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iPods and Prairie Fires: Designing Legal Regimes for Complex Intellectual Property Systems

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IPODS AND PRAIRIE FIRES: DESIGNING LEGAL REGIMES FOR COMPLEX INTELLECTUAL PROPERTY SYSTEMS

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Abstract

This article suggests that intellectual property works are the products of complex creative systems and, consequently, designers of legal regimes for the global information ecosystem can learn useful lessons from complexity theory. Several lessons can be drawn from simple analogies to two systems: the iPod music player and the tallgrass prairie ecosystem. First, good design of legal regimes requires empirical study of intellectual property systems. Empirical studies are likely to reveal significant variations among creative systems and one-size-fits-all laws may fail to optimize creation of intellectual property works. Second, there is a much wider variation in design possibilities than the traditional binary choice between private property and the public domain. Finally, legal regimes must tolerate certain chaotic elements essential to the sustainability of intellectual property systems. Such elements keep the systems poised at the edge of chaos where creativity lies.

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I. INTRODUCTION

"Life is random."
– Advertising slogan for the iPod Shuffle.[1]

With this slogan, Apple nicely captured the zeitgeist, just as it has captured the markets for portable playback devices and legal music downloads.[2] Like much modern advertising, the slogan is catchy, but misleading. Life is not entirely random and neither is the Shuffle. Both involve systems that contain certain chaotic elements, which is to say that unpredictable behavior results from the aggregation of activities that follow established rules. The iPod, for example, is a complicated system in which hardware follows a set of rules dictated by software. The shuffle function builds a little element of controlled chaos into that system. The iPod "shuffles" the playlist to provide a pleasant element of unpredictability for the listener. The iPod's unpredictability is limited by its software and the user's choice of content but, by intentional design, it mimics real complexity.

Life, by comparison, is truly complex. We experience life, individually and communally, as a series of interactions among innumerable complex systems. These systems include the biological systems that comprise our own bodies and the social, political, economic, technological, and legal systems in which we participate throughout our lives. Like the iPod, complex systems follow known rules of interaction but also contain elements of chaos, a form of "deterministic randomness" inherent in the workings of the system itself.[3] Unlike the iPod, the chaotic elements in complex systems give

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1. *See* Chris Roper, *iPod Shuffle: Life is random, but your digital music doesn't have to be*, IGN.COM, Apr. 14, 2005, http://gear.ign.com/articles/604/604389p1.html (reviewing the Shuffle and referencing the ad campaign).

2. As of May 2006, Apple controlled an estimated 80% of the legal download market in the U.S. *See* Joshua Chaffin & Kevin Allison, *Apple Sets Tune for Pricing of Song Downloads*, FIN. TIMES, May 1, 2006, http://www.ft.com/cms/s/297eecc2-d934-11da-8b06-0000779e2340.html. It controlled an estimated 78 % of the US market for digital music players and 49% of the market worldwide. *See* Eric Bangeman, *Digital Music Player Market toDouble in Next Few Years*, ARS TECHNICA, May 2, 2006, http://arstechnica.com/news.ars/post/20060502-6719.html.

3. Chaotic behavior refers to unpredictable behavior, or "deterministic randomness," that arises from the aggregation of activities within a deterministic system that obeys established rules of interaction. *See* J.B. Ruhl and Harold J. Ruhl, Jr., *The Arrow of the Law In Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 U.C. DAVIS L. REV. 405, 420

them the ability to evolve in response to changes in their environments, to self-organize, and to generate entirely new and unexpected behaviors.[4] Even during periods of relative stability, complex systems change constantly. Over long periods of time, species evolve or become extinct; markets develop, fluctuate, disappear; civilizations blossom, stagnate, and die. And, from time to time, complex systems are certainly subject to truly random, even catastrophic events.[5] The imperative for complex systems is "adapt or die." Their innate ability to produce new behaviors in response to environmental change, which in turn induces change in other complex systems with which they interact, is critical to their survival.

Most works of intellectual property are created and distributed through complex systems that must now adapt to a revolution in their environment as digital technologies replace print technologies. Digitization and global networks have heightened the "systemness" of intellectual property production modes and markets, and the laws that govern them. The reduction of many different kinds of works to bits transmissible over global networks creates particularly acute problems for the copyright regime, though similar problems occur in other regimes.[6] These developments have inspired suggestions that intellectual property systems should be viewed as part of an "information ecosystem" comparable to the ecosystems found in the natural environment and that intellectual property law might profit from the application of concepts developed in environmental law.[7] The goal of proponents of the information ecosystem is sustainable development of intellectual property that preserves the resources essential to new creation, provides incentives to creators, and produces workable legal regimes capable of adapting to new technologies.[8]

(1997). Planetary weather systems, for example, follow known rules of interaction, which periodically produce unpredictable, destructive emergent properties, like hurricanes or tornadoes. Such events are recurring products of the systems' own workings and are distinguishable from truly random catastrophes like asteroid impacts on the planet's surface.

4. *See infra* Part II for a discussion of the characteristics of complex systems.

5. For example, the collision of a large asteroid with Earth may have caused the extinction of the dinosaurs at the end of the Cretaceous period. *See* ROGER LEWIN, COMPLEXITY: LIFE AT THE EDGE OF CHAOS 76 (1992).

6. *See* James Boyle, *A Politics of Intellectual Property: Environmentalism for the Net?*, 47 DUKE L.J. 87, 91-93 (1997).

7. *See id.* at 108-13; Peter K. Yu, *Intellectual Property and the Information Ecosystem*, 2005 MICH. ST. L. REV. 1, 7-8 (2005).

8. *See* Yu, *supra* note 7, at 16.

Much of the debate in intellectual property circles resuscitates the traditional philosophic conflict between private property and the commons and relies on analogies to real property that envision limited choices between the private enclosure and the public park.[9] An emerging thread in the debate turns to science, rather than philosophy, for a new conceptual framework for intellectual property. Environmental law scholars have employed complexity theory as a framework for the study of environmental legal regimes.[10] If the information system can be compared to an environmental ecosystem, complexity theory may prove useful as a new theoretical framework for intellectual property rights in the Information Age.[11]

This article suggests that designers of intellectual property regimes can take several lessons from complexity theory and from analogies to two systems: a human-designed technological system, the iPod, and a human-managed ecosystem, the tallgrass prairie. First, good design of intellectual property regimes requires empirical study of complex intellectual property systems, just as good prairie management requires empirical knowledge of particular ecosystems. Empirical studies are likely to reveal significant variations among intellectual property systems just as harsh experience revealed essential variations among different prairie ecosystems. Consequently, a one-size-fits-all legal regime may fail to optimize creation of intellectual property works. Second, there is a much wider range of design choices available than the binary choice between the private enclosure and the public park. Finally, intellectual property regimes should be designed, like the iPod, to tolerate but control the chaotic elements essential to sustainability of intellectual property systems over the long term – to keep the systems poised at the edge of chaos where creativity lies.

Part II of this article outlines the characteristics of complex systems and their relevance to intellectual property systems. Part III briefly describes the traditional framework of debate between high

9. *See, e.g.*, James Boyle, *The Second Enclosure Movement and the Construction of the Public Domain*, 66 LAW & CONTEMP. PROBS. 33, 64 (2003) (referring to the binary opposition between intellectual property and the public domain); Carol M. Rose, *The Several Futures of Property: Of Cyberspace and Folk Tales, Emission Trades and Ecosystems*, 83 MINN. L. REV. 129, 146-53 (1998) (outlining the high and low protectionist stances with respect to cyberspace).

10. *See* J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUS. L. REV. 933 (1997) (applying complexity theory to environmental law)

11. Professor Yu suggests that a complexity approach would avoid the bipolarity of the current intellectual property debate by capturing interactions among the different components of intellectual property systems and enabling a holistic analysis. *See* Yu, *supra* note 7, at 15-18.

and low protectionists. In Part IV, I suggest an empirical approach to intellectual property systems based on principles of systems analysis and, in Part V, I explore some of the implications such an approach will have for intellectual property regimes.

II. COMPLEX SYSTEMS AND INTELLECTUAL PROPERTY

All complex systems share certain general characteristics. In this part, I briefly describe those characteristics and their relevance to the complex systems implicated in the production and distribution of intellectual property works.

A. Complexity Cliff notes[12]

In general terms, complex systems are nonlinear, dynamical systems[13] that produce emergent behaviors and evolve in response to changing circumstances. Such systems exist throughout the natural and socially constructed environments, ranging from ant colonies to human nations, from weather systems to the emergency management organizations designed to respond to weather disasters.[14] Complexity theory first developed in the sciences, but scholars have applied its basic tenets to a wide variety of political, economic, technological, socio-cultural, and legal systems.[15]

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12. This is an extremely abbreviated summary of the most general tenets of complexity theory. For a more extensive treatment, see Deborah Tussey, *Music at the Edge of Chaos: A Complex Systems Perspective on File Sharing*, 37 LOY. U. CHI. L.J. 147, 151-61 (2006).

13. A system is an aggregation of two or more inter-related, interacting elements or components that comprise a unified whole. MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 1269 (11th ed. 2003).

14. To name just a few complex systems: the global environment and its constituent ecosystems; the human body and its constituent systems, such as the brain and other organs, the nervous and endocrine systems, (all of which are, in themselves, complex systems); economies and their institutional and individual components. A comprehensive list would include most aspects of the world as individuals experience it. *See* ROBERT JERVIS, SYSTEM EFFECTS: COMPLEXITY IN POLITICAL AND SOCIAL LIFE 5-21 (1997) (describing complex systems and their characteristics); LEWIN, *supra* note 5, at 9-14 (describing the variety of complex systems explored by complexity theorists at the Santa Fe Institute and elsewhere).

15. There is considerable overlap between complexity theory and chaos theory, since complexity theory grew out of chaos theory but expanded beyond it. Both analyze nonlinear, dynamical systems. In general terms, chaos theorists may focus more on the divergent behaviors that can result from deterministic rules, while complexity theorists concentrate on the universal patterns of behavior, including chaotic behavior, displayed by complex systems. *See* LEWIN, *supra* note 5, at 10-13 (discussing the overlap between chaos and complexity). For accounts of the development of these fields, meant for the lay reader, see also JAMES GLEICK, CHAOS: MAKING A NEW SCIENCE (1987); M. MITCHELL WALDROP, COMPLEXITY: THE EMERGING SCIENCE AT THE EDGE OF ORDER AND CHAOS (1992). For comprehensive discussions of complexity theory and its application to various systems, see, for example, PER BAK, HOW NATURE WORKS: THE SCIENCE OF SELF-ORGANIZED CRITICALITY (1996); STEVEN JOHNSON,

Complexity theory suggests that all complex systems share certain characteristics: complex, interconnected structure,[16] nonlinear behavior,[17] evolution and co-evolution in a pattern of punctuated equilibrium,[18] emergence, and, as a consequence of the preceding characteristics, long-term unpredictability.[19] Of these interrelated traits, emergence and unpredictability are of particular significance to those who attempt to control the behavior of complex systems through law.

As part of their long-term evolution, complex systems generate unexpected system-wide behavioral patterns from the rule-governed

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EMERGENCE: THE CONNECTED LIVES OF ANTS, BRAINS, CITIES, AND SOFTWARE 18-21 (2001); STUART KAUFFMAN, AT HOME IN THE UNIVERSE: THE SEARCH FOR LAWS OF SELF-ORGANIZATION AND COMPLEXITY (1995). A number of legal scholars have applied aspects of chaos and complexity theories to legal theory in general and to specific legal disciplines. *See, e.g.,* Susan P. Crawford, *The Biology of the Broadcast Flag*, 25 HASTINGS COMM. & ENT. L.J. 603, 604-05 (2003) (broadcast flag mandates); David G. Post & Michael B. Eisen, *How Long is the Coastline of the Law? Thoughts on the Fractal Nature of Legal Systems*, 29 J. LEGAL STUD. 545, 545-46 (2000) (legal arguments, decision-making, and case citation patterns); David G. Post & David R. Johnson, *"Chaos Prevailing On Every Continent": Towards a New Theory of Decentralized Decision-Making in Complex Systems*, 73 CHI.-KENT L. REV. 1055, 1055-59 (1998) (cyberspace governance); Mark J. Roe, *Chaos and Evolution in Law and Economics*, 109 HARV. L. REV. 641 (1996) (law and economics); J. B. Ruhl, *Complexity Theory as a Paradigm for the Dynamical Law-And-Society System: A Wake-Up Call for Legal Reductionism and the Modern Administrative State,* 45 DUKE L.J. 849, 851-61 (1996) (interaction between law and society); Ruhl, *supra* note 10 (environmental law).

16. Complex systems are composed of multiple, richly interconnected components. Economies, for example, contain many institutions such as business associations and regulatory institutions, as well as many individual actors, such as businesspeople and consumers. As is typical of complex systems, many of these components nest within each other so that a large corporation, for example, may be composed of many smaller business units (subsidiaries, divisions, etc.), which are in turn, composed of individuals. All of these subsystems of the economy are complex systems which share lines of communication, distribution, etc., through which information, money, products, and so on, flow throughout the system. *See* JERVIS, *supra* note 14, at 17-21; Ruhl, *supra* note 10, at 947-49, 962.

17. System behavior is nonlinear in the sense that causes and effects are not proportional. Such systems frequently contain positive feedback loops that amplify change. Very small causes may produce very large effects and a single cause may produce multiple effects as change cascades through the many interconnections in the system. This "chaotic" behavior of nonlinear systems is typified by sensitivity to initial conditions. Even the slightest change in the conditions to which the system responds may produce widely different behavior, a trait more commonly known as the "Butterfly Effect." A butterfly flapping its wings in the Amazon rain forest may, on one occasion set off a chain of events in the atmosphere that, a month later, produces a snowstorm in New York; on another occasion, the butterfly's actions may have no effect at all. *See* LEWIN, *supra* note 5, at 11; JERVIS, *supra* note 14, at 34-39.

18. Complex systems evolve in response to changes in their environments and co-evolve in response to changes in other systems with which they interact. Over time, such evolution follows a pattern of punctuated equilibrium in which long periods of gradual adaptation are interrupted by periods of drastic change. *See* LEWIN, *supra* note 5, at 70-72, 100-01.

19. *See id.* at 11-14.

interactions of the systems' constituent elements.[20] Perhaps the most well known example of such an emergent pattern is the "invisible hand" of the free market economy.[21] Market economies follow standard rules of interaction imposed by laws, market practices, and social norms. According to traditional economics, the collective, self-interested activities of market actors following those rules, pursued with no regard for the general good, will nonetheless produce overall market efficiency as if guided by an invisible hand.[22] This emergent quality of market economies enables them to react to changes in supply and demand much more efficiently than centrally-controlled economies such as those of the former Union of Soviet Socialist Republics (USSR).[23]

Emergent behaviors result from processes occurring throughout the system as a whole, in particular by the formation of feedback loops that intensify certain patterns. Consequently, they cannot be predicted based on knowledge about individual system components or the local rules of interaction that they follow.[24] Emergent properties may or may not be normatively desirable from the standpoint of human beings affected by complex systems. Consequently, we tend to intervene, through legal regulation as well as other means, with the intention of controlling the workings of complex systems like markets or political institutions. Such intervention inevitably produces unintended consequences as responses to the intervention cascade through the interrelated processes and components of the system.[25]

In addition, complexity theory suggests that the most robust systems exhibit a property referred to as self-organized criticality or positioning at the "edge of chaos." Long-term sustainability of complex systems hinges on the systems' ability to maintain a state poised between order and chaos that provides the systems with the flexibility essential to adapt to changes in the environment. [26] The

20. *See id.* at 12-13.

21. *See id.* at 13.

22. *See* ERIC. D. BEINHOCKER, THE ORIGIN OF WEALTH: EVOLUTION, COMPLEXITY, AND THE RADICAL REMAKING OF ECONOMICS 26 (2006).

23. *See* JERVIS, *supra* note 14, at 63.

24. *See id.* at 125-26.

25. *See id.* at 61-67.

26. The edge of chaos concept was formulated by scientists interested in artificial intelligence who used computer models of cellular automata, which indicated that the complex behaviors essential to life and intelligence occur at a state that resembles a phase transition between a solid and fluid. At this "edge," the system is both stable enough to store information and evanescent enough to transmit it. The similar concept of self-organizing criticality

Gaia hypothesis, for example, suggests that the Earth is a homeostatic complex system that maintains conditions favorable to life through self-regulation.[27]

Whether or not one subscribes fully to the Gaia hypothesis, Earth is obviously a complex system encompassing millions of constituent complex systems that comprise the planetary environment and life within it - layer upon layer of interconnected systems interacting with each other down to the smallest organized particles of matter. The planet is itself a constituent of larger complex systems extending through our own solar system to the ends of the universe. All of these systems constantly evolve, sometimes gradually, sometimes abruptly as certain developments reach a tipping point or systems are impacted by truly random catastrophes. Included among the lesser systems co-evolving in this constantly fluctuating superstructure are the systems by which intellectual properties are produced and disseminated. Like all complex systems, intellectual property systems are complicated, interconnected, and subject to evolutionary change, both gradual and abrupt.

B. Complex intellectual property systems

Many intellectual properties are produced by complex physical systems. For example, Apple, the company that created the iTunes music store as well as the iPod, is certainly a complex system. The corporation is comprised of many interconnected components; information, money, and products flow through its interconnections with many other systems. Apple distributes millions of dollars worth of valuable copyrighted, trademarked, and patented works, including sound recordings and the iPod itself. Apple benefits from feedback loops that return to it millions of dollars in exchange for those products. Both the corporation and its products have evolved in response to changes in the social, technological, and economic environments and its current exuberant growth would have been unpredictable as little as ten years ago.

The massive networks of the Internet and the physical distribution chains through which Apple distributes its products are complex systems.[28] The many intellectual properties that flow through

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developed in the context of the study of physical systems. Related research suggests that the two constructs describe equivalent states. *See* WALDROP, *supra* note 15, at 292-310.

27. *See* LEWIN, *supra* note 5, at 108-18 (discussing development of the Gaia hypothesis).

28. Network theory is one subset of complexity theory and applies not only to physical networks like the infrastructure of the Internet but to social and informational networks. The

those systems are likewise the product of complex systems like recording and movie studios. Even works primarily created by individuals, such as novels or graphic arts, are typically mass-produced and disseminated through complex distribution systems. These production and distribution systems operate within the larger complex systems of national and global economies. Social systems affect their successes or failures and technological systems provide the essential infrastructure for their activities. Like all complex systems, intellectual property systems overlap and interact with each other, co-evolving over time. Changes in technology systems, for example, may induce changes in production and distributional systems, social norms, and laws. A recent case on point: the invention of file sharing software and the emergence of vast networks of file sharers have had a dramatic impact on the sound recording industry and are likely to have similar impacts on other intellectual property industries in the near future.[29]

Like all complex systems, intellectual property systems follow internal rules established by norms, technological standards, and laws. These rule sets may themselves form complex conceptual systems. In the case of legal regimes, the systems are both conceptual and physical since they involve institutions and human actors as well as systems of thought. The patent regime, for example, involves individual or corporate parties to patent proceedings and disputes, institutions like the Patent and Trademark Office and the Court of Appeals for the Federal Circuit, and the complicated conceptual systems of the Patent Act[30] and judicial interpretations thereof. Similarly, the copyright regime implicates creators, publishers, and consumers, the Copyright Office, the system of copyright laws and the courts that interpret them.

Since the intellectual property industries and the legal regimes governing them are complex systems, over time they are likely to produce emergent behaviors that may or may not be desirable. Many of these changes will be difficult or impossible to predict in advance. Given this unpredictability, one would hope that legislators would study such systems before imposing new legislative measures, much as ecologists might study a river system in order to design effective

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Internet is a physical network that facilitates many social and informational networks. See MARK BUCHANAN, NEXUS: SMALL WORLDS AND THE GROUNDBREAKING SCIENCE OF NETWORKS (2002), for a general guide to network theory.

29. Raymond Shih Ray Ku, *The Creative Destruction of Copyright: Napster and the New Economics of Digital Technology*, 69 U. CHI. L. REV. 263, 263-64 (2002).

30. Patent Act, 35 U.S.C. §§ 1-130 (2007).

environmental controls to prevent pollution. Once the workings of a particular system were understood, a regime could be designed to move the system toward a self-critical state in which order and chaos, rights and freedoms, exist in the productive balance that fosters sustainability. Historically, however, that has not been the approach taken by legislators or the many other interested parties who debate the appropriate scope of intellectual property rights. The debate eschews empirical investigation in favor of philosophical conflict that, too often, produces a binary discourse whose participants are forced to choose between opposing positions.

III. THE DEBATE OVER INTELLECTUAL PROPERTY RIGHTS

Participants in the ongoing debate over the scope of intellectual property rights (IPRs) often analogize intellectual property to real property. The expansion of intellectual property rights has, for example, been compared to the English land enclosure movement.[31] The propriety of the analogy from tangible to intangible property is hotly contested, but is engrained in intellectual property theory[32] perhaps as an attempt to "ground" this esoteric discipline in some comprehensible reality. Such analogies are thought to offer a guide to the formulation of appropriate IPRs. The usefulness of the real property analogy however, has been limited in a discourse almost entirely focused on the conflict between private ownership and the commons.[33] Within that framework, private ownership typically refers to exclusive ownership by individuals or corporate entities. Interpretations of the commons vary from open public access to equation of the commons with the "public domain."[34]

The phrase "tragedy of the commons" was popularized by Garrett Hardin, in a work dealing with natural resources and population control, and describes the argument that resources owned in common are inevitably subject to overexploitation.[35] The solutions posited for that tragedy in the real property world were either

31. *See* Boyle, *supra* note 9, at 37.

32. *See* Yu, *supra* note 7, at 1-5.

33. *See* Anupam Chander & Madhavi Sunder, *The Romance of the Public Domain*, 92 CAL. L. REV. 1331, 1334 (2004).

34. *See* Charlotte Hess & Elinor Ostrom, *Ideas, Artifacts, and Facilities: Information as a Common-Pool Resource*, 66 LAW & CONTEMP. PROBS. 111, 114-15 (2003).

35. *See* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE. 1243, 1243-1248 (1968).

centralized government control or private property ownership.[36] Unlike real property, creative works are public goods characterized by nonrivalrous consumption – they can be consumed by any number of people without being used up. Consequently, the tragedy of the intellectual commons does not take the form of overexploitation but rather of reduced incentives for creation or distribution.[37] High protectionists foresee a tragedy of the commons if intellectual works are too readily appropriated. They advocate strong intellectual property rights, a form of private property, as the solution for this tragedy. Low protectionists note that, unlike real property, intellectual properties must build on prior works and argue that overprotection of essential intellectual building blocks may result in underutilization of resources, the "tragedy of the anticommons." They seek to protect the public domain by limiting IPRs.[38] Both would probably agree that legal regimes must achieve some balance between incentives and public access, but the two camps would strike the balance at different locations on the spectrum between strong and weak protection. The producers and consumers actually involved in production and consumption of intellectual works too often devolve to the all-or-nothing extremes. Producers demand full compensation for all potential uses of their works and employ digital rights management technology to control access; users demand and, with the help of technology, sometimes achieve almost unlimited free access.[39]

In the context of this debate, the setting of legal entitlements to favor one form of ownership over another is presumed to bear a linear cause-effect relationship to production and distribution of intellectual property resources. That is to say, ownership forms are presumed to be determinative of good husbandry of the resource. Arguments derived primarily from the philosophies of John Locke,[40] with a strong gloss of law and economics, are deployed to support this connection. These theoretical arguments have known limitations. For

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36. *See* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 8-14 (1990) (criticizing this binary approach).

37. *See* Boyle, *supra* note 9, at 41-42.

38. *See* Yu, *supra* note 7, at 9-11; Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 622 (1998) (generally defining the tragedy of the anticommons).

39. Producer concerns drove the passage of the Digital Millenium Copyright Act prohibiting circumvention of digital rights management. 17 U.S.C. § 1201 (2000). User opportunism has been clearly displayed in the controversy over music file sharing. *See* Ku, *supra* note 29.

40. *See* Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287, 315-25 (1988) (discussing the relationship of Locke's view of the common to intellectual property).

example, pro-commons formulations ignore distributional inequities in the exploitation of intellectual commons;[41] pro-property formulations slight the importance of shared knowledge and communal creativity.[42] Both approaches fail to recognize the synergy between private property and the public domain.[43] To a considerable extent, the debate takes the form of armchair philosophy, with little or no empirical underpinning, and ignores the complexity and variety of the intellectual property systems involved. Scholars find themselves largely in one of two opposing camps regardless of the particular issue – the particular complex system – involved in any given instance.

A number of scholars have pointed out the unrealistically binary nature of the dialogue pitting the commons against private ownership and have suggested an alternative view of intellectual property as part of an information ecosystem - a complex system - in which intellectual property rights and the public domain exist in a complementary, dynamic relationship, rather than an oppositional relationship.[44] This school of thought finds support in studies of alternative ownership models for real resources such as common-pool or limited common property resources. These scholars document situations in which resources are successfully owned and managed in common by a limited group, which can exclude others from use of the property.[45] Studies also identify situations where public ownership of certain kinds of property, like public roads, clearly produces the most efficient utilization of the property - a "comedy of the commons."[46] There may be many models of ownership between the extremes of the carefully tended field and the open frontier. Such work should teach two valuable lessons: (1) that a variety of ownership models may be

41. *See* Chander & Sunder, *supra* note 33, at 1331, 1335.

42. *See* Rose, *supra* note 9, at 140-43.

43. *See* Carol M. Rose, *Romans, Roads, and Romantic Creators: Traditions of Public Property in*

the Information Age, 66 LAW & CONTEMP. PROBS. 89, 101-02 (2003).

44. *See* Yu, *supra* note 7, at 6-8. *See also* Robert A. Heverley, *The Information Semicommons*, 18 BERKELEY TECH. L.J. 1127, 1161-83 (2003) (suggesting that intellectual property should be viewed and managed as a semi-commons).

45. *See* Hess & Ostrom, *supra* note 34, at 112 (describing and analyzing common pool resources, including meadows and forests, irrigation communities, and fisheries); Rose, *supra* note 9, at 132, 139-43 (mentioning commonly owned fisheries, irrigation communities, tribal culture, tribal land management practices). Community forestry projects in the western United States currently experiment with similar schemes. *See* Jim Robbins, *Community Forestry Bids to Preserve Scenic West*, N.Y. TIMES, Sept. 4, 2005, at 21.

46. *See* Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U. CHI. L. REV. 711, 723 (1986).

viable if they are attuned to the requirements of the particular system, and (2) that public policy ought not to be based on generic models or metaphors without empirical verification. [47]

To pursue the real property analogy, consider the prairie ecosystems that once occupied vast expanses in the middle of the North American continent. For thousands of years, these ecosystems sustained millions of buffalo, and the Native American tribes dependent on them, without imposition of any formal system of property ownership.[48] Europeans slaughtered buffalo and Native Americans alike and imposed private property ownership.[49] Settlers farmed the prairie, a method of husbandry that was successful across wide swaths of the Great Plains, but disastrous in the tallgrass prairie of the Flint Hills and Osage Hills regions of Kansas and Oklahoma, where the soil is too rocky and shallow to sustain farming.[50] Eventually the land was returned to its natural use – grazing – by ranchers who came to understand the interdependence between grasses, far-ranging herds of bovines, and natural fires. Ranchers mimic with cattle the migratory patterns of the bison herds[51] and, like the Native Americans before them, use controlled fires to achieve the beneficial ecosystem effects caused by natural fires.[52] The ranchers learned to manage the prairie within a private property regime; the Native Americans successfully managed it within a non-property regime. Sustainable use of the tallgrass prairie depended not on the particular legal rights granted by the law but on users' respect for the requirements of each ecosystem. Not all prairies are alike.

Like different prairie ecosystems, different intellectual property systems may require different methods of husbandry. Some legal regimes might prove more likely than others to respect the needs of particular intellectual property systems. To the extent that the choice of ownership models may have a beneficial impact on sustainability, there are obviously more choices available than the binary choice between private property and the commons. How should we make those choices? We might start by establishing the needs of the systems, rather than by imposing a top-down regime based on

47. *See* OSTROM, *supra* note 36, at 23 (policies based on metaphors can be harmful).

48. *See* AIMEE LARRABEE & JOHN ALTMAN, LAST STAND OF THE TALLGRASS PRAIRIE 59-64 (2001).

49. *Id.* at 69.

50. *Id.* at 99.

51. *Id.* at 104.

52. *Id.* at 24.

unverified assumptions about the systems' responses to legal intervention.

Intellectual property regimes fairly beg for empirical verification of the effects of IPRs meant to preserve the balance between incentives and access. Yet there has been little systematic study of the effects of such IPRs on the hundreds of intellectual property industries that they are designed to encourage. There is, indeed, minimal empirical evidence to support the basic correlation between the incentives allegedly provided by IPRs and creativity, scientific advancement, or improved public access.[53] We know little more about the ecology of intellectual property systems than the settlers knew about the ecology of the tallgrass prairie. In the absence of actual evidence, legislators operate by a sort of logical dead reckoning, heavily influenced by lobbies for the intellectual property industries, that often proves, in the end, to be faulty.[54]

In fairness, the information and tools essential to extensive empirical investigation have, until recently, been unavailable. The basic tenets of complexity theory could emerge only after computers became sufficiently powerful to emulate the behaviors of complex systems.[55] Similarly, computer and network technologies now enable intellectual property theorists to put their models to the empirical test. Complexity theory, systems analysis, and modern computational power can add useful new elements to the toolkit for analysis of intellectual property industries and intellectual property regimes.

IV. SYSTEMS ANALYSIS AND SCIENTIFIC METHOD

Complexity theory offers insight into the behaviors of complex systems. Systems analysis provides the methodology for studying them. A systems approach requires that observers analyze each system holistically by defining and evaluating the functionality of the entire system, rather than reductively by examining only its components.[56] Since the long-term behaviors of complex systems emerge from the comprehensive web of connections and interactions

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53. *See* WILLIAM P. ALFORD, TO STEAL A BOOK IS AN ELEGANT OFFENSE 4-5 (1995).

54. Many thought, for example, that without strong IP rights, no valuable content would ever appear on the Internet. Yet the Internet today offers a vast cornucopia of content, much of which is both valuable and unprotected.

55. The development of computers powerful enough to create artificial complex systems, such as cellular automata, or to simulate real systems like the weather, was critical to the development of complexity theory. *See* WALDROP, *supra* note 15, at 63-64.

56. *See* Lynn M. LoPucki, *The Systems Approach to Law*, 82 CORNELL L. REV. 479, 481 (1997).

among all of their components, analysis of individual components is necessary, but not sufficient, for an understanding of the whole.[57]

Definition of the scope of the system is particularly critical, since complex systems tend to overlap and interact with each other. Inputs, outputs, linkages, processes, and rules of interaction should be identified and, if possible, quantified. Complexity theorists employ models to simplify this analysis and many of the central precepts of complexity theory derive from computer models.[58] However, theoretical models are tested by empirical research into the actual behavior of complex systems as various as earthquakes and stock markets. Complexity models are, moreover, avowedly probabilistic in nature – they are likely to reveal power law distributions[59] rather than linear, proportional relationships between causes and effects. Such models recognize the elements of chaos inherent in complex systems.

Since intellectual properties are produced and distributed through complex systems, general principles of systems analysis should apply to investigations into the real-world operation of intellectual property systems and the efficacy of the legal regimes that govern them. Such systems can be defined, their goals identified, and an assessment made of whether the systems function to achieve those goals. Systems analysis might be applied to certain intellectual property industries, such as the recording industry, to different types of works, or to distributional networks such as the Internet and related systems. It might equally be applied to the systems of intellectual property laws. We have some general idea of the goals of those regimes – to encourage creativity and "promote the Progress of Science and useful Arts," [60] to protect business good will, to encourage research and development – but very little proof that they achieve them. Modern statistical techniques for data collection and analysis permit testing of the assumptions about creativity, incentives, and dissemination that undergird the legal regimes.[61]

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57. *See* JERVIS, *supra* note 14, at 12-13.

58. *See* WALDROP, *supra* note 15, at 63-64.

59. A "power law distribution" describes a probabilistic range of responses in which big responses are rare, small ones are common, and intermediate responses occur at a rate somewhere in between. *Id.* at 305-06.

60. U.S. CONST. art. I, § 8, cl. 8.

61. Some empirical studies of IP systems have recently been published or are forthcoming. *See, e.g.*, David E. Adelman & Kathryn L. DeAngelis, *Patent Metrics: the Mismeasure of Innovation in the Biotech Patent Debate*, 85 TEX. L. REV. 1677 (2007); Kai-Lung Hui & Ivan P.L. Png, *On the Supply of Creative Work: Evidence from the Movies*, 92 AM. ECON. REV. 217 (2002); Kai-Lung Hui & Ivan P.L. Png, *On the Supply of Creative Work: Evidence from the Movies, (2005)* (unpublished manuscript, on file with author) (preliminary

The systems approach requires recognition that intellectual property systems involve interdependent, dynamic subsystems and processes, as well as sets of products, and that successful legal regimes must address the whole.[62] The investigator's view must comprehend not just particular markets, but the social networks and technological systems that surround them. Assessment of the impact of music file sharing on music production, for example, requires analysis not only of recording industry receipts but also attention to social sharing norms and alternative methods of distribution offered to artists by new technologies. Better understanding of these interrelationships should produce more coherent theoretical models of the operation of intellectual property systems. Those models are likely to be various and differentiated, not merely binary. A single model is no more likely to apply to all intellectual property systems than a single complexity model would be likely apply to hurricanes and tornados or to word processors and artificial intelligence. Researchers should employ standard scientific methodology in which the researcher constructs an initial model relying on available knowledge about the system, tests the model against reality, revises the model accordingly, and tests the model again. Obviously, such analysis must be an ongoing process as systems continue to evolve.

In short, a systems approach to intellectual property would identify differences as well as commonalities among systems, build theoretical models appropriate to different systems, but also seek empirical foundations upon which to base legal responses to evolutionary change within them. If the analogy to real property is one tool for grounding intellectual property law in real experience, then surely actual empirical research can only improve upon the usefulness of such analogies by testing them against reality.

The complexity approach will not be particularly easy. It will require interdisciplinary cooperation among intellectual property scholars and collaborators in other disciplines, which may include economics, business management, statistics, and cognitive science to name a few. Since intellectual property systems are now, more than ever before, global in scope, collaboration must be transnational as well as transdisciplinary. Analysis will take time – one can easily imagine dozens of researchers devoting entire careers to study of

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draft update of the 2002 paper, an attempt to test empirically the effect of extensions in copyright duration on movie production).

62. *See* Rose, *supra* note 9, at 161 (observing that limited common property systems may require that we look at such systems as sets of activities as well as sets of products).

particular aspects of intellectual property systems. Good data may be easier to come by with regard to some systems than others;[63] perfect information is unlikely to be available even where empirical work is feasible.[64] There will inevitably be disputes over the reliability and interpretation of the data that does exist.[65] Moreover, the systems will continue to change even as we study them. Nonetheless, modeling based on some information, however fluid and imperfect, is preferable to armchair analysis. Theory tested by scientific methodology is preferable to untested philosophy. Until we undertake holistic, empirical analysis of intellectual property systems, we can do no more than guess at the optimal shape for IPRs in the information ecosystem. Even the best, empirically tested models will be only probabilistically predictive – they will not offer clear-cut, linear cause-effect relationships. They will resemble predictions of the path of a hurricane within a wide zone of uncertainty. That irreducible uncertainty suggests that legislators approach the design of legal regimes for intellectual property systems with humility, not hubris.

V. IMPLICATIONS FOR LEGAL REGIMES

This part suggests that effective legal regimes must accommodate variation, change, and a certain degree of disorderly, but productive, conduct in intellectual property systems. It also briefly compares the complexity approach to prevailing theories of libertarianism and law and economics.

A. Diversity, emergence, and evolution

Empirical study of intellectual property systems is likely to reveal variations in system dynamics, which have implications for appropriate legal regulation of those systems. We already recognize

63. There appears to be significant data available regarding the music industry. *See, e.g.*, WILLIAM W. FISHER III, PROMISES TO KEEP: TECHNOLOGY, LAW, AND THE FUTURE OF ENTERTAINMENT 38-81, 259-62 (2004) (referring to publicly available industry data throughout).

64. Indeed, industries may attempt to withhold information if they consider secrecy to be advantageous commercially or politically.

65. Surveys have, for example, reached different conclusions on the effect of file sharing on sales of sound recordings. *Compare* Stan J. Liebowitz, *Pitfalls in Measuring the Impact of File-Sharing on the Sound Recording Market*, 51 CESIFO ECON. STUD. 439 (2005), *available at* http://www.utdallas.edu/~liebowit/intprop/pitfalls.pdf (finding that file sharing adversely impacts sales), *with* Felix Oberholzer & Koleman Strumpf, *The Effect of File Sharing on Record Sales:An Empirical Analysis* (2004), http://www.unc.edu/~cigar/papers/FileSharing_March2004.pdf (finding no statistical correlation between file sharing and slumps in music sales).

that copyright systems, for example, require rules different from those applied to patent systems. Even within a single regime, different industries may require different approaches. The optimum conditions for producing and distributing sound recordings may be quite different from those for producing and distributing movies. The optimum IPRs for individual works are unlikely to suit communal works.

The generic theoretical assumptions on which intellectual property law relies may prove invalid in some systems. The dominant utilitarian incentives theory presumes a linear cause and effect relationship between legal entitlements and creativity. Since complex systems often behave in a nonlinear manner, this is clearly a risky assumption. Empirical analysis might show that intellectual property entitlements are necessary to provide incentives in some fields but not others or that, in some fields, such entitlements are essential to incentivize distribution, but not creation. Analysis might also provide more reliable information about the necessary level of incentives. An inflexible, one-size-fits-all approach is unlikely to optimize production and distribution in all intellectual property systems.[66] Legal regimes should take differences among systems into account.[67]

As the prairie analogy suggests, it may in fact be possible to produce sustainable systems under a variety of ownership models so long as those with ownership or access rights understand and respect the requirements of the particular creative system. It may also be desirable to tailor a wider variety of ownership structures to the requirements of different systems. The Native Americans who were dispossessed of their lands, for example, might be conferred communal rights in their traditional cultures.[68] It must be borne in mind that rules other than law, such as social norms and market practices, will also be in play. Law is merely one of many interacting complex systems.

66. The one-size fits all approach is already noticeably failing in the marketplace as the Internet facilitates the development of thousands of niche markets, a phenomenon referred to as the "long tail" of the sales curve. Dan Mitchell, *Tail is Wagging the Internet Dog*, N.Y. TIMES, Jul. 8, 2006, at C5.

67. Intellectual property laws already include some specialized provisions tailored for particular industries. *See* 17 U.S.C. §§ 114, 115 (2000) (dealing with sound recordings and musical works); 17 U.S.C. §§ 1001-1010 (2000) (dealing with digital audio recording devices).

68. *See, e.g.*, Angela R. Riley, *Recovering Collectivity: Group Rights To Intellectual Property in Indigenous Communities*, 18 CARDOZO ARTS & ENT. L.J. 175, 178 (2000) (arguing that a group rights model of ownership of intangible property is necessary to protect the works of indigenous peoples).

While systems analysis may reveal divergences between industries or regimes, complexity theory suggests that it will also reveal commonalities permitting some application of generalized legal rules. If all complex systems share common characteristics, surely intellectual property systems will also present common issues. Legal solutions developed in one regime may prove beneficial in another, as the Supreme Court has recognized in recent cases.[69] A complexity perspective is likely to encourage some cross-fertilization among regimes.

The quality of emergence suggests that regimes should favor rules reflecting actual practices that emerge within intellectual property systems rather than impose extensive top-down legal intervention based on unverified assumptions about system behavior.[70] Given the inherent unpredictability of complex systems, attempts to use intellectual property law to influence the development of certain emergent patterns, alter them, or avoid undesirable emergent effects will provide imperfect solutions at best and will have unanticipated consequences.[71] Consequently, legislators must try to anticipate indirect as well as direct effects of legislative initiatives, with the understanding that complete predictability and control are not only unattainable, but also undesirable.

The concept of self-organized criticality suggests that intellectual property regimes should seek a balance between chaos and order that will make both the regimes and the industries they govern flexible

69. For example, the Supreme Court has adapted principles of secondary liability established in patent law to copyright disputes involving new technologies. Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 439-42, (1984) (adopting the staple article of commerce doctrine); Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 125 S.Ct. 2764, 2780 (2005) (adopting inducement standard).

70. This characteristic appears to support, for example, the approach taken by drafters of the Uniform Commercial Code in basing their legal codification on accepted commercial practices.

71. The Digital Millennium Copyright Act, 17 U.S.C. §§ 1201-1205, for example, was intended to protect copyrighted works like sound recordings and DVDs, but has generated law suits seeking to protect monopolies in replacement parts by claiming "circumvention" of authentication software. *See* Chamberlain Group v. Skylink Techs., Inc., 381 F.3d 1178 (Fed. Cir. 2004) (rejecting DMCA claim brought against manufacturer of replacement parts for garage door openers); Lexmark Int'l, Inc. v. Static Control Components, Inc., 387 F.3d 522 (6th Cir. 2004) (rejecting claim of DMCA violation brought by printer manufacturer against manufacturer of chip used in remanufactured printer cartridges). Attempts to streamline the patent process may have inadvertently harmed innovation. *See* Sabra Chartrand, *Patents*, N.Y.TIMES, Sept. 27, 2004, at C8 (reporting on a study by Professors Josh Lerner and Adam B. Jaffe showing that simplification of the patent system, intended to encourage innovation, produced a degradation in the patent review system and increasingly aggressive patent enforcement, resulting in anti-innovative exploitation of patents for lawsuits).

enough to adapt to change. Effective regimes should nudge systems toward desired results rather than imposing heavy-handed strictures.[72] The regimes themselves must accommodate indeterminacy and evolve in response to changes in the wide variety of systems governed. Here, the prairie and the iPod have lessons to teach regarding the importance of the chaotic elements found in all complex systems and the possibility of designing rules that reap the benefits of those elements.

Prairies have always been subject to periodic fires sparked by lightning strikes and other natural phenomena.[73] Such fires were chaotic elements within the ecosystem, inevitably recurring though the exact timing of a particular fire was unpredictable. Fires are certainly destructive but also essential to the health of the grassland since they prevent the encroachment of woody plants and increase productivity by stimulating new growth.[74] Cycles of destruction and re-creation connected to such chaotic elements are common to complex systems.[75] Schumpeter's concept of "creative destruction," in which economic processes continually create new economic structures and destroy old ones,[76] provides an economic example though the phenomenon is hardly limited to economic systems. Historically, entire civilizations and their economic, social, technological, and legal systems have been subject to long cycles of creation and destruction. A process of creative destruction may even now be remaking copyright industries in response to the digital, networked environment; the copyright regime must respond.[77] It may be no accident that Thomas Jefferson chose the metaphor of fire to illustrate the importance of access to ideas and the dangers of intellectual property monopolies.[78] As the prairie analogy indicates,

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72. "[G]overnments should avoid both extremes of coercing a desired outcome or keeping strict hands off, and instead seek to push the system gently toward favored structures that can grow and emerge naturally. Not a heavy hand, not an invisible hand, but a nudging hand." W. Brian Arthur, *Complexity and the Economy*, 284 SCIENCE 107, 108 (April 2, 1999).

73. *See* LARRABEE & ALTMAN, *supra* note 48, at 24.

74. *Id.*

75. *See* LEWIN, *supra* note 5, at 100-01.

76. JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM AND DEMOCRACY 83 (1976).

77. *See* Ku, *supra* note 29, at 269 (suggesting that the music industry is currently experiencing creative destruction).

78.

> That ideas should freely spread from one to another over the globe, for the moral and mutual instruction of man, and improvement of his condition, seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without lessening their density in any point, and

however, those who understand the needs of a system may intentionally control chaotic elements just as Native Americans and ranchers control fires.[79] Prairie managers design a little chaos into their management of the ecosystem.

Similarly, Apple designs a little chaos into its iPod in the form of the shuffle function. Shuffle play is hardly essential to a functional system, so why incorporate it? It obviously offers a market advantage because users crave the element of surprise, a little bit of indeterminacy, at least as much as they value predictability.[80] Our success as a species may be a result of our ability to simultaneously entertain a love of order and a restless desire for change. Of particular importance to intellectual property, surprise is an essential characteristic of creativity and one of the reasons that we value creative works. Great artists offer not merely mastery of past styles but new visions different from what came before. Great inventors leap beyond the prior art in their fields.

Cognitive scientists posit that creativity is an emergent quality of that complex system, the human brain, and occurs when the brain is poised at the edge of chaos.[81] The brain receives innumerable bits of information from the senses, responds to them, and manipulates them.[82] Because of the chaotic elements inherent in these complex processes, the brain sometimes produces output different from any of its inputs – it creates. Some degree of internal chaos is essential to its ability to do so.[83] The creative brain must also, of course, have access to resources physical and cultural. It must interact with countless other complex systems and communicate with other brains both living and dead through transmitted culture. It requires time and a modicum of stability in which to play with the information it acquires. In short,

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> like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation.

Letter from Thomas Jefferson to Isaac McPherson (Aug 13, 1813), *in* THE COMPLETE JEFFERSON, 1011, 1015 (Saul K. Padover ed., 1943).

79. *See* LARRABEE & ALTMAN, *supra* note 48, at 24.

80. The Greek poet, Constantine Cavafy, in his poem *Waiting for the Barbarians* (1904), tells the story of an antique town awaiting destruction by the barbarians. The residents are disappointed when the barbarians move off without taking the town – at least destruction would have been a change of pace. Constantine Cavafy, *Waiting for the Barbarians* (1904), http://users.hol.gr/~barbanis/cavafy/barbarians.html (English translation).

81. Ralph D. Clifford, *Random Numbers, Chaos Theory, and Cogitation: A Search for the Minimal Creativity Standard in Copyright Law*, 82 DENV. U. L. REV. 259, 274-79 (2004) (describing creativity as a result of the complex nature of the brain).

82. *Id.*

83. *Id.* at 275-79. Surely the first sign of true artificial intelligence will be a computer mind that appreciates and generates surprises.

it requires some balance between order and chaos in its own workings and in its surrounding environment.

If the overarching goal of intellectual property regimes is to induce creativity by rewarding it, then a well-designed legal regime, like a well-designed music player, must accommodate both stability and an element of controlled chaos. It must nudge intellectual property systems toward the edge of chaos yet prevent them from falling over it. Thus far, intellectual property regimes, like most laws, have concentrated more on providing order, than encouraging change. The most basic function of law, after all, is to provide predictable rules for societal interaction and lawyers, by vocational necessity, take the short view of complex systems. Lawyers prefer set playlists to the shuffle function. In the long view, however, emergence, evolution, and chaotic events, will inevitably alter the playing field and are, in fact, essential to the sustainability of intellectual property systems. Fire and the shuffle play cannot be avoided.

Intellectual property regimes, along with social norms and market practices, provide a generally orderly structure within which intellectual goods can be created and distributed and rights in them transferred. However, durational limitations[84] and exceptions created by doctrines such as first sale,[85] and fair use,[86] have historically prevented complete control of all uses of works by IPR owners. In systems terms, the regimes contain some bright line rules producing predictable, ordered behaviors,[87] and some muddy rules preserving the chaotic elements essential for adaptation.[88] In the copyright regime, the historical prevalence of personal uses[89] of copyrighted

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84. Copyrights and patents have statutorily limited durations. *See* 17 U.S.C. §§ 301-305 (2000); 35 U.S.C. § 154 (2000).

85. The first sale of a copy of a work or an invention exhausts the copyright or patent owner's rights in that copy. *See*, 17 U.S.C. § 109(a) (2000) (copyright first sale); Keeler v. Standard Folding Bed Co., 157 U.S. 659, 661 (1895) (patent first sale and exhaustion).

86. The fair use doctrine provides a defense against copyright infringement claims. *See* 17 U.S.C. § 107 (2000).

87. For example, the rules governing formalities like registration and deposit of copyrighted works. *See* 17 U.S. C. §§ 401-412 (2000).

88. If the outcome of application of a legal rule to an entitlement dispute is unpredictable, the rule is considered "muddy." Such rules typically require the decision maker to balance competing interests, as courts do in applying the "four-factor" test for fair use. *See* Dan L. Burk, *Muddy Rules for Cyberspace*, 21 CARDOZO L. REV. 121, 130 (1999).

89. Personal use refers to consumptive or adaptive uses of works by consumers for their own enjoyment and, often, includes sharing with others. It includes a variety of unlicensed uses of copyrighted works, such as performing musical compositions in family musicales, creating mix tapes or burning CDs containing customized playlists, copying favorite articles or passages from books, building fan web sites, and so on. When works existed only in analog forms, such

works provided an additional outlet for creative re-use of cultural materials. Indeed, another clever design element of the iPod is the digital rights management system that permits such uses to persist, but keeps them within limits.[90] Similarly, designers of intellectual property regimes should aim for some middle ground between all-property and no-property rights in creative works, for rules that both provide stability and anticipate change. The middle ground is where the edge of chaos, and maximum sustainability, will be found.

Any regime governing inherently unpredictable systems will inevitably require periodic "tune-ups" to accommodate unforeseen changes in the system. It will, therefore, be important for regimes to incorporate, as part of their design, feedback mechanisms for collection of data on the status of the systems, which data will provide the basis for responses to changes in the systems. One of the promising features of the otherwise largely lamentable Digital Millennium Copyright Act, for example, is the requirement that the Librarian of Congress review the fair use implications of the act every three years.[91] Such review mechanisms should be more commonly employed. Legislators must anticipate a continuing relationship with intellectual property systems. They cannot expect to set legal regimes in motion, and then leave them unattended for long periods of time.

B. Not your father's libertarianism

An approach that suggests respect for bottom-up, emergent solutions and generally cautious interventions might be thought vaguely libertarian. Not so. Complex systems are historically contingent and path dependent. The history of intellectual property systems includes rather significant legal controls, a situation which is unlikely to change. Moreover, systems have no inherent moral compass and their emergent properties, while responsive to system

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uses posed little threat to IPR owners who grudgingly tolerated them. *See* Jane C. Ginsburg, *Authors and Users in Copyright*, 45 J. COPYRIGHT SOC'Y U.S.A. 1, 11 (1997). Digitization enables such activities on an unprecedented scale. Copyright owners respond by demanding more expansive legal rights and applying technological protection systems to prevent such uses of their works.

90. Apple's FairPlay program limits, for example, the number of devices on which downloads can be used and the number of times a playlist can be burned to CD. *See* William W. Fisher, III et. al., *iTunes: How Copyright, Contract, and Technology Shape the Business of Digital Media – A Case Study*, Jun. 15, 2004, http://cyber.law.harvard.edu/media/uploads/81/iTunesWhitePaper0604.pdf (describing Apple's digital rights management system); Apple iTunes Store Terms of Service, http://www.apple.com/legal/itunes/us/service.html (last visited July 22, 2007).

91. 17 U.S.C. § 1201(a)(1)(C) (2000).

conditions, may or may not be normatively desirable. Systems care nothing for the fate of the individual, but human beings must. Hurricanes are emergent properties of weather systems, but we seek methods of ameliorating their destructiveness. Economic systems, left unregulated, produce monopolies and inequitable distributions of wealth. We regulate to control abuses. The systems approach outlined above suggests that intellectual property regimes must permit emergence because some emergent patterns will be highly beneficial and efficient, but must also be prepared to control the effects if they prove undesirable. We can only verify effects through empirical study. Because of the reliance on empirical work, the complexity approach cannot be lumped into either the high-protectionist or low-protectionist camp. Empirical work might well suggest a high-protectionist strategy for one system, but a low-protectionist strategy for another. Such an approach bears little resemblance to libertarianism. Nor does it entirely agree with traditional law and economics analysis.

To date, the utilitarian focus on economic incentives has tended to obscure other values inherent in any system involving creative expression: the importance of artistic diversity and semiotic democracy. Complexity theory suggests that traditional economic analysis is necessary, but not sufficient to a complete understanding of intellectual property systems. It is necessary because it may explain a significant set of components and processes involved in such systems. It is insufficient because it focuses only on markets and ignores other system components such as social norms and networks and technological development. It thereby commits the cardinal sin, to a complexity theorist, of reductionism. Some of the assumptions of traditional equilibrium economics, such as the rationality of economic actors, are manifestly at odds with reality.[92] Cost-benefit analysis assumes linear cause-effect relationships that may not obtain in complex systems and have at best limited utility for policymakers trying to influence outcomes in an uncertain future.[93] However, behavioral economists and game theorists already offer more realistic views of strategic economic behavior.[94] Complexity economists[95] and

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92. *See* BEINHOCKER, *supra* note 22, at 116-18.

93. Ruhl & Ruhl, *supra* note 3, at 479-81 (criticizing cost-benefit analysis as inaccurate in determining aggregate costs and benefits because it does not (cannot) account for unexpected system effects).

94. *See* Craig Lambert, *The Marketplace of Perceptions: Behavioral Economics Explains Why We Procrastinate, Buy, and Grab Chocolate on the Spur of the Moment*, HARV. MAG., Mar.-Apr. 2006, at 50.

ecological economists[96] adopt explicitly evolutionary approaches that recognize inherent resource limitations in economic systems. Interdisciplinary teams explore new decision-making methods that will provide greater flexibility where outcomes are uncertain.[97] These emerging economic disciplines can contribute important insights into the operations of intellectual property systems.

A complexity approach by no means forecloses exploration of a variety of theoretical approaches. However, it does suggest that, taken singly, traditional approaches may be too limited in scope or too lacking in empirical verification. No single approach should place blinders on our ability to study systems holistically. Complexity theory itself is merely one more tool that may improve our understanding of the intellectual property systems that produce iPods and the content loaded onto them. If the complexity approach must be aligned with any particular philosophy, it may fit most comfortably into the rather loose collection of concepts known as pragmatism of which Holmes was the foremost proponent in law. The central core to pragmatism is its emphasis on making use of a variety of theoretical ideas but grounding such use in practical effects on real life. [98] Complex systems, like life, resist the imposition of a single unified theory of everything.

VI. CONCLUSION

In this article, I have argued that complexity theory and systems analysis offer a new and useful analytical approach to the perennial argument over the proper scope of IPRs. The prairie and the iPod teach that legislators should design legal regimes with due

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95. *See,* BEINHOCKER, *supra* note 22, at 15-19 (describing economies as adaptive systems that evolve in response to technological innovation, social development and business practices).

96. *See,* HERMAN E. DALY & JOSHUA FARLEY, ECOLOGICAL ECONOMICS: PRINCIPLES AND APPLICATIONS xxii-xxiii (2004) (describing an interdisciplinary framework for economics that recognizes linkages among economic growth, environmental degradation, and social inequity).

97. *See* Steven W. Popper, Robert J. Lempert & Stephen C. Bankes, *Shaping the Future,* SCI. AM., Apr. 2005, at 67 (describing an alternative decision-making framework that finds, tests, and implements flexible policies).

98. Holmes rejected a strictly formalist approach to law in favor of an approach emphasizing the effect of experience, by which he meant the interaction of the human organism with its environment. LOUIS MENAND, THE METAPHYSICAL CLUB 342-47 (2002) (describing Holmes's jurisprudential theories in the context of pragmatism). Interestingly, Justice Breyer has recently embraced an essentially pragmatic approach to constitutional interpretation. *See* Kathleen M. Sullivan, *Consent of the Governed,* N.Y. TIMES BOOK REV., Feb. 5, 2006, at 20 (reviewing STEPHEN BREYER, ACTIVE LIBERTY: INTERPRETING OUR DEMOCRATIC CONSTITUTION (2006)).

consideration for the varying requirements of different intellectual property systems and an appreciation for the chaotic elements inherent in those systems. Empirical study is essential. The call is often heard for formulation of a new theory of the commons. I suggest that we have less immediate need of a new theory of the commons than of hard data about the workings of intellectual property systems.

Historically, philosophy served as a means of explaining real phenomena in the absence of scientific knowledge. As scientific methodology improved and real data became available, preexisting philosophies were, perforce, altered or abandoned. Our modern scientific understanding of the atom, for example, is in no wise comparable to the imaginings of the Greek atomists. In intellectual property, the time may be right to put Locke and Hegel on the shelf for a while and abandon the thin air of pure theory in favor of a more scientific exploration of the real systems through which intellectual works are produced and distributed. With that knowledge, we will be better equipped to formulate new theoretical models and to design legal regimes that encourage creativity and assure public access to information. Intellectual property systems will continue to evolve even as we study them. Well-designed legal regimes must be flexible and varied enough to gently guide that evolution and continuously respond to it.