleable, since only the parties in agreement need remember the variant entitlements of the agreement.

In reply to Merrill and Smith, Henry Hansmann and Erinier Kraakman argue that property takes a limited number of forms in order to facilitate verification of ownership when rights transfers are transacted.[132] This model emphasizes the continuity between property rights and their associated assets; property rights "run with the asset" as they put it. Subsequent purchasers must be notified of the rights conveyed with the asset, and the law disfavors fragmented or partial property interests because of the difficulty in notifying subsequent purchasers of the partial interests conveyed. This bias naturally limits the number of partial or fragmented property formats. Since contract affects only those parties in privity, the costs of alerting those parties to fragmented or partial conveyances are confined to the immediate contracting parties.

Neither of these models is necessarily exclusive of the other, and both may be at work in the operation of property as distinct from contract. But neither fits well with the modern development of contract into property, nor with the technological instantiation of contract *as* property. For

131. Thomas W. Merrill & Henry E. Smith, *Optimal Standardization in the Law of Property: The* Numerus Clausus *Principle*, 110 YALE L. J. 1 (2000); Thomas W. Merrill & Henry E. Smith, The Property/Contract Interface, 101 COLUM. L. REV. 773 (2001).

132. *See* Henry Hansmann & Erinier Kraakman, *Property, Contract, & Verification: The Numerus Clausus Problem and the Divisibility of Rights*, 31 J. LEGAL STUD. 373, 378-79 (2002).

example, the Merrill and Smith framework assumes the model of contract as consensus, rather than contract as product. But this assumption runs contrary to the development of contract into mass market licenses and to the scholarship examining this development. It is precisely in the creation of standardized form contracts that the public is unable to keep track of the myriad variations of possible rights structures. Mass market licenses bear little resemblance to contracts negotiated at arm's length; they are essentially rights against the world—at least, against any portion of the world that will use the covered product and become subject to the license.[133] The cost of remaining cognizant of the mass market licensing terms is not borne by only two parties, it is borne by the host of consumers who may purchase the product. The terms are not negotiated, so there is no process of bargaining to alert the purchaser to the variation in terms.

The inability of the general public to track all the myriad permutations of mass market license is well illustrated by the frequent appearance of outrageous terms in such contracts. Any number of bizarre and unreasonable terms may creep into the agreement, including provisions that forbid criticism of the product or that reach through the initial product license to confer upon the seller rights in second generation products produced by normal and intended use of the purchased product—conferring, for example, upon the publisher of web page design software a right in the web pages designed using the software purchased. Users of Internet applications may purportedly "agree" to tracking of their web contacts or insinuation of advertisements into their computer display, where agreement is based upon acquiescence to a mass market license that they have never read and would be unlikely to understand.[134] Consequently, while the cost analysis of Merrill and Smith seems borne out by such examples, they appear under the rubric of contract rather than that of property.

Neither does the Hansmann and Kraakman definitional separation deal well with contract as product. Their theory rests upon the cumulative costs of notice, which are anticipated to be greater for property rights that "run with the asset." But many form contracts, including the famous "copyleft" licenses accompanying open source software,[135] effectively "run

133. Margaret J. Radin & R. Polk Wagner, *The Myth of Private Ordering: Rediscovering Legal Realism in Cyberspace*, 73 CHI.-KENT L. REV. 1295, 1312-13 (1998).

134. *See* John Borland & Rachel Konrad, *PC Invaders: They're Camping Out In Your Hard Drive-With Your Express Consent*, CNET News.com, April 18, 2002, *at* http://news.com.com/2009-1023-885144.html.

135. *See* David McGowan, *Legal Implications of Open-Source Software*, 2001 U. ILL. L. REV. 241 (explaining that copyleft licenses require derivative works to be open source as well). The open source movement in general rejects the practice of keeping source code secret, holding instead that source code should be freely accessible and available. *See* Free Software Foundation, *What is Free Software?*, *at* http://www.gnu.org/philosophy/free-sw.html (last visited Aug. 26, 2004). Copyleft licenses are essentially a form of shrink-wrap implementing open source principles by requiring any modifier of the aecompanying code to make the resulting code available on the same terms—including the

with the product," making them largely indistinguishable from property on this theory. Such contracts would incur the same kind of notification costs as property. Indeed, under the Hansmann and Kraakman analysis, mass market licenses combine the worst aspects of property and contract: mass market licenses are neither constrained in the number of forms they may take nor in the number of subsequent users they may effect. Thus they inflict high notification costs on subsequent users due to the many partial conveyances of the contract, coupled with additional high notification costs due to the persistent partial conveyance to subsequent purchasers.

As contractual terms are subsumed into the design of programmable artifacts, not only do the terms of the bargain become persistent features of the artifact, the costs of consumer confusion and ownership notification become features as well. Qualities of the product, such as germination suppression or darkening polymers, unquestionably run with the asset, are not necessarily apparent upon inspection of the product, and can take myriad, often unexpected, forms. Partial conveyances here occur as contingent properties of the product, such as second-generation seed germination, conditional upon payment for activating treatment or copying privileges upon payment for duplication access. The forms of such partial conveyances are constrained only by the ingenuity of the product designers. In some cases, it will be to the advantage of the producer to inform users that additional rights are available for purchase; in other cases, where the producer prefers to restrict certain uses, the parameters of the restraint may be discovered by the user only after purchase. Statutory anti-circumvention or anti-reverse engineering provisions impose upon these physical features an additional layer of property rights by preventing alteration of the product, reinforcing the reification of the contractual terms.

We may choose in some cases to leave consumer dissatisfaction to discipline producers in the marketplace for their design choices, or we may choose in others to require disclosure of the product features. But it seems unlikely that present discourses distinguishing between contract and property, let alone between contract and product, can be part of the discourse in deciding which approach to adopt. Rather more fruitful may be certain insights that Merrill and Smith touch upon briefly in their rush to define property as a device of informational efficiency. They note that property typically entails certain social norms and attitudes, including respect for ownership, personal privacy, and security.[136] This insight impels us toward

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accompanying license. *See Free Software Foundation, What is Copyleft?*, *at* http://www.gnu.org/copyleft/copyleft.html (last visited Aug. 26, 2004).

136. *See* Merrill & Smith, *The Property/Contract Interface*, *supra* note 131, at 787-89. In the context of their argument, this observation is largely intended to buttress the contention that property, unlike contract, operates against a large number of third parties. *Id.*

the recognition, which property theorists have begun to explore,[137] that property, like designations of gender or other social classifications, is largely a performative label. Designation of an item as "property" defines the proper social behavior toward the item so classified, meaning that property may be considered not so much a set of rights as a type of performance.

Much the same might be said of contract: a designation as contract elicits a particular performance, not in the sense of fulfilling the contractual terms, but in the social behavior elicited toward the bargain. Designations such as property or contract, then, enlist the user into a particular social role, in the same fashion that I have suggested artifactual design scripts are employed to enlist users into social roles.[138] This suggests that both law and artifact may be treated in terms of the role played in the social network and the role into which they recruit the user. To the extent that product design places the user in the role that might be created by interaction with either "property" or with a "contract," the product design could be treated under the respective public policy of property or as contract. Thus the social shaping constructed by a lock-out technology may help define the legal treatment of that technology.

CONCLUSION

Genetic use restriction technologies present a new instance of programmable technological artifacts. Like DRM systems, GURTs allow embedding of physical control mechanisms into products that were formerly controlled by law. The deployment of such technologies exacerbates the movement away from publicly scrutinized, *ex post* producer controls toward privately predetermined *ex ante* controls. Indeed, the development of GURTs demonstrates the generalized movement toward programmable artifacts that take private rulemaking out of the realm of commercial agreements and related areas, which have been traditional subjects of legal scrutiny, and into the realm of product design, which has largely been immune from legal scrutiny in market economies.

Thus, the advent of GURTs reveals both practical and theoretical difficulties for current attempts to place limits upon the deployment of restrictive technical measures: all technological artifacts involve some degree of design scripting, including physically embedded constraints on their use. Many of these constraints may be equivalent to a legal prohibition on their use, but it is not conceivable that we would require regulation or even disclosure for all such constraints. Embedded constraints that violate a sufficiently important social policy might be subjected to such regulation;

137. *See, e.g.*, Marc R. Poirier, *The Virtue of Vagueness in Takings Doctrine*, 24 CARDOZO L. REV. 93, 154 (2002).

138. *See supra* note 59 and accompanying text.

however, even more so than in the case of improper contractual agreements, it will be difficult to identify those products as sufficiently unconscionable to merit a legal response without prompting unacceptably intrusive intervention in the marketplace. But in crafting policy for technologically constrained products, an approach that focuses on the social role played by the technologically constrained product, and on the role into which it places its purchasers and users, may be more fruitful than attempts to classify such products under past doctrinal standards.