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Dr. Generative Or: How I Learned to Stop Worrying and Love the iPhone

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Book Review

DR. GENERATIVE OR: HOW I LEARNED TO STOP WORRYING AND LOVE THE IPHONE

BY JAMES GRIMMELMANN* AND PAUL OHM**

REVIEW OF *THE FUTURE OF THE INTERNET—AND HOW TO STOP IT*
JONATHAN ZITTRAIN (YALE UNIVERSITY PRESS, 2008)

In *The Future of the Internet—And How to Stop It*, Jonathan Zittrain presents a compelling new theory of why the Internet has succeeded.[1] His big idea is "generativity": Personal computers and the Internet are

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1. *See* JONATHAN ZITTRAIN, THE FUTURE OF THE INTERNET—AND HOW TO STOP IT (2008).

technologies that individuals can use in ways their creators never imagined. Descriptively, Zittrain has nailed it. Generativity elegantly combines prior theories into a succinct explanation of the technical characteristics that make the Internet what it is. He offers a convincing normative argument that preserving generativity is essential for future innovation and creativity.

There's something missing from Zittrain's prescriptions, though. He writes as though it's largely unproblematic to tell which systems are generative and which aren't. But in the complex world of Internet policy, subtle technical tradeoffs are the order of the day; it's not always obvious whether a given intervention will help generativity or hurt it. Even Zittrain's *bête noire*, the "sterile" iPhone, has profoundly generative features, including an App Store that has racked up three billion downloads and a browser that gives the handheld iPhone the web-enabled power of a desktop computer.[2] Even his great generative example, the Apple II, succeeded in part because it put severe limits on what its users could do with it. Unlike many previous personal computers, it came preassembled, rather than as a bag of customizable parts.[3]

Zittrain recognizes some of these subtleties. He perceptively argues that unrestrained generativity opens the floodgates to spam, malware, and other threats. Left unchecked, these threats in turn lead to user backlash against generative platforms.

But *The Future of the Internet* is never fully rigorous in explaining how to assess generativity in the real world. Zittrain doesn't distinguish clearly between systems that are subject to remote control by their makers and systems that are actually ungenerative. He calls for compromises to preserve generativity, but doesn't provide a roadmap for distinguishing good compromises from bad. He never quite admits that his preferred solutions themselves involve controversial tradeoffs against generativity.

In this Book Review, we offer a series of (we hope) friendly amendments to *The Future of the Internet*. We celebrate Zittrain's identification of generativity as a key technical virtue, and then reconstruct the concept to make it more robust. The ambiguities that Zittrain downplays can't be eliminated; they're inherent characteristics of complex real-life technological systems. A useful theory of generativity must work through these difficulties, not duck them.

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2. *See infra* Part I.C.
3. *See infra* Part III.B.

Thus, we would rephrase Zittrain's core insight as the claim that *generativity is essential but can never be absolute*. No technological system is perfectly generative at all levels, for all users, forever. Tradeoffs are inevitable. This fact should not be any more discouraging than it is in political theory, where liberty is never absolute, either. System designers and legal regulators should seek to maximize the innovative and creative capabilities of users. Restricting generativity in one place (for example, by building computers with fixed circuit boards rather than a tangle of reconfigurable wires) can massively enhance generativity overall (by making computers cheap and usable enough that everyone can tinker with their software). This reformulated generativity principle easily accommodates all of Zittrain's specific recommendations, but also makes it easier to act in the generative spirit.

To aid in implementing this principle, we offer a series of three corollaries for system designers and policymakers. First, generativity is only one virtue among many. While it is essential for the future of the Internet to preserve generativity, there are also other, important values for Internet policy—such as human dignity and freedom from coercion—that can't be entirely reduced to generativity itself. Even if generative systems can help defend against censorship, at the end of the day, it remains a problem of free expression. Second, the perfect must not be the enemy of the good. A system that is generative enough is good enough. As Zittrain cogently argues, some limits on generativity are necessary to keep spam, viruses, phishing, and other modern horrors from completely overwhelming our technical infrastructure. Third, generativity is a systemic property, not a local one. We shouldn't ask whether each individual chunk of software and hardware is as generative as it could be. Instead, we should ask whether the overall ecosystem of the Internet—viewed across different layers of abstraction, across different devices, and across time—offers its users the generativity they need.

This Book Review will proceed in three Parts. Part I will sketch the argument of *The Future of the Internet*. Part II will focus on the idea of generativity itself, explaining why it's an intellectual advance over previous theories and bringing out some of the ambiguities in Zittrain's formulation. Part III will reconstruct generativity as a relative and context-sensitive virtue, while showing how this reconstructed version deals sensibly with the difficulties Zittrain glosses over. Throughout this Book Review, we'll use the Apple II and the iPhone—the hero and the villain of the story as Zittrain tells it—to

show how his apocalyptic narrative of freedom versus control is too cleanly black-and-white.

I. THE POWER OF GENERATIVITY

Its title notwithstanding, *The Future of the Internet* is also a book about the Internet's past and present. Zittrain takes up a question that has obsessed many before him: What makes the Internet so special? It's not just that an agglomeration of computers has become a "consensual hallucination experienced daily by billions"[4] or that daily life and the economies of nations are now thoroughly interwoven with digital threads. It's also that the net impact of computer technologies for human well-being has been unambiguously huge and positive.[5] There aren't many other technologies you could say that about. There's something special about the Internet, something important.

The nature of the Internet's secret sauce may be a question in the history of science and technology, but policymakers need to care about the answer. If we know what makes an Internet flourish, we can take good care of the one we have—and possibly even plant the seeds of other, equally fruitful technologies. If we don't know how the Internet ticks or don't use that knowledge wisely, we risk squandering its bounty.

Zittrain's answer to this question is generativity, which he defines as "a system's capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences."[6] This Part will explore Zittrain's argument that generativity explains the Internet's past and is vital to its future. It traces how Zittrain derives the generativity principle, explains why Zittrain believes generativity is in mortal peril, and shows that even critics who question whether generativity is as endangered as Zittrain believes it to be nonetheless agree with him on its importance.

A. What Makes the Internet Special?

The Future of the Internet opens with a coincidence: Apple's mercurial CEO, Steve Jobs, introduced two of his company's defining products—the Apple II and the iPhone—almost exactly thirty years apart at computer conferences in "nearly the same spot" in San Fran-

4. WILLIAM GIBSON, NEUROMANCER 51 (1984).

5. *See, e.g.*, Austan Goolsbee & Peter J. Klenow, *Valuing Consumer Products by the Time Spent Using Them: An Application to the Internet*, 96 AM. ECON. REV. 108, 108 (2006) (estimating consumer surplus from the Internet at thousands of dollars per year per user).

6. ZITTRAIN, *supra* note 1, at 70 (emphasis omitted). R

cisco.[7] For Zittrain, these two devices are emblematic of two opposing ways to build computer systems.

The Apple II was generative:

> It was a platform. It invited people to tinker with it. Hobbyists wrote programs. Businesses began to plan on selling software. Jobs (and Apple) had no clue how the machine would be used. They had their hunches, but, fortunately for them, nothing constrained the PC to the hunches of the founders. Apple did not even know that VisiCalc [the first spreadsheet program, created by third-party developer Dan Bricklin] was on the market when it noticed sales of the Apple II skyrocketing. The Apple II was designed for surprises . . . .[8]

In contrast, the iPhone was a "sterile appliance," a technological dead end:

> Rather than a platform that invites innovation, the iPhone comes preprogrammed. You are not allowed to add programs to the all-in-one device that Steve Jobs sells you. Its functionality is locked in, though Apple can change it through remote updates. . . . The machine was not to be *generative* beyond the innovations that Apple (and its exclusive carrier, AT&T) wanted. Whereas the world would innovate for the Apple II, only Apple would innovate for the iPhone.[9]

The Future of the Internet tells a story of the history and future of the tension between these two ways of designing computer systems. Chapter 1 briefly reviews the history of computers over the last few decades with an emphasis on this tension. Zittrain argues that generativity enabled personal computers ("PCs") like the Apple II to beat out less generative alternatives like batch processing (in which only a few qualified insiders are allowed to run programs) and time-sharing (in which multiple users log into a single central computer simultaneously).[10] Chapter 2 does the same for networks. The Internet, on which anyone can upload any content they like and try out any new applications ("apps") they like, beat out centralized, proprietary networks that restricted what programs users could run and who they could communicate with. Zittrain uses the "walled gardens" of

7. *Id.* at 1.
8. *Id.* at 2.
9. *Id.*
10. *See id.* at 12–18.

America Online and the now-defunct CompuServe to illustrate the significance of an open Internet.[11]

In making these claims, *The Future of the Internet* echoes themes sounded by such visionaries of the information age as Vannevar Bush,[12] J.C.R. Licklider,[13] Ted Nelson,[14] Douglas Engelbart,[15] Stewart Brand,[16] Richard Stallman,[17] and Yochai Benkler.[18] In their various ways, they have argued passionately for two ideals: That ordinary individuals ought to have powerful, personal computers, and that both people and computers ought to be linked together in networks of sharing, conversation, and collaboration.[19] They understood that computing undergoes a profound social change when it becomes accessible enough to satisfy the basic human urges to create and to share. It becomes a tool of liberation and empowerment.

There's a reason that the first truly personal computer, the Altair 8800, is inextricably linked in historical memory with a hobbyist user

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11. *Id.* at 29.

12. *See* Vannevar Bush, *As We May Think*, ATLANTIC MONTHLY, July 1945, *available at* http://www.theatlantic.com/magazine/archive/1969/12/as-we-may-think/3881 (describing the "memex," a "future . . . device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility").

13. *See* J.C.R. Licklider, *Man Computer Symbiosis*, IRE TRANSACTIONS ON HUMAN FACTORS IN ELECTRONICS, Mar. 1960, at 4 (describing a future in which "human brains and computing machines will be coupled together very tightly, and . . . the resulting partnership will think as no human brain has ever thought"). *See generally* M. MITCHELL WALDROP, THE DREAM MACHINE: J.C.R. LICKLIDER AND THE REVOLUTION THAT MADE COMPUTING (2001).

14. *See* TED NELSON, COMPUTER LIB/DREAM MACHINES (1974) ("You can and must understand computers NOW . . . . New Freedoms Through Computer Screens.").

15. *See* THIERRY BARDINI, BOOTSTRAPPING: DOUGLAS ENGELBART, COEVOLUTION, AND THE ORIGINS OF PERSONAL COMPUTING 1 (2000) (arguing that Engelbart helped create "an integrative and comprehensive framework that tie[d] together the technological and social aspects of personal computing technology").

16. *See* FRED TURNER, FROM COUNTERCULTURE TO CYBERCULTURE: STEWART BRAND, THE WHOLE EARTH NETWORK, AND THE RISE OF DIGITAL UTOPIANISM 8 (2006) (explaining Brand's influence on personal and social computing). *See generally* JOHN MARKOFF, WHAT THE DORMOUSE SAID: HOW THE SIXTIES COUNTERCULTURE SHAPED THE PERSONAL COMPUTER INDUSTRY (2005).

17. *See* RICHARD M. STALLMAN, FREE SOFTWARE, FREE SOCIETY: SELECTED ESSAYS OF RICHARD M. STALLMAN 9 (2002) (describing Stallman as a philosopher who argued that "code," the technology that makes computers run, should be "transparent to all," so that anyone can take control of it and modify it). *See generally* SAM WILLIAMS, FREE AS IN FREEDOM: RICHARD STALLMAN'S CRUSADE FOR FREE SOFTWARE (2002).

18. *See* YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM 5 (2006) (describing "the rise of effective, large-scale cooperative efforts—peer production of information, knowledge, and culture").

19. *See supra* notes 12–18 and accompanying text. R

group, the Homebrew Computer Club.[20] The social processes of building on each other's ideas go hand-in-glove with the technical processes of playing with the hardware and software of a computer that you yourself control. And both were instrumental in convincing two young hackers and friends, Steve Jobs and Steve Wozniak, to start a company named "Apple" to build their own personal computers.[21] Generativity elegantly fuses the ideals of personal computing and social computing to identify the role they play in catalyzing a self-reinforcing cycle of innovation.

Zittrain explains that generativity works because it unleashes innovation from users—far more innovation than a company's designers could develop on their own.[22] The Apple II had expansion slots, allowing owners to install new hardware and opening up new markets in creating Apple-compatible peripherals like disk drives and monitors.[23] The Apple II was also open at the software level, enabling users to easily write and run their own programs.[24] This open architecture made the Apple II generative; Dan Bricklin could write VisiCalc and users could run it because the Apple II was designed to let them.

Similarly, the Internet has a surprisingly open architecture at the hardware level. As long as your device has the right software and the right kind of plug or wireless transmitter, you can hook it up to the Internet. That's how Apple could make the iPhone work with the existing web, even though most web designers never expected that their websites would be viewed on handheld touch-screen phones. The Internet is also generative at the software level: You can design a new application and roll it out to millions of users, all without needing to ask anyone's permission. Apple can push software updates out to iPhone users using a protocol it designed for that purpose, and the Internet just works at getting the data there. The road to the iPhone wouldn't have been possible unless generativity worked—and worked almost beyond anyone's wildest imagination.

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20. *See* STEVEN LEVY, HACKERS: HEROES OF THE COMPUTER REVOLUTION 201–06 (1984) (describing the meeting of the Homebrew Computer Club where the Altair 8800 was first introduced).

21. *Id.* at 252–53.

22. ZITTRAIN, *supra* note 1, at 86 (discussing ERIC VON HIPPEL, DEMOCRATIZING INNOVATION (2005)). R

23. OWEN W. LINZMAYER, APPLE CONFIDENTIAL 2.0: THE DEFINITIVE HISTORY OF THE WORLD'S MOST COLORFUL COMPANY 17 (2004).

24. *See supra* text accompanying note 8. R

B. Generativity's Downside

Generativity, as Zittrain describes it, sounds like a profoundly good thing. Precisely for that reason, one might wonder what there is to worry about. Won't people recognize how great generativity is and seek to create as much of it as possible? Why say so much if it all goes without saying? *The Future of the Internet*'s normative argument is that generativity, while insanely great (to use Steve Jobs's phrase[25]), isn't an unalloyed good—and, for that very reason, its future can't be taken for granted.

In Chapter 3, Zittrain looks at the dark side of generativity's fruitfulness.[26] The problem is that not all innovation is to the good; swamps are fecund places, too. Openness to user-created programs also means openness to user-created spyware. The same e-mail programs and protocols that transmit meeting reminders and love notes also carry fake-watch spam and Nigerian 419 scams. Anyone can create a website about how to adopt hedgehogs; anyone can create a website about how female bloggers are sluts who deserve to be killed. Indeed, the kinds of deep-seated openness to user-created changes that enable fundamental new innovations also enable fundamental technical attacks on the generative systems themselves. The botnets of malware-infested computers available for hire by any would-be cybervandal have grown so gigantic that some security research firms have given up trying to count them.[27]

Zittrain calls this tendency the "generative pattern": A system that has flourished because of its generativity also develops instabilities and insecurities for the same reason.[28] The result is a flight to safety (in Zittrain's words, a "movement toward enclosure").[29] People want an experience that doesn't expose them to these risks and annoyances. They get it by switching to ungenerative systems or by making the systems they rely on less generative.

The iPhone is, for Zittrain, a perfect symbol of these trends. Indeed, *The Future of the Internet* ends where it began, with the iPhone looming ominously like the Ghost of the Internet Future. When he says that it "bottles some of the best innovations from the PC and In-

25. *See, e.g.*, STEVEN LEVY, INSANELY GREAT: THE LIFE AND TIMES OF MACINTOSH, THE COMPUTER THAT CHANGED EVERYTHING 5 (2000).

26. ZITTRAIN, *supra* note 1, at 36–65. R

27. Gadi Evron, *How Many Bots? How Many Botnets?*, CIRCLEID, Feb. 20, 2007, http://www.circleid.com/posts/how_many_bots_how_many_botnets/.

28. ZITTRAIN, *supra* note 1, at 99. R

29. *Id.*

ternet in a stable, controlled form,"[30] he doesn't mean it as praise. That "stable, controlled form" was a repudiation of generativity. The iPhone was a sealed black (and silver) box. On the hardware side, you couldn't even open it to replace the battery. On the software side, Apple controlled every last detail. Users couldn't install their own programs—or even change the layout of the icons.

Importantly, Zittrain's account of the generative pattern isn't a conspiracy theory. Apple didn't make the iPhone a sealed device because Steve Jobs is an evil genius bent on destroying the Internet and enslaving users. Apple made the iPhone a sealed device because Steve Jobs and his team understood that it would sell like hotcakes.[31]

Take a moment to reflect on what a well-designed device the iPhone is.[32] Not only is it sleek and elegant, the software that runs on it is a triumph of user-interaction design. Making it into a touch-screen-only device required an unsparing focus on design simplification. Everything works consistently, with an interface that guides the finger to the right active spots and trains the brain to move around the iPhone's features with ease.

Like Apple's other products, the iPhone "just works."[33] Lest this seem like an empty statement, think about your last experience using a Windows PC. Did it "just work"? Apple's "Hello, I'm a Mac. And I'm a PC," ad campaigns have relentlessly focused on the fact that Windows PCs don't.[34] John Hodgman's poor anthropomorphic Windows PC has to deal with malware, broken peripherals, crashes, and the other indignities of a design that doesn't just work. Every day there are new viruses taking advantage of its openness to steal personal data, flood the Internet with spam, and bombard users with scams and ads.

The decision to make the iPhone an appliance thus responds to the hazards of untrammeled generativity. Users who can't modify the software can't be tricked into downloading viruses. Developers who can't write custom UIs can't write unusably ugly ones that thwart users' expectations. If Apple controls the horizontal and the vertical,

30. *Id.* at 5.

31. *See* Brian Caulfield, *How Apple Will Sell 50 Million iPhones*, FORBES, Aug. 19, 2009, http://www.forbes.com/2009/08/19/apple-verizon-att-technology-enterprise-iphone.html (predicting that Apple would sell fifty million iPhones in 2011).

32. *Cf.* STEVEN LEVY, THE PERFECT THING: HOW THE IPOD SHUFFLES COMMERCE, CULTURE, AND COOLNESS (2006) (calling the iPhone's predecessor, the iPod, a "perfect thing").

33. *See* Apple, Why You'll Love a Mac, http://www.apple.com/macbook/why-mac.html (last visited May 31, 2010).

34. YouTube, Buy a Mac, http://www.youtube.com/watch?v=C5z0Ia5jDt4 (last visited May 31, 2010).

it can provide a safe, unsurprising, reliable experience. Zittrain quotes Jobs: "You don't want your phone to be like a PC. The last thing you want is to have loaded three apps on your phone and then you go to make a call and it doesn't work anymore."[35]

It's not an isolated example. On Zittrain's view, closely controlled devices—for example, the Xbox gaming console—are taking over jobs that would have gone to a computer.[36] Meanwhile, closed-world services—for example, Facebook for private messaging—are making inroads on jobs that would have gone to more open parts of the Internet, and "cloud computing"[37] services that store your data remotely—for example, Google Docs—are making inroads on jobs that would have been done locally on your PC.

Zittrain's term for the iPhone and these other sealed boxes of the information age is "appliance[s]"—"predictable and easy-to-use specialized machines that require little or no maintenance"[38] that "take the innovations already created by Internet users and package them neatly and compellingly."[39] Like your toaster, they do their job well. But also like your toaster, they're one-trick ponies. Generative technologies can grow, adapt, learn, become. An iPhone will always be only just an iPhone. So will a TiVo; it has a powerful computer in it but all it can do is record and play back television shows. The same goes for cloud computing; your idea for how to improve YouTube is worthless unless you work at Google.[40] Appliances are hedgehogs; computers and the Internet are foxes. Foxes are better for humanity, but sometimes the hedgehogs win.

The triumph of generative over non-generative technologies, then, is not safely settled in the past. Nor is it a foregone conclusion in the future. Instead, it is a constant choice in the present. In every generation, every user must regard herself as though she herself had been a slave to appliances. We must enter by the narrow gate of generativity, for wide is the gate that leads to the iPhone.

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35. ZITTRAIN, *supra* note 1, at 3 (internal quotation marks omitted). R

36. *Id.* at 3–4. R

37. *See* Webopedia, What Is Cloud Computing?, http://www.webopedia.com/TERM/C/cloud_computing.html (last visited May 31, 2010) (defining "cloud computing" as "[a] type of computing, comparable to grid computing that relies on sharing computing resources rather than having local servers or personal devices to handle applications").

38. ZITTRAIN, *supra* note 1, at 17. R

39. *Id.* at 3.

40. *See* Jonathan Zittrain, *Lost in the Cloud*, N.Y. TIMES, July 20, 2009, at A19 ("[F]reedom is at risk in the cloud, where the vendor of a platform has much more control over whether and how to let others write new software.").

C. The Generative iPhone?

In hindsight, picking the iPhone as his poster child may not have been Zittrain's best call. If the locked-down iPhone was to be the dystopian "Future of the Internet," the future lasted a year and twelve days. The iPhone went on sale on June 29, 2007; Apple unlocked it on July 11, 2008.[41] Since then, the App Store[42]—an extension of the iTunes Store through which Apple sells downloadable music—has allowed iPhone owners to download and install applications of their choosing. Some are fancy, some are simple; some are expensive, many are free. Developers have created over 100,000 applications;[43] users have downloaded them over three billion times.[44] Zittrain managed to slip a parenthetical into the manuscript of *The Future of the Internet* as it was on its way to press—"[a] promised software development kit may allow others to program the iPhone with Apple's permission"[45]—but even as the book hit the shelves, the world was going crazy with iPhone App-mania.

In fact, it's not just the iPhone. At the mall today, after checking out the iPhone at the Apple Store, you could head to the Verizon store to buy a Motorola Droid running Google's open-source Android operating system instead.[46] Or, if you wanted, you could go up the escalator to the Sprint store and buy a Palm Pre, which features its own set of powerful APIs and an Apple-style App Store.[47] In the space of just the last two years, the mobile phone market has flipped from one utterly dominated by closed platforms to one in which open, extensible systems are taking substantial market share.[48] The last few

41. *See* Kent German, *New iPhone Could Go on Sale July 17*, CNET, May 20, 2009, http://news.cnet.com/8301-17938_105-10246124-1.html (explaining that the original iPhone went on sale on June 29, 2007, and the iPhone 3G went on sale on July 11, 2008).

42. Apple, Apps for iPhone, http://www.apple.com/iphone/apps-for-iphone (last visited May 31, 2010) ("Explore some of our favorite apps here and see how they allow iPhone to do even more.").

43. Press Release, Apple, Apple Announces Over 100,000 Apps Now Available on the App Store (Nov. 4, 2009), *available at* http://www.apple.com/pr/library/2009/11/04appstore.html.

44. Press Release, Apple, Apple's App Store Downloads Top Three Billion (Jan. 5, 2010), *available at* http://www.apple.com/pr/library/2010/01/05appstore.html.

45. ZITTRAIN, *supra* note 1, at 2. R

46. Droid by Motorola, http://www.motorola.com/Consumers/US-EN/Consumer-Product-and-Services/Mobile-Phones/ci.Motorola-DROID-US-EN.vertical (last visited May 31, 2010).

47. Palm USA, Palm Pre Phone, http://www.palm.com/us/products/phones/pre (last visited May 31, 2010).

48. *See* Sara Silver, *Apple, RIM Outsmart Phone Market*, WALL ST. J., July 20, 2009, at C6 (stating that Apple's iPhone and Research In Motion's BlackBerry accounted for only three percent of cell phones sold worldwide in 2008 but thirty-five percent of operating

years in the cell phone industry, in other words, have not been good to Zittrain's appliancization thesis.

This disjuncture has opened up an important line of criticism. Libertarian commentators have claimed that Zittrain mistakes the normal, healthy diversity of technology markets—in which different approaches compete for customers—for a Clash of the Titans between two inherently incompatible futures.[49] These critics think that Zittrain's prediction—appliances will displace generativity, rather than coexisting with it—is simply wrong. Toasters haven't replaced pots and pans in most kitchens; they've supplemented them. Adam Thierer, for example, predicts a "hybrid" world where appliances and generative devices mingle freely.[50]

Zittrain, of course, is free to respond that the pressures opposing generativity are real and growing, the iPhone notwithstanding. It's a big Internet out there, and the iPhone is just one data point. Still, it wasn't Zittrain's critics who chose to make the iPhone the organizing metaphor for *The Future of the Internet*. Did the *bête noire* turn out to be a paper tiger?

We think not. It's true that the course of the long-term struggle between Dr. Generative and the Army of Appliances has yet to be determined. But we think that this counts as proof of the thesis of *The Future of the Internet*, rather than a refutation of it. We see an important distinction between Zittrain's claims about the direction of history (on which the jury is still out) and his identification of generativity itself and the forces that drive it (on which the verdict is unanimous in Zittrain's favor). Thierer, Post, and the others may not

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profits, and that those numbers could reach five percent and fifty-eight percent, respectively, in 2009).

49. *See, e.g.*, Timothy Lee, *Why Zittrain's Techno-Pessimism Is Unwarranted*, TECHDIRT, July 2, 2008, http://www.techdirt.com/articles/20080619/0938321458.shtml ("It doesn't, therefore, make sense to view the iPhone [a closed technology] as a threat to 'generativity.'"); Adam Thierer, *Apple, Openness, and the Zittrain Thesis*, TECH. LIBERATION FRONT, Mar. 30, 2008, http://techliberation.com/2008/03/30/apple-openness-and-the-zittrain-thesis ("[T]here is no reason that we can't have the best of both worlds [open and closed].").

50. Adam Thierer, *Review of Zittrain's "Future of the Internet,"* TECH. LIBERATION FRONT, Mar. 23, 2008, http://techliberation.com/2008/03/23/review-of-zittrains-future-of-the-internet. *See generally* David G. Post, *The Theory of Generativity*, 78 FORDHAM L. REV. 2755 (2010). These criticisms echo those made against Zittrain's intellectual and temperamental role model, Larry Lessig. *See, e.g.*, Timothy B. Lee, *Sizing Up "Code" with 20/20 Hindsight*, FREEDOM TO TINKER, May 14, 2009, http://www.freedom-to-tinker.com/blog/tblee/sizing-code-2020-hindsight; Ira Rubinstein, Anonymity Reconsidered (Apr. 24, 2009) (unpublished manuscript, on file with authors).

agree with Zittrain that generativity is at risk, but they share his appreciation of its value and power.[51]

As an illustration of the importance of generativity, consider the iPhone again. Specifically, look at how Apple explained the iPhone to generativity's core constituency—software developers. In a keynote address less than a month before the iPhone's launch, Jobs gave developers who wanted to write programs for it what he described as a "'very sweet solution.'"[52] Since the iPhone came with Apple's full Safari web browser built in, Jobs explained, developers could write so-called "applications" that ran in Safari—that is, they could make webpages.[53] It was a striking answer in at least four ways, all of which point up the importance of generativity.

First, Jobs felt he had to offer developers some "solution" to convince them to work with Apple and the iPhone. Offering a phone with no generativity story whatsoever was not an option that Jobs and Apple were even willing to consider.

Second, by putting a top-notch browser on the iPhone, Apple really was offering a more genuinely generative experience than was available on most other handsets on the market at the time. The mobile world was characterized by small, idiosyncratic, tightly controlled applications; most phones' browsers were useless for any interactive online websites.[54]

Third, developers recognized Jobs's "sweet solution" for the crock it was. Apple's own iPhone applications—its iPod features, its weather widget, its stock ticker, and so on—ran "natively," that is, with full access to all the software and hardware power of the phone.[55] Anyone else's application could run only as a webpage, unable to do basic tasks like take a picture through the iPhone's camera.[56] Jobs's announcement was met with nervous silence by the developers who had,

51. *See generally* Post, *supra* note 50 (praising the half-appliance/half-PC world as being "generative"). R

52. Peter Cohen et al., *WWDC Live Keynote Coverage*, MACWORLD, June 11, 2007, http://www.macworld.com/article/58339/2007/06/livekeynote.html.

53. *See id.*

54. Elena Malykhina, *Six Things Customers Hate About Cell Phone Service*, INFO. WK., May 12, 2007, *available at* http://www.informationweek.com/story/showArticle.jhtml?articleID=199501208 (describing cell phones offering restricted views of the Internet and text-only versions of websites).

55. *See* John Gruber, *WWDC 2007 Keynote News*, DARING FIREBALL, June 11, 2007, http://daringfireball.net/2007/06/wwdc_2007_keynote ("Think about it this way: If web apps—which are only accessible over a network; which don't get app icons in the iPhone home screen; which don't have any local data storage—are such a great way to write software for iPhone, then why isn't Apple using this technique for any of their own iPhone apps?").

56. *See id.*

just minutes before, been wildly cheering his announcements about the generative features of Leopard, Apple's new desktop operating system.[57] This was an audience that cared about generativity.

And fourth, Jobs's claim that webpages would be Apple's iPhone app solution was a complete lie. Apple's engineering team was already working on a full software development kit ("SDK") to enable developers to write real, native iPhone apps. In March 2008, Jobs would be back on stage, announcing the SDK for developers and the forthcoming App Store for users.[58] Apple, in short, had been aiming at a more generative solution all along.[59]

Whatever this story means for Zittrain's pessimism about the future, it's a powerful confirmation of his claims about the value of generativity. The App Store is, by some estimates, now a multi-billion-dollar-a-year business.[60] The iPhone is a hotbed of creative tinkering; people are doing amazing things with it. Nearest Tube shows you the way to the nearest subway stop by placing floating, imaginary subway signs atop a video image of the world in front of you.[61] Shazam enables an iPhone to listen to and identify the ambient music playing wherever you happen to be.[62] Ocarina turns it into a musical instrument that you play by blowing into the microphone.[63] Brushes allows artists, including David Hockney, to create beautiful paintings on their phones' little glass canvases.[64] Open up a little generativity and you get a lot back.

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57. *See id.* ("Perhaps it's playing well in the mainstream press, but here at WWDC, Apple's '*you can write great apps for the iPhone: they're called web sites*'–message went over like a lead balloon." (emphasis and internal quotation marks omitted)).

58. Antone Gonsalves, *Apple Releases iPhone SDK in Beta*, INFO. WK., Mar. 6, 2008, *available at* http://www.informationweek.com/story/showArticle.jhtml?articleID=206902287.

59. Google's announcement of the open-source, generative Android operating system for mobile phones couldn't have hurt, either. *See* Android Open Source, http://source.android.com (last visited May 31, 2010) ("Android is an open-source software stack for mobile devices, and a corresponding open-source project led by Google."). Apple needed to offer something more compelling than webpages, lest it be outflanked on the application front.

60. Om Malik, *How Big Is the Apple iPhone App Economy? The Answer Might Surprise You*, GIGAOM, Aug. 27, 2009, http://gigaom.com/2009/08/27/how-big-is-apple-iphone-app-economy-the-answer-might-surprise-you/.

61. Nearest Tube, http://www.acrossair.com/apps_nearesttube.htm (last visited May 31, 2010).

62. Shazam on iPhone, http://www.shazam.com/music/web/pages/iphone.html (last visited May 31, 2010).

63. Ocarina, http://ocarina.smule.com (last visited May 31, 2010).

64. Lawrence Weschler, *David Hockney's iPhone Passion*, N.Y. REV. BOOKS, Oct. 22, 2009, *available at* http://www.nybooks.com/articles/archives/2009/oct/22/david-hockneys-iphone-passion; *see also* Stephanie Clifford, *New Yorker Cover Art, Painted with an iPhone*, N.Y.

The App Store-enabled iPhone has generated so many compelling generative surprises that blogger Jason Kottke has drawn out an extended parallel between it and the Internet of the late 1990s.[65] Kottke compares the iPhone to mobile phones, PDAs, iPods, point-and-shoot cameras, personal computers, portable gaming consoles, GPS units, handheld video cameras, compasses, watches, portable DVD players, and e-book readers, concluding, "Well, the iPhone does a lot of useful things pretty well, well enough that it is replacing several specialized devices that do one or two things really well."[66] That is a generativity story; third-party user-installable applications make the iPhone adaptable enough to out-complete whole hordes of appliances. Just as the Internet forced "any organization offering entertainment or information"[67] to rethink its business, the iPhone is doing the same for anyone making computer hardware or software. If the iPhone is a test of the descriptive half of his generativity thesis, Zittrain passes with flying colors.

II. EVALUATING GENERATIVITY

The Future of the Internet gets a lot right, but not everything. We'll have a lot to say about what Zittrain misses, but our critiques should be read in the context of our profound appreciation for his theory. His work on generativity is a milestone in Internet law scholarship. It's the best descriptive and normative theory to date on what makes the Internet special. Zittrain's analysis becomes muddled only when he tries to extract a prescriptive policy agenda from it.

This Part will deconstruct generativity to identify what Zittrain's theory gets right—and where it goes wrong. This Part will first compare generativity (favorably) to the previous work on which it builds.[68] Then, this Part will look at Zittrain's policy prescriptions.[69] Finally, this Part will explain the gap between his theory and his practice.[70]

TIMES, May 25, 2009, at B4 (discussing how artist Jorge Colombo created a cover for the *New Yorker* with his iPhone).

65. Jason Kottke, *Your Company? There's an App for That*, KOTTKE, Sept. 16, 2009, http://kottke.org/09/09/your-company-theres-an-app-for-that.

66. *Id.*

67. *Id.*

68. *See infra* Part II.A.

69. *See infra* Part II.B.

70. *See infra* Part II.C.

A. Generativity Is the Right Theory

Zittrain's identification of generativity as the Internet's critical characteristic both builds on and improves on previous scholars' work. He's hardly the first to identify key technical characteristics of computers and the Internet. Nor is he the first to recognize that computer technologies are socially valuable, catalysts for innovation, and instruments of individual freedom. But his idea of generativity both generalizes from and unifies previous thinkers' attempts. Generativity is a scholarly improvement on the related ideas of an "end-to-end" network, a "neutral" network, a "layered" network, technical "standardization," a "decentralized" system, "tinkerable" computers, and "free" or "commons" content.[71]

End-to-End Networking: Consider first the engineering heuristic of an "end-to-end" network[72]: When designing a system that works over a network, the most robust solution will make the network as simple and stupid as possible, keeping the intelligence in the computers at each end.[73] Zittrain's description of the Internet's "hourglass architecture"[74] captures this point. At a low level, the Internet has a diversity of connections and protocols, all of which support the Internet Protocol ("IP"), which in turn supports a diversity of protocols, applications, and content.[75] And IP—the narrow neck of the hourglass—is a minimalist, almost willfully ignorant protocol.[76] All it does is sling packets around. Zittrain goes beyond end-to-end, however, in recognizing that the same hourglass architecture also applies to PCs.[77] There, the operating system sits at the narrow neck, with hardware below and applications above.[78]

Network Neutrality: Legal scholars have seized on a side effect of the end-to-end engineering principle, arguing that IP's agnosticism is an important guarantor of freedom and innovation.[79] It enables the

71. *See infra* notes 72–107 and accompanying text. R

72. *See generally* J.H. Saltzer et al., *End-to-End Arguments in System Design*, 2 ACM TRANSACTIONS ON COMPUTER SYS. 277 (1984), *available at* http://web.mit.edu/Saltzer/www/publications/endtoend/endtoend.pdf. *Cf.* David Isenberg, *Rise of the Stupid Network*, J. HYPERLINKED ORG., http://www.hyperorg.com/misc/stupidnet.html (last visited May 31, 2010).

73. *See infra* text accompanying notes 74–78. R

74. ZITTRAIN, *supra* note 1, at 67. R

75. *Id.* at 67–68.

76. *Id.* at 69.

77. *Id.* at 69–70.

78. *Id.*

79. The argument was first made in 2000. *See* Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era* 6–8 (U.C. Berkeley Program in Law & Econ., Research Paper No. 2000-19, 2000), *available at* http://

launch of new applications without the need for support from the network and thus without the need for permission from the incumbent owners of network infrastructure. "Network neutrality" has come to be the preferred term for this principle—legally mandated technical nondiscrimination.[80]

Generativity recognizes the value of end-user innovation free of an incumbent's veto. But it also shows the limits of a strict neutrality principle. This is where Zittrain's decision to treat PCs and the Internet together best justifies itself. A neutral network that connects only appliances isn't generative; an occasionally discriminatory network that connects PCs can be. Zittrain, for example, is willing to let Internet Service Providers ("ISPs") filter for viruses if that would free PC owners to be less paranoid and more open to new innovations.[81]

Layering: A related technical principle is "layering": Application writers don't need to worry about how the Transmission Control Protocol ("TCP") creates reliable connections between computers, only that it works. TCP implementers, in turn, don't need to worry about how the lower-layer IP routes packets from one computer to another, only that it works, and so on down to the raw silicon and fiber-optic cables.[82] Lawrence Solum and Minn Chung have argued that the technical separation between layers should presumptively be treated as inviolate by policymakers.[83]

Once again, generativity incorporates this insight: Hourglass architecture is a point about layering. But generativity also shows how layering is both too broad and too narrow. It's too narrow because it's not a sufficient condition; a layered protocol stack can be tightly controlled, or connected only to appliances. And it's too broad because plenty of layer-crossing designs are clever, generativity-enhancing hacks. Skype, which made peer-to-peer voice-over-IP a practical reality, uses its own highly customized transport protocol.[84] As the hour-

repositories.cdlib.org/cgi/viewcontent.cgi?article=1052&context=blewp; *see also* Written Ex Parte of Professor Mark A. Lemley and Professor Lawrence Lessig, *In re* Application for Consent to the Transfer of Control of Licenses MediaOne Group, Inc. to AT&T Corp., CS Docket No. 99-251, *available at* http://cyber.law.harvard.edu/works/lessig/lem-lesd.pdf.

80. *See generally* Tim Wu, *Network Neutrality, Broadband Discrimination*, 2 J. TELECOMM. & HIGH TECH. L. 141 (2003).

81. ZITTRAIN, *supra* note 1, at 165. R

82. *See* Lawrence B. Solum & Minn Chung, *The Layers Principle: Internet Architecture and the Law*, 79 NOTRE DAME L. REV. 815, 831–35 (2004).

83. *Id.* at 849–54.

84. *See generally* SALMAN A. BASET & HENNING SCHULZRINNE, COLUMBIA UNIV., DEP'T OF COMPUTER SCI., AN ANALYSIS OF THE SKYPE PEER-TO-PEER INTERNET TELEPHONY PROTOCOL (2004), http://www1.cs.columbia.edu/~library/TR-repository/reports/reports-2004/cucs-039-04.pdf.

glass design shows, IP is the only layer that really, truly matters. It turns out that most of Solum and Chung's examples of what not to do involve breaking IP in some fashion or other.[85]

Standardization: The Internet standardizes everyone who uses it on a common set of communications protocols, with the result that it offers universal connectivity. Likewise, computers are standardized by operating system Application Program Interfaces ("APIs")[86] and file formats. This standardization plays a role in three effects celebrated by scholars. The first is network effects—the positive externalities that come from having many people using the same network.[87] The second is universal service—the idea that everyone should be entitled to a baseline of communications services adequate to meet their needs as humans and members of society.[88] The third is that standards prevent fragmentation for self-interested commercial or political reasons.[89]

Generativity again builds on these characteristics. Network effects are the traces of generativity; they show individual users sharing with each other. Universal service provides individuals with the technical resources they need to participate in a generative system.[90] And a single network maximizes the number of others from whom an individual user can learn and with whom she can share. But generativity goes beyond standardization in recognizing that these characteristics aren't sufficient by themselves. The Bell telephone network was national in scope, had an explicit universal-service goal, and had few internal divisions.[91] But it wasn't significantly generative in Zittrain's sense.[92]

Decentralization: Batch processing was centralized; a small cadre of technicians controlled access to the machine.[93] As a system, personal computers are decentralized. If you have one, it is yours to use as you

85. Solum & Chung, *supra* note 82, at 880–926. R

86. *See* Webopedia, What Is API?, http://www.webopedia.com/TERM/A/API.html (last visited June 1, 2010) (defining "application program interface" as "a set of routines, protocols, and tools for building software applications").

87. *See* OZ SHY, THE ECONOMICS OF NETWORK INDUSTRIES 3 (2001).

88. *See* MILTON MUELLER, UNIVERSAL SERVICE: COMPETITION, INTERCONNECTION, AND MONOPOLY IN THE MAKING OF THE AMERICAN TELEPHONE SYSTEM 5 (1997).

89. *See* LAURA DENARDIS, PROTOCOL POLITICS 210, 218 (2009).

90. In Zittrain's terms, universal service makes a network maximally "accessible." ZITTRAIN, *supra* note 1, at 72–73. R

91. *Id.* at 81.

92. *See id.*

93. For a literary take on the political implications of centralized computing, see Paul Ford, *Speculation: ReichOS*, FTRAIN, Dec. 14, 2000, http://www.ftrain.com/story_possible_wwii.html (positing a totalitarian history of computing in an alternate universe in which the Germans won World War II).

see fit. An ATM network is centralized; each terminal can only talk to the main server. But the Internet is decentralized. One computer can talk to another without needing to pass every packet through a preassigned central server.

Scholars have celebrated decentralization.[94] A centralized system couldn't possibly handle the Internet's huge volume of traffic; no single administrator could respond to the individual needs of the Internet's billion-plus users. And a decentralized system has no single chokepoint, making it harder for powerful actors (like the government or large corporations) to control.[95]

This lack of central control has consequences that call generativity to mind. A decentralized communications system enables the spread of a wide range of diverse viewpoints—much more so than a mass medium controlled by a single actor with room only for a few speakers.[96] Nor is there anyone who can take away the punchbowl just as the innovation party starts to get fun. Even if a centralized system is open to user-driven changes at the endpoints, it's always subject to a take-back from the center.

Tinkerability: The idea that a technology's users should also be able to modify it is a resonant one in computer circles.[97] This positive vision of user/creators emphasizes the idea's beneficial effects for autonomy[98] and innovation.[99] This process has obvious connections to generativity. The same people are tinkering with their toasters, crowding the Maker Faire, passing good ideas back upstream to the compa-

94. *See, e.g.*, DAVID G. POST, IN SEARCH OF JEFFERSON'S MOOSE: NOTES ON THE STATE OF CYBERSPACE 170–71 (2009) (discussing the advantages of decentralized governance).

95. *See generally* LAWRENCE LESSIG, CODE: AND OTHER LAWS OF CYBERSPACE, VERSION 2.0 (2006) (discussing the potential regulability of the Internet).

96. *See* Yochai Benkler, *Siren Songs and Amish Children: Autonomy, Information, and Law*, 76 N.Y.U. L. REV. 23, 74–75 (2001).

97. *See, e.g.*, Freedom to Tinker, http://freedom-to-tinker.com (last visited June 2, 2010) (advancing "your freedom to understand, discuss, repair, and modify the technological devices you own"). Compare Freedom 1 from the Free Software Definition, the "freedom to study how the program works, and change it to make it do what you wish." Free Software Definition, GNU Project, http://www.gnu.org/philosophy/free-sw.html (last visited June 2, 2010). Freedom 3 adds the ability to share those changes with others. *Id.*

98. *See* Richard Stallman, *The Right to Read*, 40 COMM. ACM 85 (1997), *available at* http://www.gnu.org/philosophy/right-to-read.html.

99. *See* ERIC S. RAYMOND, THE CATHEDRAL AND THE BAZAAR: MUSINGS ON LINUX AND OPEN SOURCE BY AN ACCIDENTAL REVOLUTIONARY 29 (1999).

nies that make the tinkered-with devices,[100] and starting their own companies to carry on the tradition.[101]

Generativity expands on tinkering by emphasizing the role of tools in addition to finished systems. Tinkering is an act of creative deconstruction: If I take this thing apart and reassemble it in this way, what will happen? Zittrain also points out the importance of less-assembled inputs—bags of Lego blocks, paints and canvases,[102] CPU cycles and bandwidth. Both raw materials and well-functioning products are useful in the analytic-synthetic cycle of generativity.

Commons: There's a burgeoning academic interest in the "commons."[103] The object of study here is typically a set of information resources not subject to legal restriction on reuse, thus forming an intellectual commons open to all.[104] Zittrain discusses tangible infrastructure,[105] rather than intangible information goods. But there's a close affinity between his claims about generativity and the commoners' claims about freedom. Both have in mind a very similar human moral subject: Someone who's inclined to creativity and inclined to share with others.[106] Both seek to remove the obstacles in the way of creativity and sharing and to provide individuals with the foundations they need to fully develop their creative capacities. In this sense, generativity is an argument for the commons that doesn't depend on special pleading about the non-rival nature of information goods.[107]

In sum, Zittrain's theory of generativity is an elegant synthesis of an enormous body of prior scholarly research. He brings many insights together in one clear and powerful idea. *The Future of the In-*

100. *See* ZITTRAIN, *supra* note 1, at 86 (discussing ERIC VON HIPPEL, DEMOCRATIZING INNOVATION (2005) (cataloging examples of user innovation)). R

101. Hewlett-Packard, Apple, and Google were all launched from garages, a piece of corporate history that plays off the close affinity between automotive and digital tinkering. *See, e.g.*, Associated Press, *Google Purchases the Garage that Launched the Company*, BOSTON GLOBE, Oct. 2, 2006, http://www.boston.com/business/technology/articles/2006/10/02/google_purchases_the_garage_that_launched_the_company.

102. ZITTRAIN, *supra* note 1, at 74–76. R

103. *See, e.g.*, DAVID BOLLIER, VIRAL SPIRAL: HOW THE COMMONERS BUILT A DIGITAL REPUBLIC OF THEIR OWN (2009); JAMES BOYLE, THE PUBLIC DOMAIN: ENCLOSING THE COMMONS OF THE MIND (2008).

104. *See generally* James Grimmelmann, *The Internet Is a Semicommons*, 78 FORDHAM L. REV. (forthcoming 2010) (discussing ways in which the Internet is and is not a commons).

105. *See, e.g.*, ZITTRAIN, *supra* note 1, at 246 ("The deciding factor in whether our current infrastructure can endure will be the sum of the perceptions and actions of its users."). R

106. *See* James Grimmelmann, *The Ethical Visions of Copyright Law*, 77 FORDHAM L. REV. 2005, 2029–31 (discussing moral rhetoric of sharing creative works).

107. Here, Zittrain draws on LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001), which also connects content and network layers. ZITTRAIN, *supra* note 1, at 78. R

ternet convincingly presents generativity as the *summum* of technical virtues—the one that really matters.

B. The Wiki Way

Zittrain also offers a set of prescriptive recommendations to increase and defend generativity. In light of the many instabilities (such as spam and viruses) induced by generativity, he concedes that compromises against generativity are necessary. He accepts that "[w]e need a strategy that blunts the worst aspects of today's popular generative Internet and PC."[108] That strategy, however, can't simply be appliancization, which destroys the generative village in order to save it.

Instead, he turns to a perhaps unlikely source of inspiration: Wikipedia,[109] the impossible encyclopedia. Chapter 6 opens with a suggestive metaphor about a Dutch city where the roads are *verkeersbordvrij*—free of traffic signs.[110] But even without a centralized, authoritative source of coercive orders, drivers and pedestrians manage to get around without constantly getting into accidents.[111] Indeed, the streets are substantially safer.[112] Once people realize that they're (collectively) responsible for their own safety—and the absence of traffic signs sends a strong signal to that effect—they start paying more attention to each other, looking out for upcoming dangers, and using better judgment.[113] The result is a friendlier, safer equilibrium.

The substitution of bottom-up social norms for top-down enforcement is, of course, another commonplace of legal scholarship.[114] But in Zittrain's hands, *verkeersbordvrij* becomes a powerful metaphor for another way to deal with the toxic side effects of generativity. Instead of locking down platforms like the iPhone, why not harness the same cooperative, socially-oriented forces that keep drivers from indiscriminately running down bicyclists? Instead of appliances and "points of control," he offers a vision of people who "take the welfare of one another seriously and possess the tools to readily assist and limit each other."[115]

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108. ZITTRAIN, *supra* note 1, at 150. R

109. *See* Wikipedia, http://wikipedia.org (last visited June 2, 2010) (declaring the website "The Free Encyclopedia").

110. ZITTRAIN, *supra* note 1, at 127.

111. *Id.*

112. *See id.*

113. *See id.*

114. *See, e.g.*, ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 141 (1991) (arguing that people generally look to norms rather than law to decide disputes).

115. ZITTRAIN, *supra* note 1, at 129. R

Zittrain sees the *verkeersbordvrij* spirit in Wikipedia.[116] Anyone can edit it; hundreds of thousands of people do. Not all of them are well-intentioned: The site must deal with extensive vandalism and sock-puppetry.[117] But deal it does; the English-language Wikipedia is viewed over a hundred million times a day.[118] Its quality and accuracy are decent, and its coverage of many topics utterly swamps its more traditional competition. There are no Galactic Wikipedia Police ruling the site with an iron fist; instead, individual editors go around making things better here and there, fixing vandalism, and endlessly debating policies and entries.[119] It's a mess, but it more or less works.[120] Zittrain calls Wikipedia the "canonical bee": It shouldn't be able to fly, but fly it does.[121]

Chapters 7, 8, and 9 of *The Future of the Internet* are dedicated to replicating the success of Wikipedia on the Internet as a whole.[122] Using Wikipedia's *verkeersbordvrij* spirit as a metaphor, Zittrain offers solutions that try to empower well-intentioned users to collaboratively cope with generativity's risks.[123] These solutions, he hopes, will let us have our cake and eat it, too: An open and generative technical architecture, coupled with a social architecture to respond to those few who don't want to cooperate.[124]

Despite its pessimistic title and tone, *The Future of the Internet* actually recommends very little in the way of legal intervention. These three chapters are devoted largely to clever new technical designs that computer companies and ISPs could offer. In Chapter 7, on security threats, he suggests, for example, that home users would appreciate

116. *Id.* at 133.

117. *See* Wikipedia: Sock Puppetry, http://en.wikipedia.org/wiki/Wikipedia:SOCK (last visited June 3, 2010) ("The default position on Wikipedia is that editors who register should edit using one account only. The purpose of this policy is to forbid deceptive or misleading use of multiple accounts and to explain where editors may legitimately use a second (alternate) account. A second account used in violation of this policy is known as a sock puppet.").

118. *See* Wikipedia Statistics, http://stats.wikimedia.org/EN/Sitemap.htm (last visited June 15, 2010).

119. *See* David A. Hoffman & Salil K. Mehra, *Wikitruth Through Wikiorder*, 59 EMORY L.J. 151, 172–73 (2009) (discussing Wikipedia's internal norms and dispute-resolution procedures).

120. *See generally* PHOEBE AYERS, HOW WIKIPEDIA WORKS: AND HOW YOU CAN BE A PART OF IT (2008); ANDREW DALBY, THE WORLD AND WIKIPEDIA: HOW WE ARE EDITING REALITY (2009).

121. ZITTRAIN, *supra* note 1, at 148. R

122. *See id.* at 149–234.

123. *See id.* at 228; *see also id.* at 146 (explaining that "[t]he elements of Wikipedia that have led to its success can help us come to solutions for problems besetting generative successes at other layers of the Internet" and listing *verkeersbordvrij* as one such element).

124. *See id.* at 228.

computers that could run in both "green" (secure but restricted) and "red" (less secure but easier to tinker with) modes.[125] These red/green computers would retain their generative capacity but wouldn't force users to live with its risks all of the time.[126] Other solutions involve giving communities the tools they need to communicate and act responsibly. At Harvard's Berkman Center for Internet & Society, Zittrain helped found the StopBadware initiative, which collects information on virus-spewing servers.[127] The information is used to put warning signs around dangerous servers, rather than impassable *cordons sanitaire*.[128] Zittrain's legal instincts, if not exactly libertarian, are prudentially modest. Even though he calls for a "latter-day Manhattan project," he means only a sustained collaborative "series of conversations, arguments, and experiments."[129] The very spirit of *verkeersbordvrij*, it might seem, precludes more ambitious regulatory interventions.

C. What's Wrong with This Picture?

This is an attractive story, not least because it appeals to human instincts of decency and collaboration. But it's not clear that Zittrain's recommendations really lead to a comprehensive and implementable program. The problem is that in order to pick and choose the "tools and practices" that will preserve generativity rather than hasten its demise,[130] we need to be able to recognize generativity in the wild. When we predict the likely consequences of a given intervention, we need to be able to say whether it will nourish generativity or suffocate it. We need, in other words, a good way to measure generativity.

Yet, Zittrain never offers one. Instead, he offers lists. Generative systems include: the Apple II,[131] the personal computer,[132] the Internet,[133] wikis and blogs,[134] open wi-fi networks,[135] Microsoft Windows,[136] and MySpace.[137] Non-generative systems include: the

125. *See id.* at 155.
126. *Id.*
127. About StopBadware, http://stopbadware.org/home/about (last visited June 2, 2010).
128. StopBadware Frequently Asked Questions, http://stopbadware.org/home/faq (last visited June 2, 2010).
129. ZITTRAIN, *supra* note 1, at 173. R
130. *Id.* at 152.
131. *Id.* at 2.
132. *Id.* at 13.
133. *Id.* at 27.
134. *Id.* at 95.
135. *Id.* at 194.
136. *Id.* at 77.

Brother word processor,[138] the toaster,[139] TiVo,[140] and iTunes.[141] Somewhere in the middle are systems he regards as somewhat but not sufficiently generative, including Microsoft's Xbox 360 video game console,[142] cell phones,[143] and Google Maps.[144] But the dots remain unconnected. In pure generativity terms, it's hard to understand what's wrong with Google Maps[145] (to pick an arbitrary example). Compared with a paper atlas, Google Maps looks pretty good. Search makes it easier to use; its sharing features make it more collaborative.[146] And no paper atlas has ever offered anything even remotely like the Google Maps API, which lets developers create their own mash-up applications to add new functionality to the maps.[147]

Zittrain does break generativity down into five factors: leverage, adaptability, ease of mastery, accessibility, and transferability.[148] A tool with leverage enables users to do a task more effectively, while an adaptable tool can be used for a wide range of tasks.[149] The easier it is for a new user to learn, the more generative the tool; it's also more generative if it's available to more potential users.[150] Moreover, a truly generative tool isn't just personally useful: It lets users transfer their improvements to others.[151] This is a helpful taxonomy; it provides the who, what, when, where, and how of generativity.

But if Zittrain indicates what questions scholars and designers should ask, he doesn't say much about what to do with the answers. Having introduced these factors, he explains that "the absence of one of these factors may prevent a technology from being generative . . . [as] a major deficiency in any one factor greatly reduces overall generativity."[152] The analysis essentially stops there. The five factors appear almost nowhere in the book except in the chapter introducing them.

137. *Id.* at 233.
138. *Id.* at 19.
139. *Id.* at 80.
140. *Id.* at 106.
141. *Id.*
142. *Id.* at 3.
143. *Id.* at 58.
144. *Id.* at 124.
145. Google Maps, http://maps.google.com (last visited June 2, 2010).
146. *See id.* (allowing users to search maps and providing the option to share links to maps with others).
147. *See* Google Maps API Family, http://code.google.com/apis/maps (last visited June 2, 2010).
148. ZITTRAIN, *supra* note 1, at 71–73.
149. *Id.* at 71.
150. *Id.* at 72–73.
151. *Id.* at 73.
152. *Id.* at 74.

Instead, the remaining chapters proceed as though the problem of measuring generativity were now so completely solved as to be trivial. In the rest of the book, Zittrain the policymaker treats generativity as though it were like the weather—trivial to measure (it's forty-eight degrees out), easy to characterize (today is cloudy, not sunny), and moderately predictable (tomorrow will be warmer). We're not so sure.

Take another example: Google Docs, the online suite of word-processing, spreadsheet, and presentation tools.[153] It can be leveraged, is adaptable to a huge range of intellectual purposes, is easy to master, is highly accessible, and makes it trivial to transfer documents to other users. True, it's hard for a user to add new behaviors to its word processor, but it's hard to do that in most word processors, and the Google Docs spreadsheet application is as computationally powerful as any programming language. What, then, is wrong with it? Zittrain's theory—at least as he explains it—doesn't say. But Zittrain's arguments against Google Maps—based on Google's centralized control—would apply equally well to Google Docs.[154]

Zittrain also isn't clear on when and how to sacrifice some generativity for the greater good. He rejects a "categorical end-to-end approach" because he thinks that a fully neutral network will lead to "digital gated communities" at the endpoints.[155] This is a sensible enough recommendation, but the link from his "new generativity principle," which requires that modifications "do the least harm to generative possibilities,"[156] to this specific decision is undertheorized. On what basis does he conclude that extensive firewalling and virus scanning is worse for generativity than some packet filtering? He's probably right, but it's hard to escape the conclusion that Zittrain's gut is doing as much work here as his theory. He knows generativity when he sees it.

The problem with this approach is that there are genuinely hard cases. Take the iPhone again. Should Zittrain conclude that its new, mostly-unlocked form makes it generative? The availability of tens of thousands of applications would suggest that he should. Jason Kottke's point that "[t]here's an app for that" for almost everything would indicate that the iPhone has become powerfully generative.[157]

153. *See* Google Docs, http://docs.google.com (last visited June 3, 2010).

154. *See* ZITTRAIN, *supra* note 1, at 124 (discussing the pitfalls of Google Maps's centralized control).

155. *Id.* at 165.

156. *Id.*

157. Kottke, *supra* note 65. R

Zittrain would likely respond that Apple retains sole approval over which apps appear in its App Store; it's "tethered," to use Zittrain's phrase.[158] Moreover, the iPhone has a built-in "kill switch," which allows Apple to deactivate remotely any application already installed on an iPhone.[159] Apple has rejected dictionaries that contain four-letter words[160] and pulled applications over tenuous copyright and trademark complaints, some of which verge on being objectively baseless.[161] Most contentiously, Apple flatly bars applications that would re-implement any of the iPhone's central features—web browsers, music library players, and telephone apps that work over the cellular network.[162] After Google Voice disappeared down the App Store's black hole, the Federal Communications Commission launched an investigation.[163] Developers who have worked with the App Store's approval process report Orwellian doublespeak and Kafkaesque inconsistency in equal measure.[164]

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158. *See, e.g.*, Tom Krazit, *Apple Apologizes for Baby Shaker*, CNET, Apr. 23, 2009, http://news.cnet.com/8301-13579_3-10226232-37.html (explaining that Apple has the power to reject applications from inclusion in the App Store); *see also* ZITTRAIN, *supra* note 1, at 101–26.

159. *See* Nick Wingfield, *IPhone Software Sales Take Off: Apple's Jobs*, WALL ST. J., Aug. 11, 2008, at B1 (confirming that Apple has such a capability). Further, the 3.0 update to the iPhone's operating system includes a "remote wipe" feature that owners can use to erase stolen iPhones. MobileMe: Troubleshooting Find My iPhone and Remote Wipe, http://support.apple.com/kb/TS2734 (last visited June 3, 2010). If users can do it from afar, so can Apple.

160. *See* Pete Cashmore, *Apple Rejects Dictionary App for Containing Swear Words*, MASHABLE, Aug. 5, 2009, http://mashable.com/2009/08/05/apple-rejects-ninjawords ("Today comes news of what might be the strangest App Store rejection yet: a dictionary was rejected twice because it contained swear words.").

161. *See* Robin Wauters, *TweetPhoto iPhone App Rejected Because Logo Resembles Polaroid Shot*, TECHCRUNCH, Aug. 24, 2009, http://www.techcrunch.com/2009/08/24/tweetphoto-iphone-app-rejected-because-logo-resembles-polaroid-shot (discussing Apple's reasons for rejecting various applications, including TweetPhoto, which Apple rejected because it had images resembling Polaroid photographs). Your app can also be bounced for being "'politically charged,'" as the developer of an application to help users advocate for single-payer healthcare discovered. *See iSinglePayer iPhone App Censored by Apple*, LAMBDAJIVE, Sept. 26, 2009, http://lambdajive.wordpress.com/2009/09/26/isinglepayer-iphone-app-censored-by-apple/.

162. *See* Reed Abelson, *F.C.C. Looking into Rejection of Google App for iPhone*, N.Y. TIMES, Aug. 1, 2009, at B5 (describing Apple's rejection of Google Voice, which provides users with free domestic calls, inexpensive international calls, and other mobile services). This restriction prevents users from surmounting limitations in Apple's own software. The rejected Google Voice offered users a set of voicemail options that were in some ways more sophisticated than Apple's own.

163. *Id.*

164. *See, e.g.*, *There's No App for That*, RIVERTURN, July 28, 2009, http://www.riverturn.com/blog/?p=455 (describing an Apple employee's response after an application was removed from the store: "I understand your point but I can't help you with that." (internal quotation marks omitted)); *see also* John Gruber, *Choice Nuggets from Apple's Response to the*

Even with these restrictions, though, it isn't obvious that the App Store is all that far away—from a generativity perspective—from Wikipedia. Many of the charges that could be hurled against the iPhone would also stick to Wikipedia. Many Wikipedia edits are reverted quickly after they are made. Some IP addresses are banned entirely.[165] One organization has its finger on Wikipedia's master override switch, and sometimes it uses that power. For example, the news of a *New York Times* reporter's kidnapping in Afghanistan was suppressed for almost a year, on orders straight from Wikipedia's founder.[166] Compared with some of the convoluted fights over Wikipedia article edits,[167] the iPhone App Store application process sometimes seems like a model of bureaucratic rationality.

This isn't to say that Wikipedia is ungenerative, or dystopian, or doomed. It isn't. But it is a complex, messy system, and one that accepts significant limits to its generativity. Those limits may be necessary to make the whole thing work, of course. Someone has to run the server, someone has to resolve disputes, someone has to deal with spammers and sock puppets,[168] and so on. But structurally, this is the same argument used to justify Apple's control over the iPhone environment. The Wikipedia model may be superior to the Apple model, all things considered, but it's not self-evidently superior. Or, put another way, it's easy to say the first-generation, locked-down iPhone was generatively inferior to Wikipedia, but it's much harder to explain why Wikipedia beats the modern iPhone. They both make sacrifices in the name of overall generativity. You need a more precise analytical framework than what Zittrain provides to explain why one tradeoff is better than another.

III. GENERATIVE ENOUGH

We'd like to help. We don't believe that generativity can be reduced to a simple set of if-then conditions; it's necessarily a fact-bound inquiry. Zittrain deserves credit for recognizing that complexity in his

FCC's Inquiry Regarding the Rejection and Removal of Google Voice Apps from the App Store, DARING FIREBALL, Aug. 21, 2009, http://daringfireball.net/2009/08/apples_fcc_response (criticizing Apple's explanation for why Google Voice had not been approved).

165. *See* Eric Goldman, *Wikipedia's Labor Squeeze and its Consequences*, 8 J. TELECOMM. & HIGH TECH. L. 157, 164 (2010) (explaining that Wikipedia has "block[ed] IP addresses of repeat offenders, such as a controversial block of all IP addresses owned or operated by the Church of Scientology").

166. Richard Pérez-Peña, *Keeping News of Kidnapping off Wikipedia*, N.Y. TIMES, June 29, 2009, at B4.

167. *See* Hoffman & Mehra, *supra* note 119, at 154. R

168. *See supra* note 117. R

case studies. Still, we think that giving more attention to the problem of how best to measure generativity would help policymakers apply his theories.

We offer, then, some observations about the real-world problem of maximizing generativity. All of these ideas are to some extent implicit in *The Future of the Internet* and exert a gravitational pull on Zittrain's recommendations. Acknowledging them and making them explicit would make clearer what's at stake in generativity debates. They help organize the difficult process of sorting through technical and social facts to understand how generativity operates in the real world. We hope that Zittrain will accept them as friendly amendments to his work.

Our points number three: First, generativity is only one virtue among many; it won't avoid every problem or resolve every dispute online. Second, generativity is never absolute; no system has ever been perfectly generative, and, indeed, no perfectly generative system is possible. Third, generativity is normatively a system-wide, not a local, property; it can be counterproductive to maximize generativity at one layer, on one device, or at one time. Instead, we should seek to create a sustainable ecosystem of generativity.

A. Generativity Is Only One Virtue Among Many

Zittrain worries about centralized control. He tells plausible horror stories about how tethering would threaten freedom and autonomy: A judge worried about patent infringement can force a vendor to downgrade its customers' tethered DVRs,[169] a sovereign can censor tethered personal computers,[170] and a law enforcement agent can turn a tethered cell phone into a remote, wireless bug.[171] Tethering enables "perfect enforcement,"[172] which can obliterate experimentation, free expression, fair use, and privacy.

There's much to like about Zittrain's arguments against tethering. As a call to arms and a prediction about the evolution of technol-

169. *See* ZITTRAIN, *supra* note 1, at 103–04. R

170. *See id.* at 105. In June 2009, China ordered computer vendors to install Chinese censorware called "Green Dam" on every computer sold in China. Andrew Jacobs, *China Requires Software on New Computers to Block 'Unhealthy Information'*, N.Y. TIMES, June 9, 2009, at A11. After a public backlash, China backed down. Aaron Back, *China Pulls Back from Edict on Web-Filtering Software*, WALL ST. J., Aug. 14, 2009, at A7.

171. *See* ZITTRAIN, *supra* note 1, at 110; *see also* Declan McCullagh & Anne Broache, *FBI Taps Cell Phone Mic as Eavesdropping Tool*, CNET, Dec. 1, 2006, http://news.cnet.com/FBI-taps-cell-phone-mic-as-eavesdropping-tool/2100-1029_3-6140191.html. R

172. *See* ZITTRAIN, *supra* note 1, at 101–26. Or, as Lessig calls it, "perfect control." *See* LESSIG, *supra* note 95, at 179–80. R R

ogy, this is good stuff. We *should* worry about how technological tendencies toward centralized control will add to the power of the powerful. Amazon's bungled decision to delete copies of *1984* from tethered Kindles will resonate for a long time.[173] These are concerns that Zittrain shares with other scholars, of course,[174] but "tethering" is a particularly clear and succinct characterization of a serious problem.

We part company with Zittrain over tethering only because we're not yet convinced that this is a *generativity* story. The same desires for stability that threaten generativity also threaten to create architectures of control, but Zittrain hasn't shown that one can make these arguments from within the generativity framework. We think this is the point at which the idea of generativity, as useful and powerful as it is, needs to coordinate with other values that aren't reducible to it, such as human dignity and freedom from coercion.

Although tethering and appliancization sometimes flow from common pressures, one can exist without the other. Some operating systems can phone home periodically to look for critical system updates;[175] computers configured to update automatically are tethered, but they aren't appliances. Similarly, portable GPS units are completely unmodifiable, but few of them automatically phone home for updates.[176] GPS devices are appliances, but they aren't tethered. Even with its auto-update tether, the PC is still profoundly more generative than the fully appliancized GPS unit. And yet, we suspect that Zittrain loses more sleep over the tethered PC than over appliancized GPS units.

Thus, generativity alone isn't enough to resolve every online dispute. If you don't want Amazon to delete your books[177] or your ISP to spy on you,[178] generativity alone won't save you. Generativity doesn't

173. *See* Brad Stone, *Amazon Erases Two Classics From Kindle. (One Is '1984.')*, N.Y. TIMES, July 18, 2009, at B1 (describing how Amazon dropped George Orwell's *1984* and *Animal Farm* from its Kindle store).

174. *E.g.*, Julie E. Cohen, *Pervasively Distributed Copyright Enforcement*, 95 GEO. L.J. 1, 14 (2006).

175. *See, e.g.*, DAVID POGUE, WINDOWS VISTA: THE MISSING MANUAL 614–15 (2007) (explaining the process by which Windows delivers its updates).

176. *See* Jeffrey L. Wilson, *How to Update Your GPS*, LAPTOP MAG., Mar. 28, 2008, http://www.laptopmag.com/advice/how-to/how-to-update-your-gps.aspx (describing the updating process for various GPS navigators).

177. *See* Stone, *supra* note 173. R

178. *See* Paul Ohm, *The Rise and Fall of Invasive ISP Surveillance*, 2009 U. ILL. L. REV. 1417, 1417 (describing how ISPs "carry their users' conversations, secrets, relationships, acts, and omissions").

say much about the efficient term of copyright,[179] the right level of liability for online harassment,[180] the proper extent of personal jurisdiction for online activities, or the correct degree of transparency in e-government.[181] Generativity is an important value in Internet law, but only one of many. The argument against censorship can be—and ought to be—made on its own merits, grounded in appeals to democracy, liberty, and dignity.

There's room inside Zittrain's theory to recognize this plurality of goals. His breakdown of generativity into five factors is an acknowledgement that generativity has multiple axes.[182] Consider again the original black-box iPhone. It provided leverage by making many web-based tasks much easier. Apple's intensive design focus made it easy to master, and even if the initial $599 price tag was steep,[183] Apple quickly slashed the price until, within a year, it was as accessible as any other mobile phone.[184] True, the iPhone wasn't particularly adaptable, and almost by definition, users couldn't transfer their improvements to each other, but still. Three out of five ain't bad.

Further, Zittrain focuses on technological generativity, but the idea is rich enough to embrace other forms of generativity as well. Wikipedia provides a good example. Although he celebrates the burbling font of innovation that produced Wikipedia, he can't quite bring himself to celebrate Wikipedia itself as a paradigmatic example of generativity. Instead, he repeatedly refers to the "lessons of Wikipedia,"[185] which he thinks should be imported from "generativity at the content layer,"[186] a species of generativity he seems to treat as a pitiable second-class to what he seems to regard as real, technological generativity.

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179. *See* LAWRENCE LESSIG, FREE CULTURE: HOW BIG MEDIA USES TECHNOLOGY AND THE LAW TO LOCK DOWN CULTURE AND CONTROL CREATIVITY (2004).

180. *See* Danielle Keats Citron, *Cyber Civil Rights*, 89 B.U. L. REV. 61, 85–88 (2009) (advocating tort and criminal liability for cyber harassment).

181. *See* David Robinson et al., *Government Data and the Invisible Hand*, 11 YALE J.L. & TECH. 160, 160 (2009) (arguing that government should provide reusable data to satisfy its online publishing responsibility).

182. *See* ZITTRAIN, *supra* note 1, at 71–73 (discussing the five factors of generativity). R

183. *See* Chris Ziegler, *The Apple iPhone*, ENGADGET, Jan. 9, 2007, http://www.engadget.com/2007/01/09/the-apple-iphone (announcing the arrival of the iPhone and noting introductory prices).

184. *See* Mikael Ricknäs, *iPhone Timeline*, ITWORLD, June 9, 2008, http://www.itworld.com/iphone-timeline-080609 (noting that just months after the iPhone's debut, Apple lowered the price of the eight gigabyte model to $399).

185. *See* ZITTRAIN, *supra* note 1, 127–48. R

186. *Id.* at 123.

This isn't a distinction worth maintaining. Wikipedia *is* generative, and "generativity at the content layer" is worth caring about and trying to foster in exactly the same way that generativity at the hardware, IP, and application layers is. An encyclopedia is a tool for producing knowledge, just as a soldering iron is a tool for producing circuits. Wikipedia is highly leveraging for any task involving knowledge of the world, easily adaptable for any such task, trivially transferable once you hit "Save Page," and accessible from any Internet connection. Even though its wiki syntax isn't intuitive, it's still far easier to master than computer programming languages. There's no need to treat Wikipedia as a *metaphor* for generativity; Wikipedia is a generative that we should learn from and preserve in its own right.

Wikipedia's emergent community also provides a striking illustration of *social* generativity. While Zittrain celebrates the norms that make it work,[187] if anything he underplays the way in which those norms develop through a process that looks amazingly like the cycle of experimentation, sharing, feedback, and refinement that characterizes technical generativity. This is a general pattern, one seen in many other thriving online communities: Given a platform with sufficient affordances, users will build amazingly complicated social structures.[188] Social generativity is as important and valuable as the other forms celebrated by Zittrain. Policymakers should seek to foster this kind of creative ferment.

There is no one master virtue of generativity, then. On the one hand, the concept isn't so large as to capture everything policymakers need to care about, and there will be times that it must give way to other values. On the other hand, generativity itself contains multitudes, and there's no guarantee that they won't conflict. Ease of mastery, for example, is always in tension with adaptability—the fewer the possible uses, the easier it is to learn them. Working with generativity in the real world means engaging with these tensions, both between generativity and other values, and within generativity itself.

B. Generative Enough Is Good Enough

A reader of Zittrain's book may be left with the impression that PC and Internet technologists have created systems that maximize generativity, but this overstates the case. No one has ever created, and

187. *See id.* at 127–48 (discussing Wikipedia in a positive light).

188. *See, e.g.*, STEVEN LEVY, WIRED, TWITTER'S FOUNDERS CREATED A SIMPLE MESSAGING SERVICE 149–50 (2009), http://www.wired.com/images/press/pdf/twitter.pdf (describing how Twitter's "commitment to simplicity" allowed its users to create a "grammar" of shared social norms to organize conversations in ways that have fueled its astronomical growth).

no one will ever create, a system that allows any user to create anything he or she wants. Instead, every system designer makes innumerable tradeoffs and imposes countless constraints. System design should be seen as an exercise in thoughtful deprivation: All designers take away from their users the types of generativity that they think their users don't want, shouldn't have, or can't use. Indeed, constraint itself is an essential component of creativity.[189]

Take again, for example, the Apple II computer, the "quintessentially generative" example Zittrain uses to open his book.[190] Before the Apple II, hobbyist computers arrived as electronic kits, piles of microchips, and other electronic parts that one had to assemble before using. Before programmers could program the original PC, the Altair 8800, they first had to assemble and solder the parts together.[191] Zittrain notes as an aside and without irony that "[t]he Apple II was a machine for hobbyists who did not want to fuss with soldering irons."[192] In other words, part of the reason the Apple II was successful was that it was partly non-generative.

Steve Wozniak and Steve Jobs understood the virtue of thoughtfully constrained generativity. By fixing hobbyists to a common reference point—their computer's design—and by doing the soldering for them, the pair could encourage generativity at the software layer even as they diminished it at the hardware layer. Users couldn't easily "soup up" the Apple II's MOS Technology 6502 microprocessor.[193] A subsequent version, the Apple IIc, was a wholly closed system; it didn't even have expansion slots.[194] Wozniak and Jobs imposed these limitations as tradeoffs to let software hackers get right to work, without having to worry about solder-scalded fingertips or fried microchips.

Every generative technology faces similar tradeoffs. Good system designers always restrict generativity of some kinds in order to encourage generativity of other kinds. The trick is in striking the balance. Like the Apple II, from which they trace their lineage, today's PCs are easy to upgrade in some ways, but very difficult to hack at the solder-and-microchip level: Over time, PC designers have reduced the number of expansion slots inside their computers while adding Uni-

189. *Cf.* IGOR STRAVINSKY, POETICS OF MUSIC IN THE FORM OF SIX LESSONS 65 (2008) ("Whatever diminishes constraint, diminishes strength. The more constraints one imposes, the more one frees one's self of the chains that shackle the spirit.").

190. ZITTRAIN, *supra* note 1, at 2.

191. *See* LEVY, *supra* note 20, at 195. R

192. ZITTRAIN, *supra* note 1, at 1.

193. *See* LEVY, *supra* note 20, at 251. R

194. LINZMAYER, *supra* note 23, at 17–18. R

versal Serial Bus ("USB") ports for external peripherals.[195] It's become harder to hack your motherboard itself—but much easier to add new hardware functionality, which is what really matters.

Or, take operating system APIs, the narrow neck of the PC hourglass.[196] Microsoft Windows supports a vast and generative ecosystem of applications—and yet Microsoft has at times controlled the APIs themselves so tightly it faced antitrust lawsuits over them.[197] Likewise, on the Internet, IP is strongly generative but also strongly constrained. For example, IP requires all computers to use IP addresses, a finite resource.[198] Because the original Internet architects failed, forgivably, to foresee the potential growth of the network, they allocated only four billion possible IP addresses,[199] and every few years somebody raises new concerns that we're about to run out of them.

Finally, consider the evolution from low-level to high-level computer programming languages,[200] an example Zittrain omitted from this book, but described in an earlier article about generativity.[201] Programmers today generally use programming languages that use English words like WHILE and NEXT to enhance readability, which make these languages easier to learn.[202] If programmers wanted, they could choose a lower-level language, such as assembly language,[203] which, although it isn't quite ones and zeroes, is a good software metaphor for Wozniak's soldering iron. Assembly language is in some ways

195. *See, e.g.*, KEN BALDAUF & RALPH M. STAIR, SUCCEEDING WITH TECHNOLOGY: COMPUTER SYSTEM CONCEPTS FOR REAL LIFE 96 (3d ed. 2008) ("It is not unusual to find six or more USB ports on a new computer . . . .").

196. The hourglass architecture metaphor calls attention to the constraints imposed at the neck, where only a few grains of sand can pass at a time. An hourglass that wasn't constrained wouldn't work; all the sand would fall in an instant.

197. *See, e.g.*, United States v. Microsoft Corp., No. 98-1232, 2002 U.S. Dist. LEXIS 22864, at *9 (D.D.C. Nov. 12, 2002) (imposing an obligation on Microsoft to share API information with competitors).

198. *See* Stephen M. Ryan et al., *Legal and Policy Aspects of Internet Number Resources*, 24 SANTA CLARA COMPUTER & HIGH TECH. L.J. 335, 336–37 (2008) (explaining how IP address space is finite).

199. *Id.* at 367.

200. *See, e.g.*, PELIN AKSOY & LAURA DENARDIS, INFORMATION TECHNOLOGY IN THEORY 102–04 (2009) (describing categories of programming languages).

201. Jonathan L. Zittrain, *The Generative Internet*, 119 HARV. L. REV. 1974, 1983–84 (2006).

202. *See* AKSOY & DENARDIS, *supra* note 200, at 102 (explaining that instructions in low-level languages use short, targeted words, whereas instructions in high-level languages resemble sentences used regularly in English so that people can understand the command). Before these "high-level" languages can control a computer, the programmer converts the English words into the ones and zeroes that the computer understands using a compiler or an interpreter. *Id.* at 103. R

203. *Id.* at 102–03.

much more generative than higher-level languages: It provides finely tuned control over the computer, allowing the programmer a level of control impossible with a high-level language. This control matters for some programmers, such as game developers trying to squeeze every last bit of graphical detail they can. But assembly is much harder to use, which tips the overall generativity balance toward higher-level languages for most purposes.

The same patterns are replicated when one compares different high-level languages. With the programming language C, it is easy to write data into almost any part of a PC's memory,[204] which enhances generativity by providing incredibly fine-tuned control. This generative feature, however, has a downside. It makes it all too easy to write to the wrong part of memory, overwriting crucial data; computer viruses often exploit these bugs, the most common variant of which is called a "buffer overflow."[205] Generativity at the language level introduces risk. In contrast, Java provides less powerful but safer memory allocation.[206] The inventors of Java restricted the generativity of memory allocation, avoiding the kind of errors loved by virus writers.

Every generative system is non-generative in many ways. No tool or system is perfectly, maximally generative. Generativity is a relative goal. We want a system that is generative enough—one that enables broadly generative production—but we never want a system that is absolutely generative, because that way lies chaos. This point is inherent in Zittrain's argument, which calls for small sacrifices to preserve generativity. The argument would be stronger if he more explicitly acknowledged that what we are sacrificing is itself generativity—and that computer designers have always done this. Generativity is a Benthamite value, not a Kantian one: Our goal is the greatest generativity for the greatest number, not perfection.

C. The Goal: A Sustainable Ecosystem for Generativity

We should treat generativity as a quality of an ecosystem, not as a feature of individual parts. Those worried about promoting generativity shouldn't focus single-mindedly on any one layer, device, or moment in time. Generativity conservationists should instead canvass the overall level of generativity across layers, across devices, and across time.

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204. *See* T.D. BROWN JR., C FOR BASIC PROGRAMMERS 77 (1987) ("C pointers can be used to access arbitrary memory locations.").

205. 2010 CWE/SANS Top 25 Most Dangerous Programming Errors, http://cwe.mitre.org/top25/#CWE-119 (last visited June 6, 2010).

206. *See* PATRICK NIEMEYER & JONATHAN KNUDSEN, LEARNING JAVA 13–14 (3d ed. 2005).

1. Generativity Across Layers

Zittrain comes close to recognizing the need to look for generativity across layers with his distinction between generative "tools" and generative "systems"; he defines "systems" as "sets of tools and practices that develop among large groups of people."[207] He recognizes that generativity can vary from part to part or layer to layer in a system. But his conclusion—"frequently generativity at one layer is the best recipe for generativity at the layer above"[208]—is too simplistic. It overlooks that non-generative and generative systems and layers can be usefully complementary.

We think Zittrain focuses too much on one example: CompuServe, an early commercial online service. He offers CompuServe as a cautionary tale,[209] proof that non-generativity dampens innovation. CompuServe, however, was non-generative at every technical layer. It layered a proprietary, restricted software package atop a proprietary, restricted network.[210] Users couldn't create a different computer program that relied on CompuServe's network for transport, nor could they build a plug-in to extend CompuServe's software package. If CompuServe were the only network or software provider in the world, we would worry.

But Zittrain never fully analyzes *split-generativity* systems, those with generative layers built upon non-generative layers, or vice-versa. As we've already seen, the Apple II was a split-generative system; it afforded limited generativity at the solder-microchip level and significant generativity at the software level.[211] There are many other examples. The Internet is a generative layer upon which many have built closed, hard-to-extend systems. Most massively multiplayer online role-playing games ("MMORPGs"), like World of Warcraft ("WoW"),[212] provide highly dynamic, but generativity-restricted, environments.[213] The overall combination (WoW running on the In-

207. ZITTRAIN, *supra* note 1, at 74. R

208. *Id.*

209. *E.g.*, *id.* at 23–25, 29–30.

210. *Id.* at 23–25.

211. *See supra* text accompanying notes 8, 192. R

212. *See* World of Warcraft Community Site, http://www.worldofwarcraft.com (last visited June 6, 2010).

213. In fact, when users tried to gain in-game advantages by creating programs that ran outside the game, on generative PCs, the MMORPG game designers used both law and technology to prevent behavior that they disfavored, such as automated gold farming. *See* Brian Bergstein & Matt Slagle, *With Real Money Now in Play, Game Makers Look to Limit Cheating*, SEATTLE POST-INTELLIGENCER, Oct. 7, 2007 (describing game companies' efforts to limit what they described as "cheating").

ternet) is non-generative, but the fact that WoW limits generativity does nothing to diminish the generativity of the underlying Internet.[214] Indeed, part of the *point* is that the Internet supports both generative and non-generative applications.

The dynamic also works in the other direction: Wildly generative systems can be built atop a non-generative lower layer. Consider the web. It combines two wonderfully generative technologies, Hypertext Transfer Protocol ("HTTP")[215] and Hypertext Markup Language ("HTML"),[216] which can be delivered over non-generative transport layers. Thus, cell phone providers who provide access to HTTP and a browser to decode HTML but block every other Internet protocol can still provide an exciting, generative environment. Similarly, one can read and edit Wikipedia from any cell phone with a good web browser,[217] and the non-generativity of the platform does nothing to restrict this. Locking down one or more layers doesn't necessarily make an overall system non-generative.

2. Generativity Across Devices

There's a horizontal counterpart to vertical generativity across layers—generativity across devices. Your digital wristwatch is completely non-generative. The designers of this device chose a set of features that they thought users would want to use (although, to be honest, one of us still can't get the hang of the lap timer), and they provide no tools whatsoever to extend or improve it. If you're worried by this failure of generativity, you're missing the forest for the trees. We should look for generativity across devices, rather than worrying overmuch about the lack of generativity in any single device. We want enough people to have sufficient access to sufficiently generative technology. Don't complain that a keyboard isn't generative; connect it to a computer.

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214. And WoW probably wouldn't be fun if it were fully generative. Constraint is an important part of gameplay. *See* Richard A. Bartle, *Virtual Worldliness: What the Imaginary Asks of the Real*, 49 N.Y.L. SCH. L. REV. 19, 23–27 (2005).

215. *See* Webopedia, What Is HTTP?, http://www.webopedia.com/TERM/H/HTTP.html (last visited June 6, 2010) ("HTTP defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.").

216. *See* Webopedia, What Is HTML?, http://www.webopedia.com/TERM/H/HTML.html (last visited June 6, 2010) (explaining that HTML is "the authoring language used to create documents on the World Wide Web").

217. *See* Wikipedia: Help—Mobile Access, http://en.wikipedia.org/wiki/Mobile_access (last visited June 15, 2010).

Similarly, fretting too much about Apple's heavy hand in approving and rejecting applications for the iPhone focuses too narrowly on one device, because the iPhone has generative competition. At least five, high-profile, well-funded competitors have developed cell phone operating systems—Google's Android, Research In Motion's BlackBerryOS, Microsoft's Windows Mobile, Nokia's Ovi, and Palm's WebOS—that connect to application stores.[218] While each company exercises final say over what apps can appear in the official store,[219] some also allow users to download apps through competing, less restricted, more generative channels.[220]

In other words, since Zittrain wrote his book, the smartphone market has become a tournament among different visions of generativity. Although the iPhone has substantial market share,[221] some of its competitors have been attracting critical buzz. Android in particular has become a highly credible competitor, as Google rapidly iterates and improves it.[222] Aggressive interventions to try to force Apple to increase the iPhone's generative potential seem premature, at least while the iPhone's generative competitors are making such a strong showing. A few prominent iPhone app developers have quit their projects out of frustration with Apple's heavy hand,[223] and if others follow, Apple will feel pressure to lighten up or risk losing developers to its competitors. Being serious about generativity requires looking at system-wide opportunities rather than optimizing individual applications or devices in isolation.

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218. *See* John Herrman, *Giz Explains: All the Smartphone Mobile App Stores*, GIZMODO, Apr. 6, 2009, http://gizmodo.com/5199933/giz-explains-all-the-smartphone-mobile-app-stores (discussing the iPhone's App Store, Android's App Market, BlackBerry's App World, Windows's Mobile Marketplace, Nokia's Ovi Store, and Palm's App Catalog).

219. *Id.*

220. *See id.* (describing the difference between Apple's App Store and its competitors' stores).

221. *See* Jim Dalrymple, *iPhone Triples Android in Mobile Market Share*, CNET, June 5, 2010, http://news.cnet.com/8301-13579_3-20006889-37.html (reporting that "Apple's iPhone OS has more than triple the market share Google's Android operating system has" and that Apple is only "second place behind BlackBerry maker Research In Motion").

222. Andrew Berg, *Froyo Solidifies Android as iPhone Challenger*, WIRELESS WK., May 21, 2010, http://www.wirelessweek.com/Articles/2010/05/Froyo-solidifies-Android-iPhone-Challenger (explaining that "given that Android has perhaps the first proven competitor to the iPhone, it's probably not too much of a long shot to say that Google . . . ha[s] established a pretty good alternative to Apple's once untouchable smartphone").

223. *See* Jason Kincaid, *Facebook iPhone Dev Quits Project over Apple Tyranny*, TECHCRUNCH, Nov. 11, 2009, http://www.techcrunch.com/2009/11/11/joe-hewitt-developer-of-face books-massively-popular-iphone-app-quits-the-project (explaining that the developer responsible for developing the popular Facebook iPhone app quit due to "Apple's tyrannical App Store approval policies").

3. Generativity Across Time

Finally, we should also extend the time horizon for our assessment of the generative ecosystem. The goal is to have enough generativity, across all of the technology we use, sustained (and sustainable) over time. Our difference from Zittrain here is more a matter of rhetorical emphasis than anything else. He describes the course of generativity as a single, linear timeline. His "generative pattern" is a story of birth, growth, overextension, and ultimate enclosure, from generative birth to appliancized death.[224] As he tells it, the story is tragic. All generative systems are mortal. The most we can do for one is "keep it alive for another interval."[225]

We'd put the emphasis elsewhere—as a story of potential rebirth. The whole point of generativity is that generative systems are receptive to unexpected and valuable new uses. While we agree wholeheartedly with Zittrain's emphasis on preserving generativity even in the face of serious threats, we'd phrase his recommendation as an argument that policymakers think less about how to maximize generativity *now* and more about ensuring that there are ample avenues for experimentation with new ways of building things and collaborating. Think child-rearing, not life support.

That is, the generative pattern is actually a recurring cycle. Eventually, the virus and spam writers will catch up, exploiting the residual generativity in ways that harm people. As they have before, network and computer architects will lock down their machines, but so long as they do so with generativity in mind, they won't foreclose innovation, just slow it and change it. As long as the ecosystem keeps spawning new generative things, the old ones can wither and die. It is the circle of generativity.

Other parts of Zittrain's argument implicitly depend on this longer frame of reference. The procrastination principle embraces the idea that system designers should avoid making decisions at time one so that users remain able to make those decisions for themselves at time two.[226] We urge him, as well as the scholars who will follow on

224. ZITTRAIN, *supra* note 1, at 99. R

225. *Id.* at 152.

226. *See id.* at 31 ("The procrastination principle rests on the assumption that most problems confronting a network can be solved later or by others. It says that the network should not be designed to do anything that can be taken care of by its users."). This point, if developed further, could provide Zittrain a stronger generativity-based argument against the iPhone in its current form. Because Apple must approve applications before they can be downloaded by users, *see* Apple Answers the FCC's Questions, http://www.apple.com/hotnews/apple-answers-fcc-questions (last visited June 6, 2010), its approval process vio-

the trail that he has blazed, to be more explicit about the temporal dynamics that affect the uptake of technologies and the regulatory backlashes against them.

IV. CONCLUSION

On the one hand, we've made a sweeping claim—that generativity is *the* essential characteristic of the Internet for policy purposes. On the other, we've offered a series of modest points—that generativity is relative, local, and not the only thing that matters. The contrast may seem disheartening. Was *The Future of the Internet* for nothing? Is that all there is to it?

We think that things aren't so discouraging. We offer our cautions about generativity *because* we think it matters. This book provides the concept to work with; this is the framework that scholars should push forward. Our corrections around the margins of Zittrain's work are meant to smooth the process of applying generativity theory to the many problems of Internet policy where this theory has something important to say.

We see generativity as a powerful new theory of positive liberty for the Internet.[227] Instead of focusing on restraints, limitations, and technological controls, generativity asks what technology *enables* people to do. Can they remake technologies to make them their own? Can they use the technologies as platforms for innovation and creativity? Can they connect with others to share and build further? Generativity seeks to measure people's effective capacity to use technologies in pursuit of their most creative, most social, most human ambitions.

Seen in this light, our critiques of generativity are merely the appropriate cautions that must attend any theory of positive liberty. Our warnings that generativity is local and relative, that it is one virtue among many, and that it must be sustainable across time are merely echoes of similar themes in the capabilities tradition developed by Amartya Sen[228] and Martha Nussbaum,[229] among others. Helping people achieve their human potential will always be a complex, situation-dependent job. Generativity's great accomplishment is to put

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lates the procrastination principle. This fact explains why ex ante filtering is worse than ex post tethering in its consequences for generativity.

227. *See* ISAIAH BERLIN, LIBERTY: INCORPORATING FOUR ESSAYS ON LIBERTY 30–54 (2002) (distinguishing "positive" and "negative" liberty).

228. *See generally* AMARTYA SEN, DEVELOPMENT AS FREEDOM (2000).

229. *See* MARTHA C. NUSSBAUM, FRONTIERS OF JUSTICE: DISABILITY, NATIONALITY, SPECIES MEMBERSHIP 1, 5 (2006) (using a capabilities approach to resolve problems of social justice and noting that such an approach must be both responsive to world problems and sustainable over time).

computer and Internet technologies into that complex picture in a way that succinctly captures their distinctive nature.

In the end, then, our view of generativity may be less eschatological than Zittrain's. If the job is to keep the Internet "generative enough" for most people most of the time, then the enterprise is less fraught and pitched than Zittrain claims. He describes the process of finding appropriate balance as one of "threading the needle between needed change and undue closure."[230] Instead, as we understand this search for balance, generativity is easier to preserve and less likely to be stamped underfoot by the market's urge for safer systems. There will always be room for improvement, but generativity is unlikely to vanish entirely.

There's plenty still wrong with the iPhone. In the summer of 2009, Google accused Apple of lying to the FCC about why it rejected Google Voice from the App Store.[231] There are still apps verging on the fraudulent, unwarranted copyright and trademark app takedowns,[232] and a data network so overloaded by iPhone usage that AT&T for many months refused to let iPhone owners use their iPhones as mobile Internet receivers for their computers.[233] The iPhone universe shows too little generativity in some places and too much in others.

But in the three years since the iPhone's launch, it's remarkable how much it has developed in terms of generativity. And it's not just the iPhone. Zittrain acknowledges how much computing markets have favored generativity.[234] Because of network effects, innovators since Wozniak have opted for openness and extensibility. It's a tech-industry canard that to succeed, one should try to become a platform,[235] and it's hard to build a platform on a locked-down information appliance or web service. People—at least programmers, both the pros and the amateurs—yearn for generativity, and producers tend to deliver it. Platform builders also often try to control those platforms—which gives them a commercial reason to fight generativ-

230. ZITTRAIN, *supra* note 1, at 151. R

231. *See* Erica Ogg, *Google vs. Apple: Who's Telling the Truth?*, CNET, Sept. 18, 2009, http://news.cnet.com/8301-13579_3-10356462-37.html.

232. *See supra* note 161 and accompanying text. R

233. Jenna Wortham, *IPhone Overload*, N.Y. TIMES, Sept. 3, 2009, at B1.

234. *See* ZITTRAIN, *supra* note 1, at 89 ("[L]ess-generative counterparts to the PC and the Internet—such as stand-alone word processors and proprietary information services—had far fewer technological offerings, and they stagnated and then failed as generative counterparts emerged."). R

235. *See generally* CARL SHAPIRO & HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY (1998).

ity in all its fullness—but they can't avoid it entirely. It's no accident that the Firefox web browser, Google's Android, Facebook, and the iPhone all include sophisticated plug-in architectures backed by polished support and training focused on making it easy (and fun!) to develop apps.[236] They may have electronic leashes, but these companies are all trying to let loose the hounds of generativity.

The iPhone is not a doomsday device. Even Dr. Generative himself should celebrate it for how far it has come and what it might become in the future.

EPILOGUE

Call it poetic justice. We tweaked Zittrain for his ironic choice of the iPhone as his central example—and then suffered the same fate ourselves. As this Book Review made its way through the editorial process, Apple both announced[237] and launched[238] the iPad, a fully touch-based tablet computer.[239] We think the iPad puts an exclamation point on our argument: Zittrain's theory of generativity, if amended to take account of our concerns, provides a powerful intellectual infrastructure for thinking about the future of computing. To show how, we'll assess the iPad ecosystem using the analytical framework developed in Part III of this Review.

Other Values: The iPad, like the iPhone, is a tethered device that can only run Apple-approved applications.[240] As of press time, Apple was embarrassedly back-pedaling away[241] from its previous rejection of Pulitzer Prize-winner Mark Fiore's political cartoon app on the ground that it "contains content that ridicules public figures."[242] In his words, "[W]hat about someone who hasn't won a Pulitzer and who

236. *See* Add-on Developer Hub: Add-ons for Firefox, https://addons.mozilla.org/en-US/developers (last visited June 6, 2010); Android Developers: The Developer's Guide, http://developer.android.com/guide (last visited June 6, 2010); Facebook Developers, http://developers.facebook.com (last visited June 6, 2010); iPhone Developer Program, http://developer.apple.com/programs/iphone (last visited June 6, 2010).

237. *See* Brad Stone, *With Its Tablet, Apple Blurs Line Between Devices*, N.Y. TIMES, Jan. 28, 2010, at A1.

238. *See* Brad Stone, *Across the Country, Fans Gather for iPad*, N.Y. TIMES, Apr. 4, 2010, at A14.

239. Apple: iPad, http://www.apple.com/ipad (last visited June 6, 2010) (boasting that users can access websites, e-mail, photos, and movies via a multi-touch screen).

240. *See id.* (noting that iPads can run nearly all of the apps created for the iPhone).

241. *See* Brian Stelter, *A Pulitzer Winner Gets Apple's Reconsideration*, N.Y. TIMES, Apr. 17, 2010, at C3.

242. Laura McGann, *Mark Fiore Can Win a Pulitzer Prize, But He Can't Get His iPhone Cartoon App Past Apple's Satire Police*, NIEMAN JOURNALISM LAB, Apr. 15, 2010, http://www.niemanlab.org/2010/04/mark-fiore-can-win-a-pulitzer-prize-but-he-cant-get-his-iphone-cartoon-app-past-apples-satire-police (internal quotation marks omitted).

is maybe making a better political app than mine?"[243] That's a question about free speech and democracy, not just generativity.

The iPad also has something of a class problem. As Quinn Norton observes:

> I'm known among my friends for generally having less money than they do, for living hand to mouth, and for having thoughtful critiques of the American Poverty Trap, but from the inside. . . . [S]ometimes my social group kind of goes crazy and forgets that while they have a lot of power, my class is a whole lot bigger than theirs. And none of them will be buying iPads.[244]

The day-to-day experience of the poor, online and offline, is dominated by concerns that have very little to do with generativity, a point you should repeat to yourself if you're ever tempted to make generativity the only thing you care about.[245]

Generative Enough Is Good Enough: The iPad shares many significantly generative features with the iPhone, notwithstanding complaints from some commentators.[246] Apple's groundbreaking multitouch technology, extensive APIs, and relentless focus on effective design turn the iPad into the new "blank slate"[247]—a highly adaptable technology that, unlike the old blank slate, is also highly leveraging. The App Store adds transferability, and Apple has made heroic efforts to enable ease of mastery. And while the iPad may be a luxury item, its $499 entry-level price tag was still low enough to surprise most analysts and scare the manufacturers of what used to be bargain-basement laptops.[248] The iPad, in other words, puts in a highly credible performance on all five of Zittrain's axes of generativity.

Generativity Across Layers, Devices, and Time: The iPad is sealed shut at the hardware layer, and Apple rigorously controls much of its

243. Stelter, *supra* note 241 (internal quotation marks omitted). R

244. Quinn Norton, *Why I Won't Be Buying an iPad, and Why It Doesn't Matter as Much as You Think It Does*, QUINN SAID, Apr. 2, 2010, http://www.quinnnorton.com/said/?p=365.

245. Norton adds: "Also, the iPad seriously looks like thief bait. We're not idiots, we know what our drunk uncles are going to do with it if we come home with one." *Id.*

246. *See, e.g.*, Cory Doctorow, *Why I Won't Buy an iPad (and Think You Shouldn't, Either)*, BOINGBOING, Apr. 2, 2010, http://boingboing.net/2010/04/02/why-i-wont-buy-an-ipad-and-think-you-shouldnt-either.html ("If you want to write code for a platform where the only thing that determines whether you're going to succeed with it is whether your audience loves it, the iPad isn't for you.").

247. Adam C. Engst, *Why the iPad Is a Blank Slate, and Why That's Important*, TIDBITS, Apr. 5, 2010, http://db.tidbits.com/article/11152 ("[T]he iPad *becomes* the app you're using.").

248. *See* Posting of Jack Schofield to Guardian Technology Blog, http://www.guardian.co.uk/technology/blog/2010/jan/29/ipad-undercuts-taiwans-tablets (Jan. 29, 2010, 14:15 GMT).

software stack.[249] But once you get to the application layer, the profusion of highly innovative apps makes it obvious that the iPad is not a single-purpose appliance.[250] In fact, because one of the built-in applications is Safari,[251] the iPad also gives users unfettered access to the web, in all its crude and generative glory—a point Apple has emphasized in its iPhone advertising.[252]

As for devices, the iPad's size means that it can compete with PCs—particularly the market category currently known as "netbooks"[253]—in a way that the pint-sized iPhone never could.[254] Users who traded *up* to the iPhone from non-generative phones could well trade *down* to the iPad from generative PCs. That said, however, the iPad still presumes that you own a regular computer and regularly sync your iPad to it—this is a supplement to your PC, not a replacement for it.[255]

And across time, everything we said about the iPhone remains true; Apple has a reasonable defense, in Zittrainian terms, that its iPad compromises are actually healthy interventions to make generativity sustainable. Even Apple's implacable hostility to allowing Adobe's Flash Player to run on the iPad[256] is arguably a longer-term investment in generative values: Apple wants programmers to learn how to write programs that take advantage of the iPad's new and distinctive features.[257]

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249. *See* Doctorow, *supra* note 246. R

250. *See* John Herrman, *Gizmodo's Essential iPad Apps*, GIZMODO, Apr. 1, 2010, http://gizmodo.com/5507569/gizmodos-essential-ipad-apps (listing various iPad apps).

251. Apple: iPad, Features, http://www.apple.com/ipad/features (last visited June 6, 2010).

252. *See* iPhone new ad 4th: Watered Down, http://www.youtube.com/watch?v=DMOjNFmVIp8 (last visited June 6, 2010) ("This is not a watered-down version of the Internet, or the mobile version of the Internet, or the kinda-sorta-looks-like-the-Internet Internet, it's just . . . the Internet. On your phone.").

253. *See* Adam Ostrow, *iPad Brings the Growth of Netbooks to a Halt*, MASHABLE, May 6, 2010, http://mashable.com/2010/05/06/ipad-netbook-market (explaining that with the launch of the iPad, netbooks are "seeing a sales slump"); *see also* Webopedia, What Is Netbook?, http://www.webopedia.com/TERM/n/netbook.html (last visited June 15, 2010) (defining a "netbook" as "a small portable computing device, similar to a notebook" but with "a smaller form factor" and "more limited features").

254. *See* Jonathan Zittrain, *A Fight over Freedom at Apple's Core*, FIN. TIMES, Feb. 3, 2010, http://www.ft.com/cms/s/2/fcabc720-10fb-11df-9a9e-00144feab49a,s01=1.html.

255. *See* John Gruber, *The iPad*, DARING FIREBALL, Apr. 7, 2010, http://daringfireball.net/2010/04/the_ipad.

256. *See* John Naughton, *Apple's iPad War on Adobe and Flash*, OBSERVER, Apr. 18, 2010, http://www.guardian.co.uk/technology/2010/apr/18/adobe-flash-apple-iphone-ipad.

257. *See* The Progress of the Platform, http://iansamuel.com/essays/progress-of-the-platform (last visited June 6, 2010) ("[Apple has] created a whole set of user interface metaphors that are supposed to be standard and system-wide, and they want developers to do things the new way not because Apple just loves power, but because they believe it's

The iPad may raise some concerns about generativity in the long run in a more indirect way, however. For one thing, Apple's continued inability to make the App Store approval process rational or transparent may eventually cast a pall over developers—making them fearful and less willing to invest in innovation atop the iPad.[258] For another, even if fully tinkerable computers remain broadly available (as we expect they will), the rise of the iPad could shut down some of the avenues by which amateurs become interested in programming.[259] One of the most telling of recent App Store rejections was Scratch, "a well-regarded runtime geared toward allowing kids to create their own simple games and animations."[260]

All in all, then, we're as optimistic about the iPad as we are about the iPhone, and think Zittrain should be, too. He ought to be weeping with joy that Apple hasn't just invented a new user-interface paradigm for computing but is actively teaching developers how to take full advantage of it to make new and amazing things. That sure sounds like generativity to us.[261] So while we may not share Zittrain's pessimism about the iPad, we think that it illustrates, yet again, the importance of his basic insights. Zittrain's ideas have already shaped the extensive public debate over the iPad;[262] we hope he'll stay on the case.

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necessary to force developers to think about the new world of touch-based computing correctly. All of this in service of giving users who are taking their first steps into touch-based computing a great experience.").

258. *See* John Gruber, *It's Not the Control, It's the Secrecy*, DARING FIREBALL, Apr. 16, 2010, http://daringfireball.net/2010/04/not_the_control_the_secrecy (arguing that by concealing the rules for the types of applications that the App Store will accept, "what Apple is losing are iPhone OS apps that aren't being made in the first place by developers who aren't willing to take their chances"); John Siracusa, *Apple's Wager*, ARS TECHNICA, Apr. 12, 2010, http://arstechnica.com/staff/fatbits/2010/04/apples-wager.ars (arguing that "Apple's decisions regarding its mobile platform in particular have been extremely protective from the very start" and that the company's policies are angering developers).

259. *See* Dale Dougherty, *The iPad Needs its HyperCard*, O'REILLY RADAR, Mar. 29, 2010, http://radar.oreilly.com/2010/03/the-ipad-needs-its-hypercard.html.

260. *See* John Gruber, *App Store Rejection of the Week, Runner-Up: Scratch*, DARING FIREBALL, Apr. 16, 2010, http://daringfireball.net/linked/2010/04/16/scratch.

261. *See, e.g.*, Xeni Jardin, *Review: Apple's iPad Is a Touch of Genius*, BOINGBOING, Mar. 31, 2010, http://www.boingboing.net/2010/03/31/a-first-look-at-ipad.html ("Maybe the most exciting thing about iPad is the apps that aren't here yet. The book-film-game hybrid someone will bust out in a year, redefining the experience of each, and suggesting some new nouns and verbs in the process.").

262. *See, e.g.*, Steven Johnson, *Rethinking a Gospel of the Web*, N.Y. TIMES, Apr. 11, 2010, at BU1 (mentioning Zittrain); Ed Felten, *iPad: The Disneyland of Computers*, FREEDOM TO TINKER, Apr. 8, 2010, http://www.freedom-to-tinker.com/blog/felten/ipad-disneyland-computers (raising Zittrainian themes); Tim Wu, *The Apple Two*, SLATE, Apr. 6, 2010, http://slate.com/id/2249872 (mentioning Zittrain and his appliancization thesis in the first sentence).