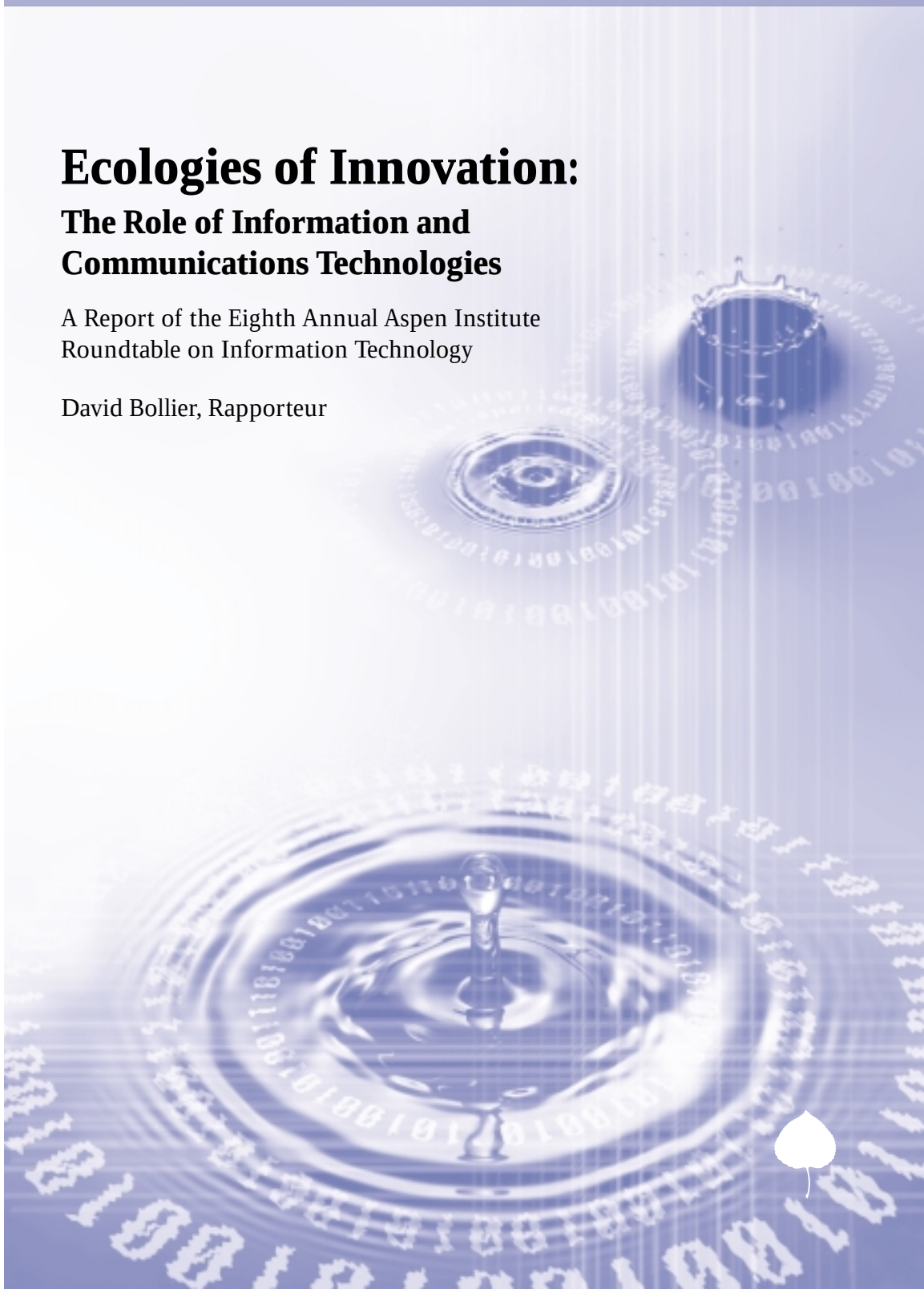
Ecologies of Innovation:

The Role of Information and Communications Technologies

A Report of the Eighth Annual Aspen Institute Roundtable on Information Technology

David Bollier, Rapporteur



Ecologies of Innovation: The Role of Information and Communications Technologies

A Report of the Eighth Annual Aspen Institute Roundtable on Information Technology

David Bollier
Rapporteur

THE ASPEN INSTITUTE

Communications and Society Program
Charles M. Firestone
Executive Director
Washington, DC
2000

To purchase additional copies of this report, please contact:

The Aspen Institute
Publications Office
P.O. Box 222
109 Houghton Lab Lane
Queenstown, Maryland 21658
Phone: (410) 820-5326
Fax: (410) 827-9174
E-mail: publications@aspeninstitute.org

For all other inquiries, please contact:

The Aspen Institute
Communications and Society Program
One Dupont Circle, NW
Suite 700
Washington, DC 20036
Phone: (202) 736-5818
Fax: (202) 467-0790

Charles M. Firestone
Executive Director

Amy Korzick Garmer
Associate Director

The Aspen Institute
One Dupont Circle, NW
Suite 700
Washington, DC 20036

Published in the United States of America in 2000
by The Aspen Institute

Printed in the United States of America

ISBN: 0-89843-288-X

00-019

Contents

Foreword

In these times of rapid change in the technological, political, and cultural spheres, we often hear people speak of "innovation"—usually in a very positive sense. Indeed, innovations are important elements for growth, progress, and success in a variety of contexts. But what do we mean by innovation? How does it differ from the process of change itself? Once defined, how are innovations encouraged? Perhaps most significantly, what types of environments are conducive to innovation? What might individuals, organizations, governments, and others do to encourage the positive aspects of this very significant societal element?

In July of 1999, the Aspen Institute Communications and Society Program convened its Eighth Annual Aspen Institute Roundtable on Information Technology in Aspen, Colorado to explore *Ecologies of Innovation.* This report, which in my opinion is among the best of this series of reports by journalist David Bollier, our perennial Roundtable rapporteur, summarizes the discussion among 23 participants from high technology industries, finance, academia, and the non-profit sector.

In the pages that follow, Bollier captures the participants' definition of innovation as having components of invention, implementation, and sustainable value. He goes on to explore the many ways that environments foster or hinder innovation, and how new communications and information technologies impact these ecologies.

Innovation and Its Stages

Innovation rarely comes all at once. Rather, the report sets forth participants' examples of how innovation occurs in stages. Taking the Internet as an example, participants observed, there are various levels of development, and different ecologies necessary to invent, scale, facilitate, and discipline it. Organizations may require very different sets of people to come up with ideas and then to move them forward to usefulness.

But innovations do not occur in a vacuum. Indeed, an innovation can change its own environment, which often reacts in a biological-like manner (hence the word ecologies). The report explicates the ecologi-

cal metaphor, including the introduction of complexity theory frameworks, feedback loops, and the interrelationship of the innovation with elements of the environment itself.

How Communications and Information Technologies Stimulate Innovation

Participants noted that communications and information technologies serve as stimulants to innovation in three distinct roles:

1. As tools enabling or facilitating collaboration, data management, or modeling;
2. As elements of the cognitive process aiding collaborative endeavors; and
3. As elements of the innovation itself.

As an example of how communications and information technology are themselves elements of innovation, participants cited the rapid increases in computing power relative to price, the effect of networks, and increases in available bandwidth. Simply, the Internet increases the dissemination and availability of information and knowledge. People who have been outside of the arena can now enter and make their thoughts known. As the technology allows new participants to add their voices and begin to explore new areas, we all benefit from new analyses of familiar topics.

Six Vectors Affecting Ecologies of Innovation

In summarizing the sessions, Bollier organizes participants' comments into six vectors, which he suggests interrelate in and affect the ecologies of innovation. They are:

- The Entrepreneurial Ethic;
- The Organizational Environment;
- National Polity and Social Norms;
- The Transnational Internet Culture and Innovation;
- The Role of Government in Fostering Innovation; and
- Financing Mechanisms for Innovation.

For example, one of the elements discussed in the "national polity and social norms" vector is the environment that encourages risk and

tolerates failure. A largely deregulated financial market, able and willing to take risks, coupled with lenient bankruptcy laws and an individual risk-seeking spirit, join to make innovation more likely. Meritocracies rather than caste systems, fluidity in the job market, a willingness of a society to accept layoffs, and a receptivity to immigrant labor all would appear to encourage innovation, though they may run afoul of other social or cultural norms.

The report touches on many other interesting aspects of the policies and practices that encourage or discourage innovation. It is these insightful nuggets of knowledge, I think, that make this report and its predecessors over the past seven years so valuable. For they come from some of the world's best thinkers, practitioners, and critics in the world of information and communications technology, brought together to develop and exchange viewpoints on an important element of our society and our future.

Acknowledgments

I would like to thank the following sponsors for their generous financial support of the 1999 Roundtable: BT Ventures, Novell, Inc., Oracle Corporation, Royal Philips Electronics, Xerox, and E.M. Warburg Pincus. I would also like to thank David Bollier, rapporteur, and all of the participants in the Eighth Annual Aspen Institute Roundtable on Information Technology for their time and the thoughtful reflections evidenced in this report (a participant list appears in the appendix). Jerry Murdock, co-founder of the Roundtable, deserves special recognition for his help in establishing the agenda and design of the conference. And finally, I wish to express my appreciation to Patricia Katopol, program associate, for overseeing the production of this report, Tricia Kelly, senior program coordinator, and Sunny Sumter Sana, program coordinator and publications manager, for their help within the Communications and Society Program on the conference and this report.

Charles M. Firestone
Executive Vice President, Policy Programs
and
Executive Director, Communications and Society Program
The Aspen Institute
April 2000

Ecologies of Innovation

Introduction

It has become a truism in recent years that technological innovation lies at the core of a robust economy. Once an arcane matter for economists, innovation has moved from the back salons of corporate strategy to the grand ballroom of mainstream culture. Fueled by the World Wide Web and other electronic technologies, unknown entrepreneurs with big ideas have joined with investment bankers, multinational corporations, and Main Street investors on a relentless search for *The New New Thing,* as the title of Michael Lewis' book on Silicon Valley calls it. [W.W. Norton & Company, 1999]

For all our fascination with innovation, we have far less understanding of what innovation actually entails and how it can be fostered. Is innovation essentially a new product or service, or does it imply something far more significant? Is innovation chiefly the work of brilliant and resourceful entrepreneurs, or are there critical environmental factors at work? And if external factors are influential, which of them matter most and in what ways? Are there specific factors—within companies; in federal policy; in national cultures—that actively foster innovation?

To probe these and related questions, the Aspen Institute Communications and Society Program convened 23 leading entrepreneurs, technologists, academics, venture capitalists, and policy experts to consider the chief factors that are driving innovation in our time. A guiding assumption of the participants is that innovation takes place in specific *ecologies*—constantly evolving, dynamic environments in which a web of separate but interconnected entities somehow converge to produce innovation.

Participants agreed that the biological metaphor of an ecology is useful because it takes account of the structural and social forces that contribute to innovation. *Ecology* suggests that a rich diversity of interrelated factors must be considered holistically. A singular focus on an individual entrepreneur or a business organization is too simplistic. Such an analysis fails to consider how the cultural norms of a society, its

public policies, and available financing mechanisms can significantly affect innovation.

The Eighth Annual Aspen Institute Roundtable on Information Technology attempted to understand the complex character of innovation: how it originates and evolves, the kinds of environments that foster innovation, and the influential role of information and communications technologies. The conference took place August 12–15, 1999, in Aspen, Colorado. This report, by David Bollier, is a synthesis and interpretation of the conference discussions.

The Age of Innovation

What Is Innovation?

A buzzword for our times, *innovation* is a promiscuous term. It is used glibly to describe everything from new electronic gadgets and business schemes to the personal computer and online auctions. The idea of "something new" is clear enough, but what are the essential features of a real innovation? Is it simply a novel invention?

Historically, innovation has been closely associated with technological invention. As the steam engine, the railroad, and other transforming factors in the Industrial Revolution arose in the late 1700s and 1800s, "People began to think of technology, in very specific terms, as being an agent of change," said British historian Asa Briggs. Clusters of inventions began to have far-reaching social and economic consequences, prompting theorists to probe the interconnections between science, technology, and economics. By the late 20th century, innovation was regarded as an engine of "progress" and the free enterprise system as a juggernaut of "creative destruction" (the term coined by economist Joseph Schumpeter to describe the constant process of new markets and innovations supplanting the old order).

Conference participants agreed, however, that change alone is not the same as innovation. "Innovation is when something new stands on its own," said Robin Neustein, managing director of Goldman Sachs & Company. "Change is a lesser form, a modification, an incremental act." For some reason, innovation tends to come in waves, Neustein noted. There are times of great innovation such as the 1990s when dozens of dramatic, new inventions alter the basic structures of society, and there

are times of consolidation such as the 1950s when previous inventions are absorbed into the culture while new ones are quietly incubating.

Intrinsic to innovation is the idea of creating value. If an innovation does not have a positive social impact or help generate new businesses and investment returns, then its value is probably negligible. A novel idea without a way to implement it—no business vehicles, no financing, no market apparatus—is worthless. These insights led roundtable participants to offer a fuller definition of *innovation* as "invention plus momentum that leads to value over time." The implication is that an innovation creates sweeping new capacities to make everyone better off, or at least to expand the economic "pie" through new market opportunities. The personal computer is a classic example of this kind of innovation. Besides creating a new technological platform and market of its own, the personal computer has given rise to hundreds of spin-off inventions and affiliated market opportunities.

From an entrepreneur's perspective, innovation is about technological invention and diffusion. But from a larger, holistic vantage point, innovation is about a culture's acceptance and metabolizing of a bold new idea. Innovation is a *social process* as much as a technological one. Quoting Schumpeter, Robert Hormats, vice chairman of Goldman Sachs International, noted that innovation entails "the willpower adequate to break down the resistance of the social environment. Overcoming that environment is as much a part of entrepreneurialism or innovation as coming up with the initial idea." A successful innovation is not just a better mousetrap but an effective strategy to get an indifferent or hostile public to see merit in that mousetrap—indeed, to *buy* that mousetrap. Thus, innovation goes far beyond the invention itself. It requires attention to organizational capacities, societal institutions and cultural norms, customer relationships, public policy, and financing mechanisms, among many other factors.

The idea that a matrix of social factors influences innovation helps explain why innovation comes in waves, said Hormats: "There are certain periods in history when a society is more amenable to change and certain periods when there is a considerable amount of resistance." Understanding the social dimensions of innovation also help explain why certain nations excel at innovation, whereas others disdain it. The United States is renowned as a hotbed of innovation; while many European nations and authoritarian regimes, by contrast, tend to be more tradition-bound and skeptical of change.

Innovation tends to be socially and politically disruptive. Therefore it tends to flourish in open, diverse, freewheeling environments—particularly in the "networked markets" made possible by the Internet. Innovation can upset entrenched oligopolies and established markets and force change on political elites. No wonder some nations seem constitutionally and culturally unreceptive to innovation (a theme explored below).

Stages of Innovation

It is important to conceptualize innovation as an unpredictable, dynamic process that goes through different stages in an environment that is itself changing. This fluid framework is sometimes difficult to grasp because traditional categories of science and economics implicitly endorse static, mechanical terms of discourse. These traditional analyses often speak of linear cause-and-effect relationships and points of equilibrium, for example, whereas we know intuitively that the world works in a far more subtle, fluid, and non-linear fashion.

Hence the appeal of biological metaphors such as "ecologies" of innovation. Biological tropes encourage us to see how innovation resembles a living organism that must struggle to grow in a changing, historically contingent environment. An innovation's success will depend critically upon the specific "fitness criteria" of its environment—that is, the attributes that are rewarded by the process of natural selection. "That was [W. Edwards] Deming's main contribution to business thought," said Murray Gell-Mann, the Nobel Laureate in physics and professor at the Santa Fe Institute. "He championed the idea that selection pressures *within* an organization should correspond in some way to the selection pressures from *outside* on the firm. The ways that managers promote employees, fire them, penalize them, and raise salaries should have something to do with whether the firm is satisfying its customers and not be based, say, on the whims of some middle manager."

In thinking about innovation, said Gell-Mann, it helps to see that innovation has different stages and that different skill sets are needed to succeed at each stage. "In theoretical science," he said, "it is often true that making a novel suggestion is not difficult. What's difficult is overcoming the objections that immediately arise in one's mind or in other people's minds. And even if objections can be met, it may take some-

body else to take the new idea seriously." The different stages in the development of an innovation may require completely different people and organizational structures.

John Seely Brown, corporate vice president and chief scientist of Xerox Corporation and director of the Xerox Palo Alto Research Center (PARC), concurred that innovation necessarily takes place in a series of environments, each having their own selection pressure. "The milieus for creating inventions have to be quite different from the milieus for actually 'finding paths to the sea,' or implementing inventions," Brown said. The processes of exploration and invention are quite different from the processes of exploitation and implementation. That is why innovation is a richer, more expansive terrain than invention alone; innovation entails the ability to implement a new concept and gain widespread acceptance for it.

The evolution of the Internet exemplifies the idea of "staged innovation." The Internet was incubated within American universities in the 1970s. To evolve to a larger, more sophisticated level of organization, however, the Net needed a rudimentary commercial infrastructure. Still another set of institutions, technologies, and policies was required for the Net to become a widely used economic and cultural medium. Raymond J. Lane, president and chief operating officer of Oracle Corporation, described these stages: "A certain ecology was needed to invent it, a certain ecology was needed to scale it and make it easy to use, and another ecology was needed to discipline it and make money with it." Similarly, the World Wide Web has migrated through some very different ecologies since it was invented by Tim Berners-Lee at CERN (Organisation Européene pour la Recherche Nucléaire), a Swiss physics research institute, in 1989.

According to William H. Janeway, senior managing director of E. M. Warburg, Pincus and Company, Inc., "Innovation is a social process that takes place through time and often requires the mobilization of large amounts of capital. As that process evolves, the innovation touches upon different established institutions and their ways of doing things—it gores different oxen, if you will. By the time the Web began to affect AOL [America Online], federal antitrust policy and communications policy had become aspects of the ecology, which was certainly not the case when Tim Berners-Lee was first playing with the idea of a World Wide Web." Janeway's point: If an innovation is going to mature,

it will necessarily move through different ecologies—and each ecology will pose different challenges and require different skills and creative responses.

The dynamics of staged innovation become even more complicated when one considers that the lead players in a given ecology begin to alter the ecology itself. As they reach a certain scale, the leading innovators can begin to use their market power to shape the larger ecology in self-serving ways. Through software design features, tactical lawsuits, political contributions, congressional lobbying, and public relations gambits, a dominant innovator can affect—and sometimes dictate—the selection criteria that will govern competitors and would-be competitors.

This process, often known as a "roll-up," involves the consolidation of a dispersed industry into a more unified, controlled market on terms favorable to the victor. In the telephone industry, for example, dozens of local telephone exchanges once struggled simply to implement Alexander Graham Bell's patents and develop a functional system. A sweeping roll-up occurred in 1907 when AT&T's chief, Theodore Vail, struck a deal with federal regulators to consolidate the local phone companies in return for AT&T's providing universal service through cross-subsidized rates. The regulated monopoly of AT&T was born.

Neustein believes that an innovator's motivations often change dramatically once the innovator achieves a roll-up. "The organization's priorities stop being about what it does [in making a product] and start being about what it *has*," she said. "And so it starts taking more and more defended positions to protect what they have. The institution becomes ingrown and inbred. Instead of focusing on what they do—their product—the company focuses on politics and defending its position."

Today, roll-ups are arguably more difficult to consummate and defend because the technology itself changes constantly and is harder to stabilize. "It's very interesting," said Brown: "The roll-up strategy of the past worked because the technology had stabilized. But now you see roll-ups happening *before* the technology has stabilized." Brown suggested that the roll-ups of a "first mover" (e.g., AT&T's consolidation of the broadband market) require different capabilities than those of a "fast follower" (e.g., Cisco System's roll-up of the market for optic switching). "Cisco's core competency is not switches," said Brown. "It's

the ability to do rapid roll-ups of different technologies. Cisco has the talent to isolate a technology, acquire it, and fold it into its corporate culture."

How Communications and Information Technologies Stimulate Innovation

The Internet is rendering many traditional strategies for managing innovation obsolete. Communications technologies with sophisticated capabilities and instantaneous use have created entirely new vectors of opportunity for fostering innovation. According to Lane, these new technologies play three distinct roles in stimulating innovation:

1. *Technology as a tool.* Communications technology enables the creation of entirely novel capacities, Lane said. The technology *accelerates innovation* by allowing users to make new iterations of products or services more quickly, for example, or by speeding their ability to perform calculations. The technology also *enables collaboration* by allowing the synthesis of a collective wisdom despite remoteness; developers from different parts of the world can collaborate seamlessly on projects. The technology helps organizations *manage data:* people can store, retrieve and analyze data digitally much more efficiently than we can in an analog fashion. Finally, the technology helps *run prototypes or simulations.* Thus, people can perform tests without the expense or harm that would occur in real-life or analog tests.

2. *Technology embedded in the cognitive process.* Computer technologies can be constructed to conduct basic forms of deductive reasoning, eliminate blind alleys of analysis, and pose new hypotheses. "If there's a collaborative team working on a project," said Lane, "having technology involved in a cognitive way could add to the sum of the parts and help formulate a collective wisdom."

3. *Technology embedded in the innovation itself.* Innovation is enhanced when digital technologies are embedded within the end product itself. Global positioning systems (GPS) in automobiles and interactive dials on a TV set are examples of innovations that are platforms for further innovation.

Lane added that these genres of innovation have at least two downsides: first, they may fall into the wrong hands or be used in the wrong circumstances; second, the technology could deaden the cognitive process in some way. New technological genres such as e-mail or Web sites can *limit* the kinds of creativity that might otherwise occur between two human beings in a face-to-face conversation.

One reason that the Internet is so powerful in stimulating innovation is because it is a "transformative infrastructure," in Brown's words. "Because the Internet touches every aspect of how we live or learn, it calls into question many aspects of the status quo and opens up the reign of entrepreneurialism."

The momentum of the Internet's catalytic power is maintained by several remarkable "laws" of technology, said Brown: Moore's Law, which asserts that computing power at the same price will double every 18 months; the law of fiber optics, which asserts that bandwidth capacity at the same price will double every 9–12 months; and Metcalf's Law, which asserts that the amount of content available over a network is n^2, where n represents the number of connected people. "You put these three laws together, and you have just an incredible period of flux," said Brown. "Things that were unthinkable two or three years ago are trivial today. In terms of ecologies of innovation, this means that it is fundamentally unclear which approaches are going to prevail."

"Right now, for example," Brown said, "there are some incredible technological wars being fought in the computer science communities over whether high-quality Internet services such as video streaming require a new Internet Protocol or whether the steady expansion of bandwidth will be sufficient to develop advanced services. There are brilliant people arguing on both sides, and the questions are not just commercial but technical and scientific as well."

The Internet's role in spurring innovation has a lot to do with how it accelerates the dissemination of information and makes information accessible anywhere. As the Internet circulates information more freely and rapidly—penetrating to previously remote disciplines, localities, and cultures—it brings specialized information to a wider set of publics and stimulates new ways of thinking and acting. Innovation requires exposure to novel ways of thinking and unexpected convergences, so it is difficult to imagine a more effective invention than the Internet, which enables eclectic people and infor-

mation from around the world to co-mingle and recombine in astonishing new ways.

The Web is also an unparalleled tool for browsing into unfamiliar territories and bringing together diverse points of view. It also allows newcomers to enter into conversations with established fields with less "friction," which helps fresh ideas to be recognized more readily. The vigor of the Internet may also have something to do with its disproportionate use by a younger, more educated demographic. This is the very cohort that is least beholden to established ways of thinking and practice and more likely to innovate.

The Internet not only facilitates a new kind of intellectual and cultural bazaar, it also helps people connect to markets in more efficient ways, said Margaret Levenstein, a professor of economics and management at the University of Michigan and Albion College and author of *Accounting for Growth: Information Systems and the Creation of the Large Corporation* (Stanford University Press, 1998). These new linkages to markets help account for the Internet's profound impact on innovation. "When railroads and canals were built through a town in the 19th century," Levenstein said, "patenting rates in the town increased immediately. Once people are connected to markets, they respond to that access by taking advantage of it. They innovate, they sell their innovations, and they make money. Some people get pushed off their farms and are not part of that revolution, but in general, you see an increase in income and in inequality as people become more connected to markets."

A related impact, Levenstein noted, is how these new lines of communication—railroads, canals, the Internet—have the potential to integrate markets and increase competition. This integration has clear short-term benefits for those who innovate fastest. Over the longer term, however, the intensified competition can also make it harder for innovators to capture sufficient returns on their investments; imitators quickly arise to steal market share with knockoffs. This dynamic "can actually decrease the incentive to innovate," said Levenstein.

The question thus arises of whether the "winner-take-all" effect is inevitable in networked markets, as many observers contend. Does a networked economy lead to a plateau of innovation, artificially maintained by the dominant player, or can resourceful entrepreneurs invariably introduce new innovations, given enough time and imagination?[1]

Six Vectors Affecting Ecologies of Innovation

In adopting the notion of an "ecology of innovation," a key premise is the organic integrity of the whole. The skein of interrelationships among the parts is too integrated and fundamental to neatly disassemble into static, analytic categories. Nevertheless, an ecology of innovation has many distinct components—quasi-autonomous realms that can have a significant influence on how the whole functions.

Six key vectors affect how an ecology of innovation works: the personal character and talents of individuals (the "entrepreneurial ethic"); the organizational environment; national polity and social norms; the Internet; government; and financing mechanisms. These vectors are among the more salient forces at play in ecologies of innovation, but this list does not presume to be comprehensive.

The Entrepreneurial Ethic

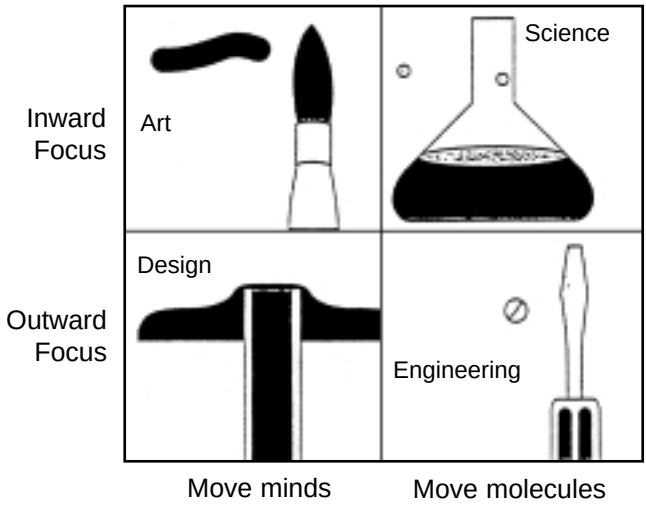
There is a distinctly American tendency to overemphasize the role of the individual and discount social and institutional influences. Yet there is no question that the individual matters. It is worth examining the entrepreneur who champions a daring idea, the manager who shepherds a new concept to market, and the CEO who leads an organization to achieve a strategic goal. The importance of the entrepreneurial ethic in spurring innovation is given a fuller treatment in the 1998 report of the Aspen Institute Roundtable on Information Technology.

"We tend to overlook the fact that to see the world differently, to make sense of it differently, actually does take a fair amount of courage," said Brown said. "You also must have the discipline and passion to actually execute an innovation—and those are quite different from courage alone." From an instrumentalist point of view, it is harder to see that innovation also requires a certain creative integrity, over and above market ends, said John Herron, Jr., chairman of Zoologic (a start-up software venture). "Over the past 10 or 15 years, people have lost sight of the importance of aesthetic curiosity—that a creative idea needs to be valued as an end in itself. People are too focused on how are we going to make change and make value."

The mindset of such an innovative individual can be inwardly focused or outwardly focused, as the following chart (devised by Brown) suggests:

MANAGING MIND-SETS

The perceived barriers between scientists (who move molecules) and artists (who move minds) are overstated. Scientists and artists, who tend to be more inward looking, are highly compatible in the experience of Xerox PARC, as are designers and engineers, who are outward looking.



Source: John Seely Brown, "Sustaining the Ecology of Knowledge," in *Leader to Leader*, Spring 1999, p. 33.

A healthy knowledge ecology, Brown writes in a 1999 article, "needs two types of contributors, characterized metaphorically as the serious scientist (analytic, focused consistent) and the hungry artist (playful, transcending boundaries, unpredictable). How we bring together different cognitive styles largely determines the success of our strategic capabilities."[2]

The organizational environment in which individuals find themselves—the organization, the civic polity, the national culture—can greatly affect how individuals are encouraged to develop their creativity. Individual initiative is a function of history as well. "One of the very, very few laws that I can discern in economic history," said Janeway, "is

that anything is better than being a peasant. Whether it's the millions of English peasants who moved to Manchester, England, in the 1820s or the farmers who marched off to Flanders in World War I to seize the opportunity to get off the land, the driving push behind all sorts of creative opportunities is the drive to get beyond the village, to achieve something beyond the rice paddy."

A corresponding "pull" that encourages the entrepreneurial ethic, Janeway said, is the profit motive. "Profit and progress have been at the core of Western notions of innovation…. The profit motive is a kind of solvent that allows Karl Popper's open society to survive its enemies, while having a kind of unintended consequence of enabling more people over time to escape the condition of peasantry. That's a framework for thinking, perhaps at the cosmic level, about the 'ecology of innovation.'"

The impulse to innovate may just be a universal human trait, an intrinsic aspect of being human, suggested Andy Sack, president and chief executive officer of Abuzz (a Cambridge, Mass., software firm). "It's impossible to stop innovation," Sack said. "I think human nature is to tinker with the world around them. It's a natural thing to play with the world." The questions start to arise, he said, about how our technological innovations play out. "I think the human condition is such that we can't foresee the consequences of the technologies that we develop," he said—particularly as organizations and nations deploy them for their own ends.

The Organizational Environment

To actualize an innovation, an individual generally needs the resources of an organization—a vehicle to amass capital, recruit workers, coordinate production inputs, develop a marketing and distribution apparatus, and so forth. A paradox immediately arises, however, because the creativity needed to innovate often wilts in a business environment dedicated to strict order, predictability, and regular financial returns. Most managers "believe in the value of new and useful ideas," writes Teresa M. Amabile.[3] "However, creativity is undermined unintentionally every day in work environments that were established—for entirely good reasons—to maximize business imperatives such as coordination, productivity and control." These business imperatives affect not only individual creativity but also the company's larger strategic capacity to bring innovation to the marketplace.

How, then, to nurture innovation within an organizational environment? A great deal of business literature is devoted to this very question. Within the context of employee management, Amabile sees "expertise, creative-thinking skills, and motivation" as three key components of creativity. Whereas the first two factors can be affected by managers only to a limited degree, *motivation* appears to be most susceptible to external influence. She cites six general categories of managerial practices that can elicit greater innovation from employees: challenge (matching employees to the right assignments), freedom (granting people the autonomy to achieve a given end), resources (sufficient time and money), work-group features (mutually supportive groups with a diversity of perspectives and skills), supervisory encouragement (praise for creative efforts), and organizational support (procedures and values that make creative effort a top priority).

Recognizing these managerial practices as critical is one thing. Executing them is another. Brown, an expert in organizational learning, believes that it helps to see an organization as "a knowledge ecology"—a living entity that "is fundamentally dynamic and gains robustness through diversity." He warns, however, that "ecologies cannot be designed; they can only be nurtured. The key to nurturing these ecologies is finding the balance between spontaneity and structure. People need both the latitude to improvise and the business processes to apply their knowledge. Thus, creative leaders must learn to be bold yet profoundly grounded."

An important way to cultivate creative leadership, Brown said, is through "communities of practice"—the "working fellowships, both within organizations and across common disciplines, bound by shared interests and tasks. For instance, marketing, design, or accounting represent communities of practice that exist in every organization, and often such communities are the source of new knowledge." In their forthcoming book *The Social Life of Information* (Harvard Business School Press), Brown and co-author Paul Duguid argue that "an information-centric view [of digital technologies] misses the broader social context in which information arises, is used, and takes on meaning. The infocentric perspective overlooks in particular the extraordinarily adaptive learning skill that people reveal in social contexts."

The notion that information has a "social life" is largely unplumbed; it has profound implications for large corporations and their ability to

sustain innovation in the new Internet culture. Joseph Vardi, an entrepreneur with International Technologies Venture who helped develop ICQ (the real-time messaging software) questions whether large companies have the social flexibility to launch successful electronic commerce (e-commerce) ventures. Large companies tend to be based on fairly rigid hierarchies of expertise, formality, and control; Internet ventures tend to be far more improvisational, informal, and innovative.

"A large part of Internet ventures—perhaps the majority—are created by start-ups, which big companies then buy," Vardi said. "It will be interesting to see if the big companies will be able to create an environment which will empower the young guys [who previously ran small, innovative firms] who are now seven layers down from the CEO—and very close to the [exit] door." In an environment of plentiful venture capital and successful IPOs [initial public offerings of stock], talented innovators have far less incentive to work within the stifling bureaucratic, fixed-salary environment of a large company.

Although large companies often bring enviable resources to the cause of innovation, they are frequently blind-sided by "disruptive technologies," writes Clayton M. Christensen in *The Innovator's Dilemma* (Harvard Business School Press, 1997). Christensen poses the question, "Why was it that firms that could be esteemed as aggressive, innovative, customer-sensitive organizations could ignore or attend belatedly to technological innovations with enormous strategic importance?"[4]

Christensen studies this question in the context of the disk drive industry; the rapid pace of innovation in this industry makes it ideal for studying the life-cycles of technology and market structure. He found that in terms of sustaining the existing trajectories of technological change, the successful pioneers were invariably large, established firms, while entrant firms were the followers. This circumstance, however, contains the seeds of a radical turnabout. Because established firms have such a powerful stake in the existing product architectures and customer base, they generally have little interest in exploring new strategic gambits in peripheral markets: Why jeopardize a large and lucrative market base by developing a new technology and market niche? Accordingly, large companies tend to channel their innovations into established rather than emerging markets.

This logic has upended the major players in the disk drive industry on several occasions as newcomers exploited mainstream inattention to

innovative possibilities. These innovators undercut the existing market by introducing disruptive technologies—typically by assembling off-the-shelf components into new and simpler product architectures. The most important such innovations, Christensen writes, have been the development of smaller disk drives (from 14-inch diameter disks to 8-inch, 5.25-inch, 3.5-inch, and then from 2.5-inch to 1.8-inch disks).

The history of innovation in the disk drive industry—and the great innovation among hundreds of start-up companies—suggests that large companies must develop new ways to stay innovative. The usual pattern, said Bill Coleman, chairman and chief executive officer of BEA Systems, is for companies to investigate promising opportunities and then build a new product to exploit them. "This model has to be reversed," Coleman said. "The model has to be invest [in innovative companies] first, acquire second, and build as a last resort."

Coleman explained that "you've got to have those 23-year-olds out there innovating, but if you try to hire them or make them do it yourself, you're probably going to hire one of the 98 out of 100 that are going to get it wrong." The most effective strategy, he said, is for large companies to use their investment portfolio as a tool for scoping out strategic shifts in technology and markets. "You invest to keep your antenna out in all the little things," said Coleman. "And as they're developing, you're using your investments to learn. And as the ecosystem moves in a given direction, you acquire the right pieces and learn from the ecosystem. We talked to the heads of investment and acquisition at Intel, Cisco, Microsoft, Hewlett Packard, and Oracle, and the synthesis of that knowledge basically says that that's what all of those companies are using investment for."

Innovation in a given industry ultimately culminates in a roll-up of the ecosystem, Coleman said, consummated by the player who manages to achieve economies of scale. That single player consolidates a diverse array of players and competing technologies into a more integrated, controlled marketplace. That kind of roll-up happened in the early 20th century when the larger automakers used their economies of scale to consolidate 180 different auto companies. It also happened when thousands of oil wildcatters were brought under the sway of Standard Oil and J. P. Morgan and when AT&T brought hundreds of local telephone companies into one system.

"When innovation gets to a point that is so dramatic and that involves a change in the fundamental economics of some part of life," Coleman said, "the innovator's dilemma makes it preordained that the winner in a market space will be a new company that executes a roll-up." The pattern goes something like this, he said: "Innovation happens so fast, but there's no way of telling what's going to be successful. No one knows what the product is, who the market is, who will buy it, what they'll pay for it, what the channel is. So a hundred companies have to form, 90 of them have to fail, 10 have to sort of 'luck into' success, and two or three are going to do well. But they are not going to have enough economy of scale, so someone is eventually going to have to roll-up the whole ecosystem. I contend in a small way, we've had a couple of small drafts of this in the personal computer industry and in biotechnology."

An interesting speculation is that the Internet fosters such roll-ups within a given market space. "What makes the United States important relative to the rest of the world," said Briggs, "is not only its cultural differences but its scale. It has the opportunity to scale." In the roll-ups in automobiles, oil production, and telephones, Briggs said, "it was an exploitation of America's geographic scale that really made possible the development of those markets. Now, is there something different about the Internet that will prevent the emergence of a dominant one firm, two firms, or three firms? Or are we talking about a different technical situation?"

Janeway believes that the advantages of scale have already been demonstrated by the major Internet portals. "The percentage of total advertising dollars on the Internet accounted for by a very small number of major global portals is now higher than in cable television, for example," he said. "The 'scale factors'—which in this case tend to be network-driven rather than capital-intensive—have already asserted themselves in the Internet ecology."

For Iqbal Quadir, founder of GrameenPhone (who, with Grameen Bank, brought cellular telephony to Bangladesh), any artificial "slowdown" in innovation resulting from a roll-up is not necessarily bad. "I frankly celebrate it," Quadir said, "because it allows David to challenge Goliath. If the Goliath were capable of continuing with innovation and becoming a bigger and bigger Goliath, I think we would live in a more unhealthy world." A critical issue, of course, may be the impregnability of a technology lock-in when a slowdown occurs.

National Polity and Social Norms

As individuals and companies strive to innovate for a global economy, it is becoming increasingly clear that some nations have a competitive advantage because of their civic polity and social norms. Governing structures, legal systems, and cultural attitudes can greatly influence the capacity of a nation's businesses to innovate.

It is tempting to consider innovation strictly in terms of market forces and organizational structure. As Janeway warned, however, "It is very important to recognize how much innovation takes place indirectly, and at several removes from a calculation of profit and loss, in domains that are away from the market—although they may come to influence and define the scope for the market."

An instructive example, Janeway said, is the former Soviet Union, where the "terrible absence" of basic elements of a civil society has greatly crippled that country's ability to nurture innovative, competitive businesses. "We take for granted the institutions of a civil society that give us a framework in which coherent, contractual, connected economic activity can take place," he said. These institutions include legal mechanisms to enforce contracts, raise capital, assure accountability to shareholders, and supervise bankruptcies, as well as the public infrastructure and cultural norms that allow business activities to proceed in reliable, consistent ways.

Esther Dyson, technology analyst, investor, and chairman of EDventure Holdings, offered broad comparisons of cultural attitudes toward innovation in the United States, Western Europe, and Eastern Europe. "In the United States, the attitude is, 'Change is good. It's great! Let's try it! Let's do what's fashionable.' The attitude in Western Europe—especially northwestern Europe—is, 'Oh, it's change! We don't need it! It's bad! It's destroying something we've got that's good already!' The attitude is that you do things right and in an orderly way—and that the government really does know best. And then, finally," said Dyson, "the attitude in Eastern Europe is, 'Gee, things aren't working. We should look at the things that are offered to us and figure out which ones are useful and which are useless.' The challenge is to winnow out the useful innovations from the changes for change's sake, through trial and error."

A natural question arises: Why is the United States at the forefront of innovation in the software and high-tech industries? Is there some sig-

nificant cultural explanation, some distinctly American dynamic that nurtures innovation? Roundtable participants agreed that, for many reasons, American society does indeed foster innovative behavior.

A key reason, Brown said, "is the ability of Americans to fail 'safely' and to learn from that." Although business failure exacts a great deal of economic loss and personal pain, the social stigma attached to it is modest. A Silicon Valley aphorism puts it this way: "The best way to succeed faster is to fail more often." Brown said that at industry gatherings in foreign nations, he is frequently asked what makes Silicon Valley so successful. His answer—"willingness to fail"—was once greeted with disbelief and hysteria, he said. Over the years, however, he has seen a greater acceptance of this fact, as reflected in changes in bankruptcy law and organizational cultures. One crude metric for assessing the amount of innovation in a given country, Brown said, is the leniency of bankruptcy laws.

It is a truism that the social structures and culture of American society encourage entrepreneurialism. The popular desire to start one's own business and strive to become rich is a deeply rooted American ethic. Millions of Americans admire and emulate entrepreneurial role models such as Thomas Edison, John D. Rockefeller, Steve Jobs, and Bill Gates, whose personal mythologies—however freakish or fictionalized—have been the stuff of dreams for millions of young people. The media revolution of the past two decades has certainly fueled public awareness of business innovators. Although many major innovations occurred in the 1950s, said Andrew Shapiro, director of the Aspen Institute Internet Policy Project, a large number of people could ignore them. "Today, my mother is on the Internet," Shapiro said. "It's very difficult to ignore the innovations that are occurring."

The American commitment to meritocracy, which is far more developed than elsewhere in the world, is very hospitable to innovation. Caste or credentials do not matter as much as demonstrable talent. "There are many places around the globe where meritocracy is going to cause huge political upheavals," noted Jerry Murdock, partner in the venture capital firm Insight Capital Partners. The cultural relations between men and women in the Middle East, for example, are likely to clash with meritocratic values, said Murdock.

Another American cultural value that facilitates meritocracy and innovation is people's attitudes toward job security. Workers are rela-

tively willing to change jobs, and employers have considerable latitude in laying people off. "This is very inimical to the way that Europeans see jobs," Hormats pointed out. "They still see jobs as a very orderly thing and are averse to the churning of jobs." Hormats recalls that when Gerhard Schroeder, Chancellor of Germany, asked a senior American official, "How do we get more employment?" the American official said, "You allow companies to fire people more easily. Then you'll get more jobs." Schroeder was taken aback by the advice, Hormats said, because layoffs are anathema to European sensibilities.

Hormats sees a close correlation between the fluidity of American culture—the willingness to take risks, to change jobs, to allow layoffs—and its ability to foster innovation and competitive success. "Most countries don't want to take that degree of risk," Hormats said. "You need to build that into the ecology and provide a social system that protects individuals, although not jobs. That's the kind of system I think we have in this country. Perhaps the social safety net isn't as good as it is in some other countries, and that is a concern. But at least we don't protect jobs that the market will ultimately eliminate."

The diversity of the American population is often cited as a boon to its competitiveness. The sheer variety of people's ethnic and cultural backgrounds in the United States means that more ideas are interacting, invigorating the marketplace with fresh attitudes and perspectives. In many cases, immigrants also bring special skills to the job market—as well as a keen desire to improve their lot and work harder.

Citing *Cities in Civilization* (Pantheon, 1998), by Peter Geoffrey Hall, Herron pointed out that "one of the things that revolutionized the cities of Athens and Florence centuries ago was immigration. People were coming from all around the Mediterranean into those cities." The American ecology of innovation, Herron suggested, may be more robust for precisely the same reason: Thousands of foreigners, many of them programmers, want to work in the United States. Certainly the impact of immigrants in American education and high-tech entrepreneurialism is dramatic. One-third of the valedictorians in American colleges last year were of Chinese heritage, and the most common surnames of people starting software companies in Silicon Valley are Indian.

The cultural advantages that the United States seems to enjoy in fostering innovation may also have something to do with the convergence of four "revolutions" in different spheres, said David Konzevik, chair-

man and chief executive officer of Konzevik and Associates, of Mexico. Konzevik cited the *technological revolution* of the 1980s, which put many new instruments in the hands of people, especially as prices dropped; the *financial revolution* of the past two decades, which helped make available new sources of investment capital; the *political revolution* since the fall of communism in 1989, which has led to the supremacy of free-market polices; and an *expectations revolution* in cultures around the world, stimulated by the scale of world markets that are steadily integrating and surpassing domestic and regional markets.

Taken together, these revolutions have permanently changed the ecology in which innovation occurs, Konzevik said. "Today, for the first time in history, every country has a free-market model. For the first time, innovation is totally in the hands of the majority of the population in a very short period of time, because there are no barriers of entry. This is the difference between today and 100 years ago."

Is high-tech innovation "Americanizing" other cultures?

If American culture is a potent incubator of innovation, must other nations seeking to reap the benefits of the technology embrace American values and norms? Does an innovation-nurturing culture require an American-style society—open, pluralistic, freewheeling, tolerant of failure and tradition breaking? Although foreign nations may need and want to embrace some aspects of U.S. culture, roundtable participants agreed that each culture is likely to retain its basic integrity.

"People take American culture and put their own spin on it," said Ranjit Singh, senior vice president and general manager of Xerox Internet and Software Solutions. Many of the software programmers in Bangalore, India, are women, Singh said—a situation made possible because they want to work at home, in close proximity to their children. "They're taking the standards and work of programming," he said, "but they're asking, 'How can I mold the work into the environment that I have?'" Similar trends are evident in Malaysia, where Muslim women wearing chadors and traditional garb work as computer programmers. These women are doing the work of the modern global economy while retaining commitments to non-Western religious values and traditions.

"I think there is no doubt that some elements of American culture have taken over," said Vardi (an Israeli), "but we have to try to define what is culture. As far as I can see, the United States is now providing

the veneer of world cultures, not the depth. Once you remove the veneer, each country continues to have its own norms of behavior." Lane sees American-style innovation as "a technology and a technique, much like French cooking or Japanese manufacturing in the 1970s. It's a process that gets exported, without affecting the culture."

Brown, however, is not so sure that the exported technologies have only a superficial cultural impact. "Our tools, and especially our media tools, are what you might call 'high-Q' tools. A 'Q factor' is an engineering concept that says that the power of that tool starts to manifest itself and become a kind of window on the world. The tools that we are building actually affect the way you think, the way you write, and the way that you interact." Brown cited the now-pervasive use of PowerPoint software to make presentations in the corporate world. Although the software has great power and versatility, it is also a distinct genre of communication. As such, it has subtly harmonized the basic modes of expression, making them similar and predictable rather than diverse and idiosyncratic.

The homogenization of world cultures via software genres and global commerce may have the paradoxical effect of *fortifying* traditional national cultures, argued Hormats. "If there is a greater sense of homogeneity in one sense, doesn't community become more important? One of the reactions to this homogenized world is that people may put more emphasis on their roots, their religion, and their community."

Another possibility is the emergence of hybrid cultures that combine national identities at one level with transnational affinities on another level. The "island economies" within Russia are a good example of this dynamic, said Dyson. Distinct market ecosystems, such as the software industry, have extensive international business relationships, often via the Internet. These enterprises generally function according to customary business principles (performance, openness, enforceable contracts) despite their location in an economy and culture that functions according to very different norms.

The point is that an individual's identity and cultural outlook need no longer be utterly defined by his or her geographical location. A gay person in Turkey can develop extensive relationships on a global scale, via the Internet, that are probably impossible within the boundaries of that nation.

The Transnational Internet Culture and Innovation: The Case of Open Source Code Software

Historically, a nation represented the largest ecology within which human activity evolved. Over the past decade, however, the Internet has incubated a new kind of transnational culture. One of its most interesting embodiments is the corps of computing irregulars who identify themselves with the free software and "open source code" movements.[5] Roundtable rapporteur David Bollier provided a brief overview of these movements based on a paper that he had prepared for the Harvard Law School's Berkman Center on Internet and Society.[6]

Although programmers who participate in open-source communities live in many different nations, their online ethos transcends national culture. More to the point, these self-organized Internet communities have demonstrated how the Internet can be exceedingly powerful in fostering innovation. Despite a geographic dispersal of creators and an absence of centralized capital structures, thousands of individuals have collaborated through the Internet to create Linux—a highly robust, reliable, and sophisticated operating system. Once a plaything of hackers, Linux since 1991, has become a highly respected mainstream operating system. Linux is the only non-Microsoft desktop operating system showing growth in market share (212 percent in 1998). It also has 17 percent of the market for server operating systems—a nearly threefold gain over the previous year.

Although Linux is probably the most prominent open source code software program, hacker communities have created hundreds of programs via the Internet, some of which have demonstrated impressive quality and popularity. Indeed, some of these programs have become critical operating components of the Internet itself: Apache is the most popular Web server software in use on the Internet; BIND (the Berkeley Internet Name Daemon) is the de facto domain name system (DNS) server for the Internet; and Sendmail is the program that routes more than 80 percent of all e-mail on the Internet.

However provocative the open-source phenomenon may seem, skeptics question its potential as a force for innovation. "I do not believe there is innovation going on in Linux," said Coleman. "It's just implementation of technology, standards, and systems that we have known for 20–30 years. It just happens to be collecting itself and moving forward."

Coleman also questioned the economics of the open-source model: "I do not believe that ultimately the open source movement is going to be a fundamental source of economic innovation. There are no economics behind it. The Internet represents the ability to distribute and manufacture intellectual property at zero cost. In the coming era, where the *lingua franca* is based on intellectual property and knowledge, and not capital, if we drive the economics out of [creating intellectual property], there will be no more created." Lane concurred: "If the whole economic model is built on maintenance, then I'm not sure where the capital for research and development will actually come from."

For these reasons, Coleman sees little future for open source code software in the commercial marketplace. "In the end," he said, "if open source is going to be a player in the next economy, it has to find a model that can pay back. I do not believe the model that Red Hat has *is* going to pay back. And their history has shown, it's not paying back."

Dyson disagreed with the proposition that open-source or free software cannot support a viable business model. In Russia, where copyright laws are deficient and poorly enforced, she said, entrepreneurs are still able to make money developing and selling software. How? By selling custom applications and implementation, product support, security, and developers' conferences. That approach represents an alternative business model. "If you look at the Linux code as advertising for the Red Hat distribution, support, and warranties," Dyson said, "that's what the business model is. It's not a moral challenge to the accepted order of things. It's a pricing model. If *all* software were free, the model probably wouldn't work. But all software is not priced the same. There's innovation in business models as much as in products."

Dyson compared the Red Hat business model to Federal Express. Neither *should* work—but they do. "Federal Express is built on what seems to be a false premise," she said, "because most of its business is transporting documents that 'ought' to be shipped electronically. But they're making money out of it regardless." So, too, with Red Hat: Although customers have every economic incentive to avoid paying Red Hat for code that can be downloaded for free and to reduce payments for service and support, enough customers nonetheless continue to pay, keeping the company (and its imitators) in business.[7]

Furthermore, Janeway noted, several major companies have made serious investments in Red Hat. Other companies have disclosed the

source code of application software in attempts to develop Linux-based market niches. "I don't think that any company that invested in Red Hat did so for benevolent purposes," said Janeway. "Silicon Graphics and Veritas did not contribute the best file systems to Linux—enabling the emergence of an enterprise-class Linux—for benevolent purposes." These companies believe they can eke out competitive advantages through an affiliation with Linux, he said.

Janeway foresees "an absolutely fascinating drama" that will be played out between the "true believers of the movement—Richard Stallman and others," and companies engaging in "the more or less high-minded hijacking of open-source software for competitive purposes." The end result of this drama, Janeway predicts, could be the radical commoditization of computer operating systems and perhaps other software components as well.

Mike Maples, ambassador for Microsoft Corporation, questioned the meaning of "openness" as used by the open-source movement. "The question of *open to whom* is always glossed over," Maples said. "Sun declared themselves to be open, and to programmers, they are open. But to operating system creators, they're *not* open. To disk drive manufacturers, they're *not* open. And so you get into this question, 'Who is the code open to?' Many people say that Microsoft is a closed system…but in a Microsoft environment, you have choice over all the hardware—200 different manufacturers and so forth. For only a small amount of software, you don't [have choice]."

Maples also questioned what "openness" really means if new variations on the code are not necessarily incorporated into the software. "I can send my innovations back [to the open-source community], but that doesn't mean that anybody ever puts it into the code or uses it, or that it's in anybody else's system." Why should a company make huge investments in modifying an open-code system, Maples asked, if the open-source community then refuses to adopt those changes because (they would respond) "it would alter the reference platform"?

The issue, said Richard Johnson, president and chief executive officers of Hotjobs.com, "is not so much about open systems as open standards and who controls those standards. There is a belief by some people that Microsoft owns something that should be open, and people are passionate about that." Bollier agreed, adding that "having standards that are accessible and open is the prerequisite to having a true array of choices. Not having proprietary standards is a key factor in having choices."

Brown noted that some open-source programs, far from being chaotic or variable, are models of stability. "The most stable text editor today is Emacs," said Brown. "Emacs has changed less than any editor I know of. We can actually read files that are 15 years old. Try to do that with any other commercial word processor, and you can't. Yet Emacs is totally open source."

The need for institutional innovation

What may be most striking about the open source code movement, Brown said, is its role as a new sort of "institutional regime." It is not a conventional business enterprise, nonprofit organization, or government entity but a new kind of Internet-mediated mode of global coordination that can yield significant results.

This assessment suggests that innovation in institutional regimes—not just in technology itself—may be a critical ingredient for the march of innovation in the future, Brown said. The pace of economic and technological change has accelerated very rapidly while expanding onto a global stage, yet the ability of national governments to build democratic consensus on the same scale has waned. This trend is producing "an impedance mismatch," said Brown. Finding new ways to assure public accountability and an international harmonization of standards—while still allowing a brisk pace of innovation—represents a significant institutional challenge.

A similar impedance mismatch may apply to intellectual property law. When the pace of innovation was slower and more predictable, various intellectual property doctrines were fairly effective in protecting innovation. But now that advantage is becoming more problematic, said Brown, as *implemented* intellectual property acquires greater strategic value than the assertion of legal claims alone. For example, a company can often reap greater revenues from getting its freshly minted intellectual property to market by selling it to a larger company than by licensing it. Moreover, the proliferation of patents for relatively minor ideas is forcing companies to enter into many more cross-licensing deals. These legal complications diminish the returns from intellectual property, making it more attractive, instead, to enter into broad partnerships that nurture the creative capacities of organizations. Although intellectual property law obviously remains important, its practical value is diminishing in the fast-

paced digital milieu—which, in turn, is spurring experimentation in new institutional strategies.

These examples, said Neustein, illustrate why institutions are so important to innovation: "Because implementation is always about cutting a path to the future. And since the past is already set in an institutional form, implementation requires the building of new institutions. Implementation of change always requires an institutional framework to tie the past to the future."

The Role of Government in Fostering Innovation

These trend-lines raise provocative questions about the proper role of government in fostering innovation. While government's role in managing the economy is often portrayed in a negative light, its legal and regulatory innovations can be indispensable to fostering the growth of technology and markets.

Hormats cited the creation of the Federal Reserve Bank, the Securities and Exchange Commission, and deposit insurance as extremely important factors in the development of banking and capital markets. "These institutions had an extraordinary impact on the ability of this country to perform economically," Hormats said. It is perhaps not incidental, he added, that "a great many institutional innovations arise during periods of enormous stress, such as the panics of the late 1800s and the Great Depression." A perceived social or political need often impels the creation of new institutional regimes, much as the lack of access to capital in Third World nations and U.S. inner cities is currently spurring the creation of new micro-lending regimes.

In many quarters, there is skepticism that government can play a particularly useful role. Dyson sees far more promise in the work of the voluntary sector, philanthropies, and social entrepreneurs than in government because government, she said, tends to become rigid and bureaucratic, stifling innovation and freedom. It's not that government is *bad*, she notes, but that it is accountable—and therefore less able to make the errors that are an integral, educational part of "trial and error" and entrepreneurial risk-taking. Dyson sees government's primary role as educational: informing the public and key constituencies about the prospects, complexities, and risks in a given market. Innovation begins earlier, however: Citizens need to be educated as citizens and as effective economic players, whether they are entrepreneurs or simply creators of

value and innovation within enterprises led by others. In terms of transformational change, Coleman sees government's role as one of noninterference until it is clear how a given technological "ecosphere" is going to be exploited; then the government's role is to help stabilize that environment.

Maples believes that government's role should be to work with industry and mediate tough issues, such as a fair taxation regime for communities in a world of e-commerce. Other challenges, such as trying to close the "digital divide"—the gap between more affluent, Internet-connected citizens and those without Internet access—may be more problematic, Maples said, because the technology and economy are moving so fast.

With regard to government action versus the free market, Nick Gleason, co-founder and president of CitySoft (an Internet development company that hires employees from urban neighborhoods), believes that there is a great deal of ideological buck-passing. The net effect, he said, is to avoid making serious headway against a given problem. Some people believe that only government can eliminate the "digital divide" or educational inequality. Others believe that the market or voluntary sector are best suited to tackle these problems.

Gleason is skeptical of the abilities of government and the social commitment of businesses. He sees the most hope in "social entrepreneurs"—business people who voluntarily and aggressively combine social ideals with their strategic management. Although he admits that social entrepreneurship is a fledgling field with only a handful of success stories, it is a way to harness the discipline of the market to make change in a self-sustaining, ongoing manner.

Gleason said he gravitated to business as a vehicle for social change after working in government and nonprofit foundations. "I'm not very hopeful that real innovations are going to come out of those fields," he said, "so it may be, in fact, that the market can have a powerful effect in this way." On the other hand, he pointed out, "If government is not addressing a social problem, then who's getting into it? And how is that driven? Saying something pithy about how the government should stay out of it is not necessarily pointing us in the direction of a solution."

Some roundtable participants believe that government has a legitimate, even compelling, role to play in addressing social inequities such as access to the Internet. "There are lots of enabling measures the gov-

ernment can take and has taken," said Hormats. One example is the Federal Communications Commission's policy of prohibiting telephone companies from levying access charges on Internet service providers. This policy played a key role in fostering cheaper, broader usage of the Internet. The Commerce Department's White Paper on Internet Policy (an effort led by Ira Magaziner) helped promote a "government hands-off" approach to the Internet. This hands-off approach allowed the Internet to evolve more easily into a popular universal medium instead of becoming fragmented through different regulatory treatment by different states and nations.

In terms of social inequities, government may or may not be able to play a quiescent role, Hormats warned. "There is a risk of a major social backlash, perhaps a political one, if there is not a more proactive approach by the government." Government does not necessarily have to take steps by itself, he added; it could instead enable the private sector to play a more positive role.

In any case, government could create a variety of institutional innovations to promote social equity in non-intrusive, non-bureaucratic ways, suggested Janeway. One precedent is AT&T's move to secure legal status as a regulated monopoly in return for universal access. This clean structural solution required only limited oversight. Another example was the Rural Electrification Administration, which authorized the creation of user cooperatives to bring electricity to remote rural regions in the 1930s.

An alternative to traditional government bureaucracies, said Janeway, "is what the British, in their delightful way, call 'QUANGOs'—quasi-nongovernmental organizations." The Internet world is "a perfect place for QUANGOs to emerge," Janeway said, because of their ability to serve variable local needs without politically motivated distortions imposed by one or another special interest.

Government can play a constructive, transformative role as well through its immense procurement powers. Federal, state, and local governments spend more than 18 percent of the nation's gross national product; as a result, government represents a powerful, largely untapped means for shaping the quality of products delivered to market. In the past, government has used its procurement powers to help develop markets for air bags in motor vehicles, recyclable products, chlorine-free paper, longer-lasting road pavement, and countless other

innovations. Instead of buying off-the-shelf products, government agencies could issue detailed performance specifications to would-be vendors, leveraging the powers of open competition to improve product innovation.[8]

Historically, the federal government's research and development spending—$76 billion in 1998—has been used to stimulate commercial innovation. Although government-funded innovation still occurs, some roundtable participants decried the increased emphasis on short-term applied research at the expense of long-term basic research. Critics also bemoaned government's decreasing ability to sponsor *disruptive innovation*. "When the Internet was begun in the early 1970s," said Brown, "ARPA [the U.S. Department of Defense's Advanced Research Projects Agency] was willing to think out of the box and make a very bold investment that was not peer-reviewed. It was kind of what you might call 'exploring the white space between disciplines.' If you look at how the government currently does things at both ARPA and the NSF [National Science Foundation]," he continued, "there's almost no willingness to think out of the box or explore the 'white space' for scientific inventions."

Hormats agreed, citing decreases in funding for basic research. "There is so much emphasis now on getting things to the market very quickly," Hormats said, "that the most innovative research, sponsored largely by government, has been cut back very dramatically." For example, although the government-funded Human Genome Project has generated many spin-off innovations, its funding has been cut back—perhaps jeopardizing long-term innovations that might otherwise emerge. Hormats also noted that the policy regime that government establishes for ushering new products to market—intellectual property rules, the drug approval process, and more can—also affect the kinds of innovations that emerge.

To help formulate a more systematic understanding of the forces affecting innovation, the Clinton Administration asked the National Science and Technology Council's Committee on Technology to identify priorities for reforming federal policy to enhance innovation. As stated by Neal Lane, assistant to the president for science and technology, the review process hopes to "develop a longer-term reform plan to ensure that federal policy fosters a proper environment for innovation well into the next millennium." Among the specific topics the commit-

tee will address are ways to stimulate longer-range research and development goals; deploy and diffuse knowledge for use throughout the economy; support education, training, and workforce development; develop standards and interfaces that are interoperable and therefore more broadly utilized; and harmonize different local, state, and federal laws that sometimes thwart the commercialization of innovation.

Financing Mechanisms for Innovation

The structure and norms of the financial sector of the economy have a huge impact on the ability of innovation to flourish. Unlike many industrial economies, the United States is blessed with a robust venture capital market. Venture capital firms gave a record $9.04 billion to U.S. start-up companies in the third quarter of 1999—more than twice as much as in the same period in 1998. Such supplies of risk capital, particularly for high technology and Internet sectors of the economy, owe a great deal to changes in federal policy in the early 1970s.

"Before 1973," said Janeway, "the venture capital limited partnership was limited as a vehicle for mobilizing risk capital from (at that point) individuals. A fundamental innovation occurred at the end of the 1970s when the rules governing fiduciary duty for pension funds and mutual funds were waived so that those pools of capital could invest in venture capital limited partnerships."

"The idea of allowing a much more energetic and less-regulated financial market was an important part of the innovative process," said Hormats. It set the stage for a lot of the venture financing and the "let a thousand flowers bloom" approach that we have today. Over the past 20 years, the deregulation of financial markets has channeled billions of dollars in new capital investment to innovative technologies.

One advantage of the American system of financing innovation is that it provides enough "open space" for a wide variety of innovations to develop. This ecology doesn't "select" winners too quickly; instead, it allows a diversity of flowers to bloom. This contrasts with the financial sector of the early 20th century, in which J. P. Morgan sought to finance only a narrow spectrum of companies and to consolidate technology and markets as rapidly as possible.

"When we think about what kinds of ecology fosters innovation," said Levenstein, "we should ask, 'How do we continue to have a financial system that's going to allow many flowers to bloom, and not force

people to consolidate too soon?'" The current speculative system may hold the best answers, she suggested.

Indeed, Janeway said he "is increasingly coming to believe that we have to integrate the concept of stock market bubbles into the fundamental dynamics of how capitalism works well." As Janeway explained it, "A stock market bubble so reduces the cost of capital to those deploying it that it becomes possible to lay out sums of money far beyond any rational calculation of possible profit as taught in business school. This represents a revolution for those of us brought up as economists. In this context, waste is a virtue, and efficiency is a profoundly negative value." He continued:

> If you look at the deployment of the railroads across the United States, so many duplicate lines were built that J. P. Morgan spent the most productive 20 years of his life desperately trying to generate predictable returns to the bondholders of the railroads. He did it by creating cartels, creating quasi-governmental restraints on trade. He was, in a sense, fighting the propensity of the London stock exchange to keep throwing money at American railroads because, in the context of the liquid capital market, you didn't have to make money 20 years from now. All you had to do was be able to sell stock to a greater fool 20 days from now. There's obvious resonance in the deployment of the Internet globally.

The abiding risk of any robust venture capital market, of course, is that the bubble might eventually burst, causing enormous ripple effects throughout the entire economy. The speculative dangers made possible by Internet stock trading; the perils of the near-default in 1998 by Long Term Capital Management, the hedge fund; the sought-after opening up of 401(k) pension funds to venture capital investments—these and other speculative excesses could trigger a serious contraction of the economy—not to mention new government restraints on capital investment.

A better, preemptive response to these perils, Hormats said, is for government to assure greater transparency of investment for investors and regulators. The process for disclosing information should be tightened and more information disclosed. These approaches are preferable to outright government intervention in financial markets, he advised.

Consistent with the discussion about government funding of research and development, however, there is a need for government to develop new mechanisms for financing innovation. Currently, said Brown, a great deal of government research is being funded "by the old boys' club using yesterday's paradigms, yesterday's problems, yesterday's field, yesterday's tools. The idea of being able to take a risk in government has gone away. You can't fund a radical project like the Internet."

One idea that has been floated is to have NSF give research grants to graduate students, not faculty members—on the assumption that grad students are more willing to take risks and innovate in their research than professors, who are too entrenched in established ways of thinking and professional networks. Another idea for invigorating innovative research is a special $200 million scholarship fund for graduate students that is being jointly established by Stanford University, the Packard Foundation, and other foundations. This fund will pay all expenses for 600 graduate students at any given time.

Yet another idea for channeling research funds in more effective directions is a "Dutch auction" proposed by Andrew Whinston at the University of Texas's Center for E-commerce, using descending-price bidding in an open format, rather than sealed bids. This idea, which is still under development, is to let the NSF and ARPA "bid" for where to channel their research funds, in conjunction with simultaneous "bids" by corporations and universities. The goal is to help blend various institutional priorities—government, corporate and academic—while finding a new balance between fundamental and applied research.

Conclusion

To talk about the ecology of innovation is to talk about a complex web of relationships that is constantly evolving in new directions. The facets of the ecology sketched above offer only a crude approximation of the whole, not a rigorous refinement. But that is precisely the value of the ecological metaphor: It highlights the interconnections of multidimensional forces in a dynamic environment. A purported innovation in one vector must be evaluated against the metrics of the whole, and not seen in parochial isolation. This approach encourages us to broaden our field of vision.

Yet we do well to attend to the themes accented by each vector of an ecology. The entrepreneurial ethic reminds us that personal character

and an individual's imagination can be catalytic forces. The diversity of a population and its patterns for interacting—within organizations and within a society—are significant forces as well. When these forces are inscribed within a country's political system and cultural norms, we see great variation in the ecology of innovation. The nations of the former Soviet Union, for example, offer a less hospitable climate for innovation than those of the West. Even among western nations, however, there are important political and social variations. On balance, however, societies grounded on democratic principles tend to be better equipped to negotiate the challenges of innovation. They are constitutionally and culturally structured to metabolize change. They have built-in feedback loops to identify dysfunction and make changes. They provide a matrix of sufficient stability, transparency, and accountability, yet they also provide sufficient freedom and "white space" to allow for risk-taking, disorder, and, ultimately, innovation.

Perhaps the most daunting challenge facing the captains of innovation is the accelerating pace of change. The Internet has vastly increased the velocity of information flow and creative initiative and intensified the race to market. We do not know whether this inexorable momentum can be mastered without nurturing many extra-market capacities as well: the freedom to pursue basic research and development, the "space" for aesthetic curiosity and reflection, and the civic culture needed to sustain a democratic ethos. If an ecology is an organic whole, indivisible and integrated, these factors must be investigated alongside the traditional vectors of organizational structure, public policy, and financing mechanisms. We are presented with the singular challenge of taking the ecology paradigm seriously—recognizing its holistic, dynamic complexity.

Endnotes

1. This issue is explored by David Bollier in *The Global Wave of Entrepreneurialism: Harnessing the Synergies of Personal Initiative, Digital Technologies, and Global Commerce* (Washington, D.C.: The Aspen Institute, 1999), and by Robert H. Frank and Philip J. Cook in *The Winner-Take-All Society* (New York: Penguin USA, 1995).

2. John Seely Brown, "Sustaining the Ecology of Knowledge," *Leader to Leader* (Spring 1999), pp. 31–36.

3. Teresa M. Amabile, "How to Kill Creativity," *Harvard Business Review* (September/October 1998), p. 77.

4. Clayton M. Christensen, "How Can Great Firms Fail? Insights from the Hard Disk Industry," in *The Innovator's Dilemma* (Boston: Harvard Business School Press, 1997), p. 25.

5. The former movement, which is identified with MIT programmer Richard Stallman, stresses the freedom to use source code as one sees fit, without the customary restrictions of copyright law; the latter—identified with Eric Raymond, Linus Torvalds, and others—stresses the availability of source code to users if proprietary derivative versions are legally permitted.

6. David Bollier, "The Power of Openness: Why Citizens, Education, Government, and Business Should Care About the Coming Revolution in Open Source Code Software," Harvard Law School, Berkman Center on Internet and Society, March 10, 1999. Available at http://www.opencode.org/h2o (last accessed February 3, 2000).

7. This situation is like the Woody Allen joke: "My brother thinks he's a chicken. I'd take him to a psychiatrist, but I need the eggs."

8. Ralph Nader, Eleanor J. Lewis, and Eric Weltman, "Shopping for Innovation: The Government as Smart Consumer," *The American Prospect* (Fall 1992), pp. 71–78.

Appendix

The Eighth Annual Aspen Institute
Roundtable on Information Technology

August 12-15, 1999
Aspen, Colorado

List of Conference Participants

David Bollier
Independent Journalist and Consultant

Asa Briggs
Historian
Former Chancellor
Britain's Open University
and
Member
House of Lords

John Seely Brown
Corporate Vice President and Chief Scientist
Xerox
and
Director
Xerox PARC

William Coleman
Chairman and Chief Executive Officer
BEA Systems

Esther Dyson
Chairman
EDventure Holdings

Charles M. Firestone
Executive Vice President
Policy Programs
and
Executive Director
Communications and Society Program
The Aspen Institute

Murray Gell-Mann
Professor
Santa Fe Institute

Nick Gleason
Cofounder and President
CitySoft, Inc.

John Herron, Jr.
Chairman
Zoologic

Robert D. Hormats
Goldman Sachs International

William H. Janeway
Senior Managing Director
E.M. Warburg, Pincus and Company, Inc.

Note: Titles and affiliations are as of the date of the conference.

Richard Johnson
President and Chief Executive Officer
HotJobs.com

David Konzevik
Chairman and Chief Executive Officer
Konzevik and Associates

Raymond J. Lane
President and Chief Operating Officer
Oracle Corporation

Margaret Levenstein
Adjunct Associate Professor
School of Business Administration
University of Michigan

Mike Maples
Ambassador
Microsoft Corporation

Jerry Murdock
Insight Capital Partners

Robin Neustein
Goldman Sachs & Company

Iqbal Quadir
Founder
GrameenPhone

Andy Sack
President and Chief Executive Officer
Abuzz

Andrew Shapiro
Director
Internet Policy Project
The Aspen Institute

Ranjit Singh
Senior Vice President and General Manager
Xerox Internet and Software Solutions

Joseph Vardi
International Technologies Venture

Staff:

Patricia F. Katopol
Program Associate
Communications and Society Program
The Aspen Institute

Patricia K. Kelly
Senior Program Coordinator
Communications and Society Program
The Aspen Institute

Note: Titles and affiliations are as of the date of the conference.

About the Author

David Bollier is an independent journalist and consultant with extensive experience in electronic media, consumer advocacy, public policy and law. A long-time collaborator with television writer and producer Norman Lear, Bollier works closely with The Business Enterprise Trust, the nonprofit organization that examines socially innovative business leadership. He also writes frequently about the civic and social implications of emerging electronic media. The author of five books, including *Aiming Higher* (1996), Bollier is a graduate of Amherst College and Yale Law School.

The Aspen Institute Communications and Society Program

The overall goal of the Communications and Society Program is to promote integrated, thoughtful, values-based decision making in the fields of communications, media, and information policy. In particular, the Program focuses on the implications of communications and information technologies on democratic institutions, individual behavior, instruments of commerce, and community life.

The Communications and Society Program accomplishes this goal through two main types of activities. First, it brings together leaders of industry, government, the nonprofit sector, media organizations, the academic world, and others for roundtable meetings to assess the impact of modern communications and information systems on the ideas and practices of a democratic society. Second, the Program promotes research and distributes conference reports to decision makers in the communications and information fields, both within the United States and internationally, and to the public at large.

Topics addressed by the Program vary as issues and the policy environment evolve, but each project seeks to achieve a better understanding of the societal impact of the communications and information infrastructures, to foster a more informed and participatory environment for communications policymaking, or to promote the use of communications for global understanding. In recent years, the Communications and Society Program has chosen to focus on the issues of learning and technology, Internet policy, electronic commerce, information literacy, digital broadcasting, international and domestic telecommunications regulation, and the impact of new communications technologies on democratic institutions and practices.

Charles M. Firestone has served as executive director of the Institute's Communications and Society Program for nearly 10 years. In 1998, he was also named the Institute's executive vice president for policy programs and international activities. In this role, Mr. Firestone oversees the Institute's portfolio of 17 policy programs and guides the Institute's relationships with its international partners in France, Italy, Germany, and Japan. Prior to his position with the Aspen Institute, Mr.

Firestone was director of the Communications Law Program at the University of California at Los Angeles and an adjunct professor at the UCLA Law School. Mr. Firestone's career includes stints as an attorney at the Federal Communications Commission, as director of litigation for a Washington, D.C. based public interest law firm, and as a communications and entertainment attorney in Los Angeles. He has argued several landmark communications cases before the United States Supreme Court and other federal appellate courts. Mr. Firestone holds degrees from Amherst College and Duke University Law School, and is the editor or co-author of seven books, including *Digital Broadcasting and the Public Interest* (The Aspen Institute, 1998), *Creating a Learning Society* (The Aspen Institute, 1996) and *Television and Elections* (The Aspen Institute, 1992).

Previous Publications from the Aspen Institute Roundtable on Information Technology

The Global Wave of Entrepreneurialism: Harnessing the Synergies of Personal Initiative, Digital Technologies, and Global Advance (1999)

David Bollier. This report examines problems arising from the growth of entrepreneurialism and digital technologies. 41 pages, ISBN Paper: 0-89843-264-2, $12.00 per copy.

The Global Advance of Electronic Commerce: Reinventing Markets, Management, and National Sovereignty (1998)

David Bollier. This report addresses the issues of electronic commerce in the context of global marketplace impact and the transformation of national sovereignty. 64 pages, ISBN Paper: 0-89843-236-7, $12.00 per copy.

The Networked Society: How New Technologies Are Transforming Markets, Organizations, and Social Relationships (1997)

David Bollier. This report explores how electronic networking—the Internet and intranets—is transforming commerce, organizational performance and leadership, business and social relationships, and personal identity and allegiances. 43 pages, ISBN Paper: 0-89843-213-8, $10.00 per copy.

The Future of Electronic Commerce (1996)

David Bollier. This report examines the communications and information technologies that are redefining the fundamental conditions and relationships of commercial transactions, and the implications of the new electronic commerce for individuals, businesses, and society. 64 pages, ISBN Paper: 0-89843-188-3, $10.00 per copy.

The Future of Community and Personal Identity in the Coming Electronic Culture (1995)

David Bollier. This report concentrates on issues of personal identity, community building, and setting boundaries in our lives and our environment, and includes a background paper entitled, "The New Intermediaries," by Charles M. Firestone. 48 pages, ISBN Paper: 0-89843-166-2, $10.00 per copy.

The Promise and Perils of Emerging Information Technologies (1993)

David Bollier. This report explores the use of complex adaptive systems as a model for determining information technology's role in both the workplace and diverse societal settings. It includes a background paper by John Seely Brown, Paul Duguid, and Susan Haviland entitled, "Towards Informed Participants: Six Scenarios in Search of Democracy in the Electronic Age," that offers progressive scenarios of how the interaction of humans and information technologies might influence and affect democratic life in the coming decade. 44 pages, ISBN Paper: 0-89843-149-2, $10.00 per copy.

The Information Evolution: How New Information Technologies are Spurring Complex Patterns of Change (1993)

David Bollier. This report explores the use of a new paradigm, that of co-evolving complex adaptive systems, for thinking about information, information technologies, and information-oriented societies. 28 pages, ISBN Paper: 0-89843-132-8 $10.00, per copy.