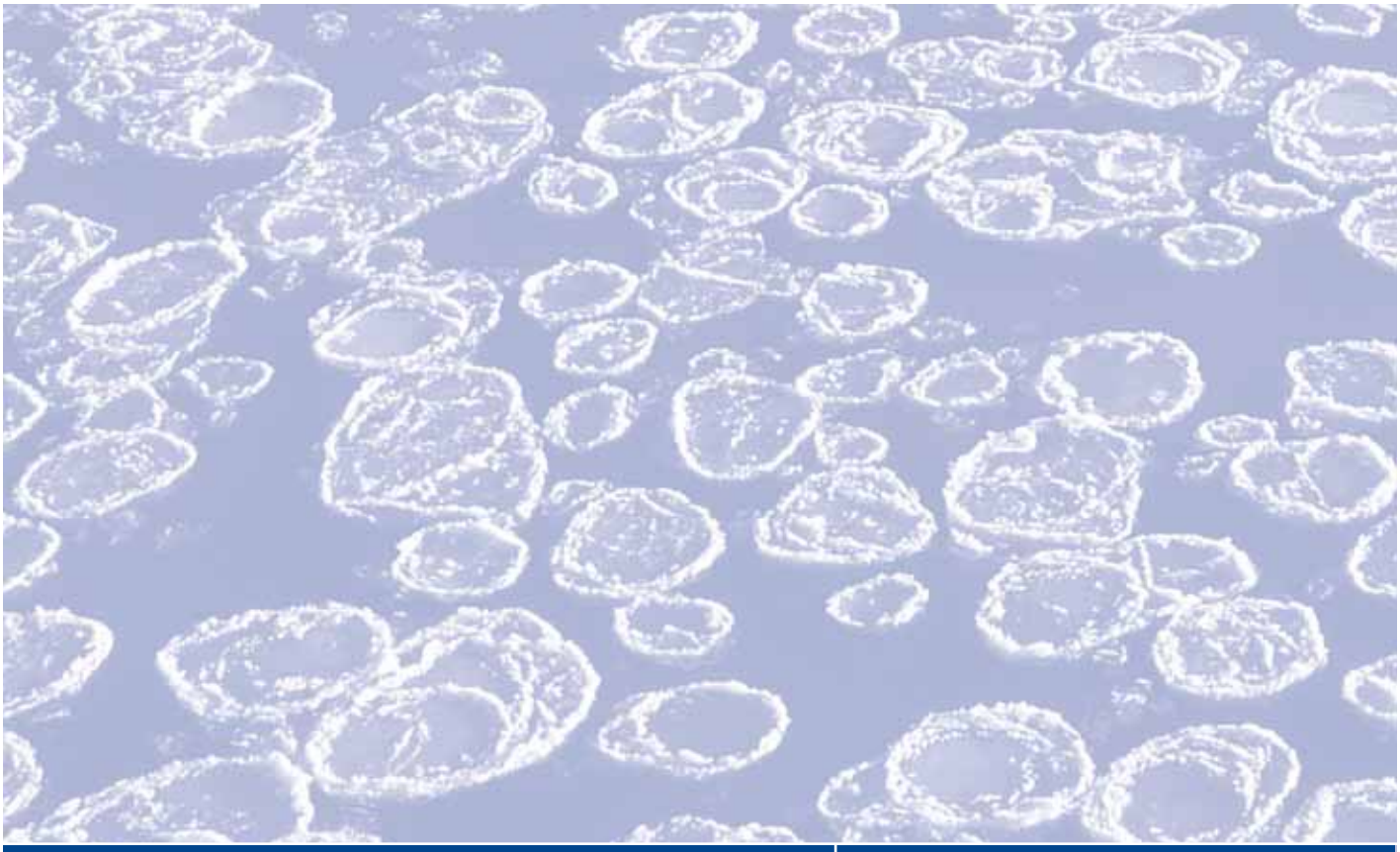
Toward a New Literacy of

Cooperation in Business

MANAGING DILEMMAS IN THE 21ST CENTURY



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Technology Horizons Program

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About the …

Technology Horizons Program

The Technology Horizons Program provides a comprehensive forecast that looks beyond any single technology to analyze what happens at the intersections of biotech, information technology, material science, and energy. We identify and evaluate discontinuities that are likely to have major impacts on businesses over the next three to ten years.

Institute for the Future

The Institute for the Future is an independent, non-profit strategic research group with 35 years of forecasting experience. The foundation of our business is identifying emerging trends and discontinuities that will transform the global marketplace and providing our members with insights into business strategy, design processes, and new business development. Our research generates the foresight needed to create insights about the future business environment that will lead to action. The results are customized winning strategies and successful new businesses. Our primary research areas are consumers, technology, health and health care, and the workplace. The Institute for the Future is based in Menlo Park, California.

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Contents

Cooperative Strategy: The Business Challege

Traditional business strategy is organized around competition—win–lose models fueled by SWOT analyses, market share frameworks, hard measurement, and protection of quantifiable private assets. In mature industries, cooperation is confined to supporting industry associations, which focus on issues of common concerns such as tax rules, and professional bodies, which set common technical standards.

In the last two decades, however, we've seen a variety of challenges to business models that stress competition over customers, resources, and ideas.

- Companies in emerging high-tech industries have learned that working with competitors can build markets and help avoid costly standards wars.
- The open source movement has shown that world-class software can be built without corporate oversight or market incentives.
- Google and Amazon have built fortunes by drawing on—and even improving—the Internet.
- Outsourcing has turned competitors into common customers of design firms and contract manufacturers.

The value of competition-oriented strategies will further decline as emerging technologies and new media diffuse from high-tech into traditional industries and as global industries become more fluid and flexible. Connective and pervasive technologies are enabling new forms of human and machine interactions and relationships; they will present business institutions with a host of new possibilities for organizing people, processes, relationships and knowledge. These forces will accelerate a shift in business strategy from solving concrete business problems to managing complex business dilemmas, which in turn will require a broader set of strategic tools and concepts than are provided by competitive models.

Cooperation Studies: Two Key Business Questions

Responding intelligently to this new world will require a much more sophisticated understanding of cooperation and cooperative strategy—as well as the basic dilemmas that tend to trigger competitive and cooperative behavior.

This understanding—and a host of examples of how to manage these dilemmas—is now being forged from important new work in mathematics, biology, sociology, technology, law and economics, psychology, and political science. Recent connections across these disciplines suggest a convergence around cooperation and collective action as deep principles of evolution, innovation, computation, and markets.

In this report, *Toward a New Literacy of Cooperation in Business: Managing Dilemmas in the 21st Century*, we take the first steps in exploring this emerging field of knowledge and practice, looking for ways to think about two key business questions.

- How can new insights about the dynamics of cooperation help us identify new and lucrative models for organizing production and wealth creation that leverage win–win dynamics?
- How can organizations enhance their creativity and grow potential innovation with cooperation-based strategic models?

Cooperative Strategy: The Business Challenge

To answer these questions, we begin by mapping the key disciplines and what they have to say about cooperation and collective action. We look at cooperation through the lenses of these disciplines, and then look across disciplines to identify seven key "levers" that can be used to "tune" organizations for cooperation and collective action. Finally, we examine business opportunities—and potentially disruptive innovations—in five arenas that traditionally pose dilemmas of competition versus cooperation.

- Knowledge-generating collectives
- Adaptive resource management
- Collective readiness and response
- Sustainable business organisms
- Peer-to-peer politics

This report is just a beginning, however. It's where we start to learn about a vast and newly emerging territory. Our research will continue in a separate project, and we invite you to join us in our ongoing inquiry. For details, contact Andrea Saveri at asaveri@iftf.org.

Cooperation: A Map to Think With

Cooperation is one partner in a pair of strategic choices; its constant companion is competition. The two go hand-in-hand, posing a choice at every juncture, a choice that arises because of a basic dilemma—traditionally framed as a social dilemma.

Social Dilemmas: The Problem of the One and the Many

Peter Kollock, author of *Social Dilemmas*: *The Anatomy of Cooperation*, explains that,

> Social dilemmas are situations in which individual rationality leads to collective irrationality. That is, individual rational behavior leads to a situation in which everyone is worse off than they might have been otherwise.

One example of a social dilemma is the so-called "tragedy of the commons," described by Garrett Hardin in 1968. Hardin argued that a grazing commons would inevitably be overgrazed or cordoned off as farmers pursued their own individual self-interest by allowing their cows to graze, ultimately reducing the benefit to everyone. Most natural-resource management problems pose this kind of dilemma. So do problems of knowledge sharing and creation in science, of innovation diffusion in markets, and of global economic policy. Many games have been built around such dilemmas—some designed specifically to explore the implications of cooperative versus competitive strategy.

Hardin's analysis was based on one such game, called the Prisoner's Dilemma, which was developed at the RAND Corporation in 1950. In the simplest form of the game, two prisoners have the chance to avoid serving time by "ratting out" their fellow prisoner. If neither confesses, they both get token convictions and serve a short sentence. But if only one confesses, he or she gets off with no time and the other serves a long sentence. If both confess, they both serve a long sentence. In this dilemma, they are both somewhat better off if they cooperate with one another and don't confess; however, one is a lot better off if he or she alone confesses and the other one does not.

This game has become the foundation for thousands of studies across fields as diverse as mathematics and sociology, biology, and economics. The good news from these studies—as well as empirical studies of real-world social dilemmas—is that there are ways to manage these dilemmas to foster cooperative behaviors that produce outcomes in which everyone is better off. Indeed, most social institutions have evolved over time to manage one or more social dilemmas in order to maximize benefits for all.

Cooperation: A Map to Think With

Lenses and Levers: A Map of the Disciplines

Our starting point for this work is to map the various ways that disciplines have looked at the core problem of social dilemmas. We have created a map to serve as a thinking tool in understanding social dilemmas, cooperative behaviors, and ultimately (we hope) strategies of cooperation (see Figure 1).

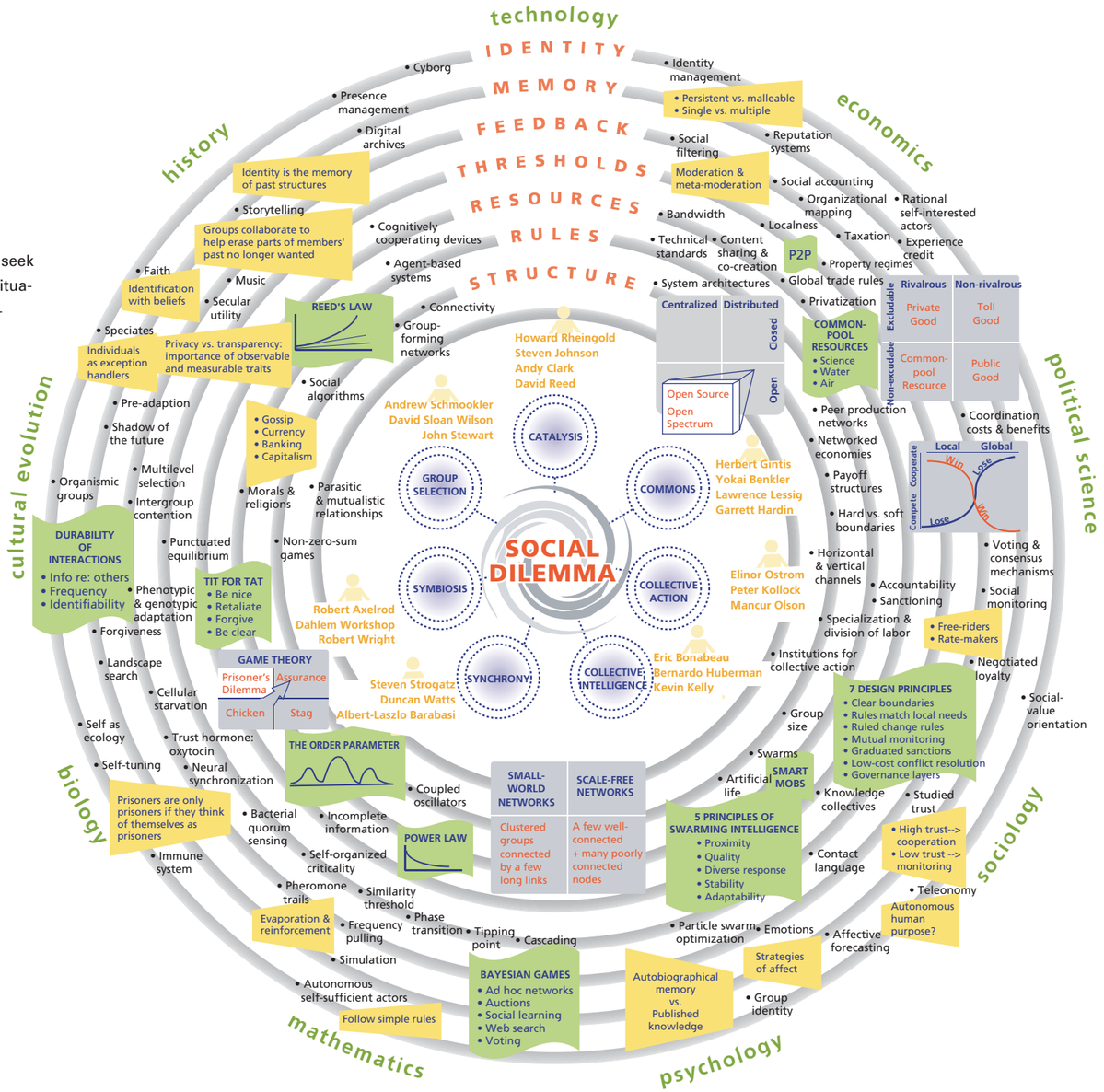
At the center of the map is the social dilemma, surrounded by *seven lenses* that use key concepts from the various disciplines to understand the process of cooperation. These concepts—*synchrony, symbiosis, group selection, catalysis, commons, collective action,* and *collective intelligence*—all describe a set of dynamics that can be tuned to foster cooperative behavior.

Arrayed around these core concepts are many more related concepts that suggest ways to alter the dynamics of cooperation. We have plotted them in seven bands that represent what we think are key *levers* for adjusting cooperative behavior: *structure, rules, resources, thresholds, feedback, memory,* and *identity*.

Together, the lenses and the levers provide a multidisciplinary framework for thinking about cooperation and cooperative strategies. They offer both an overview of the key studies to date and a palette of choices for tuning cooperative systems—a scaffolding for imagining new solutions to social dilemmas.

We must be cautious, however, in applying this tool. The field of cooperative studies is young, and this map represents only the most summary view of it. Also, in any attempt to apply scientific knowledge to human behavior, we must understand that there are no recipes or algorithms when it comes to specific groups of people, even though ample research shows predictable patterns among groups of people in general. A lens is something you see through; it's a tool for understanding, not a tool for engineering. With this in mind, we present the map as a way to reexamine basic business situations and think about the cooperative potential of groups in new ways.

Figure 1
Cooperative Strategy: An Interdisciplinary Map



THE CORE PROBLEM

The core problem that cooperative strategies seek to resolve is the so-called social dilemma: a situation in which individual rational behavior produces poor group outcomes.

THE LENSES ON COOPERATION

Cooperation looks slightly different when viewed from the perspective of different disciplines, each of which offers a key concept that reveals distinct insights into cooperation and collective action. These concepts provide a basic set of seven lenses on cooperation.

THE LEVERS OF COOPERATION

Strategy is ultimately about behavioral dynamics, and the findings of cooperation studies to date suggest many ways in which cooperative behavior can be tuned. These findings, clustered together, present seven basic levers for tuning cooperation.

KEY STRATEGIC CHOICES

The literature of cooperation suggests a number of key choices that groups can make to either enhance or limit cooperative behavior. We sometimes represent these as four-square diagrams or statements.

PRINCIPLES

Already emerging from this work are several key principles. While we caution against using them as part of an engineering formula, we offer them here as pointers to what we hope will eventually become a set of best practices.

THE MUST-READ AUTHORS

Many, many people are doing important research and writing on the subject of cooperation today. The map lists those that provide the fastest entry into the field.

Source: Institute for the Future

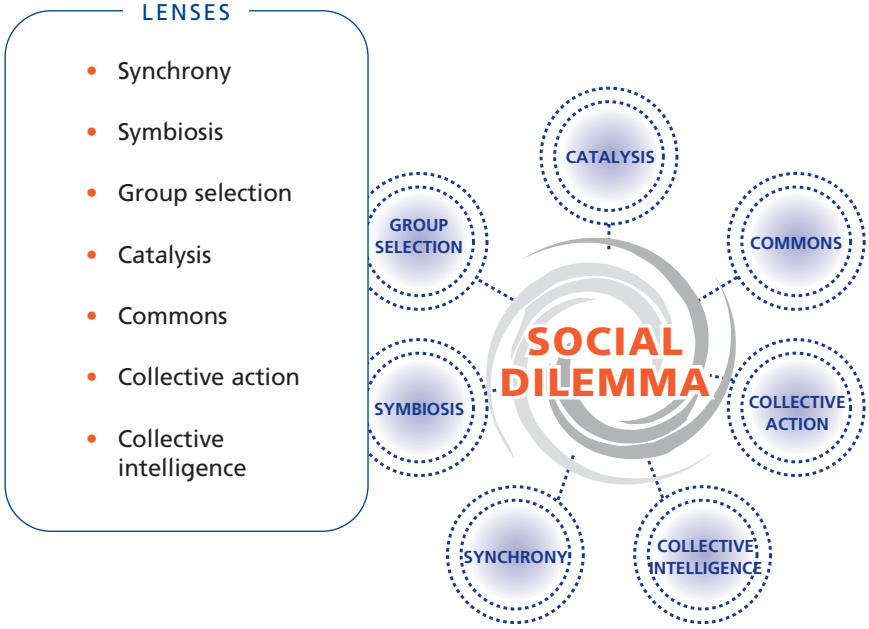
The Research to Date: Seven Lenses on Cooperation

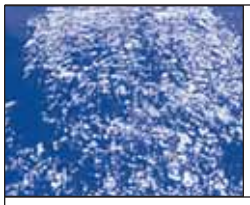
2

In the last decade, scientists and social thinkers in a range of fields have independently discovered cooperation at the heart of a number of important phenomena. Evolutionary biologists, for example, have revealed how symbiosis plays a key role in everything from cellular evolution to speciation and ecosystem complexity. Mathematicians are revealing basic patterns that underlie synchrony and swarming at all levels of nature, informing our understanding of how cooperative actions and institutions can emerge from distributed actors. Sociologists have revisited the "tragedy of the commons," illustrating how various commons have been transformed into successful cooperative ventures in different industries and environments.

When researchers look at a topic from the perspective of their disciplines, invariably one or two key disciplinary concepts rise to the surface and help frame the investigation. In looking across the research on cooperation, we have tried to find these key concepts, to use them as lenses for seeing cooperation as a biologist, a mathematician, or a sociologist would, for example. The result is a set of seven lenses that we think provide particularly compelling views of the problem of social dilemmas.

In this chapter, we look at cooperation through each of these lenses, pointing to some of the fundamental ideas emerging from the diverse disciplines engaged in this inquiry. For each lens we identify opportunity areas for creating cooperative business strategy. This is by no means a comprehensive or final summary of ideas. Rather, it is a first pass at parsing out key ideas to track and further develop our understanding of cooperation and collective action.





SYNCHRONY

the process by which patterned behavior is created among many individuals without conscious control

In the search for universal principles of cooperation, mathematics has begun to contribute new concepts for understanding how humans become linked together in patterns that might be thought of as "emergent cooperation." Central among these is the concept of synchrony: the tendency for phenomena at all levels of existence to synchronize their rhythmic behavior under certain conditions. Markets, smart mobs, social networks, and traffic patterns are all informed by the mathematics of synchrony; so are many natural (and sometimes destructive phenomena), such as earthquakes, mass extinctions, and heart attacks.

Recent mathematical thought provides three key descriptions of how people (and things) get in sync with one another.

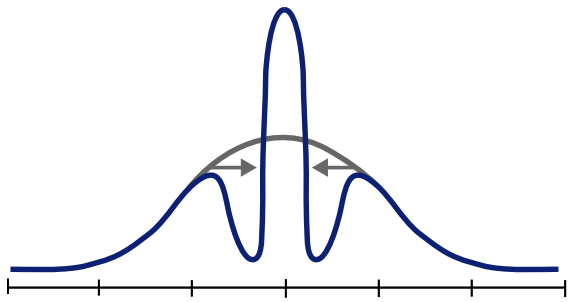
> **At the heart of the universe is a steady, insistent beat; the sound of cycles in sync. —Steven Strogatz**

Coupled Oscillators: Cycles, Order, and Organization

According to Steven Strogatz, author of *Sync*, coupled oscillation is the starting point for understanding synchronous behavior. Oscillators are dynamic phenomena that have distinct, repeating cycles; coupled oscillators are those that cycle together. Put half a dozen pendulum clocks on the same shelf, they will synchronize over time. Thus, rhythm and communication are basic enablers for synchrony.

A key insight from the mathematics of sync is the ability to predict the conditions under which groups of actors will spontaneously synchronize their behavior. If the group is too diverse, it will not synchronize. Groups that do synchronize are characterized by a modified bell curve in which a strong central peak of actors synchronize around an average cycle rate and are flanked on either side by two smaller groups synchronized around slower and faster cycle rates (see Figure 2).

Figure 2
Partially synchronized groups tend to have a three-peak distribution



Source: Steven Strogatz. *Sync: The Emerging Science of Spontaneous Order*. 2003.

swarm of fireflies

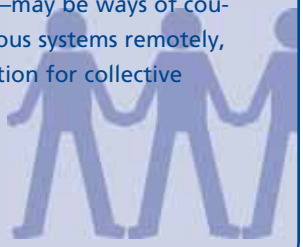
Networks: Emergent Patterns of Interaction

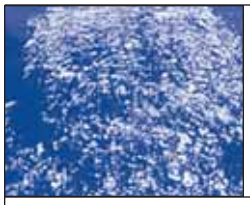
Mathematical insights also tell us about the kinds of network patterns that are likely to enable the emergence of self-organizing systems. A fundamental pattern here is Albert-Lazlo Barabasi's scale-free network, in which most of the nodes will be poorly connected while a minority will be very highly connected. On first glance, most social networks, as well as the Internet and World Wide Web, seem to exhibit this pattern, which is described by a statistical distribution known as the Power Law.

On closer analysis, however, another phenomenon—the small-world network—may also shape these emergent systems, based on the extent to which members share some sort of geographic, organizational, or social affinity. Small-world networks take into account existing affiliations and the cost to build links; Duncan Watts, author of *Six Degrees*, argues that, in many complex systems, clusters of strongly linked nodes can inexpensively extend their reach by adding a few weak links to other clusters. Small-world networks may be either scale-free, like Barabasi's, or not; in either case, the combination of strong and weak links can create unexpected and spontaneous outbreaks of coordinated behavior across decentralized networks.

KEY PRINCIPLES

- One-to-one coupling tends to grow to many-to-many coupling.
- Once in sync, systems tend to stay in sync.
- Disturbances to an equilibrium system tend to grow as a function of the similarity of players; if they are nearly identical, disturbances grow exponentially.
- Actors tend to make the minimum asymmetrical adjustment needed to get in sync with one another.
- Small differences in connectedness can lead to very large inequalities over time.
- Power Law distributions are only truly scale-free when the network is infinite; in the real world, they exhibit sharp cutoffs, which means that they are only scale-free over a portion of their range.
- Random affiliation networks—those in which members belong to overlapping groups—will always be small-world networks.
- Many local affiliations tend to lower the cost of participating in a global network.
- Social tools—such as spoken language, music, and dance—may be ways of coupling human nervous systems remotely, creating a foundation for collective action.





SYNCHRONY

Flocks and Swarms: The Rules of Emergence

A third line of mathematical inquiry focuses on the rules that individual actors follow to create the cooperative group behaviors observed in nature, such as flocking birds or swarming insects. Using agent-based models, authors like Eric Bonabeau are able to posit basic rules for systems that mimic an ant colony's collective search for food or a beehive's management of its waste. Such models are particularly useful for understanding collective intelligence—a lens that we explore in more detail later.

Opportunities for Strategists

- **New ways of measuring key indicators.** The mathematics of coupled oscillators, networks, and swarms provide new ways to measure key indicators of cooperative behavior (and its outcomes). For example, some studies have shown that connectivity of businesses in a geographic region is an indicator of prosperity.

- **Improved planning of networks.** Understanding the different kinds of network structures and their effects on synchrony—that is, on emergent group behavior—can help in designing and using all kinds of navigation and communication systems, from self-organizing sensor networks to organizational structures.

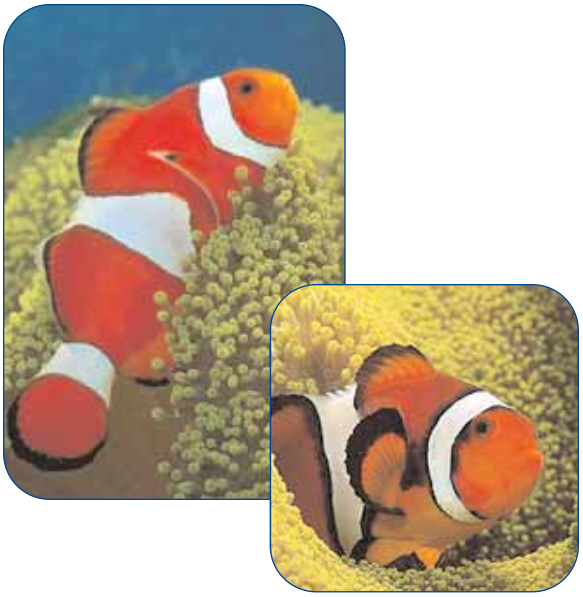
- **Assigning value to social connectivity.** Network mathematics provides a way to analyze and evaluate the value of social connectivity of an individual or organization. As we'll discover when we look at the catalysis lens, the new technologies of cooperation include systems to support affiliate networks and track their reach both within an organization and outside it. Interpreted through network math, this data could become the basis of auditing individual and group cooperative behavior and even valuing entire companies.

SYMBIOSIS

a mutually beneficial relationship that can evolve between different organisms in a system

Long overlooked in evolutionary theory, symbiosis is increasingly viewed as a fundamental process in biological evolution. As such, it is also of crucial interest in understanding the importance and mechanisms of cooperation in the survival and adaptation of species under pressure from their environment. Without invoking biological determinism, studies of symbiosis can illuminate the rules by which living beings come to resolve complex survival dilemmas—from the cellular level up to the species level.

A leading author in this endeavor has applied game theory and computer simulation to explore these biological phenomena. Robert Axelrod, author of *The Evolution of Cooperation*, used an iterated Prisoner's Dilemma game to track the evolutionary impacts of cooperative behavior. The result was a computer strategy, called "Tit for Tat," that consistently achieved long-term success in the iterated game by cooperating on the first move and then mimicking its partner on subsequent moves.



Reciprocity and Rapid Evolution: The Biological Argument for Cooperating

Symbiosis has been called "Darwin's blind spot," not because Darwin didn't recognize it but because he thought the only significant mechanism of evolution was general selection through competition and "survival of the fittest." Newer studies, however, suggest that symbiosis is perhaps the major mechanism for rapid adaptation to the environment: at the cellular level, organisms can literally swap genes, creating a new species that is a combination of its symbiotic parents.

At its core, symbiosis is about reciprocity. However, since symbiosis in nature often occurs between and among different kinds of organisms, the reciprocity is not always symmetrical. Parasitism has its place—perhaps a place of honor—in symbiosis. Tom Ray's work with Tierra as an artificial evolution system, for example, showed that parasites and meta-parasites drove evolution more quickly.

THE WINNING STRATEGY OF TIT FOR TAT

- **Be nice**—don't defect at the first opportunity
- **Retaliate**—defect if others do
- **Forgive**—Switch to cooperation when your opponent does
- **Be clear**—Always react in the same way to your opponent's behavior

SYMBIOSIS

Symbiotic Identity: The Illusive Boundaries of Organisms

As biologists take a closer look, they increasingly find that organisms are really cooperative colonies, often of different species. The mitochondria that act as the energy generators of all cells originated as parasites that have evolved into a completely interdependent relationship with cells; fueled by the energy provided by the former symbiont mitochondria, the cooperative cell colonies known as organisms have evolved. Similarly, many tree roots depend on various types of fungus that surround them to transmit nutrients from the soil (and even to exchange matter with neighboring trees).

These two examples define a range of mutual dependency from endosymbiotic (in which one organism is literally inside another) to exosymbiotic (in which the reciprocating organisms are seemingly distinct). This continuum, however, points to the difficulty of identifying clear boundaries of organisms: it challenges the very notion of the "individual" or even individual species. Humans, for instance, wouldn't exist without billions of symbiotic bacteria in our digestive systems.

Immune Systems and Infectious Disease: Symbiosis Gone Awry

Finally, symbiosis also provides insights into the processes by which cooperation and mutuality may devolve into a situation where one of the cooperating organisms suddenly becomes a threat to another. Bacteria provide an example here: there is evidence that bacteria have a quorum-sensing mechanism: that is, they do not attack their host until they sense that enough of their compatriots are present to overcome its immune response.

Opportunities for Strategists

- **Rapid innovation.** Symbiotic relationships can generate rapid innovation.They allow companies to create things they couldn't make on their own, or while working in more formal ways with partners. The successful long-term collaborations between design firms and manufacturers are great examples of symbiotic relationships that bring together very different kinds of companies, and yield ideas and products that neither party could develop independently.

- **Competitive edge.** Symbiosis gives small companies the ability to compete against large companies. Small players who are members of tight webs can pool resources and knowledge, collaborate, and compete successfully against larger, more powerful companies.

- **Managing living resources.** Insights about the processes of reciprocity and co-evolution can suggest improved processes—and policies—for managing biological resources, such as agricultural lands, forests, and fisheries. Quite apart from cooperative economic strategies (see the Commons lens for details), understanding the symbiotic relationships among biological organisms can lead to better technologies, practices, and policies.

- **Managing disease and bio-threats.** As the world becomes increasingly interconnected, the potential for devastating epidemics grows. Understanding the basic patterns and mechanisms of symbiosis and parasitism can provide both medical and organizational frameworks for global teams to cooperate in averting disasters and managing outbreaks.

- **Designing industrial ecologies** As Hardin Tibbs has suggested, the economic inefficiencies and ecological damage of industrial-era factories, plants, and physical production systems can be retuned as cooperative ecologies in which the by-products and waste-products of one industry feed the inputs to adjacent industries.

KEY PRINCIPLES

- Cooperative individuals can survive in competitive environments by finding reciprocation partners.
- Successful strategy requires cooperation with other successful strategies—that is, if someone else is playing by a successful set of rules, your strategy is more likely to succeed if it cooperates with that set of rules.
- Growing the value of long-term incentives makes short-term defection less attractive.
- The longer the shadow of the future—the likelihood that today's behavior will effect future actions—the more likely cooperative behavior is to evolve.
- Symbiosis allows the partnership to be fitter for a wider range of environmental conditions than either partner could be individually.
- Parasitism drives rapid evolution.

GROUP SELECTION

the process by which groups develop adaptive traits that improve their fitness in their environment compared to other groups

Cultural evolution theory sheds light on how cooperation can emerge in groups as an observable trait that is passed through generations—and how it can shape the meaning of members' interactions with one another and across groups. One focus of research in this area, by authors such as John Stewart, Yaneer Bar-Yam, Robert Wright, and David Sloan Wilson, is the role of cooperation in the evolution of organizations into increasingly complex systems or social super-organisms. As Wilson states: "The history of life on earth has been marked by many transitions from groups of organisms to groups as organisms. Organismic groups achieve their unity with mechanisms that suppress selection within groups without themselves being overtly altruistic."

Multilevel Selection: The Survival Value of Cooperation

Group selection declined in acceptance in the late 1960s but has regained interest among current researchers to frame questions related to cooperation and organismic life. One of the main challenges to group selection is the fundamental problem of social life: groups work best when their members provide benefits to one another, but many of these prosocial behaviors do not survive through natural selection. For example, birds who provide warning calls when they spot a predator may not gather enough food or may attract predators and get eaten even though the flock survives. Selection within the group, then, would favor those who do not signal for predators (a non-cooperative behavior).

Darwin shifted the unit of selection from the individual to the group, and reframed the problem of social life. He proposed that selection occurs across groups too. Members of flocks that include birds who give warning cries as a signal for predators may survive and reproduce better than groups without signaling birds, or with fewer signaling birds. Survival of the group with signalers allows the individual trait of signaling to be reproduced and passed on. Thus multilevel selection (selection beyond individual biological hereditary to the group level) is an important dynamic that could explain how cooperative behaviors survive and reproduce over time.

- **Religion and moral codes as adaptations.** Cooperation can thus be seen as a cultural adaptation that improves fitness. Using the lens of multilevel selection, groups evolve into adaptive units; individuals develop observable traits that are passed down and may improve the fitness level of a group within a local environment rather than just the fitness of the individual. David Sloan Wilson uses this framework to propose that cooperative

religious systems act as adaptive organisms. Moral codes encouraging cooperative behavior and punishing non-cooperative behavior among church members are framed as complex adaptations that are finely tuned to specific environments (as was the Calvinism in Geneva in the mid-1500s.) Religion is a system that binds people together to make them fit for their particular context by cooperating in opposition to their most selfish desires.

- **Pre-adaptation as seeds of the future.** Sometimes adaptations jump contexts and contain the seeds of future cultural evolution someplace else. Some traits may be pre-adaptive to future conditions, but we just don't know it yet. In *The Human Web*, McNeill and McNeill decribe how the adaptation of using human plow teams to operate heavy moldboard plows in medieval Europe provided a rich set of cooperative practices that helped stimulate early forms of urban enterprise in medieval towns. Moldboard plows had a steel blade that could cut through the muddy European soil, but required human plow teams rather than a single ox and driver for operating them. Often these teams extended beyond family relations and coordinating them required discipline and internalized moral codes. That requirement of cooperation and trust with people who were not related, helped prepare townspeople for the kind of trust and conformity to rules that helped support transactions and market activities in burgeoning urban centers.

Executive Control and System Awareness: Managing Cooperation

The potential benefits of cooperation, as argued by John Stewart, are an important driver in the evolution of increasingly complex organisms. Stewart explains that while groups exploit the benefits of cooperation among their members, many impediments—including lack of trust, reputation, and shared intent—prevent exploitation of the benefits accross groups.

Managing entities play a key role in enabling across-group cooperation and the evolution of social superorganisms by suppressing cheaters and rewarding cooperators. The organization of molecular processes into cells, of cells into multi-cellular organisms, and humans into human societies are examples of social organisms in which managing entities play this role. This process progressively extends cooperation across scales of time and space. The management function is a critical evolutionary step in overcoming the impediments to cooperation at various levels in the organization. At its highest level, management's awareness of control and coordination at all levels reaches a sense of organismic identity and self-consciousness.

moldboard plow

GROUP SELECTION

Opportunities for Strategists

- **Work-group diagnostics.** Understanding the variety of cooperative traits that support the general fitness of groups could help organizations develop a set of indicators for successful groups. These indicators could be used to diagnose underperforming groups as well as develop performance indicators at the group level and the individual level.

- **Adaptive organizational codes.** Most organizations have codes and cultures that either support or limit their flexibility in responding to environmental change. Understanding the principles of pre-adaptation—and strategically identifying pre-adaptive behaviors—could help organizations implement codes and practices that make them more adaptive both to change in general and to specific anticipated innovations in the future.

- **New basis for local–global policy.** Insights into multilevel selection and the dynamics of group selection might enable communities and organizations to develop better policies for addressing the local impacts of global cooperation and vice versa. As we reorganize to live in a globally connected society, the need for such insights and policies is urgent.

KEY PRINCIPLES

- Phenotypic traits—those not genetically determined traits, such as warning cries or moral standards—are selected at the group level and are in tune with local context.
- The invention of technologies that facilitate or encourage non-zero-sum interaction is a reliable feature of cultural evolution.
- Competitive struggles at wider scales encourage local cooperation.
- Successful strategies often require cooperation within the group in order to compete outside the group.

CATALYSIS

an action or reaction among actors that is triggered by an outside agent—a very small amount of catalytic agent can facilitate a very large-scale reaction

If we think of tools and technology as agents of human interaction, we immediately see their potential for catalyzing cooperation. Throughout history, tools have been a catalyst for increasingly complex forms of cooperation. Hand-in-hand with agricultural tools, for example, humans evolved complex irrigation systems that required social organization beyond small family clans. Writing appeared as a means of accounting for the exchange of goods, not only creating markets but also enabling taxation to support larger systems of governance and defense. Printing amplified collective intelligence, triggering the emergence of science as perhaps the largest cooperative enterprise in human history. The global Internet enabled many-to-many communication, and with it, peer-to-peer economies and collective action on an unprecedented global scale.

Unlike some catalysts, however, tools are not untouched by the reactions they spawn. Rather they appear to co-evolve with humans. As tools enable more complex forms of cooperation, people work together to design and build more complex technologies of cooperation. At the leading edge of today's technology are tools that will amplify, enable, or tune for cooperation.

gutenberg press

Connectivity: The Infrastructure for Cooperation

Open technical standards for connectivity—such as TCP/IP, WAP, HTML, and XML—lay the foundation for broad cooperation across organizations, markets, commercial products, and human activities. Distributed architectures, enabled by these standards, catalyze sharing of everything from music to political self-organization and computational processing power. Together they foster a new level of connectivity among humans and their tools; they create a complex human–machine system embedded with cooperative processes and procedures. The mobile telephone, for example, is already in the process of morphing into a wirelessly networked supercomputer distributed in a billion pockets worldwide.

Agency and Reputation: Human–Machine Co-Evolution

At the leading edge of today's technology are tools that perform functions previously managed by intimate and often unconscious human behaviors to support cooperation. For example, nascent reputation systems such as those in eBay and Slashdot enhance trust building in distributed markets and publishing, respectively. Presence-management tools allow people to develop more sophisticated and nuanced rules for interacting over time and distance. At the same time, a new class of cognitively cooperating devices will act—either as human agents or as independent machines—to make cross-organizational decisions and provide a dynamic, decentralized connectivity infrastructure.

Such tools extend the human self in time and space and, at the same time, enmesh it in an ever more complex human–machine system, perhaps conjuring the notion of cyborg. While science fiction has generally scorned the cyborg, Andy Clark argues in

Natural Born Cyborgs that humans have been cyborgs from the earliest days of tool use. Every time you invoke the mental algorithms you learned for mathematical calculations and use a pencil and paper to execute them, you are extending your nervous system both conceptually and physically. What is different today is the complexity and sophistication with which humans and their tools cooperate and co-evolve. (See also the "Collective Intelligence" lens on page 27.)

Social Software: The Value of Group-Forming Networks

A measure of the growing capacity of technology to support cooperative group behavior is the evolution of communication systems from one-to-one and one-to-many forms to many-to-many forms. (Recall the principle from the discussion of "Synchrony" that one-to-one sync tends to grow to many-to-many sync.) A new class of social software aims specifically to facilitate the evolution of group-forming networks (GFNs), including network building and tracking tools.

Measured in economic terms, GFNs demonstrate the value of cooperative behavior. David Reed, of MIT, has argued that the value of GFNs grows exponentially, at a rate of 2^N—where N represents the number of nodes in the network. Compare this to the growth rate of one-to-many networks (such as cable), which grow simply at a rate of N. One-to-one networks (such as phone) grow at a rate of N^2 (also known as Metcalf's Law) (see Figure 3).

The economic value proposition for cooperation is explored in more detail in our next lens—the Commons.

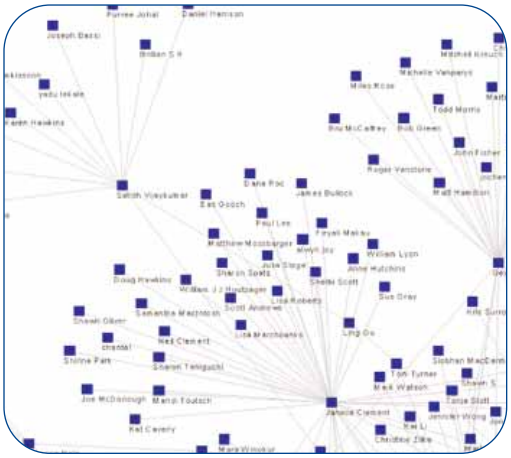
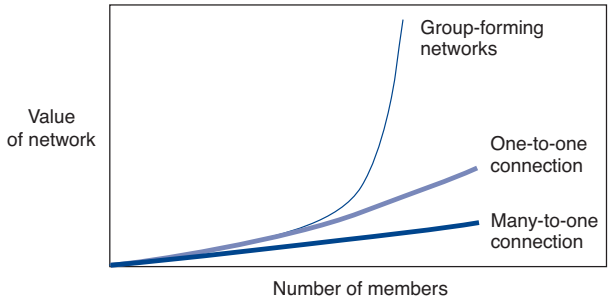


Figure 3
The value of group-forming networks greatly exceeds one-to-one and many-to-one networks



Source: David Reed. That sneaky exponential—beyond Metcalfe's Law to the power of community building. *Context* (Spring) 1999.

Opportunities for Strategists

- **New IT strategies.** Technologies of cooperation fundamentally challenge the basic IT strategies that have dominated organizations over the last 50 years. Narrow-platform standards and organizational firewalls are replaced by inter-operability standards and point-to-point security. Distributed computation such as SETI@home or folding@home, mesh networking, grid computing, and ad hoc self-organized microsensor networks all represent a convergence of microelectronics with cooperation and collective action.

- **Design and use of tools.** Understanding the social and economic value of cooperative tools—and the design principles that favor cooperative behavior—can inform the design and use of all kinds of tools, enhancing not only their diffusion in the marketplace but also their ability to serve as machine partners in solving pressing social problems.

- **Bandwidth policy decisions.** A key to the future of both technology and cooperation is the allocation of radio spectrum. A vibrant Open Spectrum movement is combining new technical capabilities with a radical rethinking of the intellectual property foundations of spectrum regulation. (See the "Commons" lens, on page 20 for details.)

- **New human capabilities.** As mentioned, technologies of cooperation extend the social self, redefining not only the capabilities of individuals to act and think together, but also challenging our basic concepts of ourselves and what it means to be human. They allow us to participate consciously in our own evolution.

KEY PRINCIPLES

- Media innovations that enable humans to communicate in new ways, at new paces, and among larger and more selective groups tend to spawn new forms of collective action.
- Reputation is the lubricant that makes large-scale cooperation among strangers possible.
- Automated collaborative-filtering systems (such as Amazon's recommendation system) work best when there is a low risk of making a bad decision; as the risk increases, so does the need for sophisticated reputation systems.
- Group-forming networks grow exponentially.
- Larger scale networks tend to support new categories of cooperation and competition.
- With mesh networks, the effectiveness of the network increases as the number of users or nodes increase.
- Cognitively cooperating devices eliminate the need for a central connectivity infrastructure by serving as an infrastructure for each other.

THE COMMONS

goods, resources, or property owned by no one but available for use by everyone

In 1968, Garrett Hardin published his now-famous paper in the journal *Science*, entitled "The Tragedy of the Commons." The paper described a particular form of social dilemma that arises when goods and resources are owned in common and there is no easy way to punish overconsumers or undercontributors—a classic Prisoner's Dilemma form. Hardin argued that the commons would inevitably be plundered by over-consumption and failure to replenish. From the perspective of economists, the fate of the commons is thus a key focal point for cooperative studies.

An important driver in a number of recent studies has been evolution of technology, which has created a number of new commons and a host of behaviors that don't seem to follow classic economic laws—or accommodate conventional business models. The result has been new insights into alternative forms of property ownership and management, commons-based production practices, and even new theories of economic behavior.

Property Regimes and Payoff Structures: The Creation of Wealth

The commons is one of several property regimes that are defined by Peter Kollock in terms of two dimensions: the extent to which a resource's use is restricted (excludability) and the extent to which one person's use subtracts from another's use (rivalrousness). (See "Resources" on page 37 for a detailed discussion of these dimensions and their associated property regimes.) Each of these regimes has unique payoff structures; each can, in a different way, be the source of wealth creation. The common-pool resource is particularly important from the perspective of cooperation, however, because it represents a social dilemma whose solution could open vast new opportunities for innovation and creation of wealth. It is the most promising source of sustainable economic growth in the coming decades.

Commons-Based Peer Production: Organizing for Quality

One of the most interesting innovations to result from the Internet is the Open Source movement—a form of commons-based peer production. Conventional business theory says that production is organized in one of two ways: entrepreneurs and managers decide or the market decides, and the transaction costs drive the choice between the two. But Yochai Benkler identifies open source style peer production as a third alternative: work is organized by distributed individuals who cooperate on an ad hoc basis to get good results.

The ideal form for a peer-production system is an almost infinitely large pool of people (or devices), each donating time to an almost infinitely small task. A review system assures the overall quality. Jay Walker has extended this concept to a security and intelligence proposal in which members of the network are asked to watch ten minutes of surveillance camera feed per day. (See the "Collective Intelligence" lens on page 27 for a discussion of the quality of results from many small contributors.)

Network Economies: Suited to an Interdependent World

Benkler takes his thinking a step further and suggests that open source is an instance of a larger fundamental economic form, different from the two traditional economic institutions of hierarchical firms and open markets. He claims that this form is the most likely to succeed in situations where obligations and reputations have become entangled to the point of interdependence; where it is not easy to measure the qualities of the items exchanged; and where relationships are long term and recurrent.

Cooperative Actors: Beyond Rational Self-Interest

One of the key questions that arises in peer-production networks and commons-based economies is, "Why do people contribute?" Eric Raymond argues that it's a gift economy in which the players are wealthy enough to do it for status, not money (and in which the status associated with freely-given innovation can lead to future wealth, in which reputation serves as brand). Benkler argues that the organizational form itself explains the motivation: people do it simply because they can, and in fact, it actually works better when people don't know each other (so status isn't a consideration).

Opportunities for Strategists

- **New business models.** The most enduring successes from the dotcom era are the companies that figured out how to create wealth from commons-based economies. An obvious example is eBay, but Amazon, Google, and other companies that incorporate volunteer or automatic referrals have also endured—and prospered—because they found the right balance of cooperative and competitive behaviors, the right blend of commons and private goods. Understanding the principles of the commons will allow firms to develop more sophisticated business models that take advantage of emerging network economies.

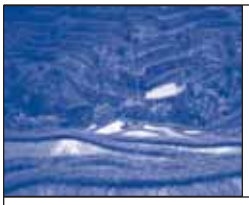
- **New structures for workplace relationships.** One of the emerging characteristics of network economies is that their members appear to identify more strongly with their peers than with their employers. They share competitive information and resources across organizational boundaries, and favor the integrity of their work over the integrity of their workplace. While these behaviors pose challenges to traditional organizational forms, they also point to new ways of organizing work that's well suited to an increasingly interdependent global production network.

- **Growing global wealth.** Many of the resources of the virtual world appear to be evolving as common-pool resources. At the same time, the depletion of natural real-world resources makes it crucial that humans figure out ways to manage these resources for the collective good. Fortunately, these commons based approaches to both soft and hard resources do not rule out wealth creation and innovation in private goods. Rather they may provide a platform for extended growth, both for the individual and the whole.

- **A choice of property regimes.** An explicit exploration of the benefits and costs of commons based systems, as well as the best practices for managing them, will ultimately lead to a wider choice of property regimes. This choice, in turn, has the potential to resolve many of the dilemmas—economic, political, and social—that are imposed by an over-commitment to one or two forms of property ownership and management.

KEY PRINCIPLES

- Tragedy is not inherent in the commons but rather can be overcome by effective management via well-designed institutions for collective action.
- Property regimes must be customized to individual contexts; there are no simple rules for matching property regimes to different types of resources.
- Commons-based peer production systems don't have to be tuned for particular motives; they can accommodate a wide variety of motives.
- Self-interested individuals maximize their own utility.
- The perception of potential gain lowers the barriers to cooperation if there are ways to punish free riders and reward contributors.
- The ability to identify a resource within multiple social contexts at the same time makes the resource more valuable.
- Digitization can make knowledge resources excludable, shifting them from the common-pool resources to private goods. This can, in some cases, endanger wealth creation, as in the increasing privatization of scientific knowledge.
- Digitization can also make certain forms of intellectual property non-excludable—hence the current debates over technologies for digitally copying music and film.



COLLECTIVE ACTION

a result of applying methods and mechanisms for aligning the interests of diverse individuals to resolve complex nested social dilemmas

Social dilemmas dominate the way sociologists and political scientists have thought about cooperation. As Peter Kollock has pointed out, much of the thinking in this field has been shaped (sometimes to the exclusion of other important perspectives) by three main metaphors: the Prisoner's Dilemma, the problem of providing public goods, and the tragedy of the commons.

Cooperation in the context of a social dilemma is often framed in terms of collective action, and luminaries like Elinor Ostrom, Mancur Olson, and Kollock himself all offer insights into the conditions under which collective action effectively resolves the conflict. Kollock further divides solutions into those that motivate individuals to play by the rules and those that change the rules. Institutions for collective action are ways to change the rules; accountability, loyalty, and trust are motivational variables.

DESIGN PRINCIPLES FOR COLLECTIVE ACTION

Elinor Ostrom offers seven design guidelines for collective-action institutions:

- Clearly define group boundaries
- Match rules for resource use to local needs
- Allow those affected to modify the rules
- Support mutual monitoring on individuals
- Enforce graduated sanctions
- Provide low-cost conflict resolution
- Build in multiple layers of governance

Institutions for Collective Action: Obstacles and Structures

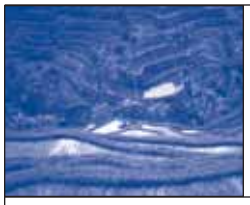
Empires and democracies, science and capitalism are all the result of the largely unconscious evolution of institutions of collective action. Ostrom has taken the lead in making the management principles for these institutions explicit, combining theory and empirical observation of real-world commons such as irrigation districts in Spain, forestry-dependent villages in Japan, and informal arrangements among Maine lobstermen. She is emphatic that in order for any given commons to succeed, it must be managed by an institution for collective action that can overcome the obstacles to collective action.

Accountability: Free Riders and Monitors

Because public goods are non-excludable (see the "Commons" lens on page 20), it is easy for free riders to take from the commons without contributing to it. Some researchers try to understand the social-value orientation of the individual—whether innate or conditioned—as a way of understanding the problem of free riders. Others focus on the group-level antidote: monitoring and sanctioning. Monitoring and sanctioning are keys to success of cooperative strategies, but they exact a price—the cost of coordination. In fact, coordination costs may be obstacles to organizing cooperative strategies in the first place. Thus, lowering coordination costs is essential to building successful cooperative strategies. For example, in Ostrom's study of water-use arrangements in the Los Angeles basin, an outside institution (the U.S. Geological Survey [USGS]) was charged with monitoring, among other things, the salinity level in private wells; this arrangement lowered the coordination costs to make it possible for the many water users in Southern California to organize institutions for managing water use for their common good.

Loyalty and Trust: The Role of Group Identity

Kollock underscores the importance of group identity in the success of collective action and the motivation of individual cooperative behavior. He found that social dilemmas were consistently treated as Prisoner's Dilemma games when the partner was an out-group member, but as Assurance games when the partner was an in-group member. That is, instead of adopting self-protective strategies that result in less-than-optimum outcomes for everyone, individuals adopt cooperative strategies when they trust that others will do the same, producing greater benefits for everyone. He also points to the striking positive correlation between group communication and cooperation, noting that, among other benefits, communication strengthens group identity. Both group identity and communication appear to trump group size, which has traditionally been thought to be a limiting factor on cooperation: in the absence of a strong group identity and communication, cooperation tends to decline as group size increases, as Mancur Olson famously claimed.



COLLECTIVE ACTION

KEY PRINCIPLES

- Dynamic creation of roles in institutions, as opposed to reliance on fixed historical roles, improves cooperation.
- Local contracts among resource appropriators work better than distantly enforced rules, but only if there are low-cost and fair means for dispute resolution and for monitoring free-riding.
- Cooperative behavior increases when interactions are repeated over and over among the same groups and communication is permitted.
- Understanding the abstract dynamics of making agreements about solving common-pool resource issues is critical.
- The threshold for cooperation in interpersonal relationships is a "rejection ratio" of 1 no to 3 yeses ; greater than that, cooperation begins to fail.
- Reducing coordination costs and benefits improves cooperation.
- People in Prisoner's Dilemma games are only stymied if they think of themselves as prisoners.
- Making group identity more perceptible increases cooperation.

Opportunities for Strategists

- **Collaborative and cooperative guidelines.** Collective action provides a fresh lens on ways to structure and manage organizations—both large and small, public and private—to foster collaborative and cooperative behavior. In particular, it gives us a more sophisticated analysis of resources and property regimes for managing wealth creation.

- **Strategies for sustainability.** One of the biggest challenges facing communities and corporations alike is the sustainability of environmental resources. The guidelines that are emerging from studies of collective action are directly applicable for developing policies and practices that protect those resources for current and future use—without resorting to politically unpopular and expensive central state regulation.

- **Reduction of inequality.** Collective action can be a remedy for Power Law distributions of wealth and access to resources—for both hard resources such as water and soft resources such as information and computing power. The design guidelines that are emerging from this research can inform, in particular, the design and management of nongovernmental organizations (NGOs).

- **Laws and governance structures for common-pool resources.** At a time when privatization of resources is a growing trend, the principles of collective action provide empirically based guidelines for developing laws and governance structures that promise to effectively manage critical resources as common-pool resources—perhaps better than privatization or state regulation.

COLLECTIVE INTELLIGENCE

the ability of groups of distributed actors to solve problems that none of the individuals alone could solve

At the intersection of cognitive psychology, mathematical sociology, and artificial life is a growing inquiry into the processes by which individuals with imperfect and incomplete information can collaborate to solve complex problems. Using agent-based modeling and other artificial intelligence methods, authors like Eric Bonabeau, James Kennedy, Russell Eberhart, and Mark Millonas have replicated the cooperative behavior of insects and birds, assuming lots of relatively unintelligent actors follow simple rules of interaction.

Out of this work is emerging a clear sense that, as Bonabeau claims, "thinking is a social process." Combined with social-psychological insights about the roles of group identity and emotions in cooperation—as well as new technologies of cooperation—these studies promise innovative approaches to complex problem solving, from production scheduling and resource allocation to political organizing, and even to predicting events in certain domains.

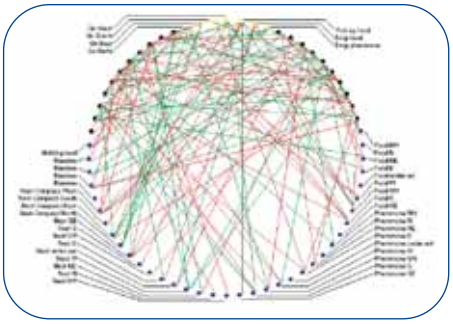
Artificial Life: How Insects and Birds Do It

Artificial life has borrowed from the behaviors of ants, bees, and birds to provide several biological metaphors for computer programs that seek to optimize human systems. For example, the ants' pheromone trails have provided basic concepts of evaporation and reinforcement to guide programmers in solving such problems as telecommunications architectures and shortest shipping routes. Kennedy and Russell showed that flocking metaphors can provide algorithms that achieve "the delicate balance between conservative testing of known regions versus risky exploration of the unknown." In addition to solving specific problems, these programs demonstrate the clear advantage of bottom-up decentralized solutions over top–down planning for many kinds of complex problems. The authors acknowledge, however, that they are inadequate tools for deep reasoning.

COLLECTIVE INTELLIGENCE

Smart Mobs and Knowledge Collectives: The Tools of Global Intelligence

In his book *Smart Mobs*, Howard Rheingold has explored the many ways that large groups of strangers are using mobile Internet access to act in concert, often bringing about revolutionary solutions from political organizing to scientific breakthroughs. In addition to mobile peer-to-peer computing and ad hoc knowledge sharing, Rheingold points to a variety of new knowledge collectives, including Wikipedia, Amazon, OhmyNews, SourceForge, and Slashdot. Wikipedia is a particularly interesting experiment in distributed knowledge creation and management: volunteer contributors from around the world have created a free encyclopedia with over 500,000 articles. It includes open public editing plus archiving by wiki collectives, who protect the integrity of the public good from individual vandalism by making a complete revision history accessible to all.



ant neural net

Emotions: The "Strategy of Affect"

Daniell Fessier and Kevin Haley have focused on what they call the "strategy of affect," citing evidence that—in addition to being the subject of sonnets and the blues—emotions are a way of thinking that co-evolved with the increasing sophistication of human group formation. Emotions provide a nonrational means of bonding, trusting, judging, and monitoring that enables people to break out of the Prisoner's Dilemma and find ways to cooperate on mutual enterprises. Taking an evolutionary biology approach to the subject, Fessier and Haley claim that panhuman emotions are adaptations crafted by natural selection to enhance cooperative behavior.

Opportunities for Strategists

- **Rapid problem solving.** Collective intelligence promises to provide an increasingly sophisticated set of strategies for solving complex problems in a hurry—and even in real time. These problems may range from traditional business problems such as resource allocation and market clustering to pressing human and environmental issues, particularly in the arenas of community disease management and sustainable development. However, don't overlook the entertainment value of this work as well: already worldwide game cults are collaborating to solve complex, computer-generated puzzles.

- **Distributed smart systems.** The biological metaphors for collective intelligence are advancing the fields of artificial life and artificial intelligence to provide distributed systems that can make increasingly sophisticated decisions. As communications and sensing capabilities are increasingly embedded in physical objects, we might expect these formerly inanimate objects to begin to engage in social behaviors.

- **New knowledge-creation processes.** The creation and management of organizational—and societal—intelligence is likely to undergo a major paradigm shift as tools, processes, and people are connected in novel ways. Certainly, Web logs have already created a bottom–up collaborative knowledge base of an entirely new kind. And though tainted by an overzealous intelligence agency, experimental markets (as explored by Bernardo Huberman) may prove to be a very efficient way of gathering and sifting through complex "weak signals" to identify important trends or insights.

- **New public-policy processes.** Public policy is perhaps one of the most difficult kinds of collective intelligence to build, often devolving into battles for control of public opinion rather than the pursuit of policies that truly resolve the dilemmas at the core of policy issues. The intersection of cognition, emotion, information, and communication is a rich territory for discovering new ways to convert Prisoner's Dilemma situations into Assurance games.

KEY PRINCIPLES

- Autonomous, self-sufficient actors, following specific rules of interaction, can provide nearly optimal, flexible solutions to complex problems better than centralized, preprogrammed approaches.
- Human experimental markets can be better forecasters than any of the individuals who participate.
- Distributed intelligence systems tend to provide a ready backlog of alternative solutions if one fails or becomes untenable.
- Collaborative searching outweighs the competitive selection whenever the resource is unpredictably distributed in patches.
- Collective identity is a cyclic process in which people immerse themselves in a group and the group emerges out of the immersive experience.
- The balance between public and private knowledge is a key variable in maintaining cooperative patterns.

Organizational Choices: Seven Ways to Tune Up for Cooperation

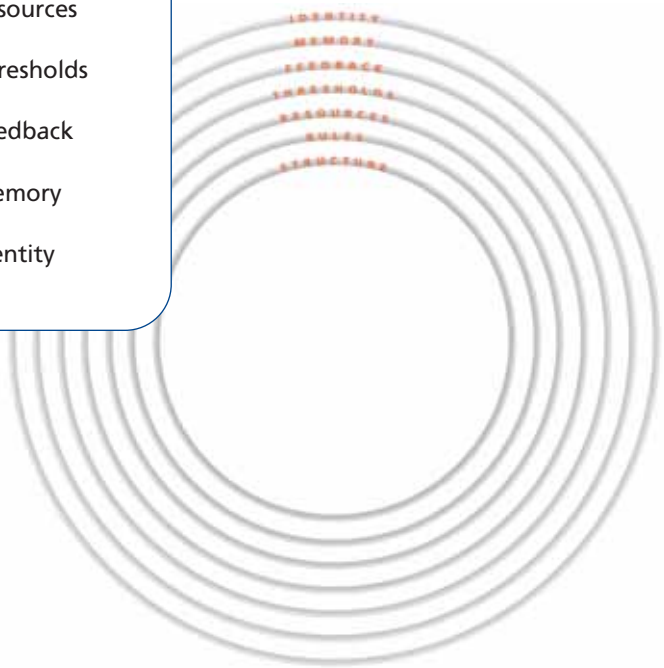
The cooperation lenses of the previous chapter provide a number of different disciplinary viewpoints for thinking about cooperative strategy. But if we also look across disciplines, we begin to see cross-disciplinary clusters of behaviors and concepts that help us understand the dynamics of cooperation and collective action—and may ultimately inform our strategic choices.

We can think of these clusters as levers that we may, at some point, be able to use to tune cooperative behavior in groups, organizations, and communities. We have identified seven such levers.

Each of these levers may be tuned along a continuum. For example, resources can be tuned along a continuum from public to private; feedback may be tuned along a continuum from local to systemic. Not all of them, of course, apply in all contexts. And some disciplines also place more emphasis on—or provide more insight into—some levers than others. For example, synchrony may be intimately tuned to key thresholds while collective action may be more closely tuned to identity. Also, these levers are not all present in all organizational forms.

LEVERS

- Structure
- Rules
- Resources
- Thresholds
- Feedback
- Memory
- Identity



Organizational Choices: Seven Ways to Tune Up for Cooperation

In this chapter, we look at what the findings from the various disciplines suggest about how to use these levers to improve cooperative behavior. Again, however, we caution that we are presenting a thinking tool, not an engineering tool. The seven levers are, at this point, merely a framework for diagnosing and probing the dynamics of cooperation—a way to begin to deepen our understanding of the dimensions of cooperative strategy.

EXPERT PANEL

Our discussion of the tuning levers for cooperative behavior and collective action was informed by the insights of an expert group, including:

Lada Adamic, Information Dynamics Lab, Hewlett-Packard Laboratories

Gene Becker, Strategic Programs Manager, Hewlett-Packard Laboratories

Glenn Brown, Executive Director, Creative Commons

Ben Crow, Associate Professor, Sociology Department, UC Santa Cruz

Jim Herriot, CEO, Herriot Research; Vice President, Science, Bios Group, Inc.

AnnaLee Saxenian, Dean, School of Information Mgt. & Systems; Professor, Dept. of City & Regional Planning, University of California, Berkeley

Susan Spath, Cyanograph

Jim Spohrer, Director, Almaden Services Research, IBM Almaden Research Center

John Stautner, Managing Partner & Founder, Essential Technology Solutions, LLC

Fred Turner, Assistant Professor, Dept. of Communication, Stanford University

Gregg Zachary, Journalist

STRUCTURE: STATIC ↔ DYNAMIC

Structure refers to the configuration of human and non-human actors and processes in an organization, and their inter-relationships. Structures range from static (for example, the "org chart" of traditional hierarchical firms) to dynamic (such as peer-to-peer networks, ad hoc group formation, or auction markets). Structure allows individual actors to visualize and comprehend a system in its whole.

In a way, multiple structures within an organizational system provide snapshots of the system as a whole, based on different perspectives (including reporting relationships, resources flows, information, message flow, identity and reputation, and so on).

Microsoft's Netscan application, for example, maps the social geography of the Usenet online space providing a visual image of the structure of conversations and topics. Netscan will help Microsoft catalyze its community, peer-based support for its products by showing where user support conversations were dynamic or static.

Multiple structures can increase potential cooperation. As Jim Spohrer points out, the ability to position resources across multiple structural perspectives increases the likelihood of cooperation and the perceived value of the resources.

Structure: Shapes the Relationship of Specialists and Adaptation in a System

Structures enable cooperation among specialists and help clarify and support their fuction. Without a sense of how they fit into the larger whole, individuals may have a more difficult time assessing the benefits of acting cooperatively. Specialists benefit by knowing how interdependencies are organized.

Yochai Benkler and Steven Weber point out that open source, peer-to-peer production systems illustrate dynamic organizational structures that allow specialists to emerge through self-nomination. Contributing producers in open source software development design their own job tasks according to their passion and expertise, rather than according to externally defined job descriptions. Specialists appear and disappear in synch with the coding needs of the community.

Dynamic relationships among specialists allow groups to be more responsive to changing conditions and apply what they learn from feedback systems and persistent memory. Eric Bonabeau describes how ants are both specialized and cross-trained to switch jobs at thresholds of criticality, making ant colonies highly adaptive and responsive to external threats. Differentiation of roles (into specialties) tends to improve cooperation, but as projects and contexts change, demand for different specialties also changes, creating a need for dynamic management structures or market signals. Considering the effectiveness of structure, John Arquilla argues that flexible networks are highly adaptable and are the only structures that can effectively compete and win against other networks.

STRUCTURE: STATIC ↔ DYNAMIC

Key Questions to Ask

- How do ad hoc groups self-organize within your organization, and what are the barriers to their formation?
- How do static and dynamic structures effect the performance of distinct corporate functions?
- How can open source, peer-to-peer structures attract diverse specialists to cooperate?
- How would job responsibilities, career paths, and training and professional development change in a more dynamic organizational structure?

Rules provide a framework for interaction in a cooperative system; they set a boundary that delineates what constitutes acceptable behavior. In cooperative settings, rules mediate between self-interest and group interest. Governing rules shape the management and coordination of people, resources, and activities.

Rules can evolve internally according to informal group norms and moral codes or be determined by higher level, more formal regulatory mechanisms like religions, laws, contracts, and constitutions. Sometimes rules are imposed by external competitors or coercive authorities (as suggested by Thomas Hobbes's *Leviathan*). Rules are not useful unless they are enforced. Enforcement takes place through forms of mutual monitoring, internalized restraint, legal control (courts), and market mechanisms.

Rules: Frame Mechanisms for Management and Coordination

If structure frames the range of relationships among actors and processes in a system, then rules frame the scope of how they interact with each other. Rules provide a critical piece of social infrastructure that makes cooperation and collective action more sustainable. Rules help coordinate and manage individual activities in relation to the group. They serve as a shared set of reference points that orient individual behaviors and balance self interests with those of the group. Communication, monitoring, and enforcement of rules help to identify cheaters and free-riders, who benefit from everyone else's collective effort without contributing themselves, while sanctions help punish them. As John Stewart explains, levels of control and management within a group help to overcome barriers preventing cooperation between groups (lack of trust or standards for communication for example) and contribute to the evolution of more complex organization. In his analysis, managing entities become key actors who support cooperators and suppress cheaters.

Affordability of monitoring behavior and enforcing rules shapes the nature of rules (who sets and enforces rules, who monitors, and so on). The Spanish *huertas* (irrigation systems) align the collective benefits of monitoring costs with the individual benefits of self-interest: when it is your time to turn on the floodgate to irrigate your fields, it is the time for your neighbor to turn off his. This simple architectural principle in the structure of users' relationship and process lowers monitoring costs enough to provoke collective action that would not happen otherwise.

A Toyota brake-assembly plant, described in Duncan Watts' book *Six Degrees*, explains how lateral relationships among suppliers and rules for engagement that did not pit suppliers against each other to compete for lowest price supported a cooperative supply community. When the plant closed due to a fire, the supplier network helped it re-open within three days.

Rules and enforcement mechanisms are markers that guide interactions in a way that manage social dilemmas. And, as Peter Kollock points out, rules for changing rules, such as constitutions, lead to important structural solutions in some kinds of institutions for collective action that provide a degree of flexibility and evolution.

RULES: INTERNAL ↔ EXTERNAL

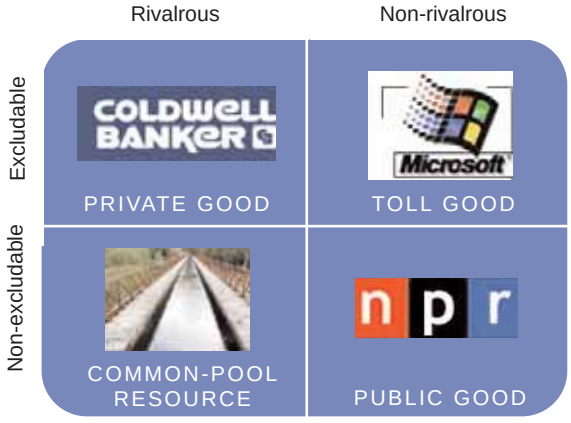
Key Questions to Ask

- What are the informal and formal rules and enforcement mechanisms within your organization?
- What is the nature of the information that supports the development and modification of rules? Who can set and modify rules?
- Who has authority in your department or organization to sanction cheaters and free riders? Is sanctioning public? How is monitoring performed—is it difficult or easy, done by a special authority, or diffused through the population? Are sanctions graduated or sharply dichotomized?
- Which rules are more appropriately formulated, monitored, and enforced by local or lateral agreement and formal or informal contract, and which are best administered hierarchically? How does this play out within your company? Within your industry?

Property regimes set up conditions and relationships that effect production, wealth creation, and innovation in different ways.

Resource regimes determine who can use which resources and how. One can think about the management of resources in terms of their excludability (access to a resource can be restricted and free-riding is easily preventable) and/or rivalrousness (one person's use subtracts from another's use) (see Figure 4). These two variables create alternative property regimes, besides private and public goods, each of which requires its own resource-management strategy. Non-excludable resources, particularly common-pool resources, benefit from management and control mechanisms by protecting them from use by free riders who do not contribute to maintaining the resource. Public goods, such as public radio or TV, may be able to tolerate free riders because they are non-rivalrous. Commom-pool resources, on the other hand, such as clean air and water are rivalrous and abuses deplete or destroy them. In this instance, social, moral, and legal institutions are critical to the sustainability of the common-pool resources.

Figure 4
A framework for cooperative strategies



Source: Institute for the Future

Resource Regimes: Shape the Extent of Collective Experimentation and Innovation

The significance of identifying public and private resources and their management structures is related to the way that they shape the creation of innovation and wealth. The rate of innovation depends on the degree to which diverse populations can build on others' work. By making a resource excludable the range of potential benefits and innovations may not fully be realized. However, commercialization has become an important driver for exploiting and disseminating new ideas and innovations. Indeed, the processes of making private resources public and of privatizing public resources enable a mix of property relationships that create a wide range of incentives for and forms of cooperation and collective action. The key is to understand which property regime is appropriate for a particular situation—there is no general formula for determining this, as Ostrum and Hess warn.

The Internet is a public good, a resource that no one owns yet everybody uses, from which significant private wealth has been generated by entrepreneurs such as Bill Gates and companies such as Google. Its privatization may curtail the open creative uses by diverse users, thus stifling innovations that otherwise would create even more benefits and wealth … and more innovation.

RESOURCES: PUBLIC ↔ PRIVATE

Scientific knowledge is a public resource facing pressures of privatization. Forces of excludability (increasingly high cost of scientific journals, private corporate ownership and investment in research labs, among other pressures) are effectively closing the traditionally public commons for scientific and medical knowledge and limiting the benefits of discovery to a few.

The open source, peer production of software (e.g., Linux) has offered an alternative way of collectively building and maintaining a public-good resource base. Open source rests on the premise that users may take from a public resource (computer code in the case of Linux) and modify it, as long as the modification remains in the public good, through a general public license. This has sparked other open source production movements (open source science, open source intelligence, Wikipedia, and the Open Archives Initiative). Open source explores a new ground of public and private ownership that expands public access yet does not constrain private benefit.

Key Questions to Ask

- How do models of resource access or ownership affect the nature of sharing, communication, and innovation in your organization? What incentives do these models create in your work setting?
- What resources in your company could become more valuable (and generate wealth) as common-pool resources?
- Are any resources in your organization treated as rivalrous when they aren't actually? Are any resources treated as excluded when they need not be?
- Where would open-source licensing regimes (such as the general public license) stimulate innovation?

Thresholds reflect transition points in the status of resources, organizational systems, and in the behaviors of actors within systems. Thresholds can act as triggers and valves that set cooperative behavior in motion or suppress it.

For example, the perception of potential gain can lower the threshold to participate in groups that practice cooperation. Threshold points exist across a variety of variables including: social cost, financial risk, time investments, identity or reputation risk, group size, network density, level of trust, extent of role specialization, level of coordination or management, and level of feedback and information available. When certain levels are reached among these variables, new behaviors are set in motion, sometimes changing the nature of the system. Threshold points may be low or high, and may be different for individuals than for the entire system. Thus, new behaviors and system phenomena occur at various times and under changing conditions over the life of the organization. Identifying the relationship among threshold points that trigger cooperation and collective action is an important element for understanding the evolutionary trajectory of cooperation in different organizations.

Threshold Points: Signal Evolutionary Markers of Cooperative and Collective Behavior

Tracking and managing threshold points can shape the nature of cooperation and the evolution of a system. In a sense, thresholds represent time and progress of a system (however small or big). Low thresholds may indicate rapid change while high thresholds would signal slower change.

For example, Strogatz and Watts show that cascading behavior in scale-free networks—that is, the sudden disproportionate growth in a behavior such as a fad or epidemic—occurs when network density reaches a certain point. If the system becomes too dense, cascading behavior stops. If every node is only connected to immediate neighbors, cascading will not occur; if some nodes are highly connected and furnish remote connections for local nodes, cascading can occur; if every node is connected to every other node, cascading can be inhibited.

As systems change, new kinds of thresholds may emerge, indicating new dynamics and relationships. Thus, measurement of thresholds to understand cooperation will evolve with the system itself.

Key Questions to Ask

- What are some critical thresholds in your organization that trigger systemic behavior change?
- How can corporate communications media stimulate bottom–up connectivity. For example, blogs and blog indexes could furnish bottom–up connectivity where it doesn't presently exist, creating new links among people and resources.

FEEDBACK: LOCAL ↔ SYSTEMIC

Feedback is a way of describing the knowledge horizon of actors in a system in which cooperative behavior emerges. It frames the information context within which actors make sense of the interactions, events, and people they experience, and ultimately the possibility and value of cooperation itself. It also serves a real-time and asynchronous coordination function, enabling individual actors to tune and retune to one another in order to achieve collective objectives.

Feedback represents the flow of information throughout a system in which cooperative behavior or collective action manifests. Several factors contribute to local or systemic information flows, including network size, affordability, ownership (private or public), technical compatibility for accessing and interpreting information, existence of information (whether someone collects it or it is generated in a system), perceptions of usefulness, and quality.

Feedback: Shapes the Extent of Contextual Awareness

Actors within an organization may be more or less likely to cooperate depending on the span and scope of their knowledge. For example, individuals may be more likely to cooperate with someone they know (social and emotional proximity) or if the benefits of cooperation are linked to local interests.

In *Governing the Commons*, Elinor Ostrom describes how expanding the level of feedback to include information about the broader status of a common-pool resource and about others' behaviors toward it can improve its collective management. She illustrates how systemic information provided by USGS about the salinity of shared aquifers had a positive impact on the behavior of individual water users. A farmer may know if he or his neighbor is pumping salt from their wells to their fields, but may not know if everyone else is too. Left to themselves, the water users would not have done a comprehensive study because of a second-order dilemma—who pays for the research? In this instance, the USGS had born all the costs of this crucial feedback, and thus made collective action more likely. By expanding systemic feedback, individual awareness grows and decisions can be made in a larger context. So, local and systemic feedback can shape the decision tracking of individual actors in a system by increasing of knowledge about the intentions of others and the likely payoff for cooperating

Key Questions to Ask

- What mechanisms create feedback in your organization?
- What new feedback loops have communication media introduced in your organization?
- What are the economics of feedback in your organization?
- Where are there local and systemic feedback flows in your organization? How do they interact?
- How do local and systemic flows of information shape the possibility for cooperation in your organization?
- Where do the coordination costs of developing systemic feedback act as an obstacle to greater wealth-producing institutions?

MEMORY: EPHEMERAL ↔ PERSISTANT

Memory is a form of stored knowledge. Some memories are more ephemeral (a message on a Post-It note) and may be useful for only a short time, while more persistent memories (archived documents, historical databases of purchases, voting records, health records) create a long-term record of choices and interactions.

Memory can be made more explicit and shareable—and thus useful for organizing cooperative activity—by articulating it in codified forms such as written documents, art, storytelling, reputation systems, or pheromone trails.

Memory: Creates the Basis for Generative Systems

Memory allows actors in a system to create a context of experience that can guide their present and future actions. Memory encourages participation in collective action by helping to build reputations, provide metrics of a group's past performance, and by generating new perceptions of possible payoffs of cooperation. By providing individuals and groups with a basis for evaluating future outcomes, memory enables individuals and systems to generate alternatives and possible scenarios about the future.

Rating systems, such as feedback ratings and the "Power Seller" icon in eBay, provide potential buyers with a long-term record of sellers' past transactions. These reputation markers are persistent signals to buyers that shape the nature of eBay interactions. Less automated bookkeeping strategies help kin and in-group members remember who reciprocated in the past and deserves reciprocation in the future.

Memory is also essential for modeling the future. This provides an important impetus to evolutionary processes, according to John Stewart in his paper "Evolutionary Progress" and in his book *Evolution's Arrow*. Modeling the forms and outcomes of cooperation is a way for individuals to learn cooperative practices and their value in different contexts. Robert Axelrod notes that enlarging the "shadow of the future" can stimulate cooperation between individuals who otherwise would be tempted to compete.

Ant pheromone trails illustrate a kind of group memory, albeit more ephemeral. As ants lay down a trail of pheromone (a volatile chemical that can be sensed at a distance and over time, grows in strength as it accumulates from many individual contributions, but also evaporates over time), it acts as a record to other ants about possible trails to food or around obstacles. The various marked trails provide alternative routes as specific ones become impassable or blocked—or disappear. As the pheromone evaporates, the group's memory effectively shrinks and the number of possible trails decline requiring the ants to innovate new paths.

In a digital world, Wikipedia systems save all revisions to wiki pages; similar mechanisms are used in software coding where memory of alternative solutions provides the next best coding alternatives.

THRESHOLDS: LOW ↔ HIGH

Key Questions to Ask

- What forms does memory take in your organization?
- To what extent is memory shared and shaped by members of the organization?
- In what new contexts can memory be used to generate alternative pathways to cooperation?
- What forms of memory in your organization act to inhibit innovation, like pheromone paths that fail to evaporate?

IDENTITY: INDIVIDUAL ↔ GROUP

Identity is at the core of many human and biological systems in which cooperative behavior and collective action emerge. Reputation (enabled by persistent identity), trust (people trust similar others and others whose past behavior has proved trustworthy), and affiliation or membership (identifying with a group expands individual identity and infuses it with a collective aspect) are all manifestations of identity that affect cooperation.

Individual identity is multifaceted, each facet reflecting its own strength, payoff, dues, and currency in broader social contexts. Indeed, individual and group identities are symbiotic. Group membership, for example, influences individual identity ("I"), while giving shape to the collective ("we").

Several mechanisms help create identity: language, past performance, clothing or plumage, diet, physical characteristics and body alterations, workplace, type of work or craft, philosophies and values, and many other implicit and explicit signals to others.

Identity: Creates a Basis for Affiliation, Trust, and Loyalty

Identity is a way to express personal values, intention, and trustworthiness to others and thereby signal the likelihood of cooperation. Individuals are more likely to cooperate and act in concert with others if there is a way to connect with others through a facet of identity. Shared language, for example, is a way to increase communication and create a sense of group identity that may increase trust levels. As Fred Turner suggests, "contact languages" between distinct groups are one way to build a common ground for discourse, which may lead to shared thinking and ideology, further strengthening group identity.

Peter Kollock argues that group identity is a key factor shaping collective action in order to solve social dilemmas: "Indeed, group identity can have such a powerful effect that it can influence rates of cooperation even in the absence of communications." He continues to suggest that mechanisms that make group identity more perceptible are likely to increase the rate of cooperation. As he explains, both identity and identifiability (the ability of those who identify each other as potential cooperators to communicate with one another) are the variables that control the capability of cooperative strategies to emerge in a competitive environment.

Key Questions to Ask

- What are the mechanisms that signal identity in your organization? How do they shape identification with group activities?
- Is your organization flexible enough to support employees' multifaceted identities and their ability to express those identities?
- Do your company's communications culture and work processes support reciprocity and learning about past performance?

What to Expect: Opportunities and Disruptions

The emerging inter-discipline of cooperation studies clearly suggests many opportunities for businesses and communities alike to develop more sophisticated, more robust, and ultimately more profitable strategies of cooperation.

When we look across these opportunities and think of some of the fundamental dilemmas that businesses face, we find five key areas of potential innovation—and disruption—to business as usual.

- Knowledge-generating collectives
- Adaptive resource management
- Collective readiness and response
- Sustainable business organisms
- Peer-to-peer politics

In this chapter, we briefly examine these innovations, looking for early indicators of how they will evolve and considering the implications for today's business decisions.

KNOWLEDGE-GENERATING COLLECTIVES

Knowledge-generating collectives are bottom–up systems of creating knowledge that value individual expression and emotional content. In essence, they form the basis of an innovations commons for organizations. Developing knowledge-generating collectives requires a shift from considering knowledge as a private resource that aids competitive advantage to considering knowledge an open resource that is developed collectively for future wealth creation. Thinking about knowledge as a commons in this way has direct implications for how teams, organizations, and business alliances define their boundaries, functions, and offerings in the marketplace.

The Dilemma: Individual Contributions Versus Collective Value Creation?

This dilemma is well known in today's knowledge-oriented organizations. Without clear payoffs and strong incentives, individuals are reluctant to share private knowledge and contribute to a collective pool of organizational knowledge that might stimulate innovation. Open sharing of personal knowledge for the good of the group remains an organizational challenge. Corporate knowledge-management systems tend to focus on the structure and access to codified knowledge rather than on the social underpinnings of knowledge creation and sharing. Organizational structure often creates silos of knowledge that become difficult to integrate and synthesize, thus constraining possible new connections and ideas.

Early Innovations

Wikis, blogs, and code repositories. Several innovations in online tools are creating new infrastructures for knowledge-generating collectives. Wikis, for example, are easy-to-edit Web pages than enable groups to edit the same document, creating huge and self-correcting knowledge repositories like Wikipedia (http://www.wikipedia.com). Every day, hundreds of contributors from around the world make thousands of edits and create new articles. In January 2001, the site had 213,062 articles: by early 2004 the total had surpassed 500,000. By making the complete revision history accessible to all the cost to repair malicious damage is low. This could be a key to other kinds of knowledge-generating collectives.

Web blogs—personal Web pages that are updated regularly with posts in reverse chronological order and linked to other Web content—are an alternative method of establishing legitimate knowledge bases that are created and vetted by community members.

SourceForge.net is a large repository of open source code and applications that are available on the Internet for free to open source software programmers. SourceForge.net provides free hosting to over 80,000 open source projects as well as tools and services to help developers control and manage their software development.

IMPLICATIONS. Watch for communities and collectives to emerge from social groups with shared interests inside and outside your organization, generating new ideas, solutions to shared problems, and tools. Many knowledge collectives may cross company, hierarchical, functional, disciplinary, and geographic boundaries and challenge traditional information flows and formal processes for evaluating and vetting ideas—as well as raising legal and policy issues.

Reputation systems. The formation of social groups for collective action often relies on systems that mediate trust and reputation. eBay, dominant survivor of the e-commerce bubble, uses a reputation system to facilitate billions of dollars worth of transactions for people who don't know each other and who live in different parts of the world. Epinions pays contributors of the most popular online reviews of books, movies, appliances, restaurants and thousands of other items. Epinions' reputation system enables people to rate reviewers and other raters through "webs of trust." The most trusted reviewers make more money. Slashdot, Plastic, and other self-organized online forums enable participants to rate the postings of other participants in discussions, enabling the best writing to rise in prominence and objectionable postings to sink.

IMPLICATIONS. Internal community systems that mediate trust and reputation are a positive sign for cooperative knowledge sharing. Be flexible with formal policies so as not to threaten community trust and reputation mechanisms. If possible, look for areas where formal processes can serve as low-cost, accepted mechanisms for resolving disputes that exceed the capacity of local community mechanisms.

Appropriation of art and media. As media tools become increasingly accessible, corporate art is becoming increasingly subject to appropriation by the public. Logos, ads, music jingles, and characters/personas may all be reused in ways that challenge the carefully crafted and guarded brand identities of large companies. This process is part of a larger movement in which the public is shifting from passive consumers to co-creators of brand, often deepening the personal identification with a product or service. Innovations like Creative Commons—which provides more flexible ways of assigning copyrights than government copyright law—suggest the evolution of a new infrastructure for managing this kind of co-creation in a way that builds value from appropriation rather than treating it as a costly threat.

IMPLICATIONS. Be prepared to manage a shifting and blurry line between corporate and public art and media. This is an area where distinct property regimes (public or private good) should be evaluated carefully to create long term value.

Automated knowledge collectives. The combination of XML and agent-based systems creates the possibility of machine-generated knowledge that otherwise would not exist. The XML standards were designed to facilitate bottom-up tagging of content, ultimately eliminating the need for predefined databases. Agent-based programs can search for XML metatags in increasingly refined ways to build context-specific knowledge collections from all the tagged documents on the Web and then act on it.

IMPLICATIONS. Metatags are a form of content in their own right. At present, many groups are cooperating to define classes of metatags to facilitate knowledge exchange and creation among members of specific groups, such as health care organizations. However, metatag ownership and management could become an area of fierce competition in the future if metatags become private property

Cross-boundary communities of practice. Communities of practice have always shared a common identity. As a result of increasing communication and connectivity across borders or all kinds—especially disciplinary and organizational—employees have greater opportunities to identify with specific intellectual tasks and problems. AnnaLee Saxenian's research on Silicon Valley shows how engineers from different companies often meet to share tools and strategies to solve problems. Intellectual challenge became a powerful uniting force and binding tie among these engineers who identified more with their content than their co-workers or organization.

KNOWLEDGE-GENERATING COLLECTIVES

IMPLICATIONS. Companies need to examine their employee contracts to reevaluate the incentives and disincentives for cross-organizational sharing of knowledge. Some of the best solutions to difficult problems may come from opening up company boundaries and creating knowledge commons across companies, providing an edge for sustained innovation. Acknowledging the informal knowledge commons and reconsidering need-to-know policies will be essential to providing a knowledge commons on top of which companies can generate new wealth.

Adaptive resource management is a strategy that uses globally networked institutions of collective action to manage resources across a distributed landscape. Adaptive resource management makes use of the end-to-end principle, in which innovation and intelligence is pushed out to the edges of a network to facilitate more efficient peer-to-peer—rather than hierarchical—exchange of resources (data, media, processing power, knowledge, and so on). Resources shift from being standard inputs in a well-defined process to being elements in an ecology of rapidly changing functions.

The Dilemma: Hoarding Scarce Resources Versus Adapting to the Environment

Resource-management systems often are plan driven and cannot respond to fluctuating environmental conditions at the edges of the organization. A tension emerges between the plan, with its forecasts of resource requirements, and distributed intelligence from "smart" actors in the field. Plans for allocating labor, sourcing inputs, or managing supply chain systems often lag behind the reality—and variability—of the local systems that they must serve. Plans that rely on linear feedback (up hierarchies or multiple layers of the organization) are slow to respond to new goals, conditions, and environmental variation. Current resource managements systems treat inputs as private goods and view exclusive ownership (at the best price) as the key to maximizing profit. This strategy puts companies at odds with more open, non-exclusive property regimes (such as public goods or common-pool resources) that could provide as much or more company wealth. Adaptive resource management represents a shift in thinking from hoarding scarce resources to sharing resources to enable increasing returns.

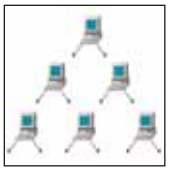
Early Innovations

Distributed processing. It isn't necessary to build more computers to multiply computation power if you know how to harvest a resource that until recently was squandered. For example, SETI@home was one of the first users of distributed processing across the Internet, also known as community computing or P2P computing. The goal is to detect possible communications from outer space, and SETI@home participants install a client software program that runs whenever the user's computer processor is idle. The client software downloads a small segment of radio telescope signals and processes it, looking for interesting patterns consistent with intelligent life. When the task is complete, the program uploads the results to SETI@home headquarters and collects a new chunk of digitized space signal to search.

Today, millions of people and their PCs are not just looking for messages from outer space, but tackling cancer research, finding prime numbers, rendering films, forecasting weather, designing synthetic drugs by running simulations on billions of possible molecules—taking on computing problems so massive that scientists have not heretofore considered them.

IMPLICATIONS. Shared processing capabilities unlock an untapped source of resources and new knowledge creation by developing collectives of amateurs as partners to professionals. Projects not otherwise supported by universities or the government may become a part of a public-knowledge commons driven by amateurs willing to share personal computing resources. This could be a driver in various other types of public-supported commons.

ADAPTIVE RESOURCE MANAGEMENT



Peer-to-peer architectures. New architectures can actually make previously scarce resources more accessible—or generate new resources. Mesh radios, for example, act as their own communication routers, sending around packets of data for the other receivers, without going through a central network; with a mesh network, the effectiveness of the network increases as the number of users increases rather than decreasing, as is the case with conventional short-range radios

A combination of Internet architecture and distributed processing may also reshape our electrical power system into an "InterGrid." The InterGrid is a proposed system in which every building powers itself as its demands require, rather than every demand depending on a centralized power station with a many-decades replacement cycle. The InterGrid starts at the edges and builds in every direction, unlike the old central grid that starts at the center and builds toward the edges. Just as centralized communications stifles innovation, so does centralized power generation.

IMPLICATIONS. The lower coordination costs of peer-to-peer connectivity will change the ability of all kinds of people to manage resources, enabling local players and non-professionals to become more sophisticated at intervening in resource use to suit their own goals and values. Simulations offer the potential for pre-testing such alternate property regimes for various resources, forecasting the ability of those regimes to generate wealth for individuals and the whole.

Global resource conversations. Current early practices of agent-based programming for factory management may presage large-scale global resource "conversations" among machines. These agent-based programs increase flexibility and responsiveness in the deployment of human, machine, and material resources to meet fluctuating conditions, such as daily and even hourly shifts in supply and demand for services and products. This model can be extended beyond the walls of local factories and organizations to include worldwide labor and resource pools. Global resources are thus likely to be increasingly managed by aware agent-based systems, with humans as occasional mediators in global production networks.

IMPLICATIONS. "Smarter" resource conversations will create new opportunities for using resources more efficiently and rapidly innovating functionality and design. However, organizational and government policies are not currently structured to keep up with the technological capability of innovation in these rapidly changing global production networks; these resource conversations are thus likely to start in pockets where policy is less developed, for example in emerging fields like genomics or computer animation.

If knowledge-generating collectives are about creating new knowledge, collective readiness and response are about new ways of making sense of complex or imperfect information. Enabled by mobile and connective technologies, individual employees are building webs of personal connection at work, extending their identities and presence across digital spaces, and leveraging the collective intelligence of social networks. In effect, they raise the individual agency of workers—their ability to take action and effect outcomes in the organization. Leadership models for effective readiness and response will recognize the growing power and voice of distributed collectives that specialize in sense making and solution generation. In a sense, readiness will become a measure of the collective, distributed intelligence of an organization.

The Dilemma: Individual Employee Agency Versus Legacy Bureaucracy

Leaders in organizations demanding flexibility and innovation must learn to identify and harness distributed employee networks that engage in highly efficient collective problem solving. Collective readiness and response indicate a shift to distributed agency.

Employee networks are nothing new. Every large organization has its share of informal networks; unions link industrial workers; and industrial regions like Silicon Valley are filled with professionals and experts who share ideas and collaborate even while working for competing companies. Thanks to connective technologies and greater job and geographical mobility, these networks can now extend across a wider institutional and geographical range, incorporate a broader range of skills, and can mobilize more quickly. These networks can be valuable sources of new ideas and flexible solutions to difficult problems, but there are two problems. First, employees may be hampered by legacy bureaucratic processes that make it difficult for them to collectively leverage their expertise and entrepreneurialism and respond to pressing company needs. Second, traditional executive management systems of knowledge work are concerned with control, risk assessment, and liability management—all of which become harder when dealing with informal networks.

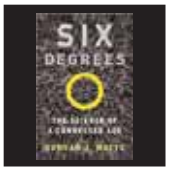
Early Innovations

Collective gamers. Entertainment media provide many examples of high-agency networks—groups of individuals who collectively take action and effect outcomes. Massively multiplayer online games such as *EverQuest*, *The Sims Online*, *There*, and *Star Wars Galaxies* require intensive cooperation and collective action for players to succeed, whether that means a successful raid on a castle or presiding over the most popular lounge in Mount Fuji.

Alternate reality games (ARG) focus on complex problem solving as the locus of play. ARGs, such as *The Beast*, *Aware*, *Acheron*, and *Search4e*, are spread across the Internet and physical space, and sometimes both. They use complex storylines, numerous characters and subplots, and thousands of media objects to populate the game. Games are designed to be solved by well-coordinated, self-organized teams. Several of these teams, such as the Collective Detectives or Cloudmakers, develop their own identity and persist beyond the conclusion of the game. The sophisticated use of communications media such as IM, chat, e-mail, and wikis, is the foundation for how players collectively identify expertise in the group and solve game mysteries.

IMPLICATIONS. New entertainment and personal media are supporting many kinds of gaming activities that provide a rich context for cooperative skill building and practice in collective action. Game environments are creating alternate realities that can offer businesses a useful immersive arena for testing strategies, policies, and for mediating crises.

4 COLLECTIVE READINESS AND RESPONSE



High-agency employee networks. The combination of pervasive personal media and social networks of trust that support collective action among employees is really a new form of individual employee empowerment. The increased agency of employees in these well-tuned networks creates new patterns of interaction and agency within and outside the organization that can lead to new sources of wealth for companies. In *Six Degrees*, Duncan Watts illustrates that the internal system of appointing temporary jury-like problem-solving task forces that cut across the org chart, together with the cooperative network of relationships among suppliers, enabled Toyota to react swiftly and adaptively when faced with a crucial challenge.

IMPLICATIONS. Empowered employee collectives offer the opportunity to develop new services based on rapid response and collective, distributed intelligence. Customer-service centers could be reframed along the lines of collective knowledge sharing principles. High-agency employee networks could provide clues for overcoming cross-department, functional barriers to sharing important customer data. Firewalls also may limit the kind of intelligence shared across networks. New approaches to the boundaries of the organization and point-to-point security protocols may replace firewalls and create a more permeable organizational membrane.

Open source intelligence. If collective gamers solve problems, and high-agency employee networks respond rapidly to new challenges, open source intelligence (OSI) groups use collective knowledge to make sense of contemporary events. The most structured OSI projects (like OSINT) apply formal intelligence analytical techniques to information gathered from periodicals, government publications, Web sites, and other non-clandestine sources. More informal projects include group blogs that analyze reports of current political and military events, or even the work of specific journalists: Robert Fisk, a British journalist who reports on Middle Eastern affairs, is such a common target of such groups that the term "fisking" was coined to describe the line-by-line analysis of his work. Other groups shade into the ridiculous: for example, Above Top Secret (http://www.abovetopsecret.com/) brings together conspiracy theorists to discuss such subjects as NASA's retouching of Mars Rover pictures to eliminate proof of advanced life on the red planet.

IMPLICATIONS. OSI is significant for two reasons. First, it suggests how much sensitive and actionable business intelligence can be gathered from public sources. The challenge today is less of acquiring useful data, but of creating analytical value from the vast quantities of available data. Second, they demonstrate the degree to which "all of us are smarter than each of us," and how loosely connected but passionate individuals can contribute expertise and experience to building reliable knowledge from varied and incomplete sources.

New forms of intelligence gathering. The insights that are emerging from social and biological mathematics are already being used to analyze weak signals from the environment and anticipate future trends and even events. For example, numerous products are already available to map and measure the social relationships of organizations. Using concepts from the works of Barabasi and Watts, these products could become routine business intelligence tools, guiding everything from internal performance evaluation of employees to external investment ratings by financial analysts who make assumptions about future performance based on present levels of connectedness in the business environment. Other innovations in collective intelligence, including gaming and knowledge markets, are also poised to change the way organizations track their business environments and solve complex problems.

IMPLICATIONS. As organizations experiment with these new forms of intelligence gathering, there are bound to be abuses. Commercialization of social capital—based on social network analysis—may not, in the end, increase the overall wealth of organizations or communities. Privacy concerns could lead new forms of deception and disinformation. Furthermore, these tools could simply set up new dimensions for competition rather than facilitating cooperation.

Sustainable business organisms are business systems that have developed innovative feedback systems and moral regulating systems that effectively lengthen the shadow of the future. Such organisms have mastered the art of group selection, developing complex cultures tuned to favor the evolution and survival of the group—which can be very broadly defined to include producers and consumers, machines, resources, and humans. By definition, sustainable business organisms look for long-term maximization of value rather than short term wins. It suggests a mind shift to business ecologies and interconnected market webs and cycles.

The Dilemma: Balancing Short Term Local Growth with Long-Term Global Viability

Competitive business practices, particularly in the United States, have tended to focus on short-term results—specifically maximization of profit in the short run, and ongoing maximization of the group's wealth. Many business metrics of wealth are specifically geared to activities that can be measured in the short term and in narrow domains, without good feedback mechanisms about the long-term global picture. Operating on a principle of finding the lowest cost input, for example, is often valued more than a long-term relationship that provides more certainty and possibly more resilience in periods of crisis. The result is a tendency toward short-sightedness and the inevitable upheavals of production, employment, and profits that it produces.

Early Innovations

New forms of capitalism. Capitalism, as a business context, is often seen as monolithic. However, as capitalism extends its global reach, three co-existing forms of capitalism are already emerging in distinct regions of the globe, each with a different timeframe as its focus and therefore with different organizational strengths. Entrepreneurial capitalism, typified by the United States, is rooted in individual entrepreneurialism and free market principles, organized around the business quarter as its main timeframe. In Europe, cultural capitalism, stresses cultural continuity and tradition, with markets operating with some regulation and a timeframe of decades. Network capitalism has its origins in Asia; it celebrates a strong, extended network of social and family ties, with a time horizon of based on generational transitions.

IMPLICATIONS. Those diverse forms will create an "evolutionary soup" for testing a variety of business practices and strategies that could lead to a better understanding of what constitutes a sustainable business organism. Strategy will be linked to different timeframes for different regions, providing an opportunity for companies to try out different business and organizational models. Sustainable practices in one region may not translate into sustainable practices in another. Meanwhile, regional economies may find themselves in competition—and even conflict—about basic business ideologies.

New economic buffers and niches. Innovations in organizational forms and practices can sometimes serve as buffers in an organization or even the larger economy. eBay is a good example. During the recession, the buying and selling of goods on eBay continued at healthy rates, providing income for those shut out of the traditional job market and perhaps preventing a more serious crash. The auction framework also provides an outlet for individuals to put their unwanted, unused goods back into the market rather than in the landfill. It also stimulated dropoff services such as Picture It Sold and Auction Drop that will take your goods and sell them online for a fee. Intuit has partnered with eBay to use its auction sales data to determine fair market value for donated goods that are reported as tax deductions to the IRS. eBay effectively is providing a link that helps to close the loop between output and input.

4 SUSTAINABLE BUSINESS ORGANISMS

IMPLICATIONS. The new connectivity presents new relationships and patterns of interaction, often revealing new sources of wealth generation. The most sustainable new organisms may be those that, like eBay, find ways to close the input–output loops in the flows of information, goods, and services—not threatening existing players but actually making them more sustainable.

Environmental feedback systems. After many decades of technology separating us from the natural world, current connective technologies—embedded sensors, mobile technologies, location based info, and so on—are bringing us back to the physical world. Biological metaphors and principles are reframing the way we think about business, with leading-edge proponents of sustainability focusing on such concepts as industrial ecology, natural capitalism, the geoweb, and even adaptive resource management. Meanwhile, remote sensing and environmental monitoring systems are beginning to provide the global feedback that is key to evolving environmentally sustainable individual and organizational practices. The data from these systems is no longer sequestered in obscure university or government laboratories but is increasingly available on the Internet, often interpreted through a diverse set of lenses by a diverse set of players.

IMPLICATIONS. If systemic feedback is a necessary condition for effective cooperation, then distributed sensors and geolinked information are creating the conditions for the evolution of cooperative strategies to sustain the global environmental commons. These tools will enable both business strategists and the general public to track—and anticipate—complex global environmental factors over time and ultimately link them to specific local patterns and problems.

Peer-to-peer (P2P) politics take advantage of the Internet and mobile communications technology to create novel form of political organizations and actions. P2P politics can take many forms, and can combine with more conventional political institutions. P2P political organizations can be leaderless, using media to coordinate and act. They can form very quickly, around controversial issues, political campaigns, or affinities. Their protean character gives them the ability to experiment rapidly with new messages, tactics, and activities. They can combine local focus and global reach, and assemble into networks of loosely-joined.

The Dilemma: Individual Influence Versus an Informed Consensus

Media traditionally have helped create the "imaginary communities" that have been a foundation of citizenship: newspapers and television provided a common frame of reference that helped orient civic culture. The growth of personalized media threatened to undermine that sensibility, by allowing individuals to focus on their own interests to the exclusion of contrasting or dissenting viewpoints. This, some political and media theorists worried, would narrow participation in civic life, and allow small, dedicated groups to control political life.

If the *New York Times* represents the old relationship between media technologies and politics, and the customized newspaper represents the medium of disengagement, OhmyNews epitomizes the rise of peer-to-peer (P2P) politics. The Korean Web site and weekly newspaper publishes reports from 26,000 contributing "citizen reporters," and has shaken up Korean political life. About 70% of the 200 or so stories submitted daily are published, creating a dynamic, bottom–up form of street reporting on news, politics, economy, culture, arts and science. More broadly, P2P politics underwrites new varieties of political activity, and present a challenge to governing bodies that see political action as the expression of fixed principles in geographically bounded locations. With P2P politics, political discourse moves away from personality-driven exchange to issue-driven processes.

Early Innovations

New forms of citizenship. Global forces, including the Internet, globalization, and the resurgence of religion, are unbundling citizenship rights and responsibilities from traditional national and state governments. A new sense of rights and responsibilities, of loyalties, and sense of protection is evolving, based on a very diverse set of criteria for affiliation and membership. Three types of citizens are emerging; each shows how cooperation and technology enable the creation of collective identity. Citizens of wealth believe in the right to prosper and the responsibility to generate wealth, and draw support from institutions as diverse as international trade laws and diaspora networks. Citizens of affinity believe in the right to belong, possibly to multiple affinities, and to define membership for themselves. They draw support from lifestyle laws, such as those related to food, marriage, tobacco) as well as the Internet and NGOs. Finally, citizens of place hold the right to assemble, in digital or physical space, as a primary entitlement. These citizens share responsibility to maintain shared infrastructure and public knowledge. Connectivity standards, access laws, as well as local communities and location based information provide support.

IMPLICATIONS. The new citizenship is a form of a grassroots organization that will play a stronger role in the next decade. Their collective organization make it easier for local groups (in place or space) to organize against large global players, say Wal-Mart or Microsoft, as the open source movement is attempting.

4 PEER-TO-PEER POLITICS

Leaderless resistance. Citizens around the world have used mobile technologies to catalyze mass events to effectively shape the outcome of political processes. The "People Power II" smart mobs in Manila who overthrew the President Estrada in 2001 organized demonstrations by forwarding text messages via cell phones. In Korea, members of the cyber-generation used Web sites, e-mail, and text messages to get out the vote and tip the election toward now-President Roh in the final hours. Protesters in Seattle, organized through cell phone and Web sites, disrupted meetings of the World Trade Organization in 1999. The Howard Dean presidential campaign demonstrated unprecedented grassroots self-organizing power through Meetup.com, Web logs, and highly successful online fundraising, creating the first cybergenic presidential candidate in the United States. And, the "flash mobs" that have broken out in cities around the world have added a new term to the lexicon, and although their earliest manifestations have taken the form of frivolous street pranks, they are portents of new forms of spontaneous street organizing.

IMPLICATIONS. P2P organizing can effectively catalyze action among individuals who identify with a common concern and share a stake in an outcome. Collectives are becoming savvy in swarm-like activities and are confronting traditional governments and institutions. As John Arquilla remarks, the only effective way to fight a network is with a network. This means that traditional institutions, like business and government, need to learn how networked based collectives operate in order to begin successful dialog and interaction with them.

Independent media. OhmyNews is one of the most spectacular single examples of bottom–up, citizen-produced media. Web blogging also has produced a vibrant new channel for public opinion and interpretation of news without mediation by the handful of powerful media companies. Blogs like the Volkh Conspiracy and Intel Dump exist in symbiosis with mass media, offering serious commentary on current economic and political reporting. Others provide first-hand reporting and on-the-ground storytelling: Salam Pax provided a window into Iraq before and after the recent war. Blogs have also emerged as a significant medium of political and cultural for diaspora communities and those living in authoritarian regimes. Iranian expatriates and domestic dissidents have created a vibrant online culture that one commentator describes as the electronic equivalent of the interior of a Tehran cab.

IMPLICATIONS. Alternatives to big media are here, both within companies and in the community. There is an opportunity to create peer-to-peer publishing within companies, industries, supplier groups, and other groups with shared interests to help provide quicker and more unfiltered intelligence.

Appendix: Basic Reading

Biology

Axelrod, Robert. ***The Evolution of Cooperation.*** **New York: Basic Books, 1984.**

Based on discoveries made at a tournament of computer programs designed to win an iterated Prisoner's Dilemma game, *Evolution of Cooperation* explains why a simple, cooperation-oriented strategy triumphed over more sophisticated and Machiavellian competitors. An annotated bibliography of works drawing on Axelrod's work is at http://pscs.physics.lsa.umich.edu/RESEARCH/Evol_of_Coop_Bibliography.html. See also "Evolution of Cooperation," Wikipedia (2003), online at http://en2.wikipedia.org/wiki/The_Evolution_of_Cooperation.

Gordon, Deborah. ***Ants at Work: How an Insect Society Is Organized.*** **New York: Free Press, 1999.**

Drawing on nearly two decades of fieldwork, Gordon explains how ant colonies self-organize, and how higher-order behaviors—adaptability, division of labor, even colony personalities—emerge from the simple rules and actions followed by individual ants.

Ridley, Matt. ***The Origins of Virtue: Human Instincts and the Evolution of Cooperation.*** **London: Penguin Books, 1998.**

Explains how cooperation became an important component of human behavior, and how it evolved out of—and is linked to—self-interest.

Ryan, Frank. ***Darwin's Blind Spot.*** **New York: Houghton Mifflin, 2003.**

Drawing on work across the biological sciences, ranging from 19th-century ecology to current work in genomics, Ryan makes the case for the centrality of symbiosis in biological processes, and argues that it has played an underappreciated role in evolution ("Darwin's blind spot").

Sociology

Buck, Susan. ***The Global Commons: An Introduction.*** **Washington DC: Island Press, 1998.**

A history of five global commons—Antarctica, the open ocean, the atmosphere, space, and telecommunications networks—and the legal and institutional structures that have been developed to manage access to and use of each.

Kollock, Peter. **Social Dilemmas: The Anatomy of Cooperation.** ***Annual Review of Sociology*** **1998; 24: 183–214.**

The study of social dilemmas is the study of the tension between individual and collective rationality. In a social dilemma, individually reasonable behavior leads to a situation in which everyone is worse off. This essay review discusses categories of social dilemmas and how they are modeled, and possible solutions for social dilemmas. http://www.sscnet.ucla.edu/soc/faculty/kollock/classes/cyberspace/resources/Kollock%201998%20-%20Social%20Dilemmas.pdf.

Olson, Mancur. ***Logic of Collective Action: Public Goods and the Theory of Groups.*** **Cambridge: Harvard University Press, 1965.**

A classic but somewhat-dated study of why collective action develops, how scale and group size affect the success of collective endeavors, and how various types of institutions—for example, industry associations, labor unions, farmers' cooperatives—overcome the problem of free-riding. A good summary is online at http://www.geocities.com/Athens/Atlantis/1747/Works/ols.htm.

Ostrom, Elinor. ***Governing the Commons: The Evolution of Institutions for Collective Action.*** **Cambridge: Cambridge University Press, 1990.**

An important study of common-pool resource management strategies, particularly involving natural resources like fisheries and water. Like Powell and Benkler, Ostrom focuses on alternatives to traditional structures (in this case, state management or privatization). Good follow-ups are: Robert Keohane and Elinor Ostrom, eds.,

Local Commons and Global Interdependence (Sage, 1995), which examine commons in global context; Elinor Ostrom and James Walker, eds., *Trust and Reciprocity: Interdisciplinary Lessons from Experimental Research* (Russell Sage Foundation, 2003); and Nives Dolsak and Elinor Ostron, eds., *The Commons in the New Millennium: Challenges and Adaptation* (MIT Press, 2003).

Ostrom, Elinor and Charlotte Hess. "Artifacts, Facilities, and Content: Information as a Common-Pool Resource." Paper presented at Conference on the Public Domain, Duke University Law School, Durham, NC, Nov. 9–11, 2001.

Summarizes the lessons learned from a large body of international, interdisciplinary research on common-pool resources in the last 25 years and considers its usefulness in the analysis of the information as a resource. Suggests ways in which the study of the governance and management of common-pool resources can be applied to the analysis of information and "the intellectual public domain." http://dlc.dlib.indiana.edu/documents/dir0/00/00/04/87

Economics

Benkler, Yochai. Coase's penguin, or Linux and the nature of the firm." *Yale Law Journal* 2002; 112.

A study of how successful peer-reviewed, open-source production systems are organized, and why they succeed without either market signals or managerial controls. Benkler's view of what motivates contributors to open source projects contrasts with that advanced by Eric Raymond. http://www.benkler.org/CoasesPenguin.html

Boyle, James. The second enclosure movement and the construction of the public domain. *Law and Contemporary Problems* (Winter/Spring) 2003; 66:33, 33–74.

Argues that we are in the midst of a "second enclosure movement," characterized by restrictive intellectual property regimes, and attempts to patent life forms and genomic sequences. This movement represents a mortal threat to promising, open source forms of intellectual production. http://www.law.duke.edu/pd/papers/boyle.pdf

Corning, Peter A. Evolutionary economics: Metaphor or unifying paradigm. *Journal of Social and Evolutionary Systems* 1996; 18:4, 421–435.

Reviews works in evolutionary economics, which present a challenge of neoclassical economic theory, and see economies as closer to biological systems or ecologies than mechanical systems. http://www.complexsystems.org/essays/evolecon.html

Heller, Michael. The tragedy of the anticommons: Property in the transition from Marx to markets. *Harvard Law Review* 1997; 111(3), 621–688.

Why are many storefronts in Moscow empty while street kiosks in front are full of goods? This article develops a theory of anticommons property to help explain the puzzle of empty storefronts and full kiosks. This article explores the dynamics of anticommons property in transition economies, formalizes the empirical material in a property-theory framework, and then shows how the idea of anti-commons property can be a useful new tool for understanding a range of property puzzles." http://eres.bus.umich.edu/docs/workpap-dav/wp40.pdf

Hunter, Dan. Cyberspace as place and the tragedy of the digital anticommons, *California Law Review*, forthcoming.

Discusses the "enclosure movement" in cyberspace, and the consequences "imposing private property conceptions upon it." Conceiving of cyberspace as a "place," Hunter argues, has led to a misunderstanding about the kinds of property rights that can be associated with it, and the rise of a digital anticommons. http://www.research.smu.edu.sg/wsrc/pdfs/DHunter_Cyberspace.pdf

Poundstone, William. *Prisoner's Dilemma*. New York: Doubleday, 1992.

Equal parts biography of John Von Neumann, discussion of game theory, and history of Cold War strategic thinking.

Raymond, Eric S. The cathedral and the bazaar. *First Monday* 1998; 3:3.

Contrasts the "cathedral" style of software development practiced by traditional companies with the "bazaar" style

of the open source software movement. Raymond argues that open source developers create gift economies and are motivated by informal group recognition, an argument that differs somewhat from Benkler. http://www.firstmonday.dk/issues/issue3_3/raymond/

Reed, David. "Why spectrum is not property—the case for an entirely new regime of wireless communications policy." Unpublished paper, 2001.

Described by its author as an "early, short rant." Against the " tradition and practice of managing wireless communications technologies … based on a legal 'metaphor' that equates spectrum allocations with rights in physical property, such as land use rights." In contrast, Reed contends, "the physics and architecture of RF communications contradicts the 'property' model of spectrum." http://www.reed.com/Papers/OpenSpec.html

Walter W. Powell, Neither market nor hierarchy: Network forms of organization. *Research in Organizational Behavior* 1990; 12, 295–336.

Powell argues that networked, interdependent firms—such as those that are seen in northern Italy, in Japanese industries, and Silicon Valley—represent an organizational form unaccounted for. http://www.stanford.edu/~woodyp/powell_neither.pdf

Politics

Arquilla, John and David Ronfeldt, eds. *Networks and Netwars: The Future of Terror, Crime, and Militancy.* Santa Monica: Rand Corporation, 2001.

A collection of essays on networked styles of organization, and their use by protesters, criminals, and terrorists.

Benkler, Yochai. From consumers to users: shifting the deeper structures of regulation towards sustainable commons and user access. *Federal Communications Law Journal* 2000; 52:3, 561–579.

Argues that "the fundamental commitment of our democracy to secure 'the widest possible dissemination of information from diverse and antagonistic sources,' which has traditionally animated structural media regulation, should be on securing a significant component of the information environment for creative use by users." http://www.law.indiana.edu/fclj/pubs/v52/no3/benkler1.pdf

de Armond, Paul. Black Flag Over Seattle. *Albion Monitor* February, 29 2000.

Lengthy account of the 1999 WTO demonstrations in Seattle, which brought to prominence the use of cell phones, the Internet, and networks and swarming tactics by protest groups. http://www.monitor.net/monitor/seattlewto/index.html

Ito, Joichi. *"Emergent Democracy."* Unpublished essay, March 12, 2003.

Argues that new technologies "will enable a form of emergent democracy able to manage complex issues and support, change or replace our current representative democracy. … These tools will have the ability to either enhance or deteriorate democracy and we must do what is possible to influence the development of the tools for better democracy." http://joi.ito.com/static/emergentdemocracy.html

Rafael, Vicente. The cell phone and the crowd: Messianic politics in the contemporary Philippines. *Public Culture* 2003; 15:3.

This essay explores a set of telecommunicative fantasies among the middle classes in the contemporary Philippines within the context of a recent historical occurrence: the civilian backed coup that overthrew President Joseph Estrada in January of 2001. It does so with reference to two distinct media, the cell phone and the crowd. http://communication.ucsd.edu/people/f_rafael_cellphonerev_files.htm

Wood, Elisabeth Jean. *Insurgent Collective Action and Civil War in El Salvador*, Cambridge: Cambridge University Press, 2003.

Examines the history of collective action in support of Salvadoran insurgents, with particular attention to the question of why peasants provided material supported to rebels despite high risks and low rewards. Manuscript version of chapter 1 is available at:

http://www.santafe.edu/files/gems/civilwarviolence/woodmsschapter1.pdf

Wood, Elisabeth Jean. *Insurgent Collective Action and Civil War in El Salvador*, Cambridge: Cambridge University Press, 2003.

Examines the history of collective action in support of Salvadoran insurgents, with particular attention to the question of why peasants provided material supported to rebels despite high risks and low rewards. Manuscript version of chapter 1 is available at http://www.santafe.edu/files/gems/civilwarviolence/woodmsschapter1.pdf

Wood, Elisabeth Jean. "Modeling robust settlements to civil war:Indivisible stakes and distributional compromises. *Santa Fe Working Papers* 2003.

Why do some civil war settlements prove robust, while others fail? This paper shows how a settlement's robustness, defined in terms of the risk factor of the mutual-compromise equilibrium, depends on the nature of the stakes of the conflict and the distributional terms of the settlement. http://www.santafe.edu/sfi/publications/wpabstract/200310056

Technologies of Cooperation

Reed, David. That sneaky exponential—beyond Metcalfe's Law to the power of community building. *Context* (Spring) 1999.

While many kinds of value grow proportionally to network size and some grow proportionally to the square of network size, Reed discovered that some network structures create total value that can scale even faster than that. Networks that support the construction of communicating groups create value that scales exponentially with network size, that is, much more rapidly than Metcalfe's Square Law. Reed calls such networks group-forming networks, or GFNs. http://www.contextmag.com/details/setFrameRedirect.asp?src=/current/masthead.asp?src=

Rheingold, Howard. *Smart Mobs: The Next Social Revolution*. Cambridge: Perseus, 2002.

Argues that "smart mobs," using pervasive computing and communications technology, will have a powerful effect on society and business in the developed world. The Smart Mobs blog (http://www.smartmobs.com) monitors more recent developments in pervasive computing technologies, cooperation, and collective action. Online political groups are discussed in Robert Hof's interview with Howard Rheingold, "A Major Change in the Political Equation," Business Week March 29, 2004, available online at: http://www.businessweek.com/magazine/cotent/04_13/b3876132.htm.

Weber, Steven. *The Success of Open Source*. Cambridge: Harvard University Press, 2004.

Examines the political and economic dynamics of the open source software movement. Excerpted in: http://www.gbn.org/ArticleDisplayServlet.srv?aid=26621; see also http://www.hiit.fi/de/mobileipr/weber_os.pdf.

Cultural Evolution

Benzon, William. *Beethoven's Anvil: Music in Mind and Culture*. New York: Basic Books, 2001.

Argues that music making encourages synchrony and coordination among musicians, both at the obvious levels of the music itself, and at the neurological level. Compare with McNeill, *Keeping Together in Time*.

Johnson, Steven. *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*. New York: Scribner, 2002.

A broad survey of work on emergence, and manifestations of self-organizing, emergent behavior in biology, neurology, history, and computing.

McNeill, William. *Keeping Together in Time: Dance and Drill in Human History*. Cambridge: Harvard University Press, 1997.

Argues that dance, military drill, singing and other syn-

chronized group activities have played an important role in creating social bonds, and fostering cooperative habits. More historically oriented than Benzon's Beethoven's Anvil.

McNeill, John and William McNeill. *The Human Web: A Bird's Eye View of World History.* New York: W.W. Norton, 2003.

An interpretation of human history centered on the growth of worldwide webs of mercantile trade, migration, disease transmission, and information flows. These webs, McNeill and McNeill argue, "have drawn humans together in patterns of interaction and exchange, cooperation, and competition, since earliest times."

Schmookler, Andrew Bard. *The Parable of the Tribes: The Problem of Power in Social Evolution.* Berkeley: University of California Press, 1984. Also reprinted, Albany: State University of New York Press, 1995.

Argues that, the history of civilization has been largely shaped by the way that, as a system, civilization has no mechanisms for restraining the raw struggle for power between societies. A summary can be found at http://www.context.org/ICLIB/IC07/Schmoklr.htm.

Stewart, John. Evolutionary progress. *Journal of Social and Evolutionary Systems* 1997; 20:335-362.

Identifies evolutionary processes that produce progressive change. Stewart proposes that evolution is driven by the potential benefits of cooperation among living processes. These benefits are able to be exploited by the formation of hierarchical organizations in which managing entities use control mechanism to support cooperators and suppress cheaters. Stewart's article can be found at http://www4.tpg.com.au/users/jes999/evpro.htm. Stewart's book, *Evolution's Arrow*, Canberra, Australia: The Chapman Press, 2000, extends the ideas developed in this paper. It is also available online at http://www4.tpg.com.au/users/jes999

Wilson, David Sloan. *Darwin's Cathedral: Evolution, Religion, and the Nature of Society.* Chicago: University of Chicago Press, 2002.

Uses key principles of evolutionary biology, such as multilevel selection, adaptation, and fitness to discuss how human groups, and religious groups in particular, acquire properties that enable them to survive and reproduce in their environments.

Wright, Robert. Nonzero: *The Logic of Human Destiny.* New York: Vintage, 2001.

Argues that biological evolution and human history "have a direction, an arrow" toward ever-increasing complexity.

Mathematics

Ronfeldt, David. Social science at 190 mph. *First Monday* (February) 2000; 5:2.

A study of strategy in stock-car racing, where "the effort to win leads to ever-shifting patterns of cooperation and competition among rivals."
http://www.firstmonday.dk/issues/issue5_2/ronfeldt/

Silberman, Steve. The quest for meaning. *Wired* (February) 2000.

On software company Autonomy, which uses Bayesian filtering to analyze and automatically manipulate unstructured data.
http://www.wired.com/wired/archive/8.02/autonomy.html

Strogatz, Steven. *Sync: The Emerging Science of Spontaneous Order.* New York: Hyperion, 2003.

On varieties of spontaneous synchronous behavior in the physical and natural worlds, and efforts to develop a cross-disciplinary understanding of those behaviors.

Watts, Duncan. *Six Degrees: The Science of a Connected Age.* New York: Norton, 2001.

A tour of networks and their place in social life, business, and nature. Watts ranges widely, from the Dutch tulip craze in the 1600s, to the spread of computer viruses and New York City's response to 9/11.

BASIC READING

Collective Intelligence

Bonabeau, Eric, Marco Dorigo, and Guy Theraulaz. *Swarm Intelligence: From Natural to Artificial Systems*. Oxford: Oxford University Press, 1999.

Examines emergent phenomena in insect societies, and suggests how these methods can inform the design of complex systems.

Chen, Kay-Yut, Leslie Fine, and Bernardo Huberman. Predicting the Future. *Information Systems Frontiers* 2003; 5, 47–61.

Presents a novel methodology for predicting future outcomes that uses small numbers of individuals participating in an imperfect information market. By determining their risk attitudes and performing a nonlinear aggregation of their predictions, the authors are able to assess the probability of the future outcome of an uncertain event and compare it to both the objective probability of its occurrence and the performance of the market as a whole. Experiments show that this nonlinear aggregation mechanism vastly outperforms both the imperfect market and the best of the participants.
http://www.hpl.hp.com/research/idl/papers/future/
(An earlier version, "Forecasting Uncertain Events with Small Groups," is available at http://arxiv.org/ftp/cond-mat/papers/0108/0108028.pdf.)

Other Interesting Web Sites

Michael Macy, Cornell researcher on artificial agent societies and computational sociology:
http://people.cornell.edu/pages/mwm14/

Wikipedia: http://www.wikipedia.com

Collective Detective: http://www.collectivedetective.org/

Global Brain Group: http://pespmc1.vub.ac.be/GBRAIN-L.html

Online Prisoner's Dilemma Game: http://serendip.brynmawr.edu/playground/pd.html