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The Collaborative Nature of Innovation

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INTRODUCTION

In the 1970s, Tim Paterson was a member of the small group of renegades, hippies, and futurist dreamers who believed that computers could change the world. Back then, computers were large and expensive, and most people thought of them as mindless number-crunchers that balanced the books at big banks or printed bills for the phone company. But some of the first programmers had '60s-inspired visions of using the computer to create a more just and fulfilling society.[1] Paterson worked at the Seattle Computer Products ("SCP") company, which was developing a personal computer based on a new microprocessor, the Intel 8086.[2] SCP was planning to sell its new computer in a "kit" form, leaving customers to wire it together themselves. Although this would be a deal-breaker for today's computer buyer, in the 1970s, many of the people who bought computers were electronics wizards who were fully capable of wiring them together.

Every computer needs an "operating system," software that makes it possible to open and close applications, manage disk files, and communicate with the monitor and the printer. SCP had been planning to use the most popular operating system at that time, Control Program for Microcomputers ("CP/M"), sold by Digital Research.[3] CP/M had sold 600,000 copies by the time Intel released

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1. *See* THEODOR NELSON, COMPUTER LIB/DREAM MACHINES (1974).
2. DosMan Drivel, http://dosmandrivel.blogspot.com/ (Sept. 30, 2007, 23:04 PST).
3. DosMan Drivel, http://dosmandrivel.blogspot.com/ (Nov. 24, 2007, 14:15 PST).

the 8086, and there was a rich library of application programs for it, including databases and word processors.[4] But it was taking Digital Research too long to come out with an 8086 version of its operating system.

Paterson decided to make his own. Amazingly, he finished in only four months.[5] SCP called it the "quick and dirty operating system" ("QDOS"). In August 1980, customers started buying it for SCP's computer kit. Tim kept working on improving QDOS, and eight months later, in April 1981, SCP released a new version called 86-DOS.[6] When printed, it totaled about four thousand lines in a primitive kind of computer language known as assembler—a difficult-to-master language seen only by true hackers nowadays.[7] Back in the early days of personal computing, assembler was often the only way to program. Through the 1980s, as easier-to-use programming languages began to replace assembler, the old guard used to tease new college graduates and their fancy new languages by bragging that "real men program in assembler".[8]

What Paterson didn't know—what no one at SCP knew—was that something big was about to happen, something that would change computing beyond his wildest dreams. IBM, the biggest, most old-fashioned computer company, was interested in this hobbyist business run by former hippies. IBM decided to market a new personal computer based on Intel's new 8088 microprocessor, a cheaper version of the 8086. The personal computer revolution was entering the executive suite and would no longer be associated with a long-haired alternative lifestyle.

Just like SCP, IBM needed an operating system for its new personal computer, but it had no experience writing software for

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4. About.com: Inventors, Inventors of the Modern Computer, http://inventors.about.com/library/weekly/aa033099.htm (last visited May 10, 2009).

5. Economic Expert.com, QDOS, http://www.economicexpert.com (last visited May 10, 2009). Other versions of the story state durations including six weeks and two months. Patterson's website says he started in April 1980 and the first versions were shipped in August 1980. *See supra* note 2.

6. *See* Economic Expert.com, *supra* note 5.

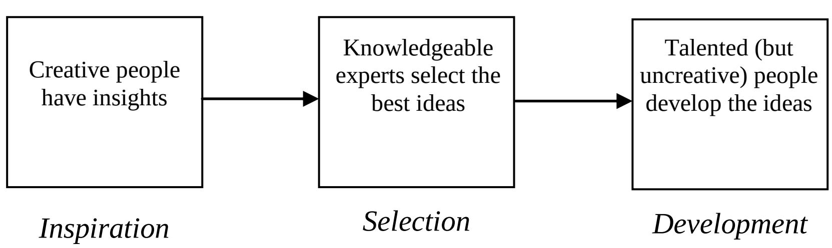
7. Answers.com, MS-DOS, http://www.answers.com/topic/ms-dos (last visited May 10, 2009).

8. This phraseology was borrowed from the name of the 1982 best-selling satire titled *Real Men Don't Eat Quiche*. BRUCE FEIRSTEIN, REAL MEN DON'T EACH QUICHE (1982).

microprocessors. IBM approached Bill Gates of Microsoft, one of the small companies known for selling PC software. Although Paterson had taken only four months, Microsoft was not sure it could replicate his feat; its programmers had never written an operating system.[9] Rather than program his own, Gates called up his neighbors at SCP, saying that he wanted to buy 86-DOS to sell to a new computer manufacturer.[10] Apparently SCP never knew that Microsoft's customer was IBM.[11] The deal netted about $75,000 for SCP,[12] which might seem like an insufficient sum given how much money Microsoft would go on to make from the IBM deal. But it must have seemed to be a substantial amount at the time for less than a year of work. Paterson did not find out who Microsoft's secret client was until he was hired by Microsoft a few months after the purchase.[13]

The story about how Paterson created DOS fits naturally with the way most people think innovation works. It is an example of what I call linear creativity, because it follows a three-step process.

FIGURE 1: LINEAR CREATIVITY



9. HAROLD EVANS, THEY MADE AMERICA 402–17 (2004).
10. *See id*.
11. *See id*.
12. *See id*.
13. Of particular interest are Tim Paterson's own blog, DosMan Drivel, http://dosmandrivel.blogspot.com/ (Aug. 8, 2007, 19:36 PST); (Aug. 17, 2007, 22:11 PST); (Sept. 30, 2007, 23:04 PST); (Nov. 24, 2007, 14:15 PST); and a recent published version in EVANS, *supra* note 9.

- Step 1. An individual comes up with an idea. The individuals who originate ideas are either scientists in research labs or universities; independent creators, such as authors preparing a new book proposal or visual artists painting a new work; or entrepreneurs preparing a new business plan.
- Step 2. A group of authorized individuals selects one idea from among the many submitted to them. If the idea originates in a research lab, typically a team of executives reviews and selects the ideas to be pursued. If the idea originates with an independent creator, typically several layers of selection filtering are applied: an author's book proposal must first be selected by a literary agent and then by the editorial staff at a publisher; a painter's new work must be selected by a gallery owner, a dealer, a museum curator, or the staff at a national arts magazine; new business plans must be selected by investors.
- Step 3. The selected idea then receives an investment of resources that enables the idea to be implemented. The business case is made; the up-front investment is allocated. With independent creators such as authors and painters, there is often no implementation stage because the work is fully created prior to the selection step.

In this linear view of innovation, creativity—the generation of new ideas—is easy to find: it is in Step 1. Creativity is required neither of the selection stage nor of the implementation stage. If the goal is increased creativity, then one needs either people who are more creative and generate ideas faster, or more total people generating new ideas.

In this Article, I argue that this is not the best way to increase societal innovation. I define "innovation" as the emergence of a viable product or service that has an impact on the world, in contrast to "creativity," which I define as the generation of new, useful, and nonobvious ideas.[14] Efforts to increase innovation could be directed at any of the three stages. One could increase creativity in Step 1 by assigning more creative people to generate ideas. In addition, in Step 2, better evaluation and selection could result in increased innovation; and in Step 3, more effective implementation of new ideas could result in increased innovation. All three steps must be working effectively to result in innovation.

In the linear model of innovation, "intellectual property" is the idea that emerges from Step 1. Many organizations are capable of Steps 2 and 3, of selecting and implementing good ideas. If good ideas did not receive IP protection, there would be many organizations capable of recognizing, selecting, and implementing them. Consequently, without IP protection, the originator of the idea would have no guarantee of receiving financial reward for that creative activity. IP protection is necessary to spur innovation because it costs money to generate new ideas (e.g., costs of supporting a staff of research scientists and lab equipment). If an organization cannot be assured an ownership right in the ideas that emerge, why would it invest the resources to generate those ideas? If ideas were free, all organizations would invest in Steps 2 and 3 and simply take good ideas wherever they were found. If that happened, the source of good ideas would dry up. Who would invest the resources to generate good ideas if any organization could then benefit from them?

For these reasons, I believe that some degree of intellectual property ("IP") protection for ideas is necessary to spur maximum innovation. I am not aware of any research suggesting that a completely free and open market for ideas would result in enhanced creativity or innovation. In this Article, I argue that the linear model of innovation is an inaccurate representation of how innovation actually occurs. Further, I argue that the current IP regime is based almost entirely on the linear model of innovation. If that model is inaccurate, then the IP regime currently is designed to work with an inaccurate conception of the innovation process.

14. This definition of creativity is derived from the statutory definition of a patentable invention. *See* 35 U.S.C. § 101 (2006) (requiring the invention be new and useful); 35 U.S.C. § 103 (2006) (requiring the invention be non-obvious).

I hold that the primary goal of an IP regime is to maximize the innovation potential of a society and/or economy. A secondary goal is to protect an individual's or group's property rights in their creations; but I view that goal as subsidiary to the ultimate goal of maximizing societal innovation. In Part I below, I provide an argument for why I think individual rights in creative ideas are over-emphasized and should not be the primary goal of an IP regime. In Part II, I outline an alternative to the linear model, which I call the "systems model" of innovation. In Part III, I start from the systems model to propose some features of an IP regime that would maximize innovation, and I suggest a list of challenges to be faced in designing a new IP regime. In Part IV, I discuss current open source communities, briefly discuss how the open source model addresses the noted challenges, and argue that these solutions will not result in maximum overall societal innovation.

I. INDIVIDUAL RIGHTS ARE OVER-EMPHASIZED

Residents of the United States generally hold to a highly individualistic theory of creativity.[15] The individualistic theory is defined by several characteristics: Ideas emerge from within an individual mind; Each individual mind is unique, resulting in distinctively unique ideas emerging from each person; the emergence of an idea is largely unpredictable (although hard work can contribute); some people are more creative than others, thereby having more ideas; creative ideas break with the past and represent something completely new.[16]

The individualistic theory of creativity aligns quite well with the linear model of innovation: In Step 1, it is individuals who generate the new ideas. Collaborative and organizational dynamics are expected in Steps 2 and 3, but idea generation is still considered to be essentially a solitary mental process.

15. R. KEITH SAWYER, EXPLAINING CREATIVITY: THE SCIENCE OF HUMAN INNOVATION 140–42 (2006).

16. *Id*.

Recent studies of creativity have shown that the individualistic theory is largely false.[17] Creativity is almost always a collaborative, interactive process, involving contributions of many distinct individuals. New products today generally contain many separate ideas. Rarely does one idea translate directly into a marketable product. In the following, I discuss two forms of creative insight that have been studied by psychologists, conceptual combination and conceptual elaboration, emphasizing that both forms of ideation are heavily based on prior art.

A. Conceptual Combination

Many successful products are created from conceptual combination. This form of innovation has been the focus of legal discussion.[18] Each individual has a basic mental ability to combine concepts and use these combinations to develop creative *new* concepts. Researchers have studied this ability by giving subjects pairs of words, for example those in the table below, and asking them to envision and describe the combined concept. For example, if a subject is presented with the words PANCAKE and BOAT, the subject might suggest that a pancake boat is a very flat boat, with a low profile that allows it to go under low-lying bridges; or that it is a new kind of restaurant that serves breakfast while touring the harbor.

17. *See id* at 153.
18. *Id*.

TABLE 1: CREATIVE COMBINATION[19]

	A	B
1	PANCAKE	BOAT
2	SNAKE	BOOK
3	CITY	DINNER
4	RUBBER	ARMY
5	ROCKET	SPONGE
6	BASEMENT	FRUIT
7	SOFA	FLASHLIGHT
8	COMPUTER	DOG
9	PONY	BOX
10	STONE	PAPER

Individuals also have the ability to understand a conceptual combination they have never heard before. Understanding a new combination requires creative mental processes. To take the words in row 4 of Table 1, a rubber army might have the property "makes a good toy for a boy," but most people do not think of "good toy" when they hear the words army or rubber. These are emergent attributes, attributes that are not true of either base concept. People are incredibly creative in coming up with emergent attributes for noun combinations.[20]

Edward Wisniewski and Dedre Gentner used pairs such as this with an interesting twist: They came up with some words that were relatively similar and other words that were very different. They did this by identifying important dimensions that apply to all nouns, such as "artifact" versus "natural," and "count noun" (nouns that can be preceded with numbers, such as "five chairs") versus "mass noun" (nouns that cannot be numbered, such as "sand" or "paper"). Then they gave subjects pairs of concepts that varied on these dimensions

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19. R. KEITH SAWYER, GROUP GENIUS: THE CREATIVE POWER OF COLLABORATION 113 (2007).

20. *See* Edward J. Wisniewski & Dedre Gentner, *On the Combinatorial Semantics of Noun Pairs: Minor and Major Adjustments to Meaning*, *in* UNDERSTANDING WORD AND SENTENCE 241, 249–50 (Greg B. Simpson ed., 1991).

and pairs that did not. For example, a "pony chair" combines a natural concept and an artifact concept, both count nouns; "snake paper" combines two concepts that are different in two ways: one is natural and one is an artifact, and one is a count noun and the other a mass noun.[21] They discovered a fascinating result: The further apart two concepts are, the more likely it is that a truly creative idea will result.

TABLE 2: CONCEPTS COMBINED IN WISNIEWSKI AND GENTNER EXPERIMENTS[22]

Group 1: Count nouns		Group 2: Mass nouns		Group 3: Count nouns	
Natural	*Artifact*	*Natural*	*Artifact*	*Natural*	*Artifact*
Frog	Box	Clay	Candy	Elephant	Book
Moose	Chair	Copper	Chocolate	Fish	Car
Robin	Pan	Sand	Glass	Pony	Clock
Skunk	Rake	Stone	Paper	Snake	Ladder
Tiger	Vase	Sugar	Plastic	Squirrel	Pencil

To understand why, it helps to know how the mind represents concepts. Each concept is stored in the mind as a set of properties and the values of each property.[23] For example, the concept "spoon" has properties and values "shape: long and thin," "function: holds liquid," "size: (large or small)," and "material: (wooden or metal)." For many concepts, the properties interact with one another; most of us think that wooden spoons are larger spoons and that metal spoons are smaller.

In the simplest type of conceptual combination, the properties for both concepts are joined together.[24] Properties that are true of one concept but incompatible with the other are discarded; a pet shark cannot be "warm and cuddly" as most pets are. For two properties

21. *See* Table 2, *infra*.
22. SAWYER, *supra* note 19, at 114.
23. Wisniewski & Gentner, *supra* note 20, at 241–84.
24. Edward J. Wisniewski, *Conceptual Combination: Possibilities and Esthetics*, *in* AMERICAN PSYCHOLOGICAL ASSOCIATION, CREATIVE THOUGHT: AN INVESTIGATION OF CONCEPTUAL STRUCTURES AND PROCESSES 51 (Thomas B. Ward et al. eds., 1997).

that are incompatible, one must be chosen; a pet "lives in a domestic environment," but a shark "lives in the ocean," and a pet shark can live in only one place. When combining, you will pick the one that's most compatible with all of the other properties of the new concept. If you said a "pony chair" is a chair that's furry and cute, but not alive, this is what you are doing.

In a second form of combination, "property mapping," you take just one value from one concept and merge it with the second concept. If you said a "pony chair" was a brown and white chair, this is what you are doing: taking the "color: brown and white" value of pony, and setting the color property of chair to the same value.

In a third, more complex form of combination, you look for a relation that can bring the two concepts together. When imagining a "book box," you might think of the relationship of "containing"; "box" is the container and "book" is what is contained. If you said a "pony chair" is a chair in which a pony sits, or a chair in which you sit while taking care of a pony, this is what you are doing.

But the most creative combinations result from a fourth process known as "structure mapping," in which you take the complex structure of one concept and use it to restructure the second concept. There are two different kinds of structure mapping: internal structure and external structure. If your pony chair is a chair shaped like a pony, that is internal structure mapping. You took the internal structure of a pony and applied it to the chair. If you said a "pony chair" was a small chair, that is external structure mapping. You are thinking of not a chair that is smaller than a pony, but a chair that is smaller than other chairs in the same way that a pony is smaller than other horses.

The more similar two concepts are, the easier it is to use the simpler strategies of combining properties and values. When concepts are very different, you have to use the more complex strategies of property mapping or structure mapping, and these strategies result in the most novel and innovative combinations.[25]

25. The preceding nine paragraphs are adapted from an article previously published by the author. R. Keith Sawyer, *Creativity, Innovation, and Obviousness*, 12 LEWIS & CLARK L. REV. 461, 465–66 (2008).

If creative ideation often involves combinations of prior art, it should take a lot of training in an area before one is capable of having a new and useful idea. Mastery of an area would result in internalization of a greater amount of existing material, thereby increasing the possible new combinations that could emerge. In fact, studies have empirically found that historical creators are experts in their fields who have invested a minimum of ten years mastering the domain.[26] This finding has relevance to the legal definition of a Person Having Ordinary Skill in the Art ("PHOSITA"). How many years of experience constitute "ordinary skill"? The courts tend to use a fairly low threshold such as holding a bachelor's degree in a relevant discipline and some familiarity with the device involved.[27]

In patent law, a property right can be granted only to an individual who uses combination to generate a new and useful idea if that combination is non-obvious.[28] Determining whether a combination is obvious or not is fraught with challenges.[29] But another issue often must be faced: The division between the existing ideas and the new combined idea is often difficult to determine. The combination, for example, often results in minor modifications to each of the component ideas. At what point do those modifications become so dramatic that the originator of a component idea no longer should be granted protection?

In another example, the combination might not be an aggregative componential one; rather, it might involve substantial integration of multiple components, such that separating out any one prior art component becomes increasingly difficult. This is often the case with the complex and intricate systems that are increasingly common in information technology and communications. With such systems,

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26. MIHALY CSIKSZENTMIHALYI, CREATIVITY: FLOW AND THE PSYCHOLOGY OF DISCOVERY AND INVENTION (1996); HOWARD GARDNER, CREATING MINDS: AN ANATOMY OF CREATIVITY SEEN THROUGH THE LIVES OF FREUD, PICASSO, STRAVINSKY, ELIOT, GRAHAM, AND GANDHI (1993).

27. *See, e.g.*, KSR Int'l Co. v. Teleflex Inc., 127 S. Ct. 1727, 1738, 1743 (2007) (holding that the level of ordinary skill for purposes of the case was "an undergraduate degree in mechanical engineering (or an equivalent amount of industry experience) [and] familiarity with pedal control systems for vehicles.").

28. 35 U.S.C. § 101 (2006) (requiring the invention be new and useful); 35 U.S.C. § 103 (2006) (requiring the invention be non-obvious).

29. *See* Sawyer, *supra* note 25, at 477–78.

innovation more naturally follows a systemic, rather than a linear process.[30]

B. Conceptual Elaboration

A second fundamental cognitive process that results in new and useful ideas is conceptual elaboration: taking an existing concept and modifying it to create something new.[31]

Arm & Hammer Baking Soda was first sold in 1846, and the company, Church & Dwight, thrived for more than one hundred years. But by 1970, Church & Dwight had a problem: Everyone was either buying box mix or not baking at all, and people did not need baking soda anymore. The old box of baking soda was so useless that people had started putting the box in their refrigerators; word of mouth had it that the powder absorbed odors.[32] The company did some research and discovered that the powder actually worked fairly well at absorbing odors.[33] It decided to market the odor-absorbing qualities of baking soda, and in 1972, it unveiled a new television ad campaign: Use Arm & Hammer in the fridge to "keep food tasting fresh."[34] Within a year, more than half of United States refrigerators contained an open box at the back of the shelf.[35] Church & Dwight have now extended the product to new brands of deodorant, toothpaste, cat litter deodorizer, and laundry detergent.[36]

The continued success of Arm & Hammer baking soda is due to conceptual elaboration. The easiest way to elaborate a concept is to modify one of its property values while keeping the other properties the same. Popular songs are often small variations of existing songs; architects design new buildings that are only slightly different from

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30. *See infra* Part II.

31. *See generally* Thomas B. Ward, *Structured Imagination: The Role of Category Structure in Exemplar Generation*, 27 COGNITIVE PSYCHOL. 1 (1994).

32. Dwight C. Minton, Members of the Board, Inst. for the Env't & Natural Res., Remarks at the University of Wyoming: Facts, Fables, and Our Environment (Apr. 28, 1998) (transcript *available at* http://www.uwyo.edu/enr/ienr/DistinguishedSpeakers/MintonApr.98.asp).

33. *See id*.

34. *See id*.

35. *See id*.

36. *See* Church & Dwight Co., Inc., http://www.churchdwight.com/Company/corp_history.asp (last visited May 10, 2009).

existing buildings; chefs create recipes that are subtle variations on old favorites. Many of these elaborations would qualify as obvious and not be patentable. But in 1972, Church & Dwight's elaboration was not obvious because they changed a key property of their product, the "function" property, and retained everything else. That insight was not obvious because the "function" property of baking soda was one of its core properties, and core properties are resistant to change. The psychologist Thomas Ward showed this by asking people to imagine, draw, and describe animals that might exist on other planets.[37] People assume certain core properties of animals: They all have eyes, ears, and legs, and their bodies are symmetrical. And like a wooden spoon being large, some properties are linked together. For example, animals with feathers also tend to have wings, and animals with scales tend to have fins. On another planet, all of these things might, of course, be different. But Ward's subjects did not usually imagine them so.[38] The property values they modified were predictable: More than two eyes, eyes in different locations, or variations on legs, such as legs with wheels at the end.[39]

When conceptual elaboration is very small—changing the number of legs or eyes—it does not take that much creativity. What Dwight & Church did sounds simple, but baking soda's "function" property—set to "baking"—was not obvious. Changing a core property results in a less obvious new idea than changing a more peripheral property.[40]

When an individual uses conceptual elaboration to generate a new and useful idea, what degree of property right in the idea should that individual be granted? Granting a property right implies that it is straightforward to distinguish between the prior art and the elaboration of it. That is often not the case, however, as the early history of aviation demonstrates.

The Wright brothers received a patent for their flying machine,[41] but many components of their flyer had appeared in prior art.[42] Their

37. *See* Ward, *supra* note 31, at 1.
38. Sawyer, *supra* note 25, at 469–70.
39. *See* Ward, *supra* note 31.
40. *See id*.
41. Flying Machine, U.S. Patent No. 821,393 (filed Mar. 23, 1903) (issued May 22, 1906).

primary creative contribution was their method for lateral control of the craft. The Wright brothers accomplished this by providing a cable that allowed the operator to warp the wings forward or backward as the vertical tail simultaneously turned left or right.[43] Whether this was a true innovation was in dispute among aviators of the period. Octave Chanute, perhaps the Wrights' closest ally and collaborator, said in 1909: "I do not think that the courts will hold that the principle underlying the warping tips can be patented. . . . There is no question that the fundamental principle underlying [this] was well known before the Wrights incorporated it in their machine."[44]

In 1911, aviator Glen Curtiss received a patent for a flying machine that used a different lateral control method.[45] Instead of warping the wings, Curtiss had the idea of keeping the wings fixed, but he attached a separate surface in between the two biplane wings—the aileron—that the operator could move up or down.[46] The Wright Brothers sued Curtiss,[47] claiming that the aileron technique was covered under their original patent, which read:

> We wish it to be understood, however, that our invention is not limited to this particular construction [i.e., twisting the entire wings in opposite directions], since any construction whereby the angular relations of the lateral margins of the aeroplanes may be varied in opposite directions with respect to the normal planes of said aeroplanes comes within the scope of our invention.[48]

42. SETH SCHULMAN, UNLOCKING THE SKY: GLENN HAMMOND CURTISS AND THE RACE TO INVENT THE AIRPLANE 55 (2002); *see* EVANS, *supra* note 9, at 180–211.

43. EVANS, *supra* note 9, at 180–211.

44. SHULMAN, *supra* note 42, at 55.

45. Flying Machine, U.S. Patent No. 1,011,106 (filed Apr. 8, 1909) (issued Dec. 5, 1911).

46. There is some evidence that this idea appeared in prior art as well, in an 1868 patent by M. P. W. Boulton of England. *See* Wright Co. v. Herring-Curtiss Co., 204 F. 597, 603 (W.D.N.Y. 1913), *aff'd*, 211 F. 654, 655 (2d Cir. 1914). The first modern-style aileron—at the rear of the wings—was created by Henri Farman of France in 1908. JOHN D. ANDERSON JR., THE AIRPLANE: A HISTORY OF ITS TECHNOLOGY 139 (2003).

47. *Wright Co.*, 204 F. at 597.

48. Flying Machine, U.S. Patent No. 821, 393 col. 5 1.38–46 (filed Mar. 23, 1903) (issued May 22, 1906).

Other aircraft designs used ailerons as well.[49] Like Farman's, many of these designs originated in Europe. The Wright brothers brought dozens of lawsuits against these aircraft.[50] Most courts ruled in favor of the Wright brothers. Judge Learned Hand issued a temporary injunction to Wright Company in its suit against Louis Paulhan for his use of the Farman flying machine.[51] Judge Learned Hand also granted an injunction to Wright Company to prevent Claude Grahame-White, an English aviator, from flying in the United States without permission from the Wrights.[52] On February 21, 1913, Judge John R. Hazel of the U.S. District Court for the Western District of New York granted the Wrights a petition for an order restraining Curtiss from manufacture and sale of his machines.[53] Curtiss, however, retained the IP right to the aileron design from the 1911 patent, but he was not able to develop and market it without receiving a license from the Wright Brothers.[54] The Wrights were asking the rather large amount of $1,000 per airplane, which Curtiss was unwilling to pay.[55] At the same time, the Wrights were not able to use the aileron design without a license from Curtiss,[56] leading to a standoff that prevented further innovation from occurring.

Historians still differ on whether they believe the Wrights' original patent was applied too broadly.[57] Seth Shulman concluded that the effect of the Wrights' case against Curtiss was to "cripple the development of the youthful aviation industry."[58] IP law provided a mechanism for giving both the Wrights and Bell protection for their contributions; but it may have been mistaken in viewing the aileron as an elaboration of wing warping. Determining the extent of a new elaboration is often not straightforward. It places a heavy burden on a

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49. *See* SCHULMAN, *supra* note 42.
50. *See id*.
51. Wright Co. v. Paulhan, 177 F. 261, 271 (S.D.N.Y. 1910).
52. CHARLES B. HAYWARD, PRACTICAL AERONAUTICS 522 (1912).
53. Wright Co. v. Herring-Curtiss Co., 204 F. 597, 614 (W.D.N.Y. 1913), *aff'd*, 211 F. 654, 655 (2d Cir. 1914).
54. *See* SCHULMAN, *supra* note 42.
55. *See id*.
56. *See id*.
57. *See id*. at 41–51.
58. *Id*. at 57.

court to expect it to predict how its decisions might impact future innovations.

II. A SYSTEMS MODEL OF INNOVATION

Most innovations today do not come from linear creativity. Modern innovation comes from collaborative webs, distributed and diffuse social networks. In a collaborative web, inspiration, selection, and development all work together simultaneously, and many people throughout the web make important contributions.[59] The international aviation community was a collaborative web.[60] Information flowed freely between these amateur hobbyists in exchanged papers and talks given at international conferences (at least until the Wrights began enforcing their patent).

It did not take long before Paterson's creation, MS-DOS, was replaced by Windows. The story of how Windows was created shows the power of collaborative webs in today's innovation economy. Microsoft released its first version of the Windows operating system in 1985, but it was the 1990 release of Windows 3.0 that made it a market success. This history suggests that an engineer or group of engineers at Microsoft created and refined Windows.

But those devoted to the Apple Macintosh tell a different story. "They know that the most distinctive features of Windows—its graphical user interface, or GUI—appeared . . . [in 1984] in the Macintosh. The . . . Macintosh was the first successful consumer computer to have a GUI with windows, menus, and a mouse pointing device . . . ."[61] Macintosh fans might say that Microsoft Windows was an idea stolen from Apple and that Microsoft did not truly create anything. And it is true that Bill Gates first became excited about the windows-and-mouse technology when Microsoft engineers visited Apple in 1981; Microsoft started to develop Windows only after Apple refused its offer to buy the rights to the Macintosh operating system.[62]

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59. SAWYER, *supra* note 19, at 179–202.
60. *Id*. at 190–91.
61. SAWYER, *supra* note 15, at 281–82.
62. *Id*. at 283.

But "Apple didn't create Windows, either."[63] Many of the creative ideas that we associate with Windows were first created in the 1960s in university research labs. In 1970, the Xerox Corporation created a cutting-edge research facility known as the Palo Alto Research Center ("PARC") to develop a computer based on these ideas.[64] Three years later, they

> released the world's first personal computer: the Alto . . . The Alto had windows and a mouse-controlled cursor. It used a laser printer—a radical new technology also developed at PARC—and you could connect several Altos using a network known as Ethernet, also developed at PARC. This was a highly influential computer, far ahead of its time; today, almost every office uses laser printers and [communicates over an] Ethernet. But Xerox chose not to market the Alto because [they would have to sell it at $40,000 to make a profit].[65]

They kept at it, though, and "[i]n 1981, Xerox released a less expensive version, the Star, for [$16,000], but the market had already settled on much cheaper personal computers . . . [running simple operating systems like CP/M,] and the Star failed to sell."[66]

> Steven Jobs, Apple's founder and CEO, was given a couple of tours of Xerox PARC in 1979, and he was inspired by [the windows-and-mouse interface]. He instructed his developers to get to work on a similar type of computer, and by 1981, Apple had hired about 15 of the Xerox developers to work on two [different] graphical user interfaces: the Lisa and the Macintosh. The Lisa and Macintosh teams worked pretty much independently, and they sometimes duplicated each other's innovations, resulting in multiple discoveries. The engineers sometimes chose different solutions for the same problem. For example, where the Mac had a mouse for cursor control, the Lisa used a touch-sensitive pad next to the keyboard [the same kind that you find today on many notebook computers]. The

63. *Id*. at 282.
64. *Id.* at 282.
65. *Id*. at 282–83.
66. *Id*. at 283.

> Lisa was released first, in January 1983, but at [$10,000] it was too expensive . . . , and was doomed like the Alto and the Star. The Mac [] . . . was released at an affordable price in 1984, and the rest is history.[67]

What we know today is that Microsoft Windows emerged from a collaborative web—a complex combination of many, many small moments of inspiration, selection, and development, taking place in many different teams.[68] Table 3 contains a lot of guesswork. “No one knows exactly which research group first came up with each of these ideas, and the origins of many of them are contested.”[69] And it is likely that some of the ideas were independently invented by different teams. “After all, it’s not that big of a leap of insight to look at radio buttons and think of extending the idea to check boxes.”[70] And most of these creative inventions emerged from the synergies of

> an entire research team: the Lisa project at Apple, for example, or the Learning Research Group (LRG) at Xerox PARC. And even the innovations that are attributed to specific people—like the idea of turning a trackball upside down to create a mouse—occurred in collaborative contexts, and it’s probably unfair to give all of the credit to any one individual.[71]

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67. *Id*. (footnote omitted).
68. *See* Table 3, *infra*.
69. SAWYER, *supra* note 15, at 284.
70. *Id*.
71. *Id*.

TABLE 3: SOURCE OF INVENTION OF VARIOUS COMPONENTS OF THE WINDOWS GRAPHICAL USER INTERFACE[72]

Invention	Year	Project Name	Person/Group
Screen pointer (lightpen touching screen)	1963	Sketchpad	Ivan Sutherland
[Trackball as] [p]ointing device, now with on-screen pointer	mid-1970s	Doug Englebart	SRI
Mouse (an upside-down trackball)	[mid-1970s]	Doug Englebart	SRI
Cursor changes that show system status (arrow to egg timer)	mid-1970s	William Newman	Xerox PARC
Menus	mid-1970s	Learning Research Group (LRG)	Xerox PARC
Popup menus	mid-1970s	Ingalls (LRG)	Xerox PARC
Pull-down menus	1983	Lisa	Apple
Disabling (graying) of inactive menu items	Uncertain[:] Lisa (1983) or Ed Anson (1980) or Xerox PARC (1982)		
Menu bar	1983	Lisa	Apple
Scroll bars	mid-1970s	LRG	Xerox PARC
Radio buttons	mid-1970s	Kaehler (LRG)	Xerox PARC
Check boxes	mid-1970s	LRG (?)	Xerox PARC
Drag and drop movement of icons	1984 (?)	Jeff Raskin	Macintosh

72. *Id*. tbl. 15.1.

Each of these creative innovations is a synergy: a combination of small creative ideas, none of which would have worked without the others. For example, the first screen pointer was the light pen used in Ivan Sutherland's 1963 Sketchpad system; it had to touch the screen to work.[73]

> Because the pointer was physically touching the screen, there was no need for a pointer icon to be displayed on the screen. In the 1970s, researchers at Xerox PARC took this idea and elaborated it. They realized that a track ball could be used instead of a light pen, but because the ball didn't actually touch the screen, a pointer had to be placed on the screen to indicate the current position. The insight . . . [that led to] the mouse was [the realization] that the trackball could be placed on the bottom of a small box, and that the box's movement would cause the trackball to move because of friction with a rubber pad. Each of these . . . [innovations] was a small, incremental elaboration on a preceding series of insights. The idea for a mouse that would control an on-screen cursor did not appear suddenly, full grown, in a burst of insight . . . .[74]

It was a synergy that emerged from a long series of small insights extending back at least to 1963.[75]

Between the time when Paterson created QDOS back in 1980 and when Windows 3.1 was released in 1990, the nature of innovation was in the midst of a radical change. That change is still poorly understood today. Creativity today is different from any other time in history. The key change today is that "collaborative webs are more important than creative people."[76] Creativity is no longer the province of the lone genius, the solitary inventor working long hours to finish ahead of the competition. In today's economy, innovation is a synergy that emerges from a collaborative web. The story of Windows has several important lessons about how synergy emerges from collaborative webs.

73. *Id*. at 285.
74. SAWYER, *supra* note 19, at 185 (emphasis omitted).
75. SAWYER, *supra* note 15, at 285 (emphasis omitted).
76. *Id*.

In a collaborative web, each innovation builds incrementally on a long history of prior innovations.[77] The creative products that are successful in the market rarely spring to life full-grown. "The consumer rarely sees the long historical path of small, incremental . . . [inspirations] that accumulate to result in the emergence of the final . . . [synergy]."[78]

A synergy is a combination of many small ideas. The mouse pointer is an interesting idea, but it is not very useful unless you also have menus and windows. Menus are a good idea, but they are not nearly as useful without a cursor control device such as a mouse. It is the synergy of all of these ideas together that resulted in the successful product.

Synergies emerge from collaborative teams.

> Although a single person may . . . [get credit for] a specific idea, it's [often] hard to imagine that person having that idea apart from the hard work, in close intimate quarters, of a dedicated team of like-minded individuals. [Team synergies are built up from] . . . many insights, each of them coming from a different team member.[79]

In collaborative webs, there is frequent interaction among the teams. "Members of a team occasionally visit and view what is being done by another team; and key employees frequently transfer allegiances, taking their expertise from one team to another." This is one reason that the most innovations come from areas where many competing companies are located near one another, such as Silicon Valley.[80]

In collaborative webs, multiple discovery is common. "There were several organizations each developing graphical user interfaces—two separate teams within Apple, and even more teams within Xerox PARC—and many critical ideas emerged in multiple teams independently, or by drawing on ideas that predated all of those

77. *Id*. (emphasis omitted).
78. *Id.* at 285 (emphasis omitted).
79. *Id*. (emphasis omitted).
80. ANNALEE SAXENIAN, REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128, at 29–37 (1994).

groups."[81] The idea of an aileron for lateral airplane control emerged in many different teams, including Santos-Dumont in France, Curtiss in the United States, and Farman in France.[82]

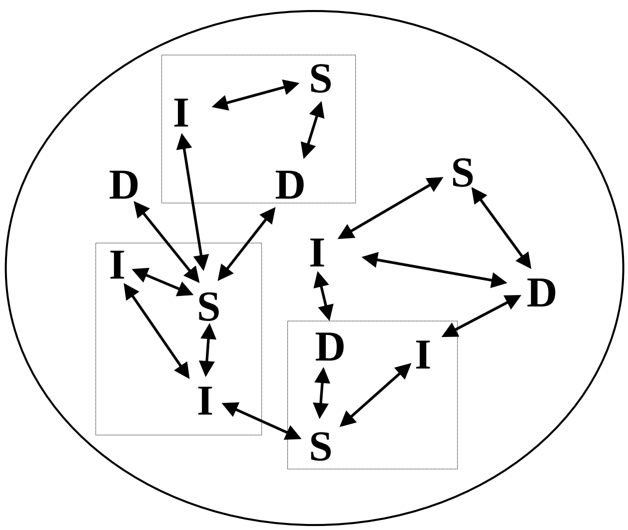
In collaborative webs, a product's success depends on broad contextual factors. Xerox was the first to innovate, with the Alto and then the Star. But neither computer made a dent in the market. It's the broader context that determines which innovations will be successful: "How much does it cost? Who and what sort of person can afford it? Is it compatible with other products and practices that are already embedded? How well is it marketed?"[83]

A collaborative web is never just one company. At most, a company can aspire to play a key role in a web, or a cash-rich company can buy all the synergies that emerge from a web. But even a successful, innovative company is not the same thing as the web.

The key to understanding today's innovation economy is to understand synergy—the emergence of innovations from collaborative webs. Of course, creative people play an important role as the active elements of collaborative webs. But in today's economy, most of the action is in the webs. People create at a higher level when they participate in collaborative webs; everyone's creative power increases so that the whole is greater than the sum of the parts.

81. *Id*.
82. PETER M. SENGE, THE FIFTH DISCIPLINE: THE ART & PRACTICE OF LEARNING ORGANIZATION (1990).
83. Manufacturers Aircraft Association—Antitrust Laws, 31 Op. Att'y Gen. 166, 172 (1917).

FIGURE 2: A COLLABORATIVE WEB
I=INSPIRATION, S=SELECTION, D=DEVELOPMENT. DOTTED LINE BOXES INDICATE ORGANIZATION BOUNDARIES. EVENTS OUTSIDE OF BOXES INDICATE ACTIVITIES THAT TAKE PLACE OUTSIDE OF FORMAL ORGANIZATIONS.



Collaborative webs are complex systems. Complex systems approaches have had a major impact on business thinking, beginning perhaps with Peter Senge's 1990 best-seller, *The Fifth Discipline*.[84] The key insights of complexity theory force us to leave behind linear, mechanistic thinking and to shift to a complex, relational, systems perspective.

Like other complex systems, effective collaborative webs maintain themselves at the edge of chaos. In the presence of too much structure and rigidity, nothing new can emerge. At the other extreme, if there is not enough structure, a chaotic mess results, and

84. SENGE, *supra* note 82; Joel I. Klein, Acting Assistant Attorney Gen., U.S. Dep't of Justice Antitrust Div., Address Before the American Intellectual Property Law Association: Cross-Licensing and Antitrust Law 5–6 (May 2, 1997), *available at* http://www.usdoj.gov/atr/public/speeches/1118. pdf.

nothing valuable emerges. Maximum innovation happens at the boundary between structure and chaos.

In the development of the windows GUI, many people created new technologies in the 1960s and 1970s that did not become viable products until it all came together in the Apple Macintosh in 1984. Innovation involves both the creation of many related new ideas and the implementation, dissemination, and adoption of those ideas by a collaborative web. Often the original inspiration changes significantly as it is developed, so much that it is essentially reinvented. To understand innovation, we have to understand the individuals who originate each idea, the collaborative teams and organizations within the system, and the complex social processes that result in implementation, dissemination, and adoption.

Almost every contemporary approach to improving societal creativity has been based on one of two solutions, both of which assume the linear model. First, companies that want to become more innovative will hire smarter, more creative people and give them more freedom. Societies that want to become more innovative invest more resources in education, research, and development. Second, companies that want to become more innovative might restructure the organization to more effectively translate inspiration into innovation, through selection and implementation. But societies that have transitioned to an innovation economy, such as the United States, have experienced a shift from linear creativity to creative synergy, and these two approaches will no longer work.

Complexity researchers have discovered that creative synergy is more likely in social networks that have the following properties:

Connectivity: The parts of the system are all connected to one another.

Communication: The parts constantly communicate with one another, sending rich and complex information.

Self organization: The system re-organizes itself in response to environmental changes without central control.

Constant change and flow: Complex systems are never static. Even when they seem not to be changing, that stasis is in fact maintained by constant activity.

Disruptive innovation: Even in an apparently stable system, if you know exactly the right place to act, you can often cause a sudden, dramatic change. This is the inspiration for recent applications of chaos theory to management.

Heavily parallel: Inspiration, selection, and development are all occurring all the time and are distributed throughout the system.

Constant failure: Many individual inspirations never get selected; many selections never get developed; many developed ideas never emerge from the system. This is not a problem to be corrected; in fact, it is a sign that this is a truly creative system.

The systems model of innovation is inconsistent with an individualistic theory of creativity. If innovation is considered to emerge from a complex social system, then each individual contributes only one small piece of the eventual solution. And in system innovation, conceptual combination and conceptual elaboration typically result in substantial modifications to the prior art components. It can become difficult even to identify what the proper componential decomposition of a new innovation is. These realities provide many challenges for IP, including how to determine what proportion of ownership rights the creator of each individual idea should receive.

Historically, enforcement of strong IP protection has often blocked innovation. Returning to the above example of the aviation industry, in the years between 1906 and the onset of World War I in 1914, innovation in the United States was blocked as the Wright Brothers successfully enforced a broad interpretation of their 1906 patent. At the same time, innovation proceeded rapidly in England, France, and Germany, where the Wrights had more difficulty enforcing their patents in the same broad manner. This situation alarmed the U.S. government, which convened a task force (led by Assistant Secretary of the Navy Franklin D. Roosevelt) that presented its report in 1917, recommending the formation of the Manufacturer's Aircraft Association ("MAA") to manage a patent pool.[85] This was followed by an opinion of the attorney general stating that the MAA was legal under antitrust laws.[86] Congress subsequently passed a law on March 24, 1917, that limited the patent enforceability of both

85. *See* SCHULMAN, *supra* note 42.
86. *See id*.

Wright and Curtiss and fixed the royalty amounts to be paid to each company from the pool.[87]

III. CHALLENGES IN DEVELOPING AN ALTERNATE IP REGIME

When innovation follows the systems model, the implications for IP are profound.

No one owns the collaborative web. An innovation emerges, but it is based in many inspirations that occurred in many different minds and organizations. Linear creativity results in an ownership mindset; creative synergy results in a collaborative mindset. Our current legal system surrounding intellectual property rights is based on the linear view of creativity, where identifying the legitimate owner of an idea is fairly straightforward. Many features of the current IP regime reward behavior that blocks the natural flow of innovation in collaborative webs: the possessiveness mindset, trade secrets, patent thickets, and non-compete agreements with key employees.

It can become difficult to identify the proportion of an individual's contribution to a single component idea of the emergent creative synergy. If ideas are always collaborative, then one person should never get complete ownership. The challenge societies face is to reward individuals for their active participation in collaborative webs and to avoid reward systems that encourage individuals to remove themselves from webs. There are many challenges that must be addressed by critiques of the current IP regime:

Challenge: How to apportion rights among the many contributors.

Challenge: How to distinguish between "a new idea" and an "elaboration of existing idea."

Challenge: How to distinguish between "simple combination" and "non-obvious combination."

Challenge: How to award ownership to a distributed entity.

Challenge: How to provide incentives for formation of, and participation in, a collaborative web.

One potential solution to these challenges is to more effectively reward small ideas. Current policy favors linear, centralized innovation, and blocks the natural rhythm of the collaborative web.

87. *See id*.

For example, large corporations often use their research and development labs to create "patent thickets." A patent thicket occurs when a company owns many related patents that require complementary innovations not yet discovered in order to be usable. The company then has a strong defensive position: the ability to sue anyone who develops a related product, even if it is based on a new idea that fills in one of the gaps in the thicket. But in collaborative webs, each person or company has only a subset of the ideas needed for innovation.

The open source community thrives because programmers do not charge when they share their sparks; rather they share their ideas in exchange for intangible benefits such as recognition and receiving the sparks from others. Creators of small sparks could get patents; but that takes effort and money, and current patent protections are not designed to reward small sparks of innovation. With very small innovations, a patent holder rarely receives any income from licensing because it is often easy for a large R&D lab to get around one small patent by inventing a slightly different solution.

Any attempt to reward small sparks would then face its own challenges:

Challenge: What sort of government policy would provide additional incentives for sharing small sparks? Effectively implemented, such policies could expand the number and size of collaborative webs dramatically.

Challenge: How to provide incentives for using existing small ideas, rather than incentives for searching for a work-around? Large companies with substantial R&D labs often find it fairly easy to avoid licensing small ideas by instead developing an alternate solution. From the perspective of the overall economy, this redundant effort is inefficient.

Incentives to develop work-arounds could be reduced if licensing were mandatory and licensing fees were regulated at a relatively low cost. Today, patent owners can, but are not required to, license their technology to others and the licensing fees are not regulated. The Wright Company's decision to charge $1000 per plane to license their patented technology was prohibitively expensive. Likewise, if a movie owner wants to charge an excessive fee, no one will use that film clip. And even when the owners are willing to license re-use, it can take a year or more to contact everyone with an ownership right, find out the price, and get all of the release forms signed. As Lawrence Lessig put it, "the cost of complying with the law is impossibly high."[88] Patent owners could be required to license their technology, and pricing for the license could be removed from the patent owner, to prevent excessively high pricing that would interfere with the flow of ideas. Government law could specify a fixed rate (Lessig suggests 1% of revenues),[89] or perhaps an auction-like system would allow the true market for the idea to set the value of the license.

Challenge: How to determine a fixed rate that is acceptable to all parties should the rate differ from industry to industry, or for patents and copyrights?

Challenge: How to best convince elected politicians and the public that such a change is necessary for national innovation? Rights-holders will not give up their current ownership rights without an intense struggle.

Encourage webs to form that include consumers as active participants. In linear creativity, companies innovate and consumers select among their products. In creative synergy, the division between a creating company and a passive consumer breaks down. Consumers today are active, participating audiences, and they play important roles in the most collaborative webs. The IP regime should recognize the innovation role played by consumers. For example, very few consumers will invest the resources necessary to secure patent protection; and for a very small idea, profits may never return that investment. Is there some way we could grant consumers some ownership in their innovations with only minimal effort on their parts?

Legalize modding. In many areas such as mountain biking, videogame modding, or music sampling, many people create modifications for their own use and never share them. But the present IP regime, far from protecting consumer innovations, actually makes some of those innovations illegal. The U.S. Digital Millennium

88. LAWRENCE LESSIG, FREE CULTURE 106 (2004).
89. *Id.*

Copyright Act,[90] which was designed to prevent users from making illegal copies of software, music, and movies, has the side effect of making it impossible to modify the products you purchase. If a dedicated videogamer hacks into the game's code and changes the way the game plays, he is breaking the law. Yet it is undeniable that these hacks occasionally result in new, useful, and nonobvious innovation.

IV. Open Source Communities as Collaborative Webs

Open source communities align reasonably well with the above characterization of collaborative webs. Under an open source license, the source code is freely available to anyone, as long as it is used in a way consistent with the license (which typically forbids using the source code in a commercially sold product or in any product with restrictive licensing). Individuals contribute effort to modify, maintain, and extend the application, even though they receive no IP protection for their contribution.

The open source model resolves many of the above noted challenges in very different ways from the current IP regime. Perhaps the key challenge is providing individual incentives. The standard defense of patents is that they increase innovation by providing a potential monetary reward to the innovator and protecting the innovator's efforts from being taken by someone else. Yet individuals in open source communities invest substantial time and effort in the absence of property rights. Why? The best explanation is that individuals participating in open source communities accrue symbolic capital; they benefit by becoming known as talented and knowledgeable developers.

The solutions to the challenges suggested above by the open source model are not ideal. First, it is difficult to imagine an entire economy based solely on symbolic capital incentives. The incremental innovations contributed by each participant are not monetizable. Second, open source communities rarely generate

90. Digital Millennium Copyright Act, Pub. L. No. 105–304, 112 Stat. 2860 (codified in scattered sections of 17 U.S.C. (2006)).

radical innovation.[91] Breakthrough innovations that have the potential to generate large revenue streams are likely to continue to require some granting of intellectual property rights to motivate implementation. Future research should explore how to improve on open source models to create collaborative webs that are potentially more innovative and that are more consistent with conceptions of IP as individual property rights.

EPILOGUE

The story of how Tim Paterson created the DOS operating system seems to fit in with our most cherished beliefs about how creativity works. In our standard view of creativity, a brilliant person is far ahead of his or her time. He or she has an idea and then applies immense individual talent and motivation to execute the idea. That person works alone, ignoring distractions that might lead him or her away from the focused task. That person ignores society and outside conventions, paying no attention to what everyone else tells him or her is the way to go. Against all odds, the creator emerges from his or her hothouse of inspiration with the product that will change the world. Some computer programmers might read Paterson's story and feel a tinge of nostalgia for those good old days when one person could make a difference. But in fact, the story with which I started this Article is incomplete because that is not exactly how it happened with Tim Paterson.

In 1978, the most popular operating system for microprocessor-based computers was CP/M, sold by a company named Digital Research, founded by a former Intel employee named Gary Kildall. Nearly every computer based on an Intel microprocessor used the CP/M operating system. Each time a new microprocessor chip was invented, CP/M had to be modified slightly to run on that chip's unique design. IBM had selected Intel's 8088 chip for its new personal computer, and it was so new that there was no version of CP/M. The difficulty was that the Intel chip was the first to use a 16-

91. *See* Kryzstof Klincewicz, *Innovativeness of Open Source Software Projects*, FREE/OPEN SOURCE RES. COMMUNITY, Aug. 11, 2005, at 7–8, http://opensource.mit.edu/papers/klincewicz.pdf.

bit design, which was twice as powerful as the previous 8-bit design, but also more sophisticated and complicated to program. For its new personal computer, IBM wanted to go with the market leader, so it approached Digital Research to license a version of CP/M for its new computer. But something went wrong. The true story has been lost to history, shrouded in myths. Some say that Kildall asked for too much money; some say that Kildall was flying his private plane and was not around when IBM came calling; some say that Kildall's company refused to sign IBM's imposing secrecy and nondisclosure agreements. When it didn't work out with Digital Research, IBM next went to Microsoft, and Microsoft went to SCP and purchased Paterson's operating system.

The part of the story that I left out at the beginning of this Article is that Paterson did not invent his own operating system.[92] Instead, he programmed a system that worked exactly like CP/M, with the same A> prompt, the same eight-character filenames with three-character extensions, and many of the same commands. And it was compatible with CP/M so that it could run all of the applications software that had already been written. Digital Research considered suing Microsoft, but it realized it would also have to sue IBM, and it did not have the financial resources for such a tough legal fight.

The story has yet another twist that is incompatible with individual creativity—it turns out that the operating system IBM sold with its first PC was not the one that Paterson wrote. The MS-DOS that Microsoft delivered to IBM had significant problems. IBM found more than three hundred bugs in it and ended up rewriting it completely. IBM called it PC-DOS, and Microsoft and IBM held a joint copyright for it. Paterson himself said, "I don't like the word 'inventor' because it implies a certain level of creativity that wasn't really the case."[93]

Perhaps we should say that Gary Kildall was the real inventor of DOS. Well, that also is inconsistent with the historical record. Kildall developed CP/M while he was working at Intel, and like every other

92. The exact details remain in dispute, but the general narrative is widely accepted. *See supra* note 13 and accompanying text.

93. Father of DOS Still Having Fun at Microsoft, http://www.patersontech.com/Dos/Micronews/paterson04_10_98.htm (last visited May 10, 2009).

computer company at that time, Intel programmers used big mainframe computers to do all of their work. Kildall was using a big DEC mainframe running a timesharing operating system called TOPS-10 because someone at Intel had developed a program that would run in TOPS-10 that emulated the Intel 8080 microprocessor. Many of the familiar features of DOS were originally taken from the TOPS-10 operating system—including the eight-character filenames and three-character extensions.

The story of DOS is a simpler version of the story of Windows. Neither innovation resulted from linear creativity; they both emerged from collaborative webs. In 1980, one person could play a bigger role in a collaborative web than in 1990, but, even then, one person could not single-handedly create an innovation. Our economy was already on the way to becoming a collaborative web economy.

Often when we closely examine a case of individual creativity, we find that the real story is about the synergies of collaborative webs. The United States' innovation economy always has been based on collaborative webs, not on isolated creative people. The companies and countries that will generate maximum innovation will not be the ones with the most creative people with the strongest IP protection for their own private ideas. The winners will be the companies and countries with the strongest collaborative webs. An appropriate IP regime is a necessary place to start.