21st Century Governance as a Complex Adaptive System

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ABSTRACT

The Information Revolution combined with connective technologies creates a unique global social network. This network is vulnerable to cascades of information, norms, and coordinated action. The inherent unpredictability of the information society demands new kinds of governance that focus on rapid network-coordinated response over centralized predictive planning.

Keywords: Complexity, Complex Adaptive Systems, Social Networks, Perpetual Contact, Smart Mobs, Computer Mediated Communications, Multiscale Connectivity, Information, Society, Governance

21ST CENTURY GOVERNANCE AS A COMPLEX ADAPTIVE SYSTEM

Complexity + Small-World Networks + Perpetual Contact = Unpredictability

The pseudo-equation above outlines the basic analytical argument presented herein. To wit, the **complexity** of our social system, composed of many interacting individuals, that conforms to the pattern of organization known as a **small-world network**, is being propelled by communicative technologies from a norm of occasional interaction to one that is characterized by constant interaction, or **perpetual contact**, and this change will result in an inherently unpredictable social system. As a consequence, political order must pursue a corresponding policy shift from predictive and anticipatory governance to rapid-response networks, and must learn to act as a **complex adaptive system**. I conclude by examining some of the ways in which we can restructure governance systems to our advantage by using **multiscale connectivity.**

COMPLEXITY

What is Complexity?

Complex systems – systems composed of many interacting parts – appear in many disciplines including physics, economics, biology, cognition, networks, and sociology. Their dynamics are **non-linear**, and the properties of the whole cannot be reduced to the properties of its parts. Robert Axelrod and Michael Cohen define Complexity as the study of **systems**, comprised of **populations**, or groups, of individuals, or **agents**[1]. As a result of their interconnected **structure**, complex systems exhibit **emergent properties**, one of which is **self-organization**, i.e. organization that has no leader but is generated from the "bottom up" by the interactions of the agents themselves. M. Mitchell Waldrop explains:

> "The very richness of these interactions allows the system as a whole to undergo *spontaneous self-organization*…. Furthermore, these complex self-organizing systems are *adaptive*…. All these complex systems have somehow acquired the ability to bring order and chaos into a special kind of balance. This balance point… [is] often called *the edge of chaos*…. The edge of chaos is the constantly shifting battle zone between stagnation and anarchy…."[2].

Complex adaptive systems, then, are systems that balance themselves on the boundary between order and chaos: too much order and they rigidify into stasis, too little order and they dissolve into chaos. In Robert Jervis' study of complexity in politics he states that compex systems "display nonlinear relationships, outcomes cannot be understood by adding together the units or their relations, and many of the results of actions are unintended"[3]. So how do these systems do it?

The Lack of Leaders

> "One of the great mysteries of large distributed systems – from communities and organizations to brains and ecosystems – is how globally coherent activity can emerge in the absence of centralized authority or control"[4].

> "We're naturally predisposed to think in terms of pacemakers, whether we're talking about fungi, political systems, or our own bodies…. For millennia we've built elaborate pacemaker cells into our social organization, whether they come in the form of kings, dictators, or city councilmen"[5].

As Steven Johnson describes in "The Myth of the Queen Ant," humans have traditionally looked for "rulers" in ordered systems, "pacemakers" that are responsible for the maintenance of order. In addition, we look for such primary causers in other systems, from terrorist networks to fads to mass demonstrations to peer-to-peer file-sharing. However, "we know now that systems like ant colonies don't have real leaders, that the very idea of an ant 'queen' is misleading. But the desire to find pacemakers in such systems has always been powerful…."[6]. In complex adaptive systems, though, organizers are entirely unnecessary when the structure of the system follows certain parameters. These parameters determine whether a system will self-organize or not, into a state which Per Bak calls "self-organized criticality"[7]. In highly interconnected systems, when conditions permit, order can emerge spontaneously, what Stuart Kauffman calls "'order for free.' – self-organization that arises naturally"[8]. Indeed, what Complexity reveals is that sometimes *the system itself* is the organizer of order.

Space and Change

Axelrod and Cohen's work with complex adaptive systems goes further than mere self-organization. Using computer modeling of intelligent evolving agents to study cooperation, their findings shed some light on the dynamics of Complexity. First,

agents exist in both **physical and conceptual spaces**, and along continuum of **proximity** – from close to distant – in each space. Second, **selection pressure** on agents directs the evolution of **strategies** that agents employ [9]. It should come as no surprise that James Rosenau entitled his most recent book Distant Proximities, and in it he explores these spaces and pressures in regard to governance specifically. "To maintain clarity with respect to the important distinction between spatial and contextual proximities, henceforth I shall refer to the former as *local phenomena* and to the latter as *localized phenomena* (suggesting they have to be contextually redefined in order to become proximate)"[10]. This continuous contextual redefinition is accelerated by modern connective technologies and generates what Rosenau characterizes as "turbulence"[11]. Axelrod and Cohen, too, suggest that because complexity is "rooted in patterns of interaction among agents, then we might expect systems to exhibit increasingly complex dynamics when changes occur that *intensify* interaction among their elements. This, of course, is exactly what the Information Revolution is doing: reducing the barriers to interaction among processes that were previously isolated from each other in time or space"[12]. We have no way to know at what point global interconnectivity will cross a self-organization threshold; in fact, we may already have. In addition, there may be multiple thresholds and multiple rounds of organization and re-organization. For this reason, it is interesting that John Holland describes complex adaptive systems as sources of "perpetual novelty" and thus provides us with our first glimpse into the need for reflexive, and not predictive, governance [13]. To better understand how "perpetual novelty" will manifest itself, we must examine the social networks that are being reshaped and redefined by complexity.

SMALL-WORLD NETWORKS

Social Networks

Social network theory, primarily in sociology and anthropology, investigates systems of interconnected individuals, and yields insights into both social **structure** and the **agents** within it. Social networks, like other networks, consist of **nodes** and **links**, or relations, that make up the network's structure. There are two aspects of network structure that define the small-world phenomenon: **clusters** and **bridges**. Clustering refers to the fact that social relations tend to be embedded in communities, wherein *most of the individuals know most of the other individuals in that community*, creating a cluster. Bridges exist when a person in one cluster knows someone in another cluster., and are particularly important when they connect distant clusters, thus making them "near." The small-world network, which describes the real world, consists of *numerous highly interlinked clusters connected to distant clusters by means of bridges* [14]. It is this unique structure, how it affects perceptions of proximity, and how those perceptions shape behavior, that are of concern.

Bridging Clusters

The bridges that serve to bring distant clusters closer often go unnoticed. As Duncan Watts describes it, the small-world network "is a global phenomenon, yet individuals are capable only of local measurements. You only know who you know, and maybe *most* of the time, your friends know the same sort of people you do. But if just *one* of your friends is friends with just *one* other person who is friends with someone not like you at all, then a connecting path exists"[15]. And Steve Strogatz echoes that "the transition to a small world is essentially undetectable at a local level. If you were living through the morph, nothing about your immediate neighborhood would tell you that the world had become small"[16]. Even so, it is the bridges that provide the crucial inroads for the arrival of new ideas and information.

Acknowledging Identity

Social networks share with Complexity the concepts of structures and agents, but unlike many complex systems, social systems are comprised of agents that have another, in fact crucial, property: **identity**. Identity has two consequences in particular for small-world networks. First, it acts as a source of **randomness**, and second, it acts to **affiliate** parts of the network through the co-membership of individual nodes.

Social network theory has traditionally been "concerned with the relationships between individuals, the patterns of interactions. The precise nature of the individuals is downplayed, or even suppressed, in hopes of uncovering deeper laws. A network theorist will look at any system of interlinked components and see an abstract pattern of dots connected by lines. It's the pattern that matters, the architecture of relationships, not the identities of the dots themselves"[17]. This inflated view of structure neglects potentialities in individual agents, and, as such, parallels deterministic structural theories in political science, e.g. Kenneth Waltz's neo-realism [18]. Agent behavior may be *influenced* by structure, but it is not *determined* by it. Individual agency effectively provides *random* input into the social network.

Social identity is complex identity. Because individuals participate in many groups, they themselves act as bridges, not across *geographical* distance, but across *conceptual* distance. "Social identity, therefore, exhibits a multidimensioned nature – individuals spanning different social contexts…."[19]. Consequently, a simplistic diagram of a social network often fails to accurately represent the complexities of the real world. For this reason, social network theorists use maps of **affilation networks**. "Affiliation networks… are thus networks of overlapping cliques, locked together via the comembership of individuals in multiple groups"[20]. Affiliation, like bridging, reduces distance. This renders network effects almost impossible to trace. Information can leap from group to group even when those groups seem to have nothing in common, because all they need in common is a single individual who is a member of both groups and therefore has a bridging identity.

Thresholds and Cascades

The structure and identities of agents in social networks determine the network's **threshold** with regards to effects that **cascade** throughout part or all of the network. Agents have their own thresholds as well, but network connectivity is what makes cascades possible.

For instance, in epidemiology, a highly clustered social network works against the rapid spread of infection because individuals have contact primarily with those who are already infected. In addition, an agent that is not susceptible to the disease has less chance and possibly no chance of becoming infected. "The possibility of an epidemic depends on the existence of what I called a *percolating cluster* – a single cluster of susceptible sites… that permeates the entire population"[21], in other words, a chain of interconnected nodes which connects the entire rest of the network. An identical analysis is possible as regards the spread of ideas, or memes, and behavior. Social

networks utilize threshold models of decision making that take into account two factors: the **number** of connections, and their **weight**, or likelihood of influence. Paralleling Complexity's "edge of chaos," individuals are poised between too few connections and too many. Too *few* connections and an individual is less likely to be influenced, but counter-intuitively too *many* connections produces the same result because the relative influence of each connection is smaller. In addition, individuals, in general, are more influenced by those socially "near" to them than by those that are socially "distant." Nonetheless, how an individual's threshold is calculated is irrelevant, since once it has been crossed, it may have repercussions for the population as a whole. Because social bridges reduce "distance" between clusters, they increase the "closeness" of all nodes, and thus, increase the likelihood that they will have an influnce. This provides a mechanism for the reinterpretation involved in creating Rosenau's "localized phenomena." It is important to realize that there are in effect *two* thresholds operating simultaneously: the individual's threshold which is similar to his "susceptibility" and the network's threshold which is a function of connectivity.

Once these thresholds are crossed, the network becomes vulnerable to cascades. "Networks of social information," Watts tells us, "are important not just because they help us make better individual decisions but also because they allow things that have caught on in one setting to spill over into another. Since this kind of spillover is critical to the dynamics of a cascade, social networks are central to the notion of a little thing becoming big" [22]. Furthermore, thresholds behave similarly "with cultural fads, technological innovations, political revolutions, cascading crises, stock market crashes, and other manners of collective madness, mania, and mass action. The trick is to focus not on the stimulus itself but on the structure of the network that the stimulus hits" [23]. Again, the danger is in looking for "causes" because "*contingent decision making* comprises the essence of an information cascade, and in so doing renders the relationship between initial cause and ultimate effect deeply ambiguous"[24].

So, what kinds of cascades are we talking about? Cascades can include cultural fads, financial bubbles, transnational environmental concern, coordinated mass demonstrations, the spread of new behavioral norms, damage from computer viruses, epidemics like SARS, large-scale system failures such as the power outage in the U.S. in August of 2003, increased participation in online social networks like Friendster, and grass-roots political campaigns like that of Howard Dean [25].

The main point is that "only when the network becomes dense enough do we see the percolating vulnerable cluster appear"[26]. And, perhaps ironically, this is the threshold where we find ourselves, ushered in by the revolution in connective technologies.

PERPETUAL CONTACT

The recent proliferation of mobile communications – cell-phones, text messaging, email, etc. – has created a social realm of constant communications. It is this innovation that changes everything, for as network connectivity becomes omnipresent, *emergent properties* manifest themselves. A host of recent communications theory has focused on the impact of technological and mobile connectivity on society, via the Internet and mobile telephony. Cell-phones and text messaging are used by people around the world in innovative new ways. Email provides geographically distant individuals with easy contact. Connective technologies are ushering in a society of "**perpetual contact**," where individuals are never isolated from their communities or from information, i.e. network pathways have become "always-on" connections [27]. The world of perpetual contact affects social change through two influences: 1) the global breadth of connective technologies, and 2) the speed of cascades enabled by these technologies.

Connective Technologies

Connective technologies include the Internet, wearable computers, Global Position Systems (GPS), Computer Mediated Communications (CMC) such as email, and Personal Communications Technologies (PCTs). These technologies have two effects on behavior: 1) the norms they help to spread, and 2) the norms they bring with them, i.e. that are a function of the technology itself. "In social relationships among adults, mobile communication leads to different forms of coordination, cooperation and conflict….Questions of folkways, norms and cultures of adoption and opposition also arise"[28]. Also, "when people interact with their PCTs they tend to standardize infrastructure and gravitate towards consistent tastes and universal features" much the same as "people and corporations worldwide create and gravitate toward common designs for airports, cars , bicycles and computers, regardless of cultural diversity"[29]. These influences taken together constitute what Katz and Aakhutz have termed *Apparatgeist* – the "ghost in the machine" – which enacts "the logic of perpetual contact"[30].

For example, one such logic is the dilution of broad-coverage centralized sources of news and information (TV, mass media, etc.) in favor of topic-specific decentralized sources. In the global information society, connective technology, "empowers individuals to decide on their own about the modalities of segregation or permeability between different institutional settings, social systems, inter-individual relationships and individual roles"[31]. Arguably individuals have always been so empowered. But the difference now revolves around *who* influences their decisions: the conceptual space of the network contends with the physical place of geography; the global info-sphere spars with traditional media. Manuell Castells warns us that the struggle for influence is "twisted, manipulated, and transformed, by a combination of computer-enacted strategic maneuvers, crowd psychology from multicultural sources, and unexpected turbulences, caused by greater and greater degrees of complexity…."[32].

Even though, we are only now beginning to get real data, one thing is clear. The effects we are witnessing are decidedly non-linear: "As more people share information in any particular venue, the ratio of potentially valuable information to the number of participants rises much faster than the number of participants – even if many participants do not actually contribute any particular content…."[33].

Smart Mobs

"On January 20, 2001, President Joseph Estrada of the Philippines became the first head of state in history to lose power to a smart mob – more than 1 million Manilla residents, mobilized and coordinated by waves of text messages…."[34]. Technology oracle Howard Rheingold clarifies: "'Mobile ad hoc social network' is a longer, more technical term than 'smart mob'. Both terms describe the new social form made possible by the combination of computation, communication, reputation,

and location awareness"[35]. Not only have connective technologies increased the breadth of influence of agents in the network, they have also severely increased the *speed of propagation*. Smart mobs are essentially a rapid cascade of coordinated action. "Whenever a new communications technology lowers the threshold for groups to act collectively, new kinds of institutions emerge…. We are seeing the combination of network communications and social networks"[36].

Examples are legion. "On November 30, 1999, autonomous but internetworked squads of demonstrators protesting the meeting of the World Trade Organization used 'swarming' tactics, mobile phones, Web sites, laptops, and handheld computers to win the 'Battle of Seattle'"[37]. Rheingold also notes the "use of the Internet and mobile communications by organizers and participants in worldwide protests against the Bush administration's war plans" towards Iraq [38]. Smart mobs changed the outcome of the recent Korean elections: "When Roh Moo-hyun's organizers wanted supporters to vote on election day, they simply pressed a few computer keys. Text messages flashed to the cellphones of almost 800,000 people, urging them to go to the polls"[39]. In Kenya, too, connective technologies were influential in insuring electoral fairness [40].

But we should not assume that smart mobs will be on the side of justice. "The cutting edge in the early rise of a new form may be found equally among malcontents, ne'er-do-wells, and clever opportunists eager to take advantage of new ways to maneuver, exploit and dominate"[41]. We can include terrorist organizations and transnational criminal networks as well as corporate cartels and power elites in our list of potential sources of network cascades.

Expecting the Unexpected

"Networks constitute the new social morphology of our societies, and the diffusion of networking logic substantially modifies the operation and outcomes in processes of production, experience, power, and culture"[42]. Furthermore, now that those networks are global, "cultural expressions are abstracted from history and geography, and become predominantly mediated by electronic communication networks that interact with the audience and by the audience in a diversity of codes and values"[43]. Rosenau believes that "actors in the state-centric and multi-centric worlds… will become increasingly responsive to world-wide norms…."[44]. If that is the case, then what Paul Wapner calls "global civil society" arises [45]. This global civil society exhibits the "*networking, decentered form of organization and intervention, characteristic of the new social movements*…."[46]. Fritjof Capra adds, "It is created by a social network involving multiple feedback loops through which values, beliefs, and rules of conduct are continually communicated, modified, and sustained. It emerges from a network of communications among individuals; and as it emerges, it produces constraints on their actions"[47]. Hans Geser contends that "boundaries are likely to become much more fluid, modifiable and unpredictable than in the past..."[48]. Examples include transnational environmentalism, feminism, anti-globalism, and religious fundamentalism, and "their impact on society rarely stems from a concerted strategy, masterminded by a center" [49].

As an example, we can look at the decline of domestic political parties because they are tied to national state-structure. The rise of global civil society creates new social norms. Therefore, Democrats and Republicans become increasingly marginalized but Environmentalism does not, because it appeals to something global that is locally *reproduced*, for example through the Green Party [50]. Equally, we can expect the unexpected with regard to human rights, and possibly even Marxism, or at least in the opposition between capital and labor.

MULTISCALE CONNECTIVITY: THE LOGIC OF NETWORK CULTURE

Avoiding the Unavoidable

Per Bak's work with "self-organized" criticality, has enabled him to conclude that "fluctuations and catastrophes are unavoidable"[51]. Insofar as these cascades are redistributions of "stress" in a complex adaptive system, they are, in fact, necessary. In addition, his models have shown that *interfering with the system to eliminate a cascade merely causes a different cascade* [52]. For better or worse, once complexity sets in, it only compounds. As network culture scholar Mark Taylor asserts, "self-organizing systems can be understood as following a teleonomic trajectory tending toward increasing complexity… Since development is punctuated [by cascades] rather than continuous, the growth of complexity is episodic as well as unpredictable"[53]. Attempting to avoid the unavoidable wastes time and resources and in the end avails us nothing. The main problem in trying to predict and avoid cascades is that, as Watts declares, "no one will know which one is which until all the action is over"[54].

Complex Adaptive Governance

Nonetheless, there are ways to *respond and adapt* to cascades, even if we cannot predict them. As we have noted, systems that achieve this kind of robust resilience are called complex adaptive systems, and include natural systems – brains, immune systems, ecologies, societies, weather – as well as many artificial systems – neural networks, power grids, evolutionary programs. Because the emergence of a global information society leaves us with "a Byzantine mishmash of overlapping networks, organizations, systems, and governance structures, mixing private and public, economics, politics, and society,"[55] our governance systems must learn to embrace chaos, and become a complex adaptive system, which means focusing on *responsive adaptation* over *predictive avoidance.*

By way of example, let us now turn to a network success story. The company Aisin, one of the two hundred companies in the group responsible for manufacturing Toyota cars, manufactured a crucial part that no one else in the group did. When the Aisin plant burned to the ground in February 1997, the other firms in the network enacted "an astonishing coordinated response by over two hundred firms… with very little direct oversight"[56]. Because "companies in the [Toyota] group, even those companies that compete with each other for Toyota's business, cooperate to an extent that almost seems counter to their interests"[57], the Toyota network "could make use of lines of communication, information resources, and social ties that were already established"[58]. As a result, although an individual agent in the network suffered a catastrophic failure, *the network as a whole was able to rapidly adapt and overcome*. In fact, "the Aisin case is different in that the system subsequently recovered almost as rapidly as it had succumbed, and with little centralized control"[59]. *Adaptive response networks succeed*; therefore, building and maintaining these networks at home and abroad should be the first priority for governance: this includes

networks of allies, trade partners, businesses, banks, humanitarian groups, and disaster relief organizations.

Fortunately, there exists the possibility of optimal network connectivity, i.e. a balance between control and autonomy. A lower threshold exists where a network has too *little* connectivity, as well as an upper threshold where the network exhibits too *much* connectivity. Axelrod and Cohen suggest that organizations can learn to **explore** and **exploit** the governance landscape between these two thresholds[60], and Watts suggests a network model of **multiscale connectivity**. Theorists are encouraged to think about governance systems "as *networks of information processors*, where the role of the network [is] to handle large volumes of information efficiently and without overloading any *individual* processors"[61]. When communicative groups are required to pass information upward through hierarchies before that information can reach other groups in distant sections of the hierarchy, the result is *information congestion* in the core (top) of the hierarchy, and *information delay* at the periphery (bottom)[62]. The solution is to reroute communication from nodes to other nodes on all levels of the hierarchy. For example, when an agent realizes that it is spending too much time acting merely as an information conduit between two other agents, it can form a direct link between them laterally and drop out of the communication loop. In this way, "the burden of any particular node can be relieved by the greatest possible amount by connecting the two neighbors for whom it relays the most messages"[63]. Also, "because the strategy always selects the most congested node to relieve, and because the nodes that it connects were handling those messages anyway, the effect is always to reduce overall congestion without increasing any individual's burden"[64]. This kind of deflection effectively redistributes traffic and avoids congestion by rewiring a very structured hierarchy into a small-world network and creating multiscale connectivity.

If we must adjust our governance systems to cope with change *post facto*, at least we can learn from organizations that already do, i.e. those that focus on rapid response and social networking, for instance, disaster relief agencies and humanitarian aid networks. Indeed, there are a number of extant examples of how governance is already moving in this direction. The U.S. military has already experimented successfully with networked units in its Landwarrior force [65]. The United Nations Standby Forces High Readiness Brigade is a rapid-response paramilitary unit. In the aftermath of 9-11, the City of New York was able to provide offices and services for businesses and individuals through decentralized social networks. Another advantage of these kinds of response systems is that they can be used for multiple tasks. Military forces are often used for disaster relief in the wake of hurricanes and the like. There is no reason to suspect that international networks or U.N. sponsored response teams would be less effective than national ones in combating humanitarian rights abuses or environmental damage.

Conclusion

"*Power, as the capacity to impose behavior, lies in the networks of information exchange and symbol manipulation, which relate social actors, institutions, and cultural movements…*"[66]. Not only is multiscale connectivity the most efficient structure for network processing, but "in multiscale networks there are no longer any 'critical' nodes whose loss would disable the network…. Essentially one can remove chunks of almost any size from a multiscale network and it will remain connected, and thereby able to access whatever resources were not directly destroyed. A multiscale network 1) realizes network efficiencies from distributed parallel processing, and 2) minimizes the effect of failures when they *do* occur. Systems of this type are referred to as "ultra-robust"[67]. Furthermore, because nothing is "distant" any longer – all global events are potentially local events – we must internalize Duncan Watts' entreaty:

> "When it comes to epidemics of disease, financial crises, political revolutions, social movements, and dangerous ideas, we are all connected by short chains of influence. It doesn't matter if you know about them, and it doesn't matter if you care, they will have their effect anyway. To misunderstand this is to misunderstand the first great lesson of the connected age: we may all have our own burdens, but like it or not, we must bear each other's burdens as well"[68].

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