PUBLICATION

The Puzzle of Competition in the Communications Sector: Can Complex Systems be Regulated or Managed?

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The Puzzle of Competition in the Communications Sector: Can Complex Systems be Regulated or Managed?

By P. H. Longstaff

Executive Summary

What does it mean to regulate or manage a system that is unpredictable? How can any government regulation or management plan deal with systems that are constantly evolving? This paper is part of the work currently being done in several disciplines with the aim of building a new foundation for regulating and managing complex systems. Here it is applied to competition in the communications sector.

Why would a regulator or manager want to admit that the fruits of their efforts are often unpredictable? That doesn't get you promoted or elected. Many people in the communications sector (and other sectors) have suspected that where the forces at work are many and the change is fast, predictability for any particular firm or trend in the sector is not possible. But they are fearful of saying that in public – they believe they must keep up the pretence that they know what's going on and are capable of controlling it. If they could admit that some systems are unpredictable both regulators and managers could avoid the Blame Game: the scapegoating that takes place when things don't turn out as predicted. This does *not* mean regulators and managers are not accountable, it means they are accountable for things they can actually control.

The paper presents several new ways of looking at the forces acting on the communications sector and then puts these new perspectives together. It begins with a brief and multidisciplinary examination of complex, unpredictable systems and explores what it means to "regulate" a system you can't predict. The role of feedback in these systems is developed as a critical but often lacking element in their regulation. This feedback must include both *data* ("cow") and *context* ("bull"). Both are necessary for both business and government systems to develop knowledge and knowledge*able* people (people *able* to use knowledge).

The critical difference between tightly and loosely coupled systems is examined as well as the potential utility of several ideas from the new science of networks. A concept called "practical drift" may help explain how strong regulation can sometimes make complex systems unstable.

The paper then discusses the current "acceptable parameters" used to regulate competition and how these parameters might be made more useful. The paper adds one more change of viewpoint by redefining the activities of firms in the communications sector into new building blocks based on Information Theory.

The paper gives some examples of how all these ideas work together and some thoughts on specific strategies that can be used to regulate or manage unpredictable processes.

- Realign everyone's expectations about certainty. This may be the most important and the most difficult.
- Look for ways to deal with uncertainty that don't require you predict the future: Detection and Response, Broad Tolerance, or Prevention.
- Recognize where your organization or system is loosely or tightly coupled.
- Establish acceptable parameters for the system that are known to all.
- Create feedback (cow and bull) loops that tell you when the system has gotten out of the acceptable parameters.

- Use that feedback to watch for practical drift – it may be a sign that feedback loops are not working OR that there are unanticipated outcomes at some levels or locations in the organization.
- Nudge the system back toward those acceptable parameters as soon as you can – don't wait for it to become too big to fix without extraordinary effort.
- Iterate your way to success. Small steps that allow you to change course often will often be more effective than big steps in a time of great uncertainty. You don't design the path – you discover it.

Finally, this paper gives some specific ideas for the regulation of competition in the communications sector:

1. Assume that competition in the communications sector is part of a complex system that will often be unpredictable. Make this assumption explicit in regulation and set out strategies to deal with the uncertainty – everyone should know what happens when something unpredictable happens (e.g., unintended collateral damage to people or firms).
2. Redefine accountability. Regulators and the firms they regulate are not *unaccountable* – they are just accountable for different things, including failure to have systems in place to deal with the unpredicted and failure to pass along the right feedback with regard to the acceptable parameters for competition in the system. Assume that the Blame Game is an inefficient and wasteful correction mechanism. Make this assumption explicit in organizational policy and public communication.
3. Revise analytical frameworks used in regulatory decisions to include analysis of:
    - Whether the firms(s) (or the firm and its customers) are tightly or loosely coupled and whether tighter regulation will make them more or less unstable. This can be determined by things like the adequacy of a firm's resources, the speed of change for the firm, the speed of the spread of influencing variables.
    - What role the firm plays in the communication process, not what technology it uses. The parameters for competition and cooperation should take into account the fact that old technological boundaries between industries in the communications sector may no longer be appropriate for counting the number of firms who are competing for the same scarce resources. Regrouping them by their function in the communication process will help to reduce this problem.
4. Articulate the acceptable parameters for competition and cooperation in the communications sector that is clear about the goals for society – what do we want to make sure happens or doesn't happen.
5. Review mechanisms for relevant feedback (with both cow and bull) to and from both policy makers and firms to make sure that the feedback generated actually gives a good indication of whether the system has moved outside the acceptable parameters. Set up incentives (or punishments) to encourage that feedback and that recognize quality.
6. Devise specific ways to watch for Practical Drift – for example, a trend in one part of the firm (or an industry) to resist regulation by coming up with a local solution – this may be an indication of unequal impact or unanticipated consequences.

Caveat

Some readers will hoping for formal models that can be tested and will lead to new regulatory schemes or globally effective business strategies. Perhaps that will happen. This paper is only part of the beginning of the application of complex system research to business and regulatory problems. In the mean time, be skeptical. There is a real danger that the jargon of complex systems research will be used to just dress up old ideas in new clothes. Nobody needs another management fad *du jour*.

Nothing more certain than uncertainties
Fortune is full of fresh variety
Constant in nothing but inconstancy.

Richard Barnfield (1574-1627)[1]

I. Introduction

Who is responsible for the fact that competition did not thrive in the communications sector after the 1996 Telecommunications Act? Unless you can believe in a giant conspiracy that involves virtually every member of Congress, countless staffers, agency heads, civil servants, and industry leaders from broadcasting, telephony, cable, satellite and many others, the answer may be "no one." It certainly did not work out the way many people thought it would, but is that somebody's *fault*? Or was the real mistake a failure to manage "expectations" about what *might* happen?

It is time to recognize that no one can "regulate" (or manage) a complex system like the communications sector with anything like pinpoint accuracy. Failure to recognize the possibility of unintended consequences leaves policy makers (and business managers) open to the "Blame Game" when things don't go as they had hoped. And because they don't want to be blamed they often refuse to admit that things are going badly until things have become unfixable and/or blame will be hard to pin down – usually when the individuals involved have moved out of a position of responsibility for this function. Wouldn't it be better to admit that there may be unintended consequences and put plans in place to deal with them? This would have the added benefit of keeping people from job-jumping to avoid blame, thereby keeping their knowledge in place and actually increasing the likelihood that the system will work as intended.

Scott Snook of the Harvard Business School has taken an in-depth look at a tragic "friendly fire" accident in the immediate aftermath of the 1991 Persian Gulf War in which a U.S. fighter

[1] From *Sonnet*, 1607.

plane shot down a U.S. helicopter. He asks why nobody predicted the problems that led to this accident *before* it happened. He concludes that

> Part of the answer lies in our inherent limitations as information processors. Part of the answer lies in our linear deterministic approach to causality. Part of the answer lies in the inherent unpredictability of events in complex organizations.[2]

During the 20th Century experts in many fields have come to similar conclusions. When many forces are at work on a system it tends to get very complex and essentially unpredictable. Some have even concluded that in complex organizations unintended consequences are virtually inevitable.[3] This is not easy to accept for people (particularly in western cultures) who have spent hundreds of years trying to describe and predict the world with mathematical certainty. But the idea that some systems are unpredictable (at least some of the time) has become an article of faith for many (but not all) practitioners in disciplines from physics to economics. It remains a difficult concept for business managers and policy makers who want to believe that their actions will lead to predictable outcomes. But the unanticipated outcomes of competition policy are now too frequent and too important to ignore. It is time to seriously reconsider our assumptions about the processes we are trying to regulate and the process of regulation itself.

Both the communications sector and the world it operates in are getting more complex all the time. This complexity is caused in large part by the fact that people and businesses are more closely linked to each other both physically and virtually through transportation and communication networks. Being connected to more people and more places means there are more forces that you can affect and that can affect you. And the more forces at work, the more complex the system becomes. As we will see, if this increased connection is “tightly coupled” then the opportunities and dangers in any part of the world are felt almost instantly in many places around the globe. The “environment” we all live in is influenced by the interaction of economic, political, and social forces from areas as remote as the highlands of Afghanistan, Scotland and West Virginia. Any change in the mix of forces at work (e.g., political/military, economic/technological, educational/scientific, religious/ideological, family/kinship) will move the system, but in essentially unpredictable ways, and often (as we have seen so often in recent years) in ways that are the opposite of those intended.

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[2] Scott Snook, *Friendly Fire: The Accidental Shootdown of U.S. Black Hawks Over Northern Iraq*, Princeton NJ: Princeton University Press (2000) *p*. 204.
[3] Charles Perrow, *Normal Accidents: Living With High-Risk Technologies*, New York: Basic Books, 1984.

For example, in the 1990's many concluded that more *competition* would be beneficial to the communications sector. It would lower prices, bring efficiency, and stimulate innovation. But almost as soon new laws were put in place to encourage this new competition (through privatization and liberalization), a wave of *cooperation* began (through mergers and acquisitions) that resulted in the highest level of consolidation the sector had ever seen. The more that individual governments and global organizations tried to promote competition, the more cooperation seemed to take place. In the short term, competition did appear in many communications industries, at least in the high margin parts of those industries.[4] But then, when the firms had been weakened by the fierce intraindustry competition, digitization and globalization enabled competition from other industries and other countries. A downturn in the economy meant even fewer resources for all the competitors, plummeting stock prices, a wave of bankruptcies, and acceleration in the development of giant, multinational entities who hoped that increased scope and scale would make them more efficient, spread their risks, and make their businesses more predicable.

This pattern was evident in all of the networked industries (communications, transportation and energy) that were opened up to competition (in some cases reopened). But it was in the communications sector where the trend was often the most visible to the public. Telephone companies often became some of the largest owners of wireless communications networks and cable systems. For a time, Internet companies gobbled up "old" communications media companies. Broadcast and print companies around the world saw unprecedented consolidation of ownership. In many of these cases, control of the communications assets went to people or firms in countries outside of where the assets were located. The communications sector began to look as if it might evolve into several large organizations, with much multinational and interlocking ownership that could acquire or destroy any competition and then ignore the concerns of the governments who had often made their growth possible through generous subsidies for things like research and development.

What might the communications sector become? Many fear that the new competition in communications services will evolve so that they will all travel through one Big Pipe (either cable or telephone – maybe wireless) to a Big Box in the home that functions as computer and

[4] For example, competition came quickly in the long haul and large load parts of the networked industries and in large metro areas for broadcast, newspaper and delivery services. See, See, P.H. Longstaff, *The Communications Toolkit: How to Build or Regulate Any Communications Business*, Cambridge, MA: MIT Press (2002) Chapter Four.

television (and connected to many other appliances) that delivered the Big Messages of a few multinational entertainment producers. And these services would be provided by Big Companies that have roots in many countries but allegiances to none. It is clear that increased competition does not necessarily bring diversity among the competitors, at least not in the long run.[5]

While the exact outcome of introducing a new variable as potentially destabilizing as increased competition may difficult (and perhaps impossible) to predict, the *rough outlines* of some expectations seem to be possible if you look at the results in similar systems. There do seem to be some outcomes that are fairly common and that should be considered when introducing competition into a networked industry. Starting with airline “deregulation,” newly competitive networks (including the internet services) underwent the following experiences:

- The appearance of many new entrants who successfully aggregated demand for long hauls and large loads but most went out of business when they failed to develop the required economies of scale and/or scope or they overestimated demand;
- A vast wave of mergers and acquisitions occurred as both new and established players attempted to develop economies of scope and scale;
- Foreign direct investment took place as players looked for resources to upgrade infrastructure or pay down debt in order to fend off competition or creditors;
- Cooperation was reduced among parts of the network, which resulted in problems of scheduling and security;
- The development of separate networks (hub-and-spoke configurations, developed by each competing network) made it difficult for customers of one network to use competing networks;
- “Feeders” from short haul and low traffic areas developed to connect with the hubs;
- Competition increased and consumer prices fell (at least temporarily) for long-haul routes and high-density areas in the network, but there was decreased competition and capital investment and higher consumer prices in short-haul and low-density portions; and
- Quality or dependability of service decreased for most customers.[6]

This was *not* what anyone predicted in any of these networks. It left many policy makers wondering what had gone wrong and whether it was possible for competition to be governed at all. But the stakes are too high for everyone and failure to find a better way is not an option. The fact that many of the same things happened in each of these systems gives us some hope that there are some clues (if not answers) to be found. But we aren’t going to find them by looking in the places where we have always looked.

[5] See, P.H. Longstaff, note 4, Chapter 4.

II. Scope of This Paper

This paper reexamines some of the basic assumptions we have come to rely on in regulating competition in networked industries like communications, including assumptions about the predictability of these systems and the very nature of competition and cooperation in networks. It does not advocate or vilify any political idea or administration. In any case, political administrations are often more different in rhetoric than they are in practice. The ideas here will be useful whatever the current political realities or economic situation. Nor is this an exercise in a particular economic theory. Economics is, for all its faults, an excellent starting place for analysis of competition policy. It has been used, with varying degrees of success, in most of the important policy debates on this topic. But there are as many points of view in economics as there are in politics, all of which have some currency around the world. An examination of political and economic forces is necessary but not sufficient to find a new way to deal with regulating competition in complex networks. Ideas from just one or two disciplines will not be enough. This is particularly true when the exact nature of the problem and what we want to accomplish are not immediately clear.

The paper does not offer a "model" that can be applied to predict problems because at this point such a model does not exist (and may never exist) and the problems are too diverse. The task at hand is not to develop a model that will help predict things that are complex, but to *manage* them.

A multidisciplinary approach is necessary but it will not be easy. Most disciplines continue to believe that they "own" the best way to look at the universe or human systems and talking to other disciplines would be a waste of time. Fortunately, many disciplines have, independently, begun to study complex systems. For example, ideas from general systems theory and biology have produced important clues (although none offers unqualified *answers*) about the causes and effects of competition and cooperation in business firms and whole industrial sectors.[7] One of the great philosophers of science, Charles Sanders Peirce, called this borrowing of metaphors from other disciplines "abduction" and described how it can be used creatively to form a new explanatory hypothesis.[8] The borrowed metaphors here should not be interpreted as

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[6] See, P.H. Longstaff, *The Communications Toolkit: How to Build or Regulate Any Communications Business*, Cambridge, MA: MIT Press (2002), Chapter 3.
[7] Id. Chapter 4.
[8] See, generally, C.S. Peirce, *Collected Papers of Charles Sanders Peirce, vol. 5: Pragmatism and Pragmaticism*, ed. C. Hartshorne and P. Weiss. Harvard University Press: Cambridge MA (1934).

wholesale incorporation of them into competition policy, but as clues for forming new ideas about regulating competition in communications industries.

Any clues from these new fields will deliver a bonus: they will not depend on any current political or economic point of view. However, they may be consistent with one or all of these points of view. This means that the ideas developed here can be applied in many countries, with many different political and economic realities. The ideas do not need to be applied the same way everywhere in order to be helpful. In the short term, different applications will almost certainly be the case. If some sort of policy making at a global level is ever contemplated, ideas (or models) that are outside any particular political or economic system will be useful.

One thing is clear: both business competition and the government regulation of it are interlinked *processes* that operate over time. Any attempt to deal with them must take this temporal aspect into account. Neither communications firms nor the governments who regulate them will ever stop evolving. The relative power of important stakeholders (both in government and in the various industries) is a key ingredient in the making of competition policy in all countries so this is likely to remain a *political* process. And the constantly shifting degrees of power for those stakeholders in their "home" and "adopted" countries means that the economic and political forces that drive or inhibit competition will make competition regulation a *complex political process*. On the business side, the development of competition and cooperation in any industrial sector is a *complex economic and social process.* Varying levels of resources available at any given place and time will mean that today's competitors may evolve into tomorrow's cooperators and vice versa.

Thus, we have an unpredictable political system trying to regulate an unpredictable business system, which is (in turn) trying to influence the political system. And neither the political system nor the business system typically recognizes the temporal aspects of the situation. They assume that the actions they take at one point in the process will have the desired effects and then the process will *stop*. Here is what is predictable from all this: the process will continue and the communications sector (and all the stakeholders) will continue to evolve in ways that are essentially unpredictable over the long term.

So we should just give up? No, but we do need change our ideas about what is possible and redefine "success." If you promise constituents or shareholders that you can "fix" a problem in the system and that it will stay fixed, you are setting yourself up for "failure." At this point, astute readers will be saying something like, "Well, if you can't predict what will happen if you do something, how can you hope to manage or regulate a complex system?" There are two answers to that very logical question. First, there are some problems in complex systems that engage only one or two of the forces in that system and the outcome will be *predictable enough* most of the time – the problem is separating those out from the really complex problems. Second, most of the world (particularly in the west) believes that prediction is possible in business and in government, and anyone who wants to take a "Well, we can't be sure" approach will be seen as irresponsible or uncommitted. If you want to be promoted or elected that is a nonstarter and it may not, in fact, be the best answer. But there is a glimmer of hope.

> Complexity research gives us a grounded basis for inquiring where the "leverage points" and significant tradeoffs of complex system may lie. It also suggests what kinds of situations may be resistant to policy intervention, and when small interventions may be likely to have large effects. For guidance in designing actions, such insights into the right questions can be very valuable. They can valuable even if the theories are too multiple and too preliminary to support any claim that a theory of complexity implies any sharply etched expectation about a future scenario and how a particular action will guarantee it.[9]

So, this research does what all managers of change have learned to do – begin a process and iterate yourself to success. Start with something you can do and build on it. This paper builds on a number of existing ideas and then uses them to offer some things that can be used as first steps. We begin with an overview of current ideas about complex systems. Readers who are familiar with complex systems theory may want to skim or skip the next section.

III. Predictability: Past and Present

Until the early 20th Century the apparent universal predictability of mathematics and Newtonian physics led many (but not all) disciplines to assume that if you could just reduce a system to its basic forces and compute how those forces interacted, you could predict anything. This is known as "reductionism" and it offered a reassuring view of the power of human beings in the world: if we can just figure any system out to the point where we can reduce it to an equation, we can predict it and control it. This deterministic view of the world started to lose its currency in science when physicists started to look ever deeper into the subatomic level of the universe and found a wildly unpredictable place. At that level there are very small particles that are sometimes

[9] Robert Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, New York and London: The Free Press ((1999) pp.21-22.

waves. These waves/particles aren't always in a definite position, and it is not possible to predict their actions with any reliability. The rules for the universe at the subatomic level have come to be called quantum mechanics.

For example, in the mid 1920's the physicist Werner Heisenberg showed that it is not possible to measure both a particle's speed and its position at the same time. This became know as the "uncertainty principle." In 1931, mathematician Kurt Godel developed his famous theorem that showed the fundamental limits of mathematics.[10] All of these exceptions to the ideals of reductionism are limited to certain levels of analysis of the universe – you can still count on things at other levels to have the predictability we have come to expect – a rock is likely to remain a rock for a long time. But by the end of the 20th century, unpredictable systems were seen to be operating in a number of places. The study of all these systems has given chaos and complexity theories their current forms.[11]

The discoveries about complex systems in the scientific community did not escape the notice of philosophers and their discipline underwent a similar change.[12] Until the 20th century, most of Western philosophy continued to search for the true nature of the universe in something unchanging and with universal application. But from Plato's "forms" to Descartes' "method," each search ended in failure as the limits of the knowable were expanded. This led many to recall the ideas of Aristotle, who abandoned the idea of universal forms and embraced the idea of the potential embodied in each individual and each species. In this he foreshadowed Charles Darwin's ideas about reality as a *process* rather than a fixed state of affairs. Some scholars advocated this change of attitude with regard to the law long before modern scientists and philosophers did. One of the most respected jurists of the United States advocated a similar idea as early 1881. In his book *The Common Law*, Oliver Wendell Holmes, Jr. (1841-1935) declared that the laws are best seen as a process and not a final destination.

> The life of the law has not been logic; it has been experience. The felt necessities of the time, the prevalent moral and political theories, intuitions of public policy and avowed or unconscious, even the prejudices which judges share with their fellowmen, have had a good deal more to do than the syllogism in determining the rules by which men should be governed. The law embodies the story of a nation's development through

[10] Readers who are not familiar with this area may want to consult some of the excellent books that have been written for nonspecialists, including Stephen Hawking's *The Universe in a Nutshell* (2001).
[11] See the Suggestions for Further Reading at the end of this paper for accessible books on these ideas.
[12] For a very readable overview of the lives and work some of these philosophers, see, Daniel J. Boorstin, *The Seekers: The Story of Man's Continuing Quest to Understand His World,* (1998).

> many centuries and it cannot be dealt with as if it contained only the axioms and rules of a book of mathematics.

Many philosophers, including Kierkegaard and the Existentialists, concluded that existence is always in the process of developing. Instead of a search for the keys to a system where things can be predicted, the goal (for many disciplines) had changed to looking for the right point of view from which to observe the process. And even that goal came under fire as Postmodernists insisted there is no right viewpoint and only diversity is essential.[13] All of this work made suspect any theory that claimed to be universal in its application. That was not good news for ideologues of any stripe, but was particularly bad news for any form of authoritarianism.[14]

Lawmakers in modern democracies and managers of modern businesses have largely ignored (or remained unaware of) most of this unsettling new philosophy and science. They turn instead to those who present Cartesian graphs with anticipated trends based on mathematical formulas and charts with bold arrows that show causal linkages ("Your problem is that A causes B and then B causes C"). It is comforting to pretend that economic, political, and social systems are predictable. They do this in spite of the fact that they put their faith (in varying degrees) in a "market" economy that is by its nature less predictable than command economies (which turned out to be less than predictable, too).

In fact, most regulators and most managers know their problems aren't simple and they know there are many forces at work that can throw their plans out the window. But since they don't know a better answer they believe they have no choice but to play the game by rules that everybody can at least understand. There is a down side to acting as though the businesses they manage (or regulate) are predictable. This behavior leads to one of the more regrettable spectacles in modern democratic politics and corporate governance: when the system does not perform as predicted, someone is assumed to have made an error. This leads to the all too familiar practice of finding a scapegoat who can be sacrificed to show that the problem has been "fixed." And, because nobody wants to be the one sacrificed, all will turn a blind eye to the problem or even

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[13] For a review of this literature see, e.g., N. Katherine Hayles, *Chaos Bound: Orderly Disorder in Contemporary Literature and Science,* Ithaca NY: Cornell University Press (1990); B. Dervin and L. Foreman-Wernet (with E. Lauterbach (Eds.) *Sense-Making Methodology Reader: Selected Writings of Brenda Dervin,* Cresskill, NJ: Hampton Press (2003) pp. 111-132.

falsify records to hide the problem – until the problem gets too big to hide and everyone runs for cover. In the meantime, the wrong people have either benefited or been inadvertently hurt. It would be better for everyone if the general understanding about and expectations for complex systems could change. In his monumental (but not uncontroversial) work on complex systems Stephen Wolfram explains the problem this way:

> …normally we start from whatever behavior you want to get, then try to design a system that will produce it. Yet to do this reliably, we have to restrict ourselves to systems whose behavior we can readily understand and predict – for unless we can foresee how a system will behave, we cannot be sure the system will do what we want.[15]

But what if you know what you want but you don't have a system that you can readily and reliably understand and predict? In the biological world, prediction is only one of the four ways that an organism might cope with change or uncertainty. They might also use:

- Detection and Response. This is only effective if your detection is accurate enough and your response is fast enough.
- Broad Tolerance. In this case you develop a broad array of response mechanisms so that you can deal with whatever happens.
- Prevention. Setting up a buffer so that fluctuating conditions do not reach you.[16]

In a very complex environment you might use all four methods. And they might each adapt to each other – your buffer would have to adapt if it gets in the way of your ability to detect danger.

The ideas about complex systems were not developed by any one field and were not accepted overnight. Indeed, they remain controversial in some disciplines and in their application to some issues. These new ideas are all slightly different and there are no bright lines between them. They include: complexity theory, chaos theory, complex adaptive systems, general systems theory, nonlinear systems, self-organizing systems, and far-from-equilibrium systems. Most scholars would agree that complex systems, as a general rule, exhibit different characteristics from chaotic ones (although a complex system could become chaotic and not all chaotic systems are complex). Chaotic systems have become unstable or turbulent due to the buildup of small

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[14] For an extended discussion of development of all of these ideas, see, F. Davis Peat, *From Certainty to Uncertainty: The Story of Science and the Ideas of the Twentieth Century*," Washington, D.C.: John Henry Press (2002).

[15] Stephen Wolfram, *A New Kind of Science*, Wolfram Media: Champaign, IL. (2002). at p. 40.

[16] See, e.g., Richard Levins, "Preparing for Uncertainty," *Ecosystem Health* (1995) Vol. 1, pp. 47-57.

perturbations in the forces working on them. For example, water running in a pipe will become turbulent or chaotic at certain velocities.[17]

Systems are said to become "complex" when they have intricate interdependencies among their various parts and many variables operating at the same time. Examples of complex systems include the weather and the spread of disease in a population. Complex systems are generally nonlinear. The effect of adding something to the system (an infected person or the air disturbed by a butterfly flapping its wings) may diffuse unevenly throughout the system because the other components of the system are not evenly distributed, or the force doing the distribution is not equally strong throughout the system. Think of throwing a handful of buttons on the floor and then connecting them in various ways: some are connected by heavy string, magnets connect some, and others are connected only by dotted lines on the floor. All the red buttons are connected to each other and some of the red buttons are connected to blue buttons. Most (but not all) of the blue buttons are connected to one yellow button while all of the red buttons are connected to another yellow button. The group of buttons is sitting on top of an active earthquake area. Could you predict what will happen to any one of the blue buttons if an earthquake hit its vicinity or if someone pulled the string at one of the yellow buttons?[18]

German scientist Dietrich Dorner has given us another way to visualize complex systems.

> …we could liken a decision maker in a complex situation to a chess player whose set has many more than the normal number of pieces, several dozen, say. Furthermore, these chessmen are all linked to each other by rubber bands, so that the player cannot move just one figure alone. Also, his men and his opponent's men can move on their own and in accordance with rules the player does not fully understand or about which he has mistaken assumptions. And, to top things off, some of his and his opponent's men are surrounded by a fog that obscures their identity.[19]

Complex systems often have a surprising property: adding an element that can be duplicated to the system may cause a shift in the total system that is much greater than the amount added. For example, sending a rumor about a company via email to a friend in that company only adds one piece of information to that company's information system. But, because many agents (employees) in the company are connected via email, the piece of information multiplies in the

[17] See Suggested Reading at the end of this paper for additional information.
[18] This is an adaptation of the "Buttons and Strings" metaphor used by Stuart Kaufman to explain complex systems in *At Home in the Universe: The Search for the Laws of Self Organization and Complexity*, New York: Oxford University Press (1995), pp. 55-58.
[19] Dietrich Dorner, *The Logic of Failure: Recognizing and Avoiding Error in Complex Situations*, New York: Metropolitan Books (1996).

system as each employee sends it to many others. The information will multiply in the system because the agents are interconnected in a network.[20]

Because the trajectories of complex systems are nonlinear (e.g., rates of increase or decline) it is easy to be fooled about what they will do next. Just because they are increasing today does not necessarily mean they will do so tomorrow. Pity the Minister of Health who declares victory over a virus, only to see it change its trajectory and increase the rates of infection. These multiple-directional trajectories are often players in the Blame Game.

Some scholars believe it is possible to measure the amount of complexity in a system. Yaneer Bar-Yam at the New England Complex Systems Institute suggests a complexity profile that may be very useful in analyzing firm structure for competition regulation.

> The complexity profile counts the number of independent behaviors that are visible at a particular scale and includes all of the behaviors that have impact at larger scales. The use of the term "complexity" reflects a quantitative theory of the degree of difficulty of describing a system's behavior. In its most basic form, this theory simply counts the number of independent behaviors as a measure of the complexity of a system.[21]

Several other things that are sometimes observed to have an impact on the complexity of systems may be relevant to mangers and regulators. These include:

- *Resistance* is built by mechanisms in the system to reduce the impact of changes. If a complex system exhibits resistance to change it is more stable in the short term but may be subject to catastrophic failure if the resistance mechanism fails.
- *Resilience*. A tendency to return to a former equilibrium in the face of temporary perturbation or displacement. If a complex system exhibits resilience it will bounce back from changes and is more likely to be stable in the long term. There is an on-going debate in the biological sciences about whether diversity (the number of species in a system) increases or decreases resilience and stability.[22]
- *Positive and negative feedback* (and feed forwards) loops of different lengths. Long feedback loops, with communication going through many agents or subsystems tend to be more complex.

[20] There is a growing body of scholarship on the nature of networks and how they increase complexity. See the list of Suggested Reading at the end of this paper.
[21] Yaneer Bar-Yam, *Complexity Rising: From Human Beings to Human Civilization, A Complexity Profile*, NECSI Research Projects, at http://necsi.org/projects/yaneer/Civiization.html
[22] See, e.g., Shahid Naeem, "Biodiversity Equals Instability?" *Nature*, (2002) Vol. 416, pp. 23-24.

- *Connectivity*. The extent to which agents or units are all connected or are connected through hubs will increase the complexity of the system.
- *The presence of "sinks"* that absorb external impacts and buffer subsystems from change will make the system less complex. For example, when the price of an input to a product goes up but the firm can immediately pass this on to consumers this acts as a sink protecting the firm from the impact of the price increase and makes it unnecessary for it to build a complex system for response.[23]

Some complex systems are *adaptive* or are said to *evolve* when individual agents operate independently in response to forces in their environments via feedback. In some systems the agents can "learn" from each other when some agents obtain more resources and their actions are copied by other agents. In systems where the change is not learnable in the current generation by other agents (for example, the change is a mutation in an organism's genetic structure) it can become prevalent in succeeding generations because agents who have changed will leave more offspring (this is evolution by natural selection). For example, a mouse with better hearing is more likely to survive the presence of foxes in her environment and will leave more offspring than other mice. Over many generations these offspring will also leave more offspring and gradually the number of mice without the acute hearing will decline.

Complex systems that evolve over time are called Complex Adaptive Systems.

> In Complex Adaptive Systems there are often many participants, perhaps even many kinds of participants. They interact in intricate ways that continually reshape their collective future. New ways of doing things – even new kinds of participants – may arise, and old ways – or old participants – may vanish. Such systems challenge understanding as well as prediction. These difficulties are familiar to anyone who has seen small changes unleash major consequences. Conversely, they are familiar to anyone who has been surprised when large changes in policies or tools produce no long-run change in people's behavior.[24]

Management theorists have begun to use these ideas.[25] In 1990, Peter Senge published what would become one of the more influential business books of the late 20th century. He

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[23] From written comments and phone interview with the author by Richard Levins, John Rock Professor of Population Sciences, Department of Population and International Health, Harvard School of Public Health.
[24] Robert Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, The Free Press: New York (1999), p. xi.
[25] For an abbreviated list of these publications see Suggested Reading at the end of this paper.

wanted to help businesses adapt to change by creating "learning organizations." But he knew it wouldn't be easy.

> Business and other human endeavors are also systems. They, too, are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Since we are part of that lacework ourselves, it's doubly hard to see the whole pattern of change.[26]

Senge set out to destroy "the illusion" that the world is created by separate, unrelated forces and to develop understanding of *dynamic complexity* where cause and effect "are not close in time and space and obvious interventions do not produce the expected outcome."[27] Subsequent writers, such as Robert Louis Flood, have expanded on this idea and repeated the warning against reductionist thinking in complex situations.

> An 'A caused B' rationality is a source of much frustration and torment in people's lives. If a difficult situation arises at work, then an "A causes B' mentality sets up a witch-hunt for the person or people who caused the problem.[28]

The Blame Game may be helpful for immediate emotional or political purposes but it seldom fixes the real problem. Most experienced lawmakers and business leaders already suspect the unpredictability of the system(s) they operate in. But they can't bring their suspicions into the open because they fear this will be seen as a less than honest "excuse" for the unintended consequences of their actions. Or, when bad things happen, leaders often fear that they have just misjudged something or done something wrong – and that would mean they can be *blamed*. In truth, they may have done everything right but could not predict (because no one could) the effect their actions would have on the system. This does *not* mean that there are no incompetent business people and regulators – and their actions will always be one of the things that make this an unpredictable system. But it is time to admit that these systems cannot be "engineered" in advance by omniscient leadership. Leaders may find that they accomplish their goals not by building organizations (and the rules that govern them) based on predictions, but by building organizations (and the rules that govern them) based on adapting to the unpredictable.

So how do we operate at all if we can't predict exactly what will happen to all the agents and all the variables in a system? There are other kinds of prediction that might get us close. *Statistical* predictions are used in many areas of life (from death rates to rainfall) and in policy

[26] Peter Senge, *The Fifth Discipline: The Art and Practice of Learning Organizations*. Doubleday: New York (1990), p. 7. For earlier work in the same vein, see, Chris Argyris, *Integrating the Individual and the Organization.* Wiley: New York (1964).
[27] Ibid. p. 364.

debates but they are often misunderstood as *actual* prediction. In some systems one can predict that variables will not exceed certain *boundedness* – even if you can not predict where they will be within those bounds. Sometimes you can predict an *association* of two variables – e.g., you can predict that if one goes up the other will go down. Sometimes you can predict the *tendencies.* But often *close* is not good enough in regulation or in business and this leads to The Blame Game when you don't get close enough.

Important clues for understanding how to manage unpredictable human organizations have been found in the study of High Reliability Organizations (HRO's) such as nuclear power plants, electrical grid dispatch centers, hospital emergency rooms, and other organizations who operate in an unpredictable environment and for whom failure can be catastrophic. These organizations accept the fact that they can not predict everything and set up systems that alert them to small changes so that they can prevent these small changes from becoming big problems.[29] This work has many similarities to the concept of Practical Drift that we will examine in Section VIII.

Some modern scholars have suggested that limited predictability can be found in game theory. This "theory" is actually a group of hypothetical games in which the players are expected to maximize their individual outcomes. Some games seem to offer clues about what makes individuals cooperate or defect in their interactions with others. Others games may give policy makers and judges some guidance on important issues such as tort reform.[30] These games reach their limitations when the game gets too big or has too many players with insufficient information to make their "moves" predictable.

> One must guard against looking at interactions between players in isolation. A problem that may look like a prisoner's dilemma or some other simple two-by-two game may be part of a much larger game. One cannot assume that, once embedded in a larger game, the play of the smaller game will be the same. Moreover, many interactions between individuals are inherently dynamic.[31]

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[28] Robert Louis Flood, *Rethinking The Fifth Discipline: Learning Within the Unknowable*, Routledge: London and New York (1999), p. 84.
[29] Karl E. Weick and Kathleen M. Sutcliffe, *Managing the Unexpected: Assuring High Performance in an Age of Complexity*, Jossey-Bass: San Francisco CA (2001).
[30] See, e.g., Douglas G. Baird, Robert H. Gertner and Randal C. Picker, *Game Theory and the Law*, Harvard University Press: Cambridge MA. (1994).
[31] Id., at 45.

> Often, one cannot easily look at an interaction in isolation. In many situations, for example, parties have repeated interactions of the same kind. Behavior that would not be sustainable without repeated dealings becomes plausible, thereby enlarging the set of problems that laws may need to address. Repetition is not the only way in which context matters, however. A particular interaction may occur within a much larger web of interactions. When a small game is embedded in a much larger game, laws that might seem sensible in the isolated small game appear insufficient when considered in the larger context.[32]

By now, many readers will have started to make a mental list of things in their experience that seem to fit the description of a complex system. *Warning!* Like all ideas that try to explain many things this idea is capable of being used to explain too much. Anything that explains everything probably explains nothing. These ideas must be carefully applied to each situation. The next section presents a (necessarily abbreviated) step in testing that application.

IV. The Communications Sector as a Complex System

In the previous section several properties of complex systems were identified: Here we take a very brief look at each of these in the context of the entire communications sector. This sector includes print, postal, broadcast, cable, satellite, telephony, the internet and emerging digital services, all the industries that act as suppliers to these firms, and all the levels government that regulate them.

Intricate Interdependencies

All these communications industries are increasingly linked together by their need to compete for several scarce resources, principally the time, attention and money of consumers. Indeed, some have predicted that they will all "converge" into one industry.[33] Although convergence is not *a fait accompli*, it is undeniable that increased competition has made all the formerly distinct industries look hungrily at each other's customers and in that sense they are now "linked" in ways they were not before. At the same time, each firm is linked to many other systems such as equipment and content suppliers as well as many layers of government. The more that globalization links these industries and firms to each other, the more complex the system becomes.

[32] Id., at 269.

The worldwide communications sector has at least two layers of agents: the consumer layer and the provider layer.[34] These agents constantly adapt to changes in the technological, regulatory and business forces in their own layer and, over time, to changes in the other layer. One way to tell if all these different industries and layers are part of the same system is to ask if they change on comparable time scales. (A biological example will help with this idea: trees and birds interact with each other but change at different rates so when looking at birds we think of trees as a constant.) If industries within a sector develop at uneven rates they may actually be pulled apart and become separate subsystems.

Many Variables

The success of any particular firm or particular industry depends on a wide variety of variables, a few of which they have some control over and many that they have little or no control over. The communications sector (except for print) has been heavily regulated and government policy is a critical variable. Firms and industries attempt to exercise some control over this variable through lobbying efforts but few seasoned lobbyists would characterize government as "predictable" because they know that governments at all levels have many forces working on them. More so than many industries, communications firms that rely on advertising revenue are also subject to the whims of the economic cycle. In the last twenty years many communications industries have been buffeted by changes (or predicted changes) in the technologies they depend on. Globalization has changed their understanding of their audience and their market. Readers will undoubtedly think of many more variables that have an impact on this sector.

Nonlinear

When forces changing the system do not add up in a simple system-wide manner we say they are nonlinear. Adding something to the system may mean it changes by more than the amount added. Some believe that "…whenever there's cooperation or competition going on – the governing equations must be nonlinear."[35] Cooperation usually takes place where people will get more of a scarce resource than they would by acting alone, thus the result is greater than the combined abilities of the individuals. An increase in both competition and cooperation has

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[33] For the forces pushing the industry together and pulling it apart, see P.H. Longstaff, *The Communications Toolkit*: *How To Build Or Regulate Any Communications Industry.* MIT Press: Cambridge MA (2002). Chapters 7 and 8.
[34] See, Robert Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, New York: Free Press (2000).
[35] Steven Strogatz, *Sync: The Emerging Science of Spontaneous Order*, New York :Hyperion (2003) .p.51.

certainly contributed to the unpredictability of the communications sector. New technology may also have effects that are greater than the investment in hardware or software.

Multi-directional and multi-velocity trajectories

Anyone who has been in the communications sector for more than a few years can vouch for the fact that it is a place where there are ups and downs. Some communications industries are closely tied to the economy (especially the retail part of the economy) while others, such as telecommunications ride the waves of the political cycles. Profits, growth, capital investment, and employment levels have wider swings than many other parts of the economy. This makes these firms a rough ride for investors, managers and regulators.

The growth rates (or velocity of growth) for the various communications industries are clearly not the same. Some, like print and broadcast show some signs of being “mature” businesses that can not look forward to much growth in their current markets. But they compete (for customer time and attention) with much faster growing industries in cable, satellite, and gaming. This does not mean that these more mature industries will die, but it means that any financial opportunities that depend on rapid growth will be less available to them – even as they feel compelled to compete with the faster-growing industries.

Connectivity

Computers have contributed to the complexity in communications by reducing the number of subsystems (industries) and forcing every one into one very complex sector. The widespread adoption of digital coding has broken down many of the technical and geographic barriers that formerly separated distinct industries such as publishing, broadcast, movies and computing. Computers also increase the speed at which information moves in the system, allowing individual agents to change strategies and tactics much faster. The system is made even more complex by a divergence in time frames: as the communication sector evolves faster, other processes (policy making, business formation) move relatively more slowly and have difficulty keeping up with the changes.

All this seems to imply that the focus for regulating a complex communications sector should not be on trying to make each and every part of it predictable but on dealing with (or managing) the unpredictability and unintended consequences.[36] This means a shift in both the focus of effort and expectations for competition policy.

V. Regulating an Unpredictable System

This discussion must begin with a question that many will assume is self-evident: What does it mean to "regulate" a system? If we look at this process outside of the governmental and management systems where most of us operate, and think like engineers for a minute, we see that regulation is *a process that is set up to keep a system within acceptable limits*. Think of the "regulator" on a boiler that provides steam heat to a building. It regulates the steam pressure inside the boiler by releasing some of it if the pressure exceeds safe levels. Or, closer to home for most of us, think of the thermostat that regulates the temperature of your home or office. The thermostat sends a signal to the furnace (or air conditioner) to turn itself on when the air temperature gets out of an acceptable range. The thermostat does not *predict* the temperature – it *controls the reaction* of the heating/cooling systems to changes in the temperature. It has two functions. First, it gathers information about the current temperature in the room using a sensing device. Second, if that information indicates that the system is outside the acceptable parameters, it sends a signal to the machines that will add hot or cool air to the room until it senses that the temperature has come back to within those acceptable parameters.

Thermostats gather information from the environment and then use that information to form a *feedback loop* that tells the furnace to turn on or off. Feedback loops are standard stuff in engineering systems that must adapt to changing conditions. They work well when the parameter of the system you want to regulate is easy to measure - like temperature. (In the next section we will come back to the idea of feedback.) In simple systems you usually "regulate" them by defining the domain of intervention (e.g., government regulation) and then set up a system to provide inputs (or outputs) to (or from) one or more parts in the system (subsidies or taxes). Or, you could change the number of linkages between a few players (or variables) or the strength of those linkages.

As we have seen, not all systems are so simple – as soon as you get more than a few players and more than a few variables the complexity starts to go up. But just because some

[36] The need for this change in perspective has been analyzed by Thomas Valovic in *Digital Mythologies:*

systems are complex, that does not mean they are unmanageable or ungovernable. The management just takes different forms and makes different assumptions.[37] Where we had come to expect certainty we are now (often reluctantly) accepting the necessity of dealing with uncertainty. This is not a new idea and was recognized by the U.S. Marines (an organization with some experience in competition and running complex operations) as early as 1989.

> All actions in war take place in an atmosphere of uncertainty – the *fog of war*. Uncertainty pervades battle in the form of unknowns about the enemy, about the environment and even about the friendly situation. While we try to reduce these unknowns by gathering information, we must realize that we cannot eliminate them. The very nature of war will be based on incomplete, inaccurate, or even contradictory information.
>
> We must learn to fight in an environment of uncertainty, which we do by developing simple, flexible plans; planning for contingencies; developing standing operating procedures; and fostering initiative among subordinates.[38]

Readers from both the government and business worlds will notice a number of concepts from this Marine Doctrine that have become well accepted in modern business and regulatory strategy. But the underlying message of accepting uncertainty and learning to manage it has not always been honored in business or in government. It is easier, especially in times when things are going well, to claim that your system is operating just the way you *planned for it* to run. But most experienced business people and government regulators will recognize that they operate in the *fog of business* and the *fog of policy making* created by increasingly complex situations.

At this point we recall that predicting the future is not the only way to deal with uncertainty or change. You can also set up systems that give you Detection and Response, Broad Tolerance, or Prevention. All three require that you know what's going on within the system and outside of it. You need feedback.

In the next section we will take a step "back" into systems theory to remind ourselves about the importance of feedback. This is done in full recognition that systems theory generally assumes that a system can be understood and engineered, but feedback seems to also be crucial in systems that are not predictable in either the short or long run.

The Hidden Complexities of the Internet, New Brunswick NJ and London: Rutgers University Press (2000).
[37] Robert Axelrod and Michael D. Cohen, *Organizational Complexity: Organizational Implications of a Scientific Frontier,* Free Press: New York, 1999

VI. Regulating With Feedback: The Cow and the Bull

If a firm does not know what actions its competitors are taking (e.g., lowering prices to largest customers) it cannot respond to them by lowering its own prices. Failure of perception is often the result of failure to develop or maintain appropriate feedback loops within the system that lets regulators know when the system has evolved beyond acceptable parameters. These loops are typically established by procedures such as reporting requirements and/or inspections.

The problem is that we often confuse feedback with the mere one-way or two-way slinging of data. In engineering terms this is just trading "signals." Real feedback allows those receiving it to know what's going on.[39] You can send a lot of data without sending any real knowledge about what you're doing (read almost any report filed with a corporate headquarters or a government agency). But unless each party really understands what the other party is telling them, they cannot respond to them appropriately and unintended consequences are almost inevitable.

It is NOT a matter of more data! Both business and government have spent billions of dollars on all kinds of new communications technologies that increased by several orders of magnitude the amount of data exchanged. Wasn't better "communications" among subunits one of the main goals of all those management information systems? Yes, it was. But, as managers inside and outside of government have learned, data without context is not knowledge. Snook has documented that having data that there is a helicopter over there but not "knowing" anything else about that data can lead to tragedy. One of the people Snook interviews in the friendly fire tragedy notes that he had data, but that looking at data without knowing what it means is like "pigs looking at watches." There is a signal but there is no understanding of that signal. Responding to a request for information with undigested data or in jargon that is unintelligible outside your own subunit is worse than a waste of time because it gives the *illusion* of knowledge. Yet it is common within and between subunits and organizations because the failure to send real information (let alone share knowledge) actually accomplishes several goals: it preserves the

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[38] *Warfighting*, Foreword by Gen. A. M. Gray, U.S. Marine Corps. Department of the Navy, Washington D.C. (1989) Government Printing Office: 1995-401-461/40383.

[39] Positive feedback amplifies fluctuations in a system while negative feedback enables the system to correct fluctuations that may be harmful. Both are used in business management and government regulation. But there can be too much feedback. Too much positive feedback can lead explosive growth while too much "long-pathway" negative feedback leads to instability that oscillates in an ever greater range.

unit's power (information *is* power), it reduces the chance of second-guessing about operating decisions, it makes it less likely that you will be blamed for any bad things that happen with regard to this information, and it hides any evidence of Practical Drift (see Section VIII) that may be frowned on by the larger organization.

Harvard's Anthony Oettinger has (for almost 40 years) been trying to get communications business leaders and government policy makers to understand the difference between *Knowledge* and what he calls *Cow* and *Bull.* He defines them this way:

> **Pure Cow** (n.) is data without any context or frame of reference
>
> **To Cow** (v. intrans) the act of cowing; to list data (or perform operations) without awareness of, or comment upon, the contexts, frames of reference, or points of observation which determines the origin, nature or meaning of the data (or procedures). To write on the assumption that "a fact is a fact." To present evidence of hard work as a substitute for understanding, without any intent to deceive.
>
> **Pure Bull** (n.) is context or frame of reference without any data.
>
> **To Bull** (v. intrans) To discourse upon the contexts, frames of reference, and points of observation which would determine the origin, nature, and meaning of data if one had any.
>
> **Knowledge** (n.) is data in context. It is born of the union between cow and bull. [40]

In government agencies, as in most large, multi-unit organizations, there are many specialist subunits that have their own cow and their own bull. They collect only information relevant to what they do and interpret that data from the perspective of their discipline. They send their cow and bull (often only cow or only bull) to the top of the organization where it gets used to make decisions. It is seldom sent to other subunits. To improve decision- making in public policy, Oettinger has advocated putting various government subunits

> "...in constant touch and interchange with people and data elsewhere in their own and other hierarchies, without altering their responsibility and the focus of their attention. They are given unlimited peripheral vision and the means to avail themselves of relevant

[40] Anthony Oettinger, "A Bull's Eye View of Management and Engineering Information Systems," *Proceedings of the Association for Computing Machinery*, Philadelphia, PA, 1964, and, "Knowledge Innovations: The Endless Adventure," *Bulletin of the American Society for Information Science and Technology*, December/January 2001, Vol. 27, No. 2, pp.10-15. Similarly, the terms cow and bull have been used to discuss the intellectual development of college students and how they arrive at knowledge. See, William Perry, *Forms of Intellectual and Ethical Development in the College Years: A Scheme*, New York: Holt, Rinehart and Winston (1970).

> expertise or data, irrespective of the location….they are better prepared to volunteer significant data or respond to requests in a more timely and intelligible fashion."[41]

How can an organization encourage a sharing of both cow and bull? Oettinger says this part of the knowledge process is where information technology can contribute the least. He suggests that living together, learning together, and doing together are still the best. This need for proximity probably means that large organizations with offices in many locations will have to work a lot harder at achieving good feedback loops. This may mean that there is an upper limit on the size of an organization that requires high levels of feedback.

But there are things that can be done to increase good feedback. Organizations can develop new ways to index, things like promotions, unit perks, and budget increases to feedback *quality* as well as *quantity*. This would include some measure of the veracity of both the cow and the bull as well as how easy it is to integrate into the feedback systems of other units and how it contributes to the organization's missions and goals. It may even be possible to show how good feedback converts into profits and thus give managers inclined to the old "hide your cards" strategy a bigger incentive to play a new game.[42]

These ideas can be used to increase the quality of feedback loops in government. There are certainly feedback loops in any regulatory processes. Some loops are direct and some are indirect. Agencies and elected officials often ask for public input to their proceedings and they set up Advisory Committees of all sorts. Lobbyists are surely in the feedback business –both to and from their clients. Litigation can also send a message that things are not going as planned. In an attempt to set up some feedback about what's happening with competition in the communications sector the FCC has set up annual revenues of conditions – certainly a laudable start and one that will almost certainly become more valuable as the participants discover better sources for both cow and bull.

In the next section we look at several new ideas that may help provide for better cow and bull.

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[41] Anthony Oettinger, "Compunications in the National Decision-Making Process," in Martin Greenberger, editor *Computers, Communications, and the Public Interest*, Baltimore: Johns Hopkins University Press, 1971, pp. 73-114, at p.85.
[42] For these ideas on motivating feedback, the author is indebted to Caryn L. Anderson.

VII. Network Science

There is a new (and growing) body of work that looks at the connections between things that function as a network. This work also indicates that the strength of the ties between things is critical for understanding (if not always predicting) the operation of the networked systems. Network Science gained popularity as the "small world" problem, and, more recently, the "Kevin Bacon game." The former is the puzzle of why most people on the earth seem to be separated from each other by only six other people, or six degrees of separation. The latter uses movie actor Kevin Bacon and his connection to other people in the film industry to test the degrees of separation between them. This work, originally done in a branch of mathematics known as graph theory, is being examined by many disciplines including political science, biology, sociology, and computer science. In some of the networks studied by these fields, the distribution of things in the network (e.g., wealth, web links) follows a power law. When graphed, these systems are characterized by a continuously decreasing curve, showing many small things existing with a few large ones (many people with small amounts of money and a few with a large amount, many web sites with a few links and a few with many links). This is in contrast to systems where the distribution follows the typical bell curve with a few things at either end of the spectrum (a few small things at one end and a few large things at the other) but most of the things clustered in the middle.

There is some indication that networks following a power law develop differently from other systems. They seem to grow one node at a time (as in one web page at a time) and have preferential connections (e.g., some nodes are connected to more often because they were first or have more resources). In these systems the rich tend to get richer because the more connections you have the more connections you attract.[43] Some networks develop what is known as a "scale-free" topology, that is, there are many small nodes that connect to a few larger nodes that in turn connect to still larger nodes in a hierarchical configuration. In other networks the "winner takes all" when one node has all the connections and there is one giant hub with many tiny nodes.[44] These ideas have obvious implications for the regulation of monopolies.

The strength of the various connections in networks seems to have a critical impact on the system. There is some evidence from the study of natural ecosystems that weak links between

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[43] See, e.g., Albert-Laszlo Barabasi, *Linked: The New Science of Networks*, Cambridge MA: Perseus Press (2002), Chapter Six.

[44] Id., Chapter Eight.

many interacting species will make the system more stable and less likely to suffer sudden catastrophic changes. A link between two species is said to be strong where one species eats only one other species. A drop in the number of prey will have immediate and devastating effect on the predator species. This idea is thought to work in human social networks as well. If a person (or firm) depends only on several close relationships their network of support can collapse if something happens to one of those relationships.

Where a species eats many other species, a drop in any one of them will not result in declines in populations of that predator but it may have effects far beyond the interaction between this predator and prey.

> Most species within a food web can be thought of as 'local' to each other and existing in surprisingly 'small worlds' where species can potentially interact with other species through at least one short trophic chain…This suggests that the effects of adding, removing or altering species will propagate both widely and rapidly throughout large complex communities.[45]

In both biological and human systems that have many interacting individuals (or groups) there are often a super-connected individuals who have weak links to many other individuals and groups.[46] They become the hubs that enable the many interactions that keep the system stable. If you *remove* one of these hub species (or people, or firms) the system will experience rapid (and often unpredictable) change. If you *add* a hub to a random network of individuals you are likely to get an "aristocratic" (the rich get richer) configuration where power (and scarce resources) are drawn to the hub. These networks where superconnected hubs form are often very efficient and robust at lower levels because destroying any of less connected nodes will have little impact on the system. But this strength is also their Achilles heel because destroying a superconnected hub can destroy the entire network. Any firm that becomes a superconnected hub for the sector becomes both an opportunity for efficiency and a danger because it can bring everyone down with it. Generally, an industry with a few giants (an aristocratic network) is what regulators want to avoid. If an industry is inclined toward a power law distribution then we need to know if that can be changed by intervention in the process of the network's formation or at some later point in its development.

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[45] Richard J. Williams, Neo D. Martinez, Eric L. Berlow, Jennifer A. Dunne, and Albert-Laszlo Barabasi, "Two Degrees of Separation in Complex Food Webs," working paper 01-07-036, Santa Fe Institute, 2000. Available at www.santafe.edu/sfi/publications/00wplist.html

[46] For a discussion of this in human systems see, Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference,* Boston: Little, Brown and Company (2000).

But the impact of this work on complex networked systems is still in the formative stages. Duncan Watts, one of the original researchers in this area, has this to say:

> What can the science of networks tell us about the properties of complex systems, and especially their strengths and weaknesses? The honest answer, unfortunately, is not too much – yet. It is important to recognize that, despite 50 years of percolating in the background, the science of networks is only just getting off the ground.[47]

But Watts thinks this work has already given important insights that are consistent with the ideas expressed in this paper. In particular, he believes that, "…in connected systems, cause and effect are related in a complicated and quite often misleading way." This seems to be evidence that any simplistic form of the Blame Game is inappropriate in these types of systems. This is an area of study that should be watched closely by everyone trying to manage or regulate networked systems.[48]

VIII. Tightly/ Loosely Coupled Systems

Like the system of variously connected buttons described in Section III, most systems have connections that vary in their strength. This has been observed in living systems (at the cellular, organism and group levels) as well as in nonliving and human-engineered systems. Understanding the strength of coupling in a system can help devise regulatory or management responses to perceived challenges. It should be noted that any insights gained from viewing a system in this way DOES NOT increase the ultimate predictability of complex systems. But these insights may give those trying to manage such systems new ideas about how to nudge them in the desired direction or keep them within the desired parameters.

Although Robert Glassman originally wrote about loosely and tightly coupled systems in biological systems, he saw that the concepts he developed could be applied to many organizations. In fact, his ideas have been applied to military organization,[49] organizational development,[50] cooperation among business firms,[51] and many other fields.[52] Glassman described

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[47] Duncan Watts, "Unraveling the Mysteries of the Connected Age," *The Chronicle of Higher Education*, Feb. 14, 2003. at http://chronicle.com/free/v49/i23/23b00701.htm
[48] For more information, see the Suggested Reading at the end of this paper.
[49] Scott Snook, note 2.
[50] John W. Meyer and W. Richard Scott, *Organizational Environments: Ritual and Rationality*, Beverly Hills CA: Sage (1983).

the fundamental process of organization this way: "as soon as the relation between two entities A and B becomes conditional on C's value or state, then a necessary component of organization is present."[53] He then noted that the strength of that relationship (whether it is loose or tight) is important to understanding how the system reacts to stimuli. A number of similarities in loosely coupled and tightly coupled systems have been identified and are used to help understand (even if they can't always precisely predict) these systems.

Tightly coupled organizations are those where any change in one component (individuals or subsystems) of the system will engender an immediate response from the other component(s). Any organization that requires an organization-wide rapid adjustment to new conditions is likely to be tightly coupled. A system could be tightly coupled if its components share many variables or the link between the variables is very strong. Engineered systems with automatic controls are said to be tightly coupled (if A happens then B is the automatic and immediate response). These systems often have very tight feedback loops that control all variables – this is sometimes described as a "feedforward" or "planning" system. Since anything that affects one part of a tightly coupled system will affect all parts, these systems are often unstable because the individual parts are not able to adjust to maintain their local stability. These systems are not associated with persistent behavior because they adjust as a unit to changes in the environment.

Loosely coupled systems are those where the components have weak enough links that they can ignore small perturbations in the system. The components of a loosely coupled system are said to have more independence from the system than tightly coupled components since they can maintain their equilibrium or stability even when other parts of the system are affected by a change in the environment. The components of loosely coupled systems are also better at responding to local changes in the environment since any change they make does not require the whole system to respond. Thus, if innovation or localized response to particular problems were a goal, then loosely coupled systems would seem to be in order. A more tightly coupled system could lead to premature convergence on a solution since all the components would be responding

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[51] Marc J. Dollinger, "The Evolution of Collective Strategies in Fragmented Industries," *Academy of Management Review*, 1990, Vol. 15, No. 2, pp. 266-285.
[52] For a comprehensive review, see, J. Douglas Orton and Karl E. Weick, "Loosely Coupled Systems: A Reconceptualization," *Academy of Management Review*, 1990, Vol. 15, No.2, pp. 203-223.
[53] Robert B. Glassman, "Persistence and Loose Coupling in Living Systems," *Behavioral Science*, Vol. 18, pp. 83-98 (1973) at p. 84. For an excellent overview of these ideas, see, Karl E. Weick, "Educational Organizations as Loosely Coupled Systems," *Administrative Science Quarterly*, March 1976, Vol. 21, pp. 1-19.

more or less in unison. However, if the goal is *standardization* across the entire system, then a tight coupling of the entire system (including all subsystems) is more likely to yield the desired outcome.

There is good evidence in Network Science that weak ties (or loose coupling) are often more important than strong ones when dealing with a new problem. If two firms are strongly linked (or tightly coupled) to each other they are probably also probably strong linked to each other's links. The weaker links of each firm will be bridges to other systems with other resources or ideas that can be used when they face a new problem.[54] Long term stability of a system (or a firm) may actually increase if it has many weak ties and becomes more complex – even if this means it is less predictable in the short term. This has led to speculation that "…the superconnected few should be linked to others mostly by weak links, while those with few links to others should be connected by strong links."[55] A variety of weak links requires some *diversity* in the system and a loss of too many of them will have serious implications for the stability of the superconnected few.

Large organizations with several levels of subsystems may have some that are tightly coupled and others that are more loosely coupled. This allows local areas of stability when a subsystem is relatively independent of (or loosely coupled to) the larger organization or to other subsystems. This has implications for the adaptation of the larger organization because this process can only take place as fast as the most loosely coupled component. The temporary or partial independence of one or more components will slow down (or change) the process. This is an important insight for executives and regulators who must make predictions about the ability of a merged organization to develop "synergies" that result in higher profits or lower costs. For example, if one unit of the newly merged company is a film production company (they are famous for being loosely coupled internally) and it must be coupled with a telephone company (they are equally famous for tight internal coupling) the result may be a slower adaptation process than the telephone culture is accustomed to. If the telephone firm becomes unstable after it has become more tightly coupled to the film company, the latter will become unstable as well. At this point the film company is likely to seek a more loosely coupled relationship – or even a break in the relationship.

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[54] See, e.g., Mark Buchanan, *Nexus: Small Worlds and the Groundbreaking Science of Networks*, New York and London: W.W. Norton & Co. (2002), Chapter Two, "The Strength of Weak Ties."
[55] Id. At p. 149.

Large organizations can maintain stability (loose coupling) at a higher level or among various subsystems by having a special subsystem that deals with perturbations in variables that would upset other parts of the organization. In human political systems police and military forces are an example of subsystems that deal with problems (crimes or attacks) that affect parts of the system before those problems can affect the entire system. These special systems are often tightly coupled within themselves since they must often deal instantly and cohesively with situations that are dangerous to themselves and to others. The strength of the coupling within an organization can also change over time and in the face of new challenges. If an industrial organization that is loosely organized must deal with a security problem, it is likely to develop tight coupling for this purpose if it must respond to the problem as a unit. This explains why governments typically allow competitors to cooperate in times of national crisis – particularly in the communications sector, a key element of security information gathering and dissemination. Loose coupling might have some security advantages for a system if a problem (e.g., intruder, contamination) can be isolated in one (or a few) subsystems that are not tightly coupled to others.

The strength of coupling within or between organizations can been predicted by the level of resources available, the time it takes the system to change, and how fast influence spreads in the system. This information can be used to manage or regulate these systems, either to strengthen or to weaken the coupling.[56]

Adequate Resources

An organization may become loosely coupled if the individuals or subunits have resources that are more than adequate to meet their demands. They do not need to act as a team to get what they need. If governments want parts of their communications sector to act independently (e.g., eschew the urge to merge) they should look at whether there are adequate resources in the system to support the current organizations. If resources to individual companies are reduced (due to a falling economy or more firms trying to compete for the same amount) then one could expect some form of tighter coupling relationships to emerge.[57]

[56] The examples of loose coupling are taken from Weick, Id., at p. 5.

[57] Similar ideas about cooperation have been developed in biological systems. These systems can give many other clues about the nature of competition and cooperation that would be useful in competition regulation and business management. See, P.H. Longstaff, *The Communications Toolkit: How to Build or Regulate Any Communications Business*, Chapter Four, Cambridge, MA: MIT Press (2002), Chapter 4.

Slow Change

An organization is probably loosely coupled if, no matter what new rules are applied, things do not change. This may indicate that the individuals or subsystems are effectively independent of the rule-maker. The rule-maker would need some reward (or, perhaps a punishment) to make the relationship tighter between its actions and those it seeks to regulate. If a CEO of a newly merged company made new rules regarding preferential treatment for fellow units but the units were slow to change, this would indicate that the corporate headquarters is more loosely coupled to the subunits than it thinks. This loose coupling might be seen as a good thing if conditions at corporate headquarters become unstable.

Slow/Weak Spread of Influence

An organization may be more loosely coupled than it appears if, although it is highly connected, influence (the impact of a part on the whole) spreads weakly or slowly. Consider again the button system that has connections of many strengths and lengths. If the connection between two button is a tight one (e.g., they are connected by a rigid steel rod), then any influence on one will be felt immediately on the other and any other buttons that are tightly connected to them. If there is one button with many connections it may not be able to have as much effect on the whole system if those connections are loose (e.g. they are made of single strands of human hair). A modern multinational communications firm that is horizontally and/or vertically integrated may look like it is a tightly coupled monolith (and maybe a tightly coupled monopoly). But looks may be deceiving – both to regulators and shareholders. A large company that has loosely coupled subunits will not have fast or strong impact on its customers (for example, a company that sells to customers via an independent dealer network). Another firm that may not be as large may be more tightly coupled to its customers (because they sell directly to the customers) and its influence will spread more quickly or more strongly than larger, more loosely coupled organizations.

IX. Practical Drift

When subunits of large organizations are loosely coupled to each other and to the larger organization's structure, there is a danger that they will evolve local solutions to their needs without telling each other (and the larger organization) that they have deviated from expected procedures. Snook has described this phenomenon and calls it "Practical Drift." He concludes that, in complex organizations such as the military, the operation of subunits will drift away from the operational rules of the larger organization as they become more loosely coupled from one another.

> Practical drift is the slow steady uncoupling of local practice from written procedure. It is this structural tendency for subunits to drift away from globally synchronized rule-based logics of action toward locally determined task-based procedures that places complex organizations at risk.[58]

Snook found that precise causation in a situation like the "friendly fire" incident that he studied is extremely difficult to pin down. But he notes that loose coupling led to differentiation in procedures in the various military units and that these procedures were not coordinated with each other. In a situation where coordination was imperative (to identify enemies and friends) this loose coupling led to tragedy. Is the answer tighter coupling in the form of stricter rules? Not always, says Snook. He notes that tighter rules

> …increase the likelihood that such rules will be perceived as overly controlling, wholly inappropriate in a primarily loosely coupled world, and clearly unsustainable in the long run…The tighter the rules, the greater the potential for sizable practical drift to occur as the inevitable influence of local tasks takes hold.[59]

How do you spot practical drift? Snook cautions us against looking in one particular place/unit (or level within a unit) or at one particular time.

> Focus solely at any one level and you'll miss it. A second way to miss it is to take a snapshot. As a dynamic process, it cuts across time just as surely as it does levels of analysis. Like an animal in the wild that remains hidden until it moves, drift can't be seen in a single glance.[60]

Snook's concept of practical drift has obvious implications for both business and government organizations at many levels and with regard to many problems. Two implications seem most relevant to this paper. For government organizations involved in competition policy, we note that policy directives from elected officials must often be interpreted and implemented by many subunits of government. These subunits are often loosely coupled and may even be in several different agencies. For example, in the U.S., the FCC, the FTC, and the Justice Department handle competition policy for the communications sector. If practical drift were to occur, these subunits would slowly drift away from the already ambiguous policy directives in the Clayton and Sherman Acts[61] toward procedures that allow them to accomplish their own local

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[58] Snook, note 2, at p. 24.
[59] Id. at p. 201.
[60] Id. at p. 225.
[61] For example, the Clayton Act of 1914 makes it illegal to "monopolize or to attempt to conspire to monopolize trade." The Sherman Act of 1890 forbids any "contract, combination or conspiracy in restraint of trade." See Phillip Areeda, *Antitrust Law*, Boston: Little, Brown & Co. (1996).

objectives. Some sort of coordination in the form of feedback loops should be built and the messages collected in that process reviewed over time as the regulatory process evolves in each subunit.

For business organizations that must try to make and enforce procedures that will comply with competition law, the idea of practical drift may be even more important. Like subunits of a military organization, subunits of a company are given specific tasks (usually profit or cost-containment goals) and given a certain amount of flexibility in how they accomplish those tasks. They are also told to obey the law and to obey company policies (either exquisitely detailed or very vague) on everything from buying paper, to firing staff, to dealing with competitors. Anything they do that is later interpreted as a “mistake” (an antitrust violation, for example) is likely to engender a new set of more elaborate rules from corporate headquarters – in an attempt at tighter coupling of the subunits to the larger organization. Since these rules are supposed to be followed company-wide, they are unlikely to have flexibility for the realities on the ground at the subunits. Thus they are likely to be perceived as “overly controlling, wholly inappropriate in a primarily loosely coupled world, and clearly unsustainable in the long run.” This makes them easier to ignore. And if no one is looking for practical drift at all levels of the organization the likelihood of another antitrust problem only gets bigger. This is NOT to say that companies should not make rules regarding how they deal with competitors in order to avoid breaking the law. It is to suggest that just making the rules is not enough in complex organizations. It is not easy or cheap, but such organizations, like their government counterparts, need more reliable, intelligible, and ongoing feedback. This sharing of cow (data) among subunits also helps them develop some overlapping bull (context) for the data they have access to and increases the likelihood of shared opinions about what the data means for the organization’s mission and when Practical Drift is dangerous.

The mission of competition regulation is often hard to define and achieving it on a permanent basis is not possible in an evolving system. But regulators could define the parameters within which they want the system to operate. The next section examines the existing ideas about the mission of competition regulation in the communications sector and presents some ideas for refining them.

X. Defining the Acceptable Parameters For Competition Regulation

The regulation of competition is *not* like the home thermostat "regulator" that gets feedback from the environment and uses that data to turn the furnace on an off when the temperature is outside acceptable parameters. In competition policymaking and its enforcement there is often very little feedback – bull or cow. The statutes (which theoretically set out the acceptable parameters of business actions) are extremely vague, the court decisions interpreting them struggle to set precedent (judges are often given contradictory cow and bull), and the signals about possible levels of enforcement coming from government are often confusing and change with each administration. However, the FCC has begun to address the issue of feedback regarding competition in annual reports on the state of the industries it regulates.

Once a system of feedback is set up to move the appropriate cow and bull, somebody has to define the acceptable parameters in which the system can operate before some enforcement mechanism is engaged – when the system says "ouch" and moves to a different position with respect to a firm or an industry. For regulatory agencies these parameters are set by legislation, by directives from the executive office (president, governor), and by judicial review of their actions. Competition policy in the U.S. is said to regulate the following parameters[62]:

- *Economic Efficiency*
- *Consumer Welfare,* including *Lowest Price, Highest Quality, Most Diversity (of Products/Services and of Vendors)*
- *Distribution of Wealth*
- *Innovation*
- *Stability*

It is sometimes not possible to optimize all of these parameters at any moment in an industry. Sometimes it is necessary to choose less economic efficiency in order to get more vendors. At other times more innovation trumps the need for stability. This makes competition regulation a complex process indeed. A similar problem would arise if we were to build an atmosphere control system for our homes (to replace the thermostat described above) that would control heat, humidity, dust, bacteria and smell. If you raise the temperature the air will hold more moisture but that may encourage the growth of certain bacteria – this would create an odor and trigger more deodorizer. To make matters even more complicated, the people who live in the house (like the people who regulate competition) may have different ideas about what parameters are the most comfortable and the most affordable. In the atmosphere control system, as in competition regulation, all of the parameters can feed back on each other, making adjustment (or regulation) of the system very tricky and maybe unpredictable.

A political consensus on the acceptable parameters of competition within the economy generally or within a particular industry is not easy to come by. But even if one were to be worked out, the measurement of these parameters is far more difficult than measuring things like temperature and humidity. How do you measure the amount of competition in an industry? Regulators have employed a variety of tools to determine when the acceptable parameters have been reached. These include “body counts” (how many firms are competing), market share (how many of the potential customers does each firm have), and entry barriers (how easy is it for new firms to enter this business). Unfortunately, they are not well-defined concepts and their application is often difficult in new situations. The data (cow) about these parameters is difficult to get and to organize and the context for interpreting the data (the bull) is often seen as, well, bull (pejorative sense intended here).

One area worthy of immediate study and debate is the concept of stability. Is a very competitive environment a stable one? Can we have both? Are there times when stability is more important than competition? Does more diversity in the number of firms offering a good or service make the system more or less stable? Does the number of substitutable products make the system more or less stable? The work being done in biological systems will be a good starting point for this study.

There are many other examples of problems where policy makers and regulators need to evolve some new cow and bull to deal with the many changes in the communications sector. Some of them are fundamental for applying any sort of competition regulation. For example, if you are counting the number of firms in an industry, how do you count the number of firms that have many different products or slightly different products? This is not a trivial problem in the communications sector. What is a “telephone” service these days? The answer will be critical for

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[62] See, Phillip Areeda, *Antitrust Law*, Boston: Little, Brown & Co. (1996); W. Kip Viscusi, John M. Vernon, and Joseph E. Harrington, *Economics of Regulation and Antitrust*, 3rd Edition, Cambridge MA: MIT Press, 2000.

defining the “market” for that service and the competitive effect of “bundling” several functions. This author has previously suggested that data about these firms be reorganized within a new context that describes what they do and not what they used to do. This is an example of how looking at the problem of regulating competition could benefit from looking at it as a system and a process that keeps changing. What we need now are things that are the really basic building blocks of the system. In the communications sector these building blocks come from Information Theory because it describes the basic functions of all communications industries. This allows us to analyze different types of firms (e.g., cable and telephone) who are performing the same function in the communication process.[63]

There are only a few *types* of blocks (several sizes and shapes) but you can build many different things with them. The basic building blocks of any communication are: senders, receivers, coding, channel, noise, and message. All complex modern systems of communication—radio, television, satellite communication, cable, and wireless phones and computers—are refinements or elaborations of these building blocks.

New Communication Industry Building Blocks

Building Block	*Definition*	*Examples in the Communications Sector*
Sender	The one attempting to send a message to one or more receivers	Radio producer, e-mail sender
Receiver	Anyone who perceives the message whether or not they were the intended recipient.	Radio listener, e-mail recipient
Encoding	The process that puts the message in the appropriate form for the channel.	Analog signal, digital signal
Sending Device	A machine that puts the coded message in the channel.	Radio transmitter, personal computer
Receiving Device	A machine that takes the coded message back out of the channel.	Car radio, personal computer
Decoding	The process that puts the message in a form that is understandable by the receiver.	Analog signal becomes audible as music, digital signal becomes readable as text
Channel	The route through which the message travels. A message can go through several layers of channels in a networked system or through several channels before it reaches the receiver(s).	The air (using variations in electromagnetic waves), phone, or cable lines

[63] See, Longstaff, *Information Theory as a Basis for Rationalizing Regulation of the Communications Industry*, PIRP (1994), and *The Communications Toolkit: How to Build and Regulate Any Communications Business*, MIT Press: Cambridge, Mass. (2002), Chapter Two.

Message	Changes or variations in what goes over the channel	Variations in wave frequency or length, variations in ones and zeros
Noise	Other messages or signals in the channel that make it difficult for the receiver to perceive the message	Electromagnetic signals caused by sunspots or storms, temporary interruptions in the signal

These building blocks map very well onto the competition issues identified by the FCC and the courts for the communications industry. For example, in its 2002 Biennial Regulatory Review of broadcast ownership rules the FCC identified four goals for diversity.[64] These can be restated using the new building blocks this way:

FCC Diversity Goals as currently stated	**Restated in new Building Blocks**
Goal: *View Point Diversity* by mandating many owners	Goal: Multiple owners of each channel of communication
Goal: *Outlet Diversity* through access to many types of communication services	Goal: Multiple channels of communications
Goal: *Source Diversity* through access to many "content providers and producers"	Goal: Multiple senders
Goal: *Program Diversity* through variety of "formats and content" (e.g., comedies, dramas, newsmagazines, etc.)	Goal: Multiple message types

Of course this restatement does not answer the really hard questions such as how many senders, channels, or message types is enough and how many people must have access to them in order to achieve pubic policy goals. The restated goals do make the issues clearer by allowing us to disregard the technology employed where that is appropriate. If treating a technology differently is desirable these new building blocks will facilitate discussion of the differences as well as the similarities among the players. For example, channels that operate in low density markets might be treated differently from channels that operate in high density markets.

[64] *In the matter of 2002 Biennial Regulatory Review of the Commission's Broadcast Ownership Rules and Other Rules Adopted Pursuant to Section 202 of the Telecommunications Act of 1996*, MM Docket No.'s 02-277, 01-235, 01-317, 00-244. NPRM adopted September 12, 2002. See, pp. 13-19.

It has been observed that media ownership limits are not really about promoting competition, but about political and cultural pluralism.[65] Those are related but not the same. A single owner (or a few owners) of a channel (e.g., broadcast) could coordinate the messages in their channel to fit one political or cultural point of view, but there is no reason why multiple owners could not do the same thing if they thought it was what sells. In fact, programming does tend to "follow the leader" even when there are many owners involved. If multiple points of view is the desired acceptable parameter and not a certain number of owners, then different cow and bull would be collected.

While it is not clear *a priori* that big firms will reduce the number of messages or the diversity of messages, very big firms may present other policy problems that have nothing to do with competition. For example, they can get "Too Big to Fail." In network science terms, a firm could become a superconnected node (or hub) whose failure would affect the entire sector, causing many more firms to fail and leaving the public without adequate communications services.

This paper makes no attempt to decide what the acceptable parameters *should* be. But what ever parameters are chosen, they should be clear to everyone, the feedback loops should be in place, and regulators should move immediately when the system moves outside those parameters.

XI. Putting It All Together

At this point we very briefly put all these ideas together to see what it might look like they become some of the regulatory tools used for competition regulation in the communications sector. For example, knowing that a *channel* is tightly coupled to the *encoding process* or the *message* would help to set acceptable parameters for competitive (or cooperative) activity involving firms involved in (or proposing to be involved in) tight coupling (e.g., merger) of those communication functions. Knowing the strength of coupling would also give some clue about whether denial of merger approval is more likely to inhibit innovation, as it would in tightly coupled organizations or where the industry is tightly coupled to government.

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[65] See, e.g., Gillian Doyle, *Understanding Media Economics*, London and Thousand Oaks: SAGE Publications (2002), pp. 161-174.

If stability is the most important goal for any of these communications functions, then tight coupling in the form of horizontal integration of a channel (e.g., one company owning many radio stations) might bring financial stability (efficiency) in the short run. But any ill wind will affect all the subunits of this type of firm, and it will be less likely to be able to respond to local challenges. On the other hand, tight coupling among firms who are brought under one corporate umbrella will allow ideas and innovations to spread more quickly than if they were uncoupled or very loosely coupled. However, tightly coupled firms may be less likely to generate those innovations internally.

Another example: loose coupling in firms engaging in message-making (TV, newspaper, etc.) means there will be more innovation in that function because they will not respond as a unit (with the same message) to stimuli. In the U.S. this is encouraged in virtually all competition policies, which assume that "new messages from many sources" is an important goal in democracies. This goal is often called the “marketplace of ideas.” But these message-makers will not stay loosely coupled if they don’t have adequate resources. As soon as their revenue streams are reduced by a down-turn in the economy or new competitors, the coupling is likely to get tighter and the number of messages fewer.

Some communications functions have historically been more tightly coupled to government than others. For example, most firms performing a channel function depend on government to subsidize their infrastructure and fund the research that gives them access to the innovative new technologies they will use to gain new customers or market share. Some of these channels depend on government assets (spectrum, right-of-way) for their very existence. The tighter they are coupled to government, the more likely that any ill winds that hit these channels will also hit government and visa versa. There is, therefore, some reason to expect that government is more likely to be able to influence competition goals in tightly coupled situations, such as encouraging the entry of new competitors to lower consumer prices. But in tightly coupled situations, governments are also more likely to set up “sinks” that will allow the regulated firm to pass on higher prices to consumers because danger to one is likely to be seen as danger to the other.

In addition, the more tightly coupled an industry is to government, the more likely it is that individual firms will respond to the actions of government. When tightly coupled, government and industry are much less likely to take any important action independent of each other. In societies where this relationship is not transparent this tight coupling can lead to corruption, a lack of checks and balances, and catastrophic consequences if harm comes to one of them. A collapse of such a government will cause the collapse of the industry that is tightly coupled to it. Where this relationship is transparent, both the industry and the government can argue to consumers (who are also voters) that the right balance is being struck. If the balance becomes economically unfavorable for consumers it will become politically unpopular and it will be realigned through the enforcement of antitrust laws.

If both industry and government are taking into account the interests of consumers/voters (and the interests of each other) it might mean that fewer rules are necessary to maintain the appropriate balance of power – and this would lead to looser coupling! This seems to be borne out in the real world where the power of the coupling between an industry and government does, in fact, fluctuate over time, finding new balances in changing times.

XII. Regulation and Management of Complex Systems – First Steps

Accepting uncertainty is not easy. It is much easier to believe that if you just had the right information and used the right formula (economic, political, etc.) you could build the right answer to your problem. But as soon as one gives up this belief, it is possible to end the search for the perfect data (the perfect cow) and the perfect formula (the perfect bull) and begin to build a system that gives more of what you want, more of the time. Both regulators and business managers can start to reorder their systems with these steps:

- Realign everyone's expectations about certainty. This may be the most important and the most difficult.
- Look for ways to deal with uncertainty that don't require you predict the future: Detection and Response, Broad Tolerance, or Prevention.
- Recognize where your organization or system is loosely or tightly coupled.
- Establish acceptable parameters for the system that are known to all.
- Create feedback (cow and bull) loops that tell you when the system has gotten out of the acceptable parameters.
- Use that feedback to watch for practical drift – it may be a sign that feedback loops are not working OR that there are unanticipated outcomes at some levels or locations in the organization.

- Nudge the system back toward those acceptable parameters as soon as you can – don't wait for it to become too big to fix without extraordinary effort.
- Iterate your way to success. Small steps that allow you to change course often will often be more effective than big steps in a time of great uncertainty. You don't design the path – you discover it.

These ideas can be used in regulating many systems and organizations. But the communications sector may need them sooner than most. The communications industries are important for the general welfare of all citizens. The many new forces working on this sector are making its operation extremely complex but not ungovernable. The economic and political consequences of failing to getting a better handle on competition policy will be enormous and long lasting.

Of course, what everyone wants is a simple set of instructions that can be applied to predictable problems and will result in predictable outcomes. Alas, this paper has no "Simple Rules For Predictable Regulation of Competition." But the ideas developed here can make the regulation of competition more reliable, even if what we seek to regulate remains unpredictable.

Specifically, policy makers can:

1. Assume that competition in the communications sector is part of a complex system that will often be unpredictable. Make this assumption explicit in regulation and set out strategies to deal with the uncertainty – everyone should know what happens when something unpredictable happens (e.g., unintended collateral damage to people or firms).
2. Redefine accountability. Regulators and the firms they regulate are not *unaccountable* – they are just accountable for different things, including failure to have systems in place to deal with the unpredicted and failure to pass along the right feedback with regard to the acceptable parameters for competition in the system. Assume that the Blame Game is an inefficient and wasteful correction mechanism. Make this assumption explicit in organizational policy and public communication.
3. Revise analytical frameworks used in regulatory decisions to include analysis of:
    a. Whether the firms(s) (or the firm and its customers) are tightly or loosely coupled and whether tighter regulation will make them more or less unstable. This can be

determined by things like the adequacy of a firm's resources, the speed of change for the firm, the speed of the spread of influencing variables.

- What role the firm plays in the communication process, not what technology it uses. The parameters for competition and cooperation should take into account the fact that old technological boundaries between industries in the communications sector may no longer be appropriate for counting the number of firms who are competing for the same scarce resources. Regrouping them by their function in the communication process will help to reduce this problem.

4. Articulate the acceptable parameters for competition and cooperation in the communications sector that is clear about the goals for society – what do we want to make sure happens or doesn't happen.
5. Review mechanisms for relevant feedback (with both cow and bull) to and from both policy makers and firms to make sure that the feedback generated actually gives a good indication of whether the system has moved outside the acceptable parameters. Set up incentives (or punishments) to encourage more feedback and recognize quality.
6. Devise specific ways to watch for Practical Drift – for example, a trend in one part of the firm (or an industry) to resist regulation by coming up with a local solution – this may be an indication of unequal impact or unanticipated consequences.

Caveat

The ideas listed above are only first steps and they make use of systems theory concepts that may ultimately be incompatible with what we come to understand about complex adaptive systems. This paper is only part of *the beginning* of the work, both conceptual and practical, that must be done by many disciplines to give us tools for regulating and managing the complex and the unpredictable. But beware of the simple answer. Be skeptical of the diagram with circles and arrows that indicate simple causes and effects. There is a real danger that the jargon of complex adaptive systems research will be used to just dress up old ideas in new clothes. Nobody needs another management fad *du jour.* As Networks pioneer Duncan Watts has said,

> … the connected age cannot be understood by trying to force it into any one model of the world, however reassuring that might seem, nor can it be understood by any one discipline working alone. The questions are simply too rich, too complicated, and frankly, too hard for that….. So if you're looking for answers, try the new-age section.[66]

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[66] Duncan Watts, *Six Degrees of Separation: The Science of the Connected Age*, New York and London: W.W. Norton & Co. (2003), p.15.

Suggested Further Reading

(All are appropriate for nonspecialists)

Complexity, Chaos, General Systems Theories

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