A COMPLEX ADAPTIVE SYSTEMS APPROACH TO THE FUTURE OPERATIONAL ENVIRONMENT

A Monograph

by

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ABSTRACT

A COMPLEX ADAPTIVE SYSTEMS APPROACH TO THE FUTURE OPERATIONAL ENVIRONMENT, by Major Nathan M. Colvin, Army, 98 pages.

Military and political leaders often claim that we are facing a complex future, but do not specify why this is so. Is the world truly becoming more complex? If so, why and how is it becoming more complex? This monograph uses multidisciplinary analysis and synthesis to answer these questions. Using these tools, it develops a complex adaptive systems view to explain the underlying trends that drive changes in the operational environment, from the micro to the macro. Increasing growth of technological capability provides an incredible integrating capability that allows for individual and group development. The tempo and tendencies of this relationship result in an operational environment that is increasingly diverse, particularized, and subject to rapid change. Rather than a flat world, the operational environment is shown to be an increasingly differentiated, dancing landscape that requires creative, flexible, and agile responses from the Joint force.

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ACRONYMS

ABM	Agent Based Model
ADP	Army Doctrinal Publication
ADRP	Army Doctrinal Reference Publication
CA	Cellular Automa(ton)
CAS	Complex Adaptive Systems
DSIT	Dynamic Social Impact Theory
GST	General Systems Theory
JOE	Joint Operating Environment
JP	Joint Publication
OODA	Operate, Orient, Decide, Act
SAMS	School of Advanced Military Studies
SIT	Social Impact Theory
TOTE	Test – Operate – Test - Exit
UN	United Nations

ILLUSTRATIONS

We are called to be architects of the future, not its victims.[1]

—Buckminster Fuller

INTRODUCTION

Near the end of November 2013, Ukrainian President Viktor Yanukovich rejected a European Union trade pact due to its possible influence on Russian relations.[2] Less than three months later, not only was a Russian trade alliance unlikely, but the Parliament seized power, reinstituted the 2004 constitution, freed opposition leader Yulia Tymoshenko, and was poised for European alignment as the former President fled in the night.[3] Not long after protestors achieved this victory, internal tensions indicated that the state might fracture along cultural lines.[4] These destabilizing events occurred in one of the most successful former Soviet states. The Arab Spring and turmoil in many African states display similar patterns of rapid change. Even in Europe, longstanding governments face pressures of fragmentation from Scotland, Catalonia, Flanders, and many others.[5] Anecdotally, this suggests a type of differentiation occurring at an increasing

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[1]Joel Garreau, *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies-and What It Means to Be Human* (New York: Broadway Books, 2006), 234.

[2]"Timeline: Protests and Political Crisis in Ukraine," *Reuters*, December 17, 2013, http://www.reuters.com/article/2013/12/17/us-ukraine-timeline-idUSBRE9BG10N20131217 (accessed February 24, 2014).

[3]Ibid.

[4]David Stern, "Ukraine's Fractured Society," *BBC News*, http://www.bbc.com/news/world-europe-26318058 (accessed February 28, 2014).

[5]For more information on each of these examples, see the following respective references "Rising Separatist Sentiment in Europe," *Washington Post*, last modified November 3, 2012, http://www.washingtonpost.com/world/rising-separatist-sentiment-in-europe/2012/11/03/2d809caa-2624-11e2-9313-3c7f59038d93_graphic.html (accessed February 24, 2014); Edward Cody, "Europe's Separatists Gaining Ground, Adding to Continent's Strains," *The Washington Post*, November 3, 2012, sec. World, http://www.washingtonpost.com/world/europe/europes-separatists-gaining-ground-adding-to-continents-strains/2012/11/02/20bcb438-2433-11e2-ac85-e669876c6a24_story.html (accessed February 28, 2014).

tempo, creating a dancing landscape of events. If this is true, military planners need to evaluate the phenomenon through doctrinal processes.

In the United States Army, leaders drive the operations process through understanding, visualization, description, direction, leading, and assessing.[6] These activities play out in the context of the operational environment, which is "a composite of the conditions, circumstances, and influences that affect the employment and capabilities and bear on the decisions of the commander."[7] Understanding of the operational environment provides the foundation that enables commanders to anticipate and prepare for operations. Even if assessments are not completely accurate, the process of assessment provides a framework for the commander to start decision-making processes. Hence General Eisenhower's famous phrase; "the plans are worthless, but planning is everything."[8]

The first step in understanding the operational environment is through analysis of the operational and mission variables.[9] Analysis is a critical and necessary step on the path of understanding, but it is not sufficient in most operational scenarios. Systems theorist Ludwig von Bertalanffy points out that the analytical procedure is inherently limited to simple, "linear" relationships, because it looks only at components, and not at how those parts interact.[10] However, doctrine highlights that the operational environment is neither composed of isolated

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[6]Headquarters, Department of the Army, Army Doctrine Reference Publication (ADRP) 5-0, *The Operations Process* (Washington, DC: Government Printing Office, 2012), 1–2.

[7]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 3-0, *Joint Operations* (Washington, DC: Government Printing Office, 2008), IV–1.

[8]Dwight D. Eisenhower, "Dwight D. Eisenhower: Remarks at the National Defense Executive Reserve Conference," *The American Presidency Project*, http://www.presidency.ucsb.edu/ws/?pid=10951 (accessed February 22, 2014).

[9]Headquarters, Department of the Army, Army Doctrine Publication (ADP) 3-0, *Unified Land Operations* (Washington, DC: Government Printing Office, 2011), 2.

[10]Ludwig von Bertalanffy, *General System Theory* (New York: Braziller, 1984), 18–19.

components, nor does it behave in a linear manner. This kind of behavior is indicative of complexity and supports the Chief of Staff of the Army's first major objective for the future force: "Adaptive Army Leaders for a Complex World."[11]

Analytical processes are necessarily descriptive and well defined, while synthesis is inherently novel based on the situation. In one sense, not delineating a method of synthesis frees commanders from a proscriptive process, allowing them to apply judgment, experience, and mission command principles. This latitude is important because each situation is dynamic over time and circumstance.[12] However, time often becomes a constraint to even the most experienced commander, let alone a less experienced staff who are yeomen in military decision making. In these situations, tools of synthesis may provide a bridge to develop intuition and rapid understanding in a complex environment. To this end, Joint Publication 5-0 highlights the need "to produce a holistic view of the relevant enemy, neutral, and friendly systems as a complex whole within a larger system that includes many influences."[13] This includes pointing out the "relevant relationships within and between the various systems that directly or indirectly affect the problem at hand."[14]

As major operations in Afghanistan decrease in scope, the military faces the likelihood of an interwar period that requires it to continue limited operations while preparing for future threats. Preparing the doctrine, organization, training, material, leadership, personnel, and facilities the military relies upon long lead times, especially in a resource-restricted

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[11]Ray Odierno, "Waypoint #2: Follow up to CSA's Marching Orders," *US Army*, last modified February 19, 2014, http://www.army.mil/article/118873/ (accessed February 22, 2014).

[12]Headquarters, Department of the Army, ADP 3-0, 2.

[13]Chairman, Joint Chiefs of Staff, Joint Publication (JP) 5-0, *Joint Operational Planning* (Washington, DC: Government Printing Office, 2008), III–10.

[14]Ibid., III–11.

environment.[15] The capabilities to function in the future operational environment require planning today. The Joint Intelligence Preparation of the Operational Environment process orients readers to network and system perspectives, but is understandably limited to tools of analysis and organization. [16] Documents such as the former Joint Forces Command's *Joint Operating Environment 2010* (*JOE: 2010*) paint vivid pictures of possible futures, but do not necessarily outline the way trends are determined.[17] This monograph attempts to meet three goals that bridge these two perspectives. First, it seeks to outline the underlying principles of a *systems approach*. Second, it applies systems principles to synthesize various multi-disciplinary components of the operational environment. Third, it uses the multi-disciplinary tools to outline the major trends of the operational environment. These steps produce an iteration of analysis and synthesis, to address the question: "How does the future operational environment work"?

This monograph seeks to understand this question through a new synthesis of existing theories in order to increase the margin for operational success. It argues that complexity dominates the imminent operational environment. Because of this, there are underlying principles from complexity science that help bind other multidisciplinary observations and theory. To demonstrate this, the monograph proposes an underlying philosophical heuristic that outlines the essential mechanics of complex developmental systems, through the synthesis of various theories from systems thinking, complexity, and other fields. Second, the model assimilates the concept of

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[15]For a discussion of the various causes of lengthy acquisition processes see Defense Science Board, *Creating a DOD Strategic Acquisition Platform* (Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, April 2009).

[16]For an understanding of the complete JIPOE process, refer to, Chairman, Joint Chiefs of Staff, Joint Publication (JP) 2-03, *Geospatial Intelligence Support to Joint Operations* (Washington, DC: Government Printing Office, 2007).

[17]For more information on this report's findings see United States Joint Forces Command, *The Joe 2010 Joint Operating Environment*, Research Report (Norfolk, VA: United States Joint Forces Command, February 18, 2010).

technological growth, explaining how its integrating potential accelerates individual growth. Third, the monograph explores the dynamics of individual decision-making, need, motivation, and growth to explain the path of human development, using the proposed complex systems heuristic. Also reviewed is the effect of technology on individual development. Fourth, existing theories of group formation and behavior explain how the components of technology and individual development emerge as macro phenomenon in the operational environment. Finally, the effects of these interdependent systems and agents highlight the potential for the future operational environment, including a review of possible effects on military planners and operators.

Using a systems approach, the operational environment is a network of individuals and groups of individuals, acting as agents. These agents connect through communication and observation, undergoing a continuous process of integration and differentiation.[18] Technology is the critical element that increases the connection of these agents. In other words, technology provides integrating capability. Higher levels of integration require higher levels of differentiation to maintain development.[19] Human nature, as understood through the behaviors of individuals and social groups, is naturally differentiating.[20] Together these components provide the fuel for rapid development and change. Therefore, understanding the underlying characteristics and relationships between these three elements is essential to understand how the future operational environment may unfold.

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[18]J. Gharajedaghi, *Systems Thinking: Managing Chaos And Complexity: A Platform for Designing Business Architecture* (Burlington, MA: Elsevier/Butterworth-Heinemann, 2006), 92–96.

[19]Ibid., 103.

[20]Ibid., 95.

By building a general systems understanding, the importance of the integration/differentiation dynamic becomes apparent. This monograph assumes the continued accelerated growth of technology as a precondition for projections. However, where others see technology's integrating tendencies as a catalyst toward greater homogeneity, this monograph uses existing models of human behavior and social structures to demonstrate why military planners should expect a rapidly shifting, heterogeneous operational environment. The world is not becoming flat. In fact, exponential growth in technology combines with human preferences to introduce long-tailed dominated events with increasing frequency. These events create a map of the future operational environment that is topologically diverse and dynamic, a concept known as a *dancing landscape*.[21] However, not only is this landscape dancing, the unremitting expansion of technology's effects cause the tempo of the dance to increase at a progressively fevered pace.

BACKGROUND

The military relies on tools of doctrine, theory, and history to enable planning. Current doctrine highlights the need for a systems approach to understand the operational environment. A useful method to gain understanding is an interdisciplinary approach that "integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or field of research practice."[22] Due to the large amounts of overlap in the topic, clear delineation of the literature is difficult. For the clarity, topics of individuals, groups, technology, and system studies outline the literature review.

[21]Scott E Page, *Diversity and Complexity* (Princeton, NJ: Princeton University Press, 2011), 93–94.

[22]National Academies et al., *Facilitating Interdisciplinary Research* (Washington, DC: The National Academies Press, 2005), 26.

As explained in depth later in the monograph, institutions, nations, artifacts, and groups can act as individual agents. For the purposes of this review, human individuals are the focus. Economics, anthropology, sociology, history, and geography all concern themselves with the human condition, but psychology and its related disciplines are uniquely suited to provide a foundational explanation of human behavior. Human behavior plays a critical role as a bridge between the internal and external - the ethereal and the physical. Observing behaviors and communication between individuals underlies our social reality and its effects on the physical world.

Psychology, rooted in classical philosophy, emerged as its own branch of science in theoretical and applied fields, known as structuralism and functionalism.[23] Sigmund Freud merged these fields with a mix of science and interpretation. His psychoanalysis principle introduced the idea that human behavior comes from irrational unconscious drives in competition with rational conscious decision-making.[24] The characteristics of the conscious and unconscious are established at an early age. With the rise of experimental processes, behaviorists pushed Freud out of from primacy in the field. The behaviorists' experimental approach created the stimulus-response model that interpreted that environmental stimuli and pleasure/pain outcomes were the essential determinants to human behavior.[25] Although behavioral psychology achieved success in many areas, failures in some areas of human performance left it open to criticism. Systems pioneer Ludwig von Bertalanffy called behaviorism the "robot model of human behavior" which

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[23]Cass R. Sunstein, *Infotopia How Many Minds Produce Knowledge* (New York: Oxford University Press, 2006).

[24]For an in-depth comparison of various personality theories and Sigmund Freud in particular see Salvatore R. Maddi, *Personality Theories: A Comparative Analysis* (Prospect Heights, IL: Waveland Press, 1996), 21-41, 269-282, 428-446 .

[25]Ibid., chap. 11.

was "demonstrably false."[26] While this may overstate behaviorism's shortcomings, the statement is indicative of the attitudes that led to the perspective of cognitive, humanistic, and other branches of psychology.

In fact, Bertalanffy saw clear linkages between psychology, motivation, and General System Theory in the fields of cognitive, gestalt, and humanistic psychology.[27] He pointed to "active personality system" as a holistic binding thread between these various branches of psychology.[28] Understanding individual behavior through a systems perspective occurs through synthesis of three major theories of motivation, need, and behavior. Humanistic and applied psychological theorists, including Maslow, Vroom, and Herzberg provide the basis of a human dynamics model.[29] Additionally, the process of decision-making is incorporated through integration of Boyd's *OODA Loop,* elements of James March *Primer on Decision Making* and Johnson and Tierney's *Failing to Win.*[30] Additional perspectives on individual behavior embed themselves throughout discussions of cognitive science, artificial life, and social studies discussed in the following sections.

Varieties of works in the fields of social studies, anthropology, international relations, economics, military science, strategy, social psychology, swarm intelligence, and human relations

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[26]Bertalanffy, *General System Theory*, 188, 190–191, 194, 205, 206.

[27]Ibid., 6–7,192–194.

[28]Ibid., 192–193.

[29]For additional information on these theories see the following sources respectively Abraham H. Maslow, *Motivation and Personality*, 3rd ed. (New York: Harper and Row, 1987); Victor Harold Vroom, *Work and Motivation* (Malabar: R.E. Krieger Pub, 1982); Frederick Herzberg, *The Motivation to Work* (New York: Wiley, 1959).

[30]For additional information on Boyd's OODA model see Frans P. B. Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd* (New York: Routledge, 2007); Particularly helpful for information on bias, James G. March and Chip Heath, *A Primer on Decision Making: How Decisions Happen* (New York: Free Press, 1994); Dominic D. P. Johnson, *Failing to Win: Perceptions of Victory and Defeat in International Politics* (Cambridge, MA: Harvard University Press, 2006).

provide additional context. *The State of Humanity* provides volumes of empirical studies that support the notion of continued human development.[31] Robert Axelrod's work was particularly influential in determining an agent-based approach to this problem.[32] Mancur Olson's work on the relationship between individual and collective interest plays a pivotal role in explaining the roots of emergent group behavior.[33] Bennis and Slater's *The Temporary Society* provides a view of a previously anticipated future that we are living through in the present. [34] Using a complexity perspective, Nye's *The Future of Power* gives a perspective of how power, especially *soft power*, can influence groups.[35] Geert and Gert Jan Hofstede's *Culture and Organizations* and Clifford Geertz's *The Interpretation of Cultures* provide excellent evaluations of culture.[36] Hatch and Cunliffe's work on *Organization Theory*, along with Brown and Ainley's Understanding *International Relations*, provide broad overviews of the various schools of thought of group behavior. Especially helpful are their reflections on constructionist thought, constructivism, Actor-Network Theory, Social Network Theory, Social Construction of Technology, and Social

[31]For additional information and specific examples, see Julian Lincoln Simon, ed., *The State of Humanity* (Oxford, UK ; Cambridge, MA: Blackwell in association with the Cato Institute, 1995).

[32]For additional information, see Robert M. Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier* (New York: Basic Books, 2000).

[33]For additional information, see Mancur Olson, *The Logic of Collective Action Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 1971).

[34]For additional information, see Warren G. Bennis, *The Temporary Society*, Rev. ed. (San Francisco: Jossey-Bass, 1998).

[35]For additional information, see Joseph S. Nye, *The Future of Power* (New York: PublicAffairs, 2011).

[36]For additional information, see respectively Clifford Geertz, *The Interpretation of Cultures: Selected Essays* (New York: Basic Books, 1973); Geert H. Hofstede, *Cultures and Organizations: Software of the Mind*, Rev. and expanded 2nd ed. (New York: McGraw-Hill, 2005).

Impact Theory.[37] These ideas led to the incorporation of Latané's Dynamic Social Impact Theory as a key explanatory feature linking society to technology.[38]

In an interconnected, digital world, it is useful to establish broader views on what defines technology. Historically, technology was the description of the arts.[39] Today, "the intelligent organization, and manipulation of materials for useful purposes" is a helpful definition that scopes how humans interact to change the world.[40] Simon's, *The State of Humanity* helps establish technology's developmental contributions over time. The idea of technology as an interdependent agent or force is prevalent throughout the literature. Works from authors such as Carr, Sustein, Shapiro, and Brown and Duggard explain many of the transitions currently experienced, due to the presence of information technology in day-to-day experience.[41] Allenby and Sarewitz explore how technology has first, second, and third order effects, reinforcing the complex system principle that actions have multiple consequences.[42] Johnston's *Allure of the Machinic Life* plus Kennedy, Eberhart, and Yuhui's *Swarm Intelligence* explores the realms of

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[37]Mary Jo Hatch, *Organization Theory: Modern, Symbolic, and Postmodern Perspectives* (New York: Oxford University Press, 2006), 26, 43–47, 110, 141–142, 155–156,161–169, 238, 329, 333–335; Chris Brown and Kirsten Ainley, *Understanding International Relations*, 4th ed. (Basingstoke: Palgrave Macmillan, 2009), 17, 19, 33, 48–50, 52, 68, 83, 88, 152, 267.

[38]Bibb Latane, "Dynamic Social Impact: The Creation of Culture by Communication," *Journal of Communication* 46, no. 4 (1996): 13–25.

[39]George Crabb, *Universal Technological Dictionary or Familiar Explanations of the Terms Used in All Arts and Sciences* (London: Baldwin, Cradock, and Joy, 1823).

[40]Stephen H. Unger, *Controlling Technology: Ethics and the Responsible Engineer*, 2nd ed. (New York: Wiley, 1994), 3.

[41]For more information, see respectively Nicholas G. Carr, *The Big Switch: Rewiring the World, from Edison to Google* (New York: W.W. Norton & Co., 2013); Sunstein, *Infotopia How Many Minds Produce Knowledge*; Cass R. Sunstein, "The Law of Group Polarization," *Journal of Political Philosophy* 10, no. 2 (June 2002): 175; Andrew L. Shapiro, *The Control Revolution: How the Internet Is Putting Individuals in Charge and Changing the World We Know* (New York: PublicAffairs, 1999); John Seely Brown and Paul Duguid, *The Social Life of Information* (Boston: Harvard Business School Press, 2002).

[42]For more information, see Gharajedaghi, *Systems Thinking: Managing Chaos And Complexity: A Platform for Designing Business Architecture*.

cybernetics, artificial intelligence, and artificial life research.[43] Doing so reveals the interdependence of the human mind and the attempts to supplement it. The most radical conversation comes from Garreau's review of dystopian, utopian, and middle ground of humanity's future integration with technology.[44] Bousquet's *Scientific Way of War* provides an excellent perspective on how the dominant scientific narratives of any given era transform accompanying theories of warfare.[45] One of his contentions is that current revolution in military affairs revolves around the combination of chaos and complexity, or "chaoplexity."[46] This concept drove the monograph's author to explore the future of the operational environment through the complexity lens.[47]

Closely linked to each of these separate fields are the synthetic perspectives of futurists. *Joint Operating Environment: 2010* and several other works look at what may lie ahead. For a compilation of varied sources, journalist Mike Wallace compiled 15 diverse perspectives in *The Way we will be 50 Years from Today*.[48] Penn's *Microtrends* is an overview of possible changes

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[43]For more information, see respectively John Johnston, *The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI* (Cambridge, MA: MIT Press, 2008); James F. Kennedy, Russell C. Eberhart, and Shi Yuhui, *Swarm Intelligence*, Morgan Kaufmann series in evolutionary computation (San Francisco: Kaufmann, 2001).

[44]For more information, see Garreau, *Radical Evolution*.

[45]For more information, see A. Bousquet, *The Scientific Way of Warfare* (New York: Columbia University Press, 2010).

[46]Ibid., chap. 7.

[47]Although the term chaoplexity appears in other literature, many researchers contend that chaos science is a component of complexity science. To see a diagram of the various components of complexity studies see, Brian Castellani, "Complexity Map," *SACS Toolkit: A New Approach to Modeling Complex Social Systems*, last modified July 30, 2013, http://www.personal.kent.edu/~bcastel3/ (accessed March 8, 2014).

[48]For more information, see *The Way We Will Be 50 Years from Today: 60 of the World's Greatest Minds Share Their Visions of the next Half Century* (Nashville, TN: Thomas Nelson, 2008).

rooted in contemporary forces.[49] STRATFOR's George Friedman's *The Next 100 Years* and Thomas L. Friedman's *The World is Flat* provide specific predictions of the future.[50] Alvin and Heidi Toffler provide the largest body of forward-looking work, including *War and Anti-War, The Third Wave,* and *Future Shock.*[51] Many of their predictions, made over 30 years ago, are eerily accurate. However, differences in timing or specificity are cautionary reminders that our anticipated future is never quite what we anticipate. The Toffler's come from a camp of futurists that *The State of Humanity* derides as being overly swayed by the potentials of technology. This is a similar thought echoed in Cooper and Layard *What the Future Holds.*[52] The need to balance the Tofflers' incredibleness with Cooper and Simon's incredulousness appears throughout this monograph.

The final group of literature provides the framework upon which the central tenants of this monograph rest, systems and complexity. As mentioned previously, Bousquet highlights that the revelations of complexity science shape the current frame for understanding war and warfare.[53] General systems, chaos theory, complexity, and network theory broadly outline both the chronological progression of the field, as well as the essential literature reviewed. The aforementioned Ludwig von Bertalanffy is one of the pioneers of formulating the field of General Systems Theory. His title by the same name provides a good understanding of systems

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[49]For more information, see Mark J. Penn, *Microtrends: The Small Forces behind Tomorrow's Big Changes* (New York: Twelve, 2009).

[50]For more information, see respectively George Friedman, *The Next 100 Years* (New York: Doubleday, 2009); Thomas L. Friedman, *The World Is Flat: A Brief History of the Twenty-First Century*, Rev. pbk. ed. (New York: Picador, 2007).

[51]For more information, see respectively Alvin Toffler, *The Third Wave* (New York: Morrow, 1980); Alvin Toffler and Heidi Toffler, *War and Anti-War* (New York: Warner Books, 1995); Alvin Toffler, *Future Shock* (New York: Random House, 1970).

[52]For more information, see Richard N. Cooper, *What the Future Holds: Insights from Social Science* (Cambridge, MA.; London: MIT, 2003).

[53]Bousquet, *The Scientific Way of Warfare*, 33–34.

concepts.[54] Ervin Lazlo provides a short reference of how holistic approaches apply to a variety of applications in *The Systems View of the World*.[55] The concept of chaos science emerges from the basis of simple and complicated systems, defined in the works of Lorenz, Mandelbrot, Feigenbaum, and many others. James Gleicks's *Chaos: Making of a New Science*, provides a lay perspective of chaos and complexity studies. [56] One of the seminal works he points to is Prigogine and Stengers' *Order out of Chaos*, which merges dynamic and thermodynamics to demonstrate the irreversibility of time, dissipative structures, and hierarchy of systems. [57] These characteristics provide the underlying connection between differentiation, organization, and hierarchy of development used in the monograph author's proposed complex system heuristic. Major Glenn E. James' *Chaos Theory: The Essentials for Military Applications* provides military applications to chaos theory that helped connect theory to emergent trends in the operational environment.[58]

Research such as Steven Wolfram's cellular automaton revealed that there was another realm of system behavior between the predictability of simple/complicated systems and the randomness of chaotic systems.[59] At "the edge of chaos," these systems led to the development of complexity and complex adaptive systems (CAS). Instances of CAS demonstrate emergent behaviors that are not only separate from the particular characteristics of its component parts, but

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[54]For more information, on these foundational concepts see Bertalanffy, *General System Theory*.

[55]For more information, see Ervin Laszlo, *The Systems View of the World: A Holistic Vision for Our Time*, Advances in systems theory, complexity, and the human sciences (Cresskill, NJ: Hampton Press, 1996).

[56]For more information, see James Gleick, *Chaos: Making a New Science* (New York: Penguin, 1988).

[57]For a rigorous review of these concepts, see Ilya Prigogine, *Order Out of Chaos: Man's New Dialogue with Nature* (New York, N.Y: Bantam Books, 1984).

[58]For more information, see Glenn E. James, *Chaos Theory* (Newport, RI: Naval War College Press, 1996).

[59]This concept is discussed throughout Stephen Wolfram, *A New Kind of Science* (Champaign, IL: Wolfram Media, 2002).

that also anticipate and adapt their behaviors to respond to their environment. John Holland's *Adaptation in Natural and Artificial Systems* provides a mathematical description of the process of adaptation that is as at home in biology as in information science.[60] Jervis' *System Effects*, Harrison's *Complexity in World Politics*, and Axelrod & Cohen's *Harnessing Complexity* explore the social and political science perspectives of complexity.[61] Johnson's *Emergence* and Taleb's *The Black Swan* are two popular explorations of the unexpected behaviors caused by a multiplicity of connected individual actions.[62] The aforementioned *Swarm Intelligence* and Barabási's *Linked*[63] bring together complexity with the field of network science to help quantify group behaviors. Synthesis of these thoughts guides the evaluation of the future operational environment.

These works represent many of the various works that helped shape the author's understanding of systems, complexity, technology, individual behavior, and group dynamics. Each of these areas represent a field that one could study in depth and never truly master. Aggregating and synthesizing them into coherence required a deliberate process to provide meaningful results. The approach to this monograph outlines this process of incorporating the multidisciplinary literature.

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[60]For more information see John H. Holland, *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence* (Cambridge, MA: MIT Press, 1992).

[61]For more information, see respectively Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, NJ: Princeton University Press, 1997); Neil E. Harrison, ed., *Complexity in World Politics: Concepts and Methods of a New Paradigm*, Paperback, SUNY series in global politics (Albany: State University of New York Press, 2007); Axelrod and Cohen, *Harnessing Complexity*.

[62]For more information, see respectively Steven Johnson, *Emergence: The Connected Lives of Ants, Brains, Cities, and Software* (New York: Scribner, 2001); Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable* (New York: Random House, 2007).

[63]For more information, see Albert-László Barabási, *Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life* (New York: Plume, 2003).

APPROACH

Using the aforementioned literature, this monograph acknowledges the operational environment as a complex system of systems, which requires a holistic view.[64] Abductive, inductive, and deductive processes support the research process. Abductively, the complex adaptive system's perspective is assumed extendable to other fields of study that ties the various literature together.[65] The abductive approach leads to the breadth and depth of the multidisciplinary literature research. The information gathered in the literature review helps to "arriv[e] at general knowledge from specific incidents or fragments of knowledge."[66] This generalization helps to develop an underlying CAS heuristic that guides understanding throughout the monograph. This heuristic's deductive application to the areas of technology, individuals, and groups provides a framework to understand how the various components may interact to shape the future operational environment. Doing so leads to "arrival at specifics of knowledge from the existence of known generalizations or premises."[67] The exchange between inductive and deductive reasoning is critical to obtaining holistic understanding.[68]

Philosopher Sir Karl Popper points out that full perspective is impossible to achieve within a given system under observation.[69] Clearly, this becomes an issue for evaluating the

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[64]Chairman, Joint Chiefs of Staff, JP 5-0, III–10–11.

[65]Igor Douven, "Abduction," in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, 2011, http://plato.stanford.edu/archives/spr2011/entries/ abduction/ (accessed February 11, 2014).

[66]Everett Carl Dolman, *Pure Strategy: Power And Principle In The Space And Information Age* (New York: Routledge, 2005), 179.

[67]Ibid., 181.

[68]Osinga, *Science, Strategy and War*, 71.

[69]As cited in Dolman, *Pure Strategy: Power And Principle In The Space And Information Age*, 60; For more information on Popper's thoughts see Karl R. Popper, *The Logic of Scientific Discovery* (London: Hutchinson, 1959).

operational environment, since the evaluators are also agents of this system. It becomes necessary to externalize oneself and look at the system from multiple perspectives. By defining the operational environment as being composed of individuals and groups, not only are the interdependencies realized, but micro and macro levels are established as platforms for separate evaluation. Stathis N. Kalyvas claims, "generating robust intuitions about micro-foundations and testing them with reliable data ought to be a prerequisite for research at the macro level."[70] This is wise advice, executed in this monograph by an informal *trikonic* method.[71] Each category is looked in isolation to itself, then in relationship with the other components. This synthesis closes the loop started by multidisciplinary analysis, necessary for holistic system understanding.[72] Rather than provide new data, this monograph uses existing findings of various researchers to synthesize a holistic understanding of the emergent properties of these interdependent relationships. To accomplish this, the monograph outlines a general CAS heuristic, and then uses it to review the characteristics of technology, individuals, and groups. It concludes with the ramification of these interactions on the future of the operational environment as compared to the findings outlined in *JOE: 2010*.

There are some difficulties in the methodology to address including, the unknowable nature of the future, error, and the bias of western psychology. Various authors have shown the

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[70]Stathis N. Kalyvas, *The Logic of Violence in Civil War* (New York: Cambridge University Press, 2006), 392.

[71]Gary Richmond, "Trikonic Analysis-Synthesis and Critical Common Sense on the Web," *Arisbe: The Pierce Gateway*, 6, last modified 2006, http://www.cspeirce.com/menu/library/aboutcsp/richmond/ccsarisbe.pdf (accessed February 11, 2014).

[72]Gharajedaghi, *Systems Thinking: Managing Chaos And Complexity: A Platform for Designing Business Architecture*, 108.

future is inherently unknowable.[73] In fact, complexity science itself revolves around principles of the quantum uncertainty principle and sensitivity to initial conditions.[74] Of course, this uncertainty did not stop these same authors to investigate the phenomenon.

The synthesis of so many disparate theories also introduces opportunity for multiple instances of error, which may accumulate. Because of complex system's dependence on initial conditions, the aggregation errors of instrument, observation, interpretation, and bias may yield significant divergence from accurate conclusions. In a quantitative study, integration of an error term provides for stochastic uncertainty. In a qualitative approach, the monograph relies on published studies in peer-reviewed documents as a filter to introduction to error. Because of the possibility that of one of those links may break the connections made, thereby foiling the overall findings, this monograph often reaches back to the underlying complexity principle of self-similarity. The essential assumption is that each of these components represents complex adaptive systems in and of themselves, which means that there is a degree of comparison possible between them as well. This is an assumption that underlies the work of many researchers including Axelrod, Holland, Mandelbrot, Kennedy, and Yuhui Shi.

As a reader examines this monograph, there are likely doubts forming about applying western psychology to non-western cultures. Along these lines, Gert Hofstede argues that there

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[73]This thought is found throughout the writings of these authors, among others. Ludwig M. Lachmann, "From Mises to Shackle: An Essay on Austrian Economics and the Kaleidic Society," *Journal of Economic Literature* 14, no. 1 (March 1, 1976): 54–62; Taleb, *The Black Swan*; Prigogine, *Order out of Chaos*; Dolman, *Pure Strategy: Power And Principle In The Space And Information Age*; Popper, *The Logic of Scientific Discovery*.

[74]For more information on unpredictability of the future and its causes see Dolman, *Pure Strategy: Power And Principle In The Space And Information Age*; Prigogine, *Order out of Chaos*; Cooper, *What the Future Holds*; Holland, *Adaptation in Natural and Artificial Systems*; Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*; Johnston, *The Allure of Machinic Life*; Claude Elwood Shannon, "A Mathematical Theory of Communication," *The Bell System Technical Journal* 27 (October 1948): 379–423, 623–656; Taleb, *The Black Swan*, 178, argues that the quantum effect is an unnecessary explanation to understand this inherent unpredictability.

are two essential flaws in applying western psychology to eastern thought: focus on individualism and cognitive consistency.[75] Maslow addressed this criticism himself saying, "[t]he claim [of universality of the hierarchy] is made only that it is relatively more ultimate, more universal, more basic than the superficial conscious desires, and makes a closer approach to common human characteristics."[76]

Furthermore, research also demonstrates that individuals' attachment to culture is not fixed. For example, Brown and Ainley demonstrate that diasporas often grow apart from their home cultures once separated by physical distance.[77] Wolfgang Schivelbusch found significant similarities amongst cultures, throughout different periods, in responses to military defeat.[78] As Bennis and Slater hold, "[h]uman beings are all equipped with the same emotional repertoire, the same basic needs, the same basic defenses."[79] Similarly, geographer Yi-Fu Tuan says, "the biological imperatives of growth nonetheless impose rising curves of learning and understanding that are alike and hence may be said to transcend the specific emphases of culture."[80] Culture is an artifact that represents the successful adaptive schemes of groups, whose influence does act as an agent on individuals and groups. Culture is an emergent phenomenon caused by the initial and experienced conditions encountered through particular histories. This is similar to Kenneth

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[75]Hofstede, *Cultures and Organizations*, 108, 230.

[76]Maslow, *Motivation and Personality*, 28.

[77]Brown and Ainley, *Understanding International Relations*, 209.

[78]This is a generalization of one the central tenants of Wolfgang Schivelbusch, *The Culture of Defeat: On National Trauma, Mourning, and Recovery* (New York: Picador/H. Holt, 2004).

[79]Bennis, *The Temporary Society*, 80.

[80]Yi-fu Tuan, *Space and Place: The Perspective of Experience* (Minneapolis: University of Minnesota Press, 1977), 19.

Pomeranz's finding of the "great divergence" between eastern and western cultures on the cusp of the industrial revolution.[81]

A fundamental assumption of this monograph is that, as groups are able to use technology to raise the standards of individuals, behaviors will converge along common lines. In this way, it acknowledges post-modern deconstruction as a tool of understanding individual emergent instances, but maintains that these instances come from underlying phenomenon more similar to the approach of structuralism or functionalism.[82] While the individual instances of behavior are heterogeneous, their emergence continues to converge along Maslow's hierarchy. As individual emergent events and underlying structure compete as attractors, a critical tension in the future operational environment develops.[83] The underlying hierarchy at times acts as the opposing force to cultural inertia. Also shown is that virtual communities have the potential to overcome cultural inertia, which further justifies the use of fundamental psychology to explain individual behavioral tendencies.

Further exploration of these concepts occurs in the monograph. What comes to the forefront of the previous discussion is the idea that predictions must remain in the realm of the general rather than the specific – predictions are much more like anticipation. Furthermore, the realization of this phenomenon requires humility and openness to reevaluation. This description of systems focuses on self-organizing tendencies, but clearly, the potential for directed change is

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[81]This is one of the central findings that flows throughout Kenneth Pomeranz, *The Great Divergence* (Princeton, NJ: Princeton University Press, 2001).

[82]James Ladyman, "Structural Realism," in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Spring, 2014, http://plato.stanford.edu/archives/spr2014/entries/structural-realism/ (accessed February 23, 2014); Janet Levin, "Functionalism," in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Fall 2013, http://plato.stanford.edu/archives/fall2013/entries/functionalism/ (accessed February 23, 2014).

[83]Cooper, *What the Future Holds*, 252.

equally critical. Therefore, nothing in this monograph proscribes the future. Rather it represents a set of tools to anticipate possible futures. That said, an outline of the underlying model is appropriate to review.

A FOUNDATIONAL SYSTEMS MODEL TO UNDERSTAND TRENDS IN THE OPERATIONAL ENVIRONMENT

General Systems Theory (GST) sought to conceptually fuse elements of physics, cybernetics, information theory, automata, game theory, decision theory, queuing theory and classic scientific understanding of systems to develop a general model that understood "sets of elements standing in interrelations," whether they were closed or open.[84] In doing so, GST retains concepts such as number, species, relations, feedback, stability, instability, growth, competition, summation, hierarchy, isomorphism, and finality.[85] Examining each of these components, it appeared that there is an underlying unity to many, if not all systems.[86] This reoccurrence of patterns is also known as self-similarity or fractal behavior. The underlying similarity of CAS processes allows for application of behaviors across different contexts.

The operational environment, as a CAS environment, exists in non-isolation; it is an open system, not a closed system. Closed systems' limitations derive from their susceptibility to the second law of thermodynamics, which states a system's entropy, or disorder, increases over time.[87] This oft-quoted bit of physics is cited as the reason for any particular system's eventual

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[84]Bertalanffy, *General System Theory*, 38.

[85]Ibid., chap. 3–4.

[86]Ibid., 86–88.

[87]Gharajedaghi, *Systems Thinking: Managing Chaos And Complexity: A Platform for Designing Business Architecture*, 121.

demise. However, Ilya Prigogine and Isabelle Stengers showed that disorder/entropy is not exclusively destructive; in fact, the attraction toward entropy is necessary to the development of all open systems. Misapplying the consequences of entropy to open systems causes fundamental misjudgments in system behavior.

Figure 1 aids in visualization of Prigogine's dichotomy. Step one shows the closed system relationship of order or equilibrium on one side and disorder, chaos, and disequilibrium, or entropy on the other. Observation of nature led Erwin Schrödinger to the conclusion that open systems "fed" off a quantity of negative entropy.[88] Therefore, when an ordered state of being is most like a closed system, entropy attracts it through the process of growth or differentiation (Figure 1 – Step 2). At a certain point, in order to survive, complex systems begin to turn back toward a process of integration or organization. To do so, it absorbs resources from the environment's own entropic process.[89] This process of reordering, through dissipative systems allows for movement to higher levels of evolution or development.[90] The repeated iterations of this cycle create hierarchy. This is a fundamental concept to understanding Maslow's principles and group formation.

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[88]Discussed throughout Erwin Schrödinger, *What Is Life?: The Physical Aspect of the Living Cell ; With, Mind and Matter and Autobiographical Sketches* (New York: Cambridge University Press, 1992).

[89]Ibid.

[90]Prigogine, *Order out of Chaos*, 189, 303.

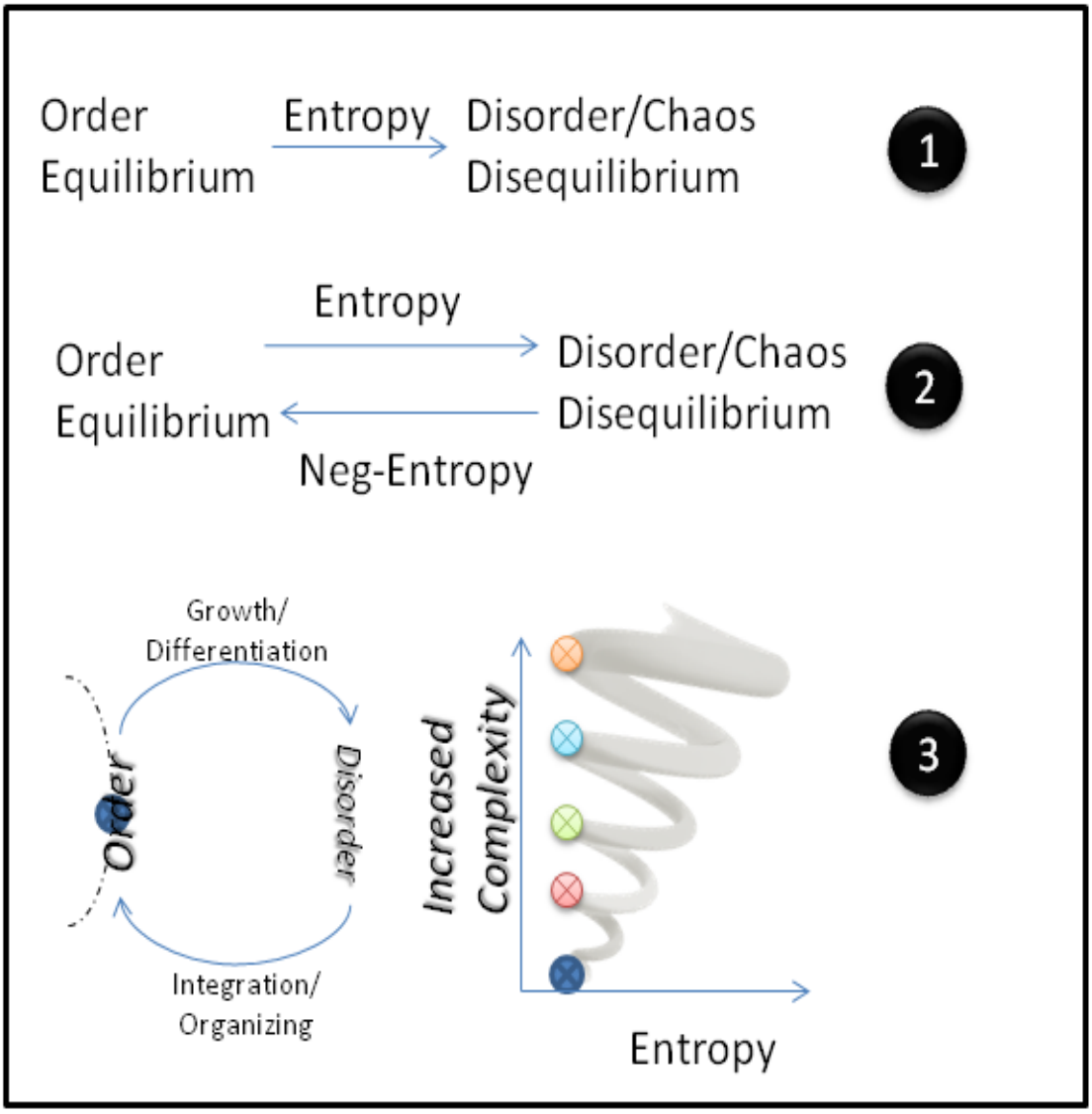

Figure 1 - Systems Model.

Source: Created by author. *Note:* 1. Second Law of Thermodynamics demands that closed systems move toward maximum entropy, disorder. 2. Schrödinger introduces the concept of negative entropy in open systems, allowing agents in an open system to draw resources from their environment. 3. Prigogine blends thermodynamics and dynamics, using dissipative structures, allowing for hierarchies of complexity to form.

Researchers in various fields explore the consequences of these ideas. The term *information* replaced Schrödinger's negative entropy in some contexts.[91] As digital computing emerged after World War II, mathematicians, physicists, and other scientists found themselves increasingly entwined in computer use and development. This included Dr. Stephen Wolfram, who transitioned from a focus on physics, toward computing and information science. In his pioneering work on cellular automaton (CA), he discovered four classes of reoccurring behavior for these systems. Class 1 CA settled into static behavior, Class 2 CA returned to static or periodically oscillating behavior, and Class 4 CA displayed chaotic or random behavior. However, Class 3 behavior seemed to function between the complicated and chaotic classes. This concept meshed well with similar discoveries such as Mandelbrot fractals, Kolmogorov complexity, chaos theory, and adaption. CA are an idealized complex model because they represent a large network of simple components, with limited communication among components, with no central control. They display complex dynamics from simple rules, capability of information processing, and can evolve through genetic algorithms.[92] These four regions organize as simple, complicated, complex, and chaotic systems. It is in the complex region where agents demonstrate behavior that appears to sense and react to the environment.

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[91]The terms negative and information are similar, but not fully interchangeable. The idea presented is that there are underlying similarities that extend across fields, leading to a connection between physics, communication, and systems. For an in depth understanding in the differences in these fields, see Shannon, "A Mathematical Theory of Communication"; Léon Brillouin, *Science and Information Theory* (New York: Academic Press, 1956); N. J. Cerf and C. Adami, "Negative Entropy and Information in Quantum Mechanics," *Physical Review Letters* 79, no. 26 (December 1997): 5194–5197.

[92]Melanie Mitchell, "Cellular Automaton - Unit 6 Slides" (Santa Fe Institute for Complexity Studies, November 4, 2013), http://s3.amazonaws.com/complexityexplorer/IntroToComplexity/Unit6Slides.pdf (accessed February 22, 2014).

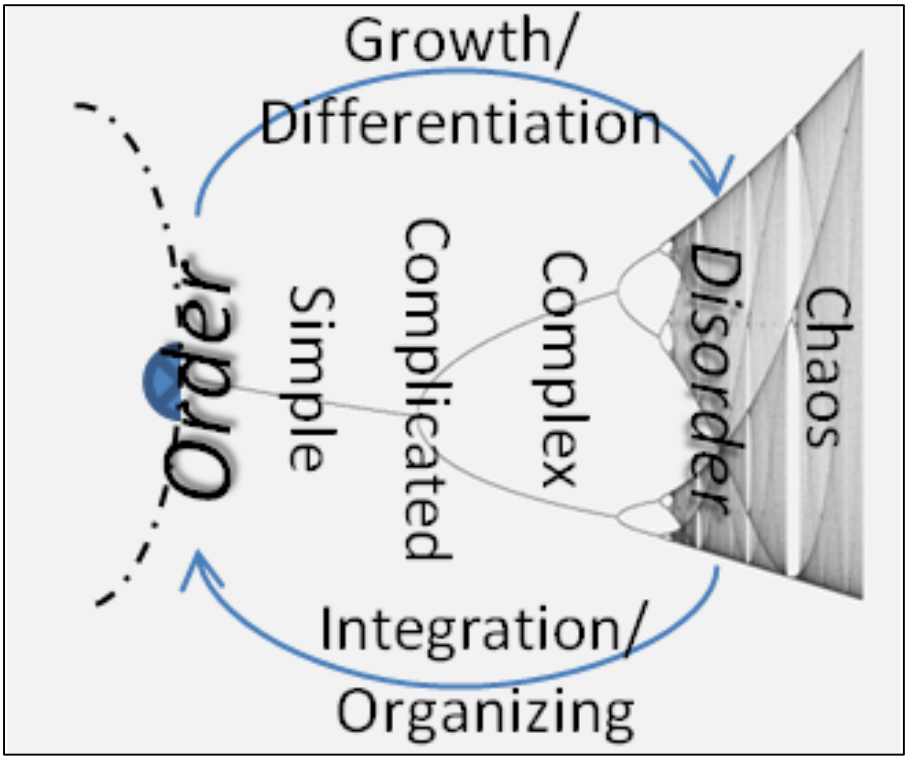

Figure 2 –The relationship of simple, complicated, complex and chaotic behavior

Source: Created by author.

Figure 3 illustrates the different behaviors of systems. From left to right, the paths from being to becoming are given. The top row demonstrates the path along differentiation/growth toward entropy/disorder, then back towards a state of being using integration/organization. The second row shows the path in regards to levels of development. The simple system makes only minor deviations then returns to a similar state of being. The complicated system requires greater organization to return it back to its original state. Complicated systems move between states of being between simple and chaotic systems. In the upper scenario, complex systems never resemble previous states, but continue upward development. In the lower scenario the path from chaotic to simple returns in a way that allows similar patterns to repeat, creating hierarchy. To the furthest right, a chaotic system grows beyond the point of adaption, and reacts in unpredictable,

non-repeating ways. Complex systems properties include simple components or agents relative to whole system, nonlinear interactions among components, no central control, emergent behaviors, hierarchical organization, information processing, dynamics, and evolution and learning.[93] The ability to manage the path of differentiation and integration is a key factor of complex adaptive systems (CAS).

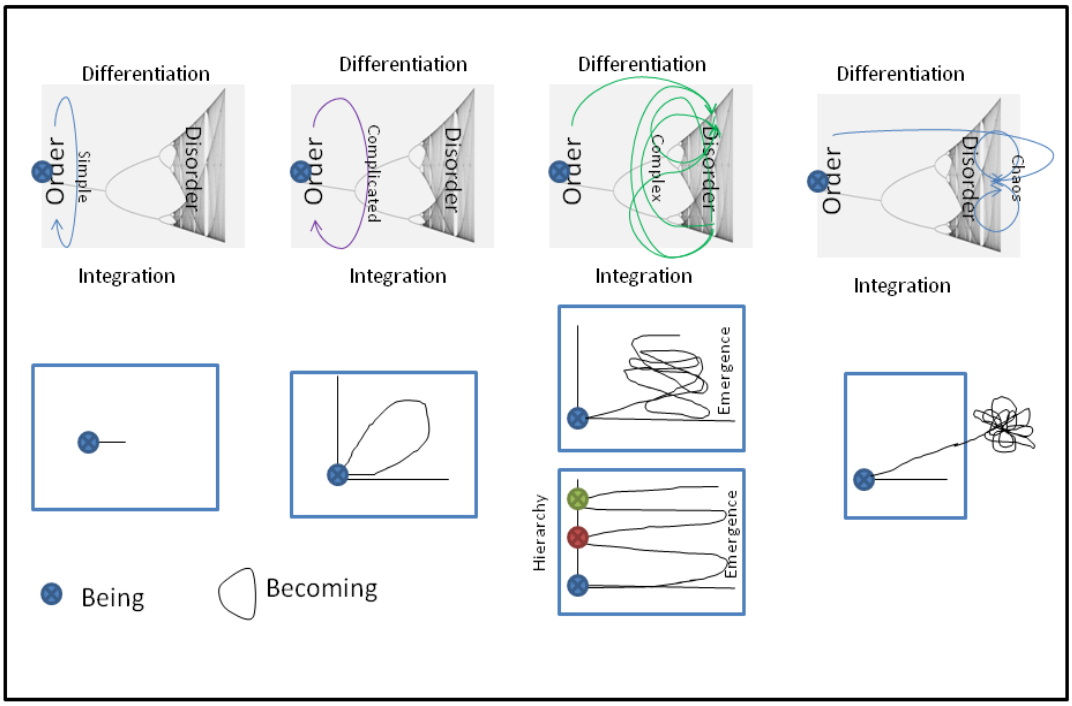

Figure 3 – Simple, Complicated, Complex, and Chaotic Systems.[94]

Source: Created by author. *Note:* Simple, Complicated, Chaotic, and Complex systems are often considered analogous to Class 1, 2,3,4 CA behavior. For another explanation of the differences in these behaviors, refer to Cognitive Edge, "Introduction to the Cynefin Framework," Cognitive Edge Network, last modified October 29, 2011, https://cognitive-edge.com/library/more/video/introduction-to-the-cynefin-framework/ (accessed February 23, 2014).

[93]Melanie Mitchell, "What Is Complexity?" (Santa Fe Institute, September 24, 2013), http://s3.amazonaws.com/complexityexplorer/IntroToComplexity/Unit1Slides.pdf (accessed February 22, 2014).

System adaption is inherent in the characteristics of CAS agents. The complex behaviors that emerged from them derived from following simple rules, rather than central control. This had significant ramifications in cognitive science, neurology, biology, artificial life, genetics, and many other fields. While this brought the question of CA universal computing into question,[95] it greatly enhanced the work on genetic algorithms and other evolutionary approaches. Borrowing heavily from his work in genetics, John Holland empirically showed how an agent could develop an adaptive plan that judged fitness against the environment.[96] He demonstrates that complex adaptive systems depend on "large numbers of parts undergoing a kaleidoscopic array of simultaneous nonlinear interactions."[97] The interaction of a few simple components (genotypes) can self-organize over multiple iterations into extremely complex emergent hierarchical outcomes (phenotypes).[98] The details of Holland's work helped to generate an understanding of why agents anticipate and adapt to their environment. This constant adaption is what allows survival in a continually evolving environment without drifting into the chaotic region.

Another inherent property of CAS is bifurcation. The four classes of behavior demonstrate patterns of behavior that are common within each type.[99] The point where a system evolves toward is an attractor.[100] Where the path moves from one attractor to another, a point of

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[95]Melanie Mitchell, James P. Crutchfield, and Peter T. Hraber, "Dynamics,Computation, and the Edge of Chaos": A Re-Examination," in *Complexity: Metaphors, Models, and Reality*, ed. George A. Cowan, David Pines, and David Melzner, vol. 19 (presented at the Santa Fe Institute Stuides in the Sciences of Complexity, Reading, MA.: Addison-Wesley, 1994), http://web.cecs.pdx.edu/~mm/dyn-comp-edge.pdf (accessed February 12, 2014).

[96]Discussed throughout Holland, *Adaptation in Natural and Artificial Systems*.

[97]Ibid., 184.

[98]Holland, *Adaptation in Natural and Artificial Systems*, 95.

[99]When a system trends towards a certain property, that property is known as an attractor; simple systems trend toward a fixed point, a complicated toward a limit cycle, a complex toward a limit torus, and a chaotic toward a strange attractor.

[100]John Milnor, "Attractor," *Scholarpedia* 1, no. 11 (2006): 1815.

bifurcation occurs.[101] While Gilles Deleuze holds that bifurcations are the path toward differentiation because they open up new singularities of attraction, bifurcations can actually provide for both differentiation and integration, depending on their value.[102] A period-doubling bifurcation leads toward chaos, whereas a period-halving bifurcation leads to order.[103] The path of an agent is dependent on these bifurcations, especially in a complex adaptive system because they represent where an agent displays influence over the path taken. With more interactions come more opportunities for bifurcation, as well as risk. In the previous figures, bifurcations are depicted as the splitting fan-like lines that multiply from left to right.

Agents in the complex adaptive system of the operational environment array in interconnected systems of systems. These colliding systems increase the bifurcations experienced by any particular agent, pressuring them ever closer to chaos. Furthermore, agents are connected in various networks of other individuals and groups. Holland's adaptive plans use schemas to carry forward successful behaviors to survive in this changing environment.[104] Two of these schemas include copying what is popular and what is successful. These are two instances of what Albert-László Barabási describes as preferential attachment. When preferential attachment combines with growth, a phenomenon known as "hub-dominated scale-free topology" emerges, also known as "power law behavior."[105] Power law behavior is behind the rapid growth situations

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[101]Johnston, *The Allure of Machinic Life*, 126–127.

[102]For more information see Gilles Deleuze, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987); This argument is highlighted in Johnston, *The Allure of Machinic Life*, 126–128.

[103]Charles Tresser, Pierre Coullet, and Edison de Faria, "Period Doubling," *Scholarpedia*, last modified September 7, 2013, http://www.scholarpedia.org/article/ Flip_bifurcation (accessed February 20, 2014).

[104]Holland, *Adaptation in Natural and Artificial Systems*, 139–140.

[105]Barabási, *Linked*, 91.

that Nassim Nicholas Taleb has dubbed Black and Grey Swans.[106] When these kinds of conditions are evaluated through agent-based models, a heterogeneous topology emerges. Professor Scott E. Page has described these fluid differentiated worlds as *dancing landscapes*.[107]

The general understanding of complex adaptive systems allows for a review of the components of the macro system of systems. First, the characteristics of technology present an overwhelming integrating force due to its continued exponential growth. These integrating characteristics provide a positive feedback that act as a catalyst to the differentiating tendencies of human nature. These differentiated individual behaviors aggregate through social groups to create a heterogeneous operational environment, marked by the rapid turnover made possible from technology's growth. The result is a highly differentiated, dancing operational environment, landscapes experienced at an increasing tempo. An understanding of these landscapes requires an understanding of the characteristics and effects of technology.

TECHNOLOGICAL GROWTH: THE DEFINING CATALYST OF CHANGE IN THE FUTURE OPERATIONAL ENVIRONMENT

There is an inherent limitation in prediction first posited by Karl Popper, and later summarized by Nassim Taleb. "Prediction requires knowing about technologies that will be discovered in the future. However, that very knowledge would almost automatically allow us to start developing those technologies right away. Ergo, we do not know what we will know."[108] This is certainly true in complex adaptive systems, because the possible intersections of bifurcating pathways requires an increasing amount of precision in initial conditions to process

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[106]Taleb, *The Black Swan*, 272–273.

[107]Page, *Diversity and Complexity*, 94.

[108]Taleb, *The Black Swan*, 173.

trace further into the future.[109] Predictions of the specific occurrences are assuredly flawed. Yet, the requirement for preparation demands some sort of projections. Current technology provides a starting point, but more importantly, trends in development rather than specific applications can be projected. Therefore, an understanding of technological development and its effects are essential.

The continued development of human society relies upon on a codependent relationship with technology.[110] Technology acts as a "volition enhancer," allowing us to complete tasks otherwise not possible or at a much lower cost than otherwise possible.[111] Technology is "the intelligent organization, and manipulation of materials for useful purposes,"[112] meaning that it consists not only of physical tools (or artifacts), but also the techniques and knowledge that enables the tools' use. From another perspective, technology may be considered a component of a techno-human adaptive system.[113] This system is self-referential, with positive feedback. Over recorded history, humanity has continued to increase its capability to prosper in its environment, whether measured by lifespan, wealth, agricultural production or other measure. In fact, in *State of Humanity*, the authors empirically show that, "almost every absolute change, and the absolute component of almost every economic and social change or trend, points in a positive direction, as

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[109]Similar arguments are made throughout Bousquet, *The Scientific Way of Warfare*; Gleick, *Chaos*; Johnston, *The Allure of Machinic Life*.

[110]Braden R. Allenby and Daniel Sarewitz, *The Techno-Human Condition* (Cambridge, MA: MIT Press, 2011), 71; Axelrod and Cohen, *Harnessing Complexity*, 23.

[111]Allenby and Sarewitz, *The Techno-Human Condition*, 37.

[112]Unger, *Controlling Technology*, 3.

[113]Also known as transhumanism in some literature. Allenby and Sarewitz, *The Techno-Human Condition* coin the "techno-human" phrase in the book of the same title.

long as we view the matter over a reasonably long period of time. That is, all aspects of material human welfare are improving in the aggregate."[114]

The assumption of continued growth does project forward in a linear way. Developmental rates increase over time. Where phase changes or bifurcations mark shifts in capability, historians can delineate the epochs in our history. These eras fall into different categorizations or phases based on perspective, but generally fall into agrarian, industrial, and post-industrial periods. Futurist Alvin Toffler calls these the First, Second, and Third Waves.[115] In each of these periods, technology integrated larger groups together, increasing collective intelligence. Technology that integrated humans into first wave farming communities also allowed for individuals' differentiation into specialized labor and concentrated centers of power.[116] Later, harnessing power through machines allowed transportation and early communication technologies to continue the trend of integration in the second wave. At the cusp of this postindustrial society, technology plays an even stronger part, especially in its role in information control and proliferation.[117] The accelerating growth of technology intensifies integrating capabilities by increasing the number, immediacy, and strength of interactions in the system. In the increase in integrating potential enhances the differentiating tendencies of individuals and groups.

The growing prevalence of technological applications causes the number of agent interactions to increase, pushing the operational environment system towards a chaotic regime. Ubiquity is made possible by the price-capability describe in Moore's Law. In 1965, Dr. Gordon

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[114]Simon, *The State of Humanity*, 7.

[115]Toffler, *The Third Wave*, chap. 1.

[116]Hofstede, *Cultures and Organizations*, 15.

[117]Daniel Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, Special anniversary ed. (New York: Basic Books, 1999), ix–lxxxv.

Moore modestly proposed that the ability to double transistor density on a single processor was likely to continue for another 10 years.[118] Nearly 50 years later, this trend has not abated, allowing for the rapid succession of information technology that drives our social and individual lives. This exponential growth provides not only a model of greater capability, but also explains the progressively lower cost of technological capability over time. Lower costs means technology is more accessible to more people over time.

While general technological capability doubles every 18-24 months, the internet doubles in a steeper power law, every twelve months.[119] This is because the internet is a social process driven by technology, measured by the number of connections. These connections are the natural adaptations of humans facing an environment that requires constant problem solving.[120] The internet's growth is one part technological growth, plus the insatiable drive toward higher needs satisfaction.[121] Outlining the associated growth of technologically related systems, Garreau states, "[i]n short, the number of other curves of accelerated change unleashed by Moore's Law have themselves begun to proliferate exponentially."[122] Information fuels the information age or *third wave*.[123] As information becomes cheaper to process, technological growth acts as a backbone that enables applications that leverage technology to grow just as rapidly.

In many ways, we are seeing the commoditization of information processing, such as

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[118]This is the underlying concept found in Gordon E Moore, *Cramming More Components onto Integrated Circuits* (New York: McGraw-Hill, 1965).

[119]Garreau, *Radical Evolution*, 59.

[120]The progressive explanations in the sections that follow describe this process.

[121]See the following section for a description of the human capacity for needs.

[122]Garreau, *Radical Evolution*, 59.

[123]Toffler, *The Third Wave*, 138–154.

electricity and gas underwent in the industrial area.[124] As these costs drop, activities succeed using fewer resources, for equal or less risk. This leads to more participation, and a greater diversity of activity. This greater diversity is indicative of greater differentiation in these systems. The use of this greater diversity allows for a more robust population, because the population can carry multiple parallel adaptation plans.[125] Because more plans allow survival over a larger range of problems, overall these systems can reach higher levels of complex development. Existing agents in these systems are more capable of connecting over time, while the combination of these agents creates new artifacts that add to the complexity of interactions. These same technological advances enable adaption schemas that keep these systems from drifting into chaos. However, the increasing pressure toward chaos is palatable as the nodes continue to connect.

The increasing pressure in the problem space of these systems forces the seeking of environmental niches and advantage through fragmentation of networks.[126] Niches are increasingly prevalent due to the lower cost of survival made possible by lower costs. This allows otherwise weaker agents to survive where before they would not have. The rapid and continuous connection of agents aggregates in a way that allows nodes to break away to become hubs. The creation of multiple niches allows for a wider variety of information that individuals can choose from, via personalized selection. Technology such as indexing, search engines, and social media allow personalization and tailorability of information. The combination of automated systems and

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[124]Carr, *The Big Switch*, 3–5, 12–16, 21, 58–59, 111–112, 117, 135, 245–246.

[125]For a discussion of intrinsic parallelism in systems see, Holland, *Adaptation in Natural and Artificial Systems*, 71–72, 88, 99, 103–104, 125–127, 130–131, 140, 157, 160–161.

[126]For information on niche creation see, Prigogine, *Order out of Chaos*, 196; Carr, *The Big Switch*, 150; Toffler and Toffler, *War and Anti-War*, 104; Holland, *Adaptation in Natural and Artificial Systems*, 11, 32; For information on network fragmentation, Barabási, *Linked*, 87.

personal choice create a media phenomenon known as *narrowcasting*.[127] Intensive focusing of information to individuals creates an echo-chamber effect that limits information to what is preferred.[128] When combined with relative anonymity and transience, it is easy to see how preferred patterns strengthen and serendipitous patterns weaken.[129]

In addition to decreasing transactional costs, technology automates increasingly higher levels of tasks, distributing cognitive workload.[130] This frees up resources for the creation of increasingly polished media published from the bottom up.[131] Much of the discussion of technological advantage focuses on "increasing values of scale" because of the low cost digital distribution.[132] This means that as information propagates, the returns to the originator are even higher, which allows greater propagation with a greater persuasive impact. These stronger effects can shock agents as they attempt to adapt to the changing system – they may get shoved toward chaos with a stronger force.

Technology also affects the immediacy of interactions in these systems, because it effectively compresses time and space. Light speed communications connect devices that are capable of exponentially faster processing. As routine tasks are replaced with greater autonomous systems, we are forced into more cognitively challenging tasks that replace those functions we previously conducted. Although science measures time against objective measures, individuals

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[127]Shapiro, *The Control Revolution*, viii.

[128]Cass R. Sunstein, *Infotopia How Many Minds Produce Knowledge* (New York: Oxford University Press, 2006), 97.

[129]Johnson, *Emergence*, 159.

[130]Garreau, *Radical Evolution*, 76.

[131]Toffler and Toffler, *War and Anti-War*, 199.

[132]Carr, *The Big Switch*, 132.

experience time subjectively and objectively.[133] By bringing more bifurcations together at one point of being, these systems requires choices to be made with higher frequency. Considering time as the passage from one change to the next, the piling of these changes truly accelerates the perception of time. Increasing technological introduction degrades the cognitive buffers that life at a more *human* tempo allows. While accomplishing more than ever, it may feel as though we will never have enough time to do what is coming next.[134]

Technology rarely functions along the same rhythms as humans. Information systems and machines are pushed to maintain their peak efficiency, often running twenty-four hours a day. Humans find themselves deciding whether to have their machines run at less than optimal conditions, or secede greater levels of personal decision making to maximize technological utility. The intensification of immediacy is not limited to the cognitive domain. Technology improves physical modes of transportation, loading/queuing systems, navigation, and maximizes inter-maintenance period. These improvements and many others shorten effective physical distances. The accelerating growth of technology makes it likely that immediacy becomes greater, not less.

The impact of technology's accelerating growth is to place agents near the area of chaos where complex adaptive systems become necessary for survival. Near this boundary, technology allows for higher levels of complex development, by providing means of integration. This is possible because technology effectively compresses relationships between agents in time and space, physically and cognitively by increasing the number, strength, and immediacy of interactions. This phenomenon's behavior supports power law development, which means cycles

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[133]Tuan, *Space and Place*, chap. 9.

[134]March and Heath, *A Primer on Decision Making*, 24.

of integration (organization) and growth (differentiation) are occurring with an increasing tempo. Yet, technology's integrating/organizing tendencies are only one half of the developmental model. To understand the full cycle of development in the operational environment, we must turn our attention to the differentiating tendencies of individuals.

INDIVIDUAL BEHAVIOR: THE PRIMARY COMPONENT OF SYSTEM DYNAMICS

Technology provides the integrating capabilities that are depicted in the lower half of the systems model in Figure 2. Interactions between innumerable bifurcations keep the operational environment in the complex region of systems behavior. To adjust adequately to this complex region, agents must employ adaptive behaviors that take advantage of technology's integrative possibilities. The following section of this monograph uses various theories to demonstrate how agents continue to employ differentiating/growth behaviors that push humanity to higher levels of development. Furthermore, it will look at how these natural propensities interact with technology's integrating potential to accelerate human development. Individual agents' choices, as influenced by their understanding of the environment, become another influence of the path of system development.[135] This section takes integrates four models to explain agent behavior: Maslow's hierarchy of needs, Herzberg's two-factor theory, Boyd's OODA loop, and Vroom's expectancy theory. Together these theories shed explanatory light on how individuals act as micro complex adaptive systems in and of themselves, as well as how they cause differentiation in the macro operational environment. The goal of this section of the monograph is to show how human nature drives individuals to higher levels of development and how technology fuels this tendency, which then shapes the actions of groups in the operational environment.

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[135]Jervis, *System Effects*, 4.

As a humanistic psychologist, Abraham Maslow practiced systems science.[136] Additionally, many of his concepts directly align with the language used by Prigogine and are compatible with modern concepts of adaption. His work is most famously associated with Maslow's Pyramid, a visualization that the psychologist never used himself. While Maslow did endorse a system's concept of hierarchy, he never claimed that the transition between his phases of needs were never as clean as depicted in the pyramid description.[137] He believed that human nature shared many characteristics that align with CAS. For example, psychopathological frustrations provide negative feedback, curiosity drives individuals toward growth, the need to know and understand provides the ability to anticipate future situations, while gratification of cognitive impulses acts as positive feedback.[138] Generally, he believed that humans display a positive orientation toward achieving higher levels of development.[139]

Maslow described the developmental processing unfolding in a process of sequential hierarchal priorities: physiological, safety, belonging, esteem, and self-actualization needs. Each of these needs act as motivations when they were unmet. He explained, "undoubtedly these physiological needs are the most prepotent of all needs…what this means specifically is that in the human being who is missing everything in life in an extreme fashion, it is most likely that the major motivation would be the physiological needs rather than any others."[140] This pattern repeats itself at each level of need. Once a need is satisfied, they no longer play an active organizing

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[136]Bertalanffy, *General System Theory*, 105–06.

[137]Maslow, *Motivation and Personality*, 27.

[138]Maslow, *Motivation and Personality*, 22.

[139]Ibid., 34.

[140]Ibid., 16.

role.[141] However, this does not mean previous achievements play no role in that individual's existence. Herzberg's Two- Factor theory demonstrates why this is so. Before moving on, there is an essential quality to the hierarchy to describe, that is fundamental to the overall thesis.

As one travels up the hierarchy, desired results become more subjective. In other words, "the pursuit and gratification of the higher needs leads to greater, stronger, and truer individualism."[142] Therefore, as an individual meets successive hierarchies of being, more individualized or differentiated goals drive that individual. This is the point at which this component system links to the proposed heuristic. As individualized needs aggregate into groups, they provide the differentiation necessary to take advantage of technology's integrative tendencies. If managed properly, the result is greater development; however, there are consequences to this development.

If a system does not remain open, it becomes a closed system answerable to the second law of thermodynamics and entropy. Therefore, the previously met motivated needs are a requirement for sustainment met by the resources of the environment. Herzberg's experiments in workplace motivation demonstrated this relationship through the two classes of hygiene and motivational factors. Hygiene factors were those items that employees *maintained* at an acceptable level, or else they would have a negative outlook on their work experience.[143] These maintenance factors include the quality of peer networks, supervision, company policy, job

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[141]Maslow, *Motivation and Personality*, 30.

[142]Ibid., 58.

[143]Herzberg, *The Motivation to Work*, 114.

security, working conditions, and salary. These conditions generally align with the first three of Maslow's basic needs: physiological, safety, and belonging.[144]

The application of additional hygiene/maintenance factors does very little to increase the motivation or productivity of an individual. Instead, positive attitudes develop through Herzberg's motivational factors of quality of activity, achievement, responsibility, recognition, advancement, and status. These factors roughly align with Maslow's self-actualization and esteem needs.[145] As many have pointed out, the specific factors that Herzberg points to, as either maintenance or motivational, are snapshots of a particular time and culture.[146] However, the relevant phenomenon is the requirement to *meet* maintenance factors whatever they might be. Failure to do so will cause dissatisfaction. If a higher the level of development is reached, the greater the accumulation of maintenance requirements will be. Therefore, the more complex the individual's development, the *needier* they will be for resources from the environment to maintain their state of being and continue further development.

If Maslow's proposal of humans' positive tendency of development came to fruition, the fully self-actualized individuals would fill the operational environment. Judging by the crime, violence, and war in our world, this is clearly not the case. In some instances, the conditions of the environment block this pursuit, in others it is due to suboptimal individual decisions. This means there is a gap in the proposed system model as presented to this point. A complete explanation requires an accounting for not only drives, but also decision-making. Acknowledging Maslow, Herzberg, and other researchers, Victor Vroom understood decisions based upon a

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[144]Barry L. Reece, *Effective Human Relations: Interpersonal and Organizational Applications*, 12th ed. (Mason, OH: South-Western, 2014), 146.

[145]Ibid.

[146]Hofstede, *Cultures and Organizations*, 264.

variety of internal and external motivations. The emphasis of his analysis highlights not only what people want, but also how likely it is they will pursue it.[147]

Vroom looked to construct a measureable, systematic view of behaviors[148] He also acknowledged the interdependency between the individual and the group.[149] Vroom suggested a persistent cognitive model of motivation, compatible with Maslow's cognitive need.[150] Like Maslow, Vroom believes that humans rationally decide between preferences amongst possible outcomes - a relationship he describes through terms of valence. Positive valence means an outcome is preferred, while negative valence signifies outcomes to avoid.[151] Vroom adds that people will not act unless they perceive that their effort is likely to achieve the motivating factor. He considered the probability of that occurrence as analogous to a force.[152] Combining the properties of these variables, Vroom proposes, "the force on a person to perform an act is monotonically increasing function of the algebraic sum of the products of the valences of all outcomes and the strength of his expectancies that the act will be followed by the attainment of these outcomes."[153] In other words, humans are in an environment of competing possibilities, and their perception of the likelihood of obtaining something they want, or avoiding what they do not want drives them to make choices and determines the weight of their effort. Where Maslow gives direction, Vroom gives direction and magnitude – a vector approach to behavioral determination.

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[147]Vroom, *Work and Motivation*, viii.

[148]Ibid., 3.

[149]Ibid., 6.

[150]Ibid., 14.

[151]Ibid., 15. Vroom also distinguishes between valence, or expected outcomes, versus *value* which is the eventually worth of that outcome. While different, Vroom did not use value in his main model, so it is minor in importance to this study.

[152]Ibid., 17. Vroom cites several psychologist that established this principle in the late 1950's.

[153]Ibid., 18.

Manipulation of valence or expectancy modifies the behavior of an individual.

A critical component of valence is that communicated information and stimulation affects the desirability of an outcome.[154] Likewise, communication of the probability of success and consistency of reception effect expectancy.[155] For the sake of simplicity, the discussion up to this point focused on human decision making as an internal, individual process. However, an internal explanation is incomplete because of the social construction of individual understanding, which maintains that all knowledge requires at least a component of shared perspective.[156] Individual identity emerges through a dichotomous tension between individualization and socialization.[157] Observation and interaction between the individual and the environment is a critical problem-solving requirement for this model. The *Test - Operate - Test – Exit* (TOTE) model is an example of an early systematic solution that sought to bridge cognitive and behavioral science.[158] In military circles, John Boyd's *Observe, Orient, Decide, and Act*, or OODA model, is perhaps the more familiar version of this idea. As Frans Osinga points out, Colonel Boyd adopted the thoughts of many of the same authors that outlined complex systems approaches.[159] Each of these approaches helps conceptualize the process that individuals and groups go through, to move from being acted upon *by* the environment, to acting *on* the environment.

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[154]Vroom, *Work and Motivation*, 23–24.

[155]Ibid., 26.

[156]Peter L. Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (Garden City, NY: Doubleday, 1967), 130.

[157]March and Heath, *A Primer on Decision Making*, 62–64.

[158]George A. Miller, *Plans and the Structure of Behavior* (New York: Adams-Bannister-Cox, 1986) explains this concept throughout.

[159] Osinga, *Science, Strategy and War*. discusses these influences throughout.

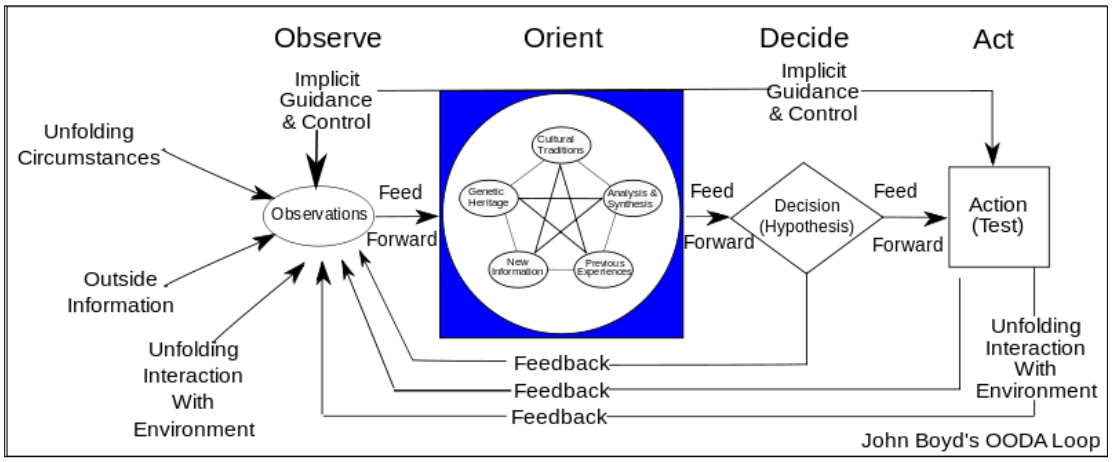

Figure 4 – Colonel John Boyd's OODA loop.

Source: Patrick E. Moran, "John Boyd's OODA Loop," *Wikimedia Commons*, last modified April 19, 2008, http://upload.wikimedia.org/wikipedia/commons/3/3a/ OODA.Boyd.svg. *Note*: Also available in Osinga, *Science, Strategy and War*, 231(accessed March 9, 2014). While often mistaken for a closed system, this model draws information from the environment at several steps.

In the OODA model, the *observe* and *orient* steps provide a pathway for the external to interact with the internal. During the observe stage, the agent is drawing information in from the environment, including direct and indirect information gathered through the senses. The second step is about transforming information into knowledge, by combing data with the cognitive schemas, heuristics, and other mental frameworks. The orientation phase is the point that historical influences of socialization, including culture and experience, merge with individual experience and historical knowledge. Filtering interactions through analysis and synthesis allows an individual to make a choice on what action to take on the environment. Therefore, the observe and orient steps help establish what the individual believes to be appropriate expectations for their environmental conditions.

It is the *combined* effect of the individual's observation of the world and their social contextualization of those observations' significance that establish the strength and orientation of expectancy. The environment affects expectations. During observation, the probabilistic nature of the environment and perceptual limitations can lead to information bias. Even in rational agents, the inability to process the multiplicity of interactions relevant to a particular situation extends

uncertainty into a given system.[160] Furthermore, even if obtaining and processing all relevant data were possible, limitations of the mind emerge through psychological biases caused by cognitive processes, affective processes, learning, and cultural influences.[161] While these biases toward self and social confirming hypotheses may be self-defeating to an individual, they still represent a winning adaption plan to the group, due to the power of parallel iteration of individuals.[162] True learning is inherently social and causes the dynamics of groups that are explored in the last section. For now, it is important to realize that individuals rely on social input.

Before reviewing the social aspects of individual actions, it is useful to reassess the concepts against the CAS model, in order to describe the integrating impacts of technology. Building from the fundamental model reviewed earlier, Figure 6 depicts this process. An individual is in a state of being, evaluating the environment through observation and orientation, and developing a vector of expectation. Once the individual decides to act, the agent passes through a series of bifurcations that establishes the growth and organization necessary for development. The individual continues to incorporate resources from the environment towards higher states of being as long as a positive expectancy vector emerges from the OODA process. As the individual passes through new states of being, the previously motivating factors transition to maintenance requirements. These maintenance requirements aggregate as the individual passes through successive states of increasingly complex and individualized being. If pathways collapse due to lack resources or other intervention, the individual seeks to regain that level as quickly as

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[160]Johnson, *Failing to Win*, 38.

[161]Dominic D. P. Johnson, *Failing to Win Perceptions of Victory and Defeat in International Politics* (Cambridge, MA: Harvard University Press, 2006), 38.

[162]Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 322.

possible. Continued frustration of the developmental pathway leads the individual to increased levels of pathological or neurotic behavior.

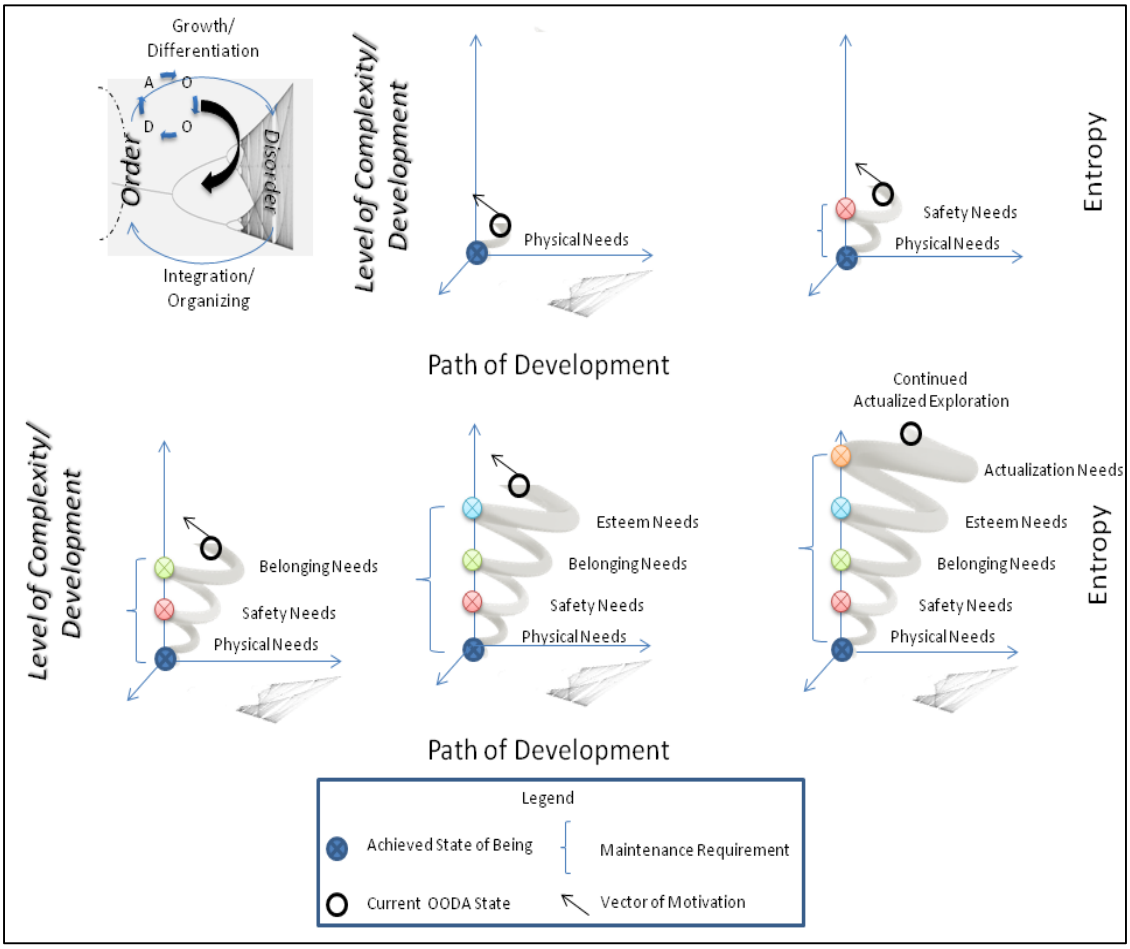

Figure 5 – Maslow, Herzberg, Vroom, and Boyd's models combined in a complex adaptive system of individual behavior and development.

Source: Created by author

This component of the system shows the pathway of growth and integration required for individuals take toward higher development. A balance between potential outcomes and choice are required to maintain a stable existence. It shows a process of directed effort, requiring resources to maintain previous needs and to attempt to reach emergent motivated needs. Through the OODA loop, internal and external influences shape decision-making. This component model

also demonstrates the residual underlying costs associated with maintenance factors. It opens the possibility of technological influence at several points. The horizontal component of the spiral represents the pathway of development. In the lowest needs, the pathway shortens because technology allows a reduced path of achievement. For example, technology lowers the cost of obtaining basic food, shelter, and health requirements. In the highest needs, technology may stretch the pathway toward disorder by the increased potential for achievement, realized through enhanced observation. For an esteem-need example, keeping up with the Joneses is never as difficult when you are comparing yourself with the world presented in connected media, instead of the person next door. A new awareness emerges from the visibility of so many diverse experiences, if approached in a balanced way, can be quite healthy. However, the propensity of human communication is to focus on the exceptional, the bizarre, and the fabulous. The pace and impact of these messages increase through technology driven experience, distorting the perception of these exceptions to become the rule. These effects emerge through individual orientation and group aggregation, affecting the shape of the operational environment.

The effects of technology increase the number, strength, and immediacy of interaction in a way that provides for greater integrative capability. The combination of many of these technological characteristics leads to three major influences on individual behaviors. First, the march through the initial states of physical and safety needs happens quite rapidly. Second, the rapid acceleration leads to earlier emergence of higher needs and generally increases expectations. Third, personalized definitions of higher needs are more strongly experienced and held. Each of these interactions leads to individual and social consequences essential to understanding the operational environment.

The increased immediacy and number of interactions push lower needs to satisfaction earlier in the individuals' experience. As mentioned earlier, physical and security needs are more clearly defined amongst individuals. The decreasing transaction costs provided by the

accelerating growth of technology allow more capability and resources obtained with less overall cost.[163] For example, green revolutions, including mass farming techniques, irrigation, nitrate fertilization, and refrigeration are technologies that help stave off the Malthusian apocalyptic scenarios of overpopulation.[164] While not ending famine or starvation, these technologies created an accumulated effect or *tipping point* in society that allowed a critical mass of individuals to focus on higher levels of development.

In addition to meeting physical needs, safety need satisfaction is more prevalent in the contemporary environment. While it may not seem so, due to the prevalence of media coverage of violence, the world is in fact a safer place.[165] It is an interesting phenomenon of expectation that violence and other scourges of society are so prevalent in our minds. As society obtains the means to address these issues, they are more likely to face them head on, rather than accept them as part of normal existence. Media and communication technology make these atrocities more visible to us, and because our lower needs are met, we are cognitively freer to pursue solutions.[166] Perhaps the reason we do not recognize our success is that our satisfaction is so short lived.[167] Indeed these motivations rapidly turn into maintenance factors, and individuals move on to "bigger wants."[168] If the requirements for the factors become routine enough, they will be viewed

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[163]Simon, *The State of Humanity*, 644.

[164]Malthus, Thomas Robert, *An Essay on the Principle of Population* (London: J. Johnson, in St. Paul's Church-yard., 1798), para. I.I.6, http://www.econlib.org/library/Malthus/malPop1.html#Chapter%20I (accessed October 2, 2013).

[165]Steven Pinker, *The Better Angels of Our Nature: Why Violence Has Declined* (New York: Viking, 2011), xxi.

[166]Allenby and Sarewitz, *The Techno-Human Condition*, 96.

[167]Maslow, *Motivation and Personality*, 33.

[168]Simon, *The State of Humanity*, 656.

as rights.[169] In fact, Geert Hofstede found that the relative wealth and individualistic tendencies of the dominant powers led to the content of the Universal Declaration of Human Rights and other UN covenants.[170]

It is easy to understand how higher expectations for maintenance extends through the expectancy vector to future motivational needs. As individuals continue to observe their environment, they incorporate these new inputs into their growing database of historical experiences and cultural cues. Already sensitized to expect quick results by the intense information processing capabilities of new technologies, individuals come to expect immediate gratification. This is a statement of perceptual experience, not a value judgment. Lowered transaction costs also lower barriers to entry for media and communication operations, whose ubiquitous nature can significantly shape people's opinions.[171]

It is not just the mass of these messages that change expectations, but their content. The relative ease of transmitting cheap information means that it is penetrating more areas where cultural context might be very different from the originators' intent. It is difficult enough for Americans to discern reality from *reality television*, so you can forgive the officer from a Southwest Asian military who once queried the author on why there were so many issues with the *real housewives* in America. There are countless other examples of misplaced perspectives separated from content. As individuals increase exposure to these media effects, the likelihood also increases that observations may not match the cognitive context embedded in their orientation processes, leading to a stretch of the *becoming* path. In other words, the likelihood of needs satisfaction becomes more difficult in some circumstances, because the individual's

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[169]Maslow, *Motivation and Personality*. 52.

[170]Hofstede, *Cultures and Organizations*, 106.

[171]Johnson, *Failing to Win Perceptions of Victory and Defeat in International Politics*, 67.

expectation decouples from the actual circumstances of their environment. The need or path to achievement is simply not realistic. Additionally, when alternative perspectives derive from groups of higher development to groups of lower development, power holders in the lower developed group may form countering narratives to maintain the status quo.[172]

Of course, higher expectations are not inherently negative. The larger disequilibrium can provide the impetus for innovation and higher levels of development. Alternatively, "neurosis may be regarded as a blockage of the tendency toward self actualization."[173] Faulty expectations may contribute toward a misappropriation of resources that lead to unmet needs. Commenting on the potential instability of complex systems, artificial intelligence researcher W. Grey Walter commented, "no wonder that the incidence of neuropsychiatric complaints marches with intellectual attainment and social complexity."[174]

Yet, traditional mass media is not the most individualizing result where technology intersects with individual tendencies. During the discussion of technological characteristics, media narrowcasting and service personalization emerged as dominating phenomenon.[175] These technologies combine with other factors to solidify and strengthen particularized identities. While identities derive from individualization and socialization, the proportional influence of each of

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[172]Alex Ryan, discussion with author, March 17, 2014. Dr. Ryan pointed out that cross-cultural communication may lead to the formation of conservative counter-cultures when threatened by external forces.

[173]Maslow, *Motivation and Personality*, xxxv.

[174]William Grey Walter, "A Machine That Learns," *Scientific American* 185, no. 2 (1951): 63. While not in the scope of this monograph, it would be interesting to use this viewpoint to study the growing need for resilience training in the prevention of suicides and other mental health issues inside the military.

[175]Shapiro, *The Control Revolution*, viii; Carr, *The Big Switch*, 150.

these processes varies by cultural region.[176] When individualization combines with socializing factors such as culture, identities morph to rectify their dissatisfied states.[177] Search is an adaptive behavior that looks for popular and successful schema that can achieve the desired condition in relation to the environment.[178]

Technology enhances *search behaviors*, most notably through the appropriately named search engine. Using the tireless effort of indexing algorithms, a growing proportion of the internet is categorized for keyword search. With a few keystrokes, individuals are directed toward information that matches their interests, for better or for worse. This potentially allows anyone to access more information today than in any time in human history, through billions of web pages.[179] For many motivated, isolated, or marginalized individuals this is a tremendous opportunity.[180] For those who are unfamiliar with in-depth Boolean searches, the results they receive are often the most popular or most commercially beneficial for the search provider. For most individuals, an attempt to incorporate so much raw data is over stimulating. This causes a fall back to the informational and psychological biases to attempt to reduce "the rates of transience, novelty and diversity in our lives."[181] Without critical review, the ease of access may provide distorted perceptions of reality.

Tailored information systems combine with search technology to quickly connect individuals to other like-minded individuals. When combined with confirmation bias, individuals

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[176]For information on socialization and individualization see March and Heath, *A Primer on Decision Making*, 62; For information on the of socialization on culture see Hofstede, *Cultures and Organizations*, 108.

[177]March and Heath, *A Primer on Decision Making*, 23.

[178]Discussed throughout Holland, *Adaptation in Natural and Artificial Systems*.

[179]Friedman, *The World Is Flat*, 211.

[180]Sunstein, *Infotopia How Many Minds Produce Knowledge*, 97.

[181]Toffler, *The Third Wave*, 334.

can enter into *information cocoons* or *echo chambers*, where preferences overrule disinterested rationality. "Communications universes in which we hear only what we choose and only what comforts and pleases us," are the result.[182] Maslow, in reviewing the work of British psychoanalyst Roger Money-Kyrle, thought that this "misinterpretation of the world" indicated that neurosis is a cognitive fallacy, not an emotional sickness.[183] Fueled by observations that confirm personalized outlook, the orientation and decision steps of the OODA loop direct the expectation vector toward a very specific and hardened outlook of reality. When individuals deliberate, bandwagon, and cascade effects can cause those particular beliefs to increase in extremity.[184] Therefore, "[t]he effect is not merely a tendency for members to conform to the group average but a radicalization in which this average moves toward extremes."[185] Technology can support individuals in the strengthening of internal biases and binds them to the sustaining resources of their membership in a way that supports partisanship, fundamentalism, and zealotry. By interconnecting similar points of view, technology can decrease diversity and may warp individual perspectives.

As Penn and Zalesne point out, "the potential for personal satisfaction due to individual choice and freedom is at its highest level ever."[186] While factions in the world population have existed throughout the historic record, now these factions align along personal choice rather than

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[182]Sunstein, *Infotopia How Many Minds Produce Knowledge*, 9.

[183]Maslow, *Motivation and Personality*, 129.

[184]Sunstein, *Infotopia How Many Minds Produce Knowledge*, 15.

[185]Cass R. Sunstein, "The Law of Group Polarization," *Journal of Political Philosophy* 10, no. 2 (June, 2002): 175. In Marshall Van Alstyne and Erik Brynjolfsson, "Global Village or Cyber-Balkans? Modeling and Measuring the Integration of Electronic Communities," *Management Science* 51, no. 6 (June 2005): 853.

[186]Penn, *Microtrends*, 389.

circumstance.[187] Human capital aggregated along traditional lines due to necessity to meet the challenges of the lowest and most pressing needs on the hierarchy. As systems have been integrated and routinized, the capital transfers to more individualistic pursuits. These effects especially manifest themselves in *imagined* or *virtual* communities that modern information technology enables. It begins a process of redefining propinquity along ideological rather than spatial-temporal lines.[188] Technological growth increases the number, immediacy, and strength of system interactions. This supports a form of individual development that races through initial need satisfaction, raises expectations, and solidifies individual definitions of being. The individual emergent properties of these systems combine to create many small, strong groups that will increasingly pressure the large groups of the industrial era. While the potential for fulfillment increases, the ability to meet those needs with broad policies as often wielded by the state, become increasingly ineffective. A far back 1959, it was predicted, "the rate of social change is itself accelerating so that in many cases not a logarithmic but a log-log acceleration will be found in cultural change."[189] These social groups create an operational environment whose topology is increasingly heterogeneous and subject to rapid transition. Understanding underlying group tendencies helps to explain the emergence of the dancing landscape.

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[187]Penn, *Microtrends*, 389.

[188]James Gleick, *What Just Happened: A Chronicle from the Information Frontier*, (New York: Pantheon Books, 2002), 60; Bennis, *The Temporary Society*, 84–85. Propinquity is the concept of affection or attachment to those things that are closest. Also, see Bennis, *The Temporary Society*, 84–85.

[189]As quoted in Bertalanffy, *General System Theory*, 26 who drew this thought from; H. Hart, "Social Theory and Social Change," in *Symposium on Sociological Theory*, ed. Llewellyn Gross (Row, Peterson, 1959), 196–238.

GROUP DYNAMICS: THE DANCING LANDSCAPE EMERGES

While the individual is the smallest irreducible cognitive agent in these systems, the majority of interactions in the operational environment come through meetings with aggregates of individuals, or groups. The previous paragraphs demonstrate that the integrative capabilities of technology compliment the differentiating tendencies of human nature. This leads to greater levels of individual development, which are increasingly particularized. In this section, these relationships of particularized individuals demonstrate why groups form, how they combine to influence group characteristics, and what the consequences are to the operational environment. By synthesizing various perspectives from social, information, and complexity sciences, distinct phenomenon emerge to affect the condition of the future operational environment. These include the continued individualized orientation of social groups, greater internal homogeny that intensifies ideological identities, greater external heterogeneity, and power-law or long tailed behavior that leads to rapid change. Understanding groups leads to understanding of the most visible observations encountered in the operational environment.

Individuals and their social groups are interdependent for their respective survival and propagation. Biological anthropologists, sociobiologists, and other researchers demonstrate that human offspring are born undeveloped to the point where they would perish without parental support. Because the brain does not fully mature until 15-20 years after birth, additional social support is required to reach maxim potential.[190] There are significant economic, physical, and survival advantages inherent to group participation.[191] As complexity theory suggests, the

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[190]"Brain Maturity Extends Well Beyond Teen Years" MP3, *Tell Me More* (NPR, October 10, 2011), http://www.npr.org/templates/story/story.php?storyId=141164708 (accessed March 15, 2014).

[191]Hofstede, *Cultures and Organizations*, 282.

interaction of so many individuals leads to varied and unexpected results. Culture represents the emergent patterns of individuals living in proximity to each other.[192] Culture plays a significant role in an individual's development, setting up a reciprocal micro-macro interaction. Many hold that culture is not the underlying driver of individuals or groups. Sociobiologists, for example, hold that fitness maximization produces flexible decision making in humans and culture is an artifact of that underlying drive.[193] Anthropologists of the functionalist school have shown that institutions and culture have developed to support the needs in a particular environmental setting.[194] In turn, rules develop through groups to control their negative human tendencies. Evolution of the society parallels the progressive growth of its capabilities, which, as Maslow suggests, is also true of the individual. In turn, the number of specific associations in the society reflects the relative development of a culture: diversity of groups means more advancement.[195] In many ways, group formation represents the first great technological leap of humanity, as it allows for distribution of effort and passes information forward in time, both of which give survival advantages to the individual.

In fact, group participation is a selfish pursuit in many ways. Historically, many assumed that as groups formed, individuals in those groups worked to achieve the common purposes that those groups represented. However, the economist Mancur Olson showed that this is not the case. He posited that rational individuals, "will not act to advance their common or group objectives unless there is coercion to force them to do so, or if some separate incentive, distinct from the

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[192]Robert H. Lavenda, *Core Concepts in Cultural Anthropology*, 3rd ed. (Boston: McGraw-Hill, 2007), 92.

[193]John Alcock, *Animal Behavior: An Evolutionary Approach* (Sunderland: Sinauer Associates, 1998), 610–613.

[194]Lavenda, *Core Concepts in Cultural Anthropology*, chap. 6.

[195]Olson, *The Logic of Collective Action Public Goods and the Theory of Groups*, 19.

achievement of the common or group interest, is offered to the members of the group individually on the condition that they help bear the costs or burdens involved in the achievement of the group objectives."[196] This phenomenon magnifies as large groups increasingly fall short of providing an optimal supply of goods, returning smaller percentage of benefits to its individuals compared to their input, and requiring greater organization costs than small groups or individuals.[197] The results are more free riders, collectively known as the latent members, who seek benefit with the minimum amount of input. If this phenomenon is in question, one should consider why the state requires an enforceable tax code to fund its activities in support of the common good, as opposed to taking up donations.[198]

Interestingly, the need for coercion and influence is not the same for small groups, which gain advantages due to rational and affective actions of individuals. As Olson states:

> In some small groups each of the members, or at least one of them, will find that his personal gain from having the collective good exceeds the total cost of providing some amount of that collective good; if there are members who would be better off if the collective good were provided, even if they had to lay the entire cost of providing it themselves, than they would be if it were not provided."[199]

In addition to economic returns, small groups are more effective at providing individual, non-collective goods such as social status, esteem, friendship, prestige, and other psychological factors.[200] These are the most critical motivating factors in the future operational environment. Since small groups are uniquely capable of satisfying these motivations, small groups are likely to proliferate.

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[196]Olson, *The Logic of Collective Action Public Goods and the Theory of Groups*, 2.

[197]Ibid., 48.

[198]Ibid., 13.

[199]Ibid., 33.

[200]Ibid., 56–61.

Also by virtue of these factors, the small group is a more cohesive and effective entity.[201] Yet, small groups are not sufficient to meet many resource intensive tasks. Large groups continue to exist for situations where small groups do not have the ability to garner sufficient resources to meet particular needs. This explains their persistent presence in the operational environment. However, as an organization's size increases, so does the need for it to mobilize participation through coercion or selective incentive in its latent population.[202] As the group increases in size, it often chooses to take on substantially larger requirements of maintenance needs from individuals, as an incentive for individuals' continued participation in the group. In a more competitive environment, with a larger variety and number of agents, large groups will either focus on limited objectives or find more ways to meet these growing requirements.

Olson demonstrates that people will continue to act based on their individual proclivities unless influenced or coerced to do otherwise. Understanding group behavior depends on how the environment influences individual desires, the ability to meet those desires, and how desires transform through the interdiction of other influences. Economics, political science, anthropology, social psychology, and many other fields look at these very characteristics through various lenses. In recent years, many researchers have used complexity and CAS to bridge these various perspectives and look for underlying trends. From the palette of explanations available, Latané's Dynamic Social Impact Theory (DSIT) and Axelrod's complex approach to organizations are best suited to understand how cognitive and physical factors combine to affect the operational environment through network principles.[203]

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[201]Olson, *The Logic of Collective Action Public Goods and the Theory of Groups*, 53–57.

[202]Ibid., 44.

[203]Each of these authors will be discussed in-depth, but for more information see Latane, "Dynamic Social Impact: The Creation of Culture by Communication."; Axelrod and Cohen, *Harnessing Complexity*.

Network theory is a branch of science that seeks to understand commonalities of the relationships between agents and groups. Network theory represents another way of understanding systems thinking, including the growth and organization of social groups. The idea is that groups are naturally occurring networks. The integrative capability of technology is driving the creation of greater numbers of groups in novel circumstances. Therefore, understanding network theory allows for the understanding of group formation in the operational environment.

The agents in a network are nodes, which combine to create clusters and hubs. A clustering coefficient captures the relationship between nodes.[204] Studies of various social groups have shown that there is a tendency to form small, tightly knit groups with a high clustering coefficient.[205] These small groups connect to other tightly knit groups, through much lower clustering coefficients. The graphical depiction of these relationships in real or cognitive space is topology.[206] In many large networks, the "majority of nodes have only a few links and that these numerous tiny nodes coexist with a few big hubs, nodes with anomalously high number of links."[207] Because of its persistence in networks of various scales, this behavior is known as scale free, power law, or long-tailed behavior. This behavior is particularly apparent during the "phase change" between chaos and order indicative of self-organization in CAS.[208] When networks have a small average distance and high clustering, they demonstrate "small world network" behavior.[209] These networks are resistant to change and more efficient in relaying information,

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[204]Barabási, *Linked*, 47.

[205]Duncan J. Watts and Steven H. Strogatz, "Collective Dynamics of 'Small-World' Networks," *Nature* 393, no. 6684 (June 4, 1998): 440–442.

[206]David Terman and Eugene Izhikevich, "State Space," *Scholarpedia* 3, no. 3 (2008): 1924.

[207]Barabási, *Linked*, 70.

[208]Barabási, *Linked*, 77.

[209]Watts and Strogatz, "Collective Dynamics of 'Small-World' Networks," 440–442.

similar to the advantages Olson assigns to small groups. Information technology increases the number, immediacy, and strength of connections in a way that supports small world networking and the persistence of small groups.

Mathematician Albert-László Barabási posited that any network or system that displayed growth and preferential attachment would act with scale-free power law behavior. In the case of the operational environment, the continued growth of technological capability allows the integration of nodes (individuals and groups) in ways determined by their particular choice (combination of preference for popular/successful and individual motivations). Growth alone provides only linear increase, where growth and preferential attachment provide a "rich get richer" scenario that creates rapid growth of those hubs that demonstrate a preferential characteristic.[210] Figure 6 demonstrates that as members with preferential attachment join networks their distribution eventually resembles the trend Barabási describes. Power law and long-tailed behavior supports internal homogeny, external heterogeneity, and the potential for rapid change.

The variety of these hubs actually represents an adaptive characteristic on the macro level. The diversity of the hubs means that there are more possibilities to respond to environmental stresses. Statistically there is a greater likelihood that a fit hub is available. A greater number of hubs mean that a larger area of the problem space can be searched for solutions simultaneously. These multiple hubs can also provide the basis for novel combinations and configurations to meet novel problems. In social interactions, individuals create "complex patterns of attitudes, behaviors, and cognitions"[211] that optimize the outcomes of survival and development. Individual actions derive in part by social interactions, because they help transmit

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[210]Barabási, *Linked*, 87.

[211]Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 49.

adaptive behavior over time. Conversely, individual action reacts to changes in the environment, which is absorbed into the norms and culture of the group. [212]

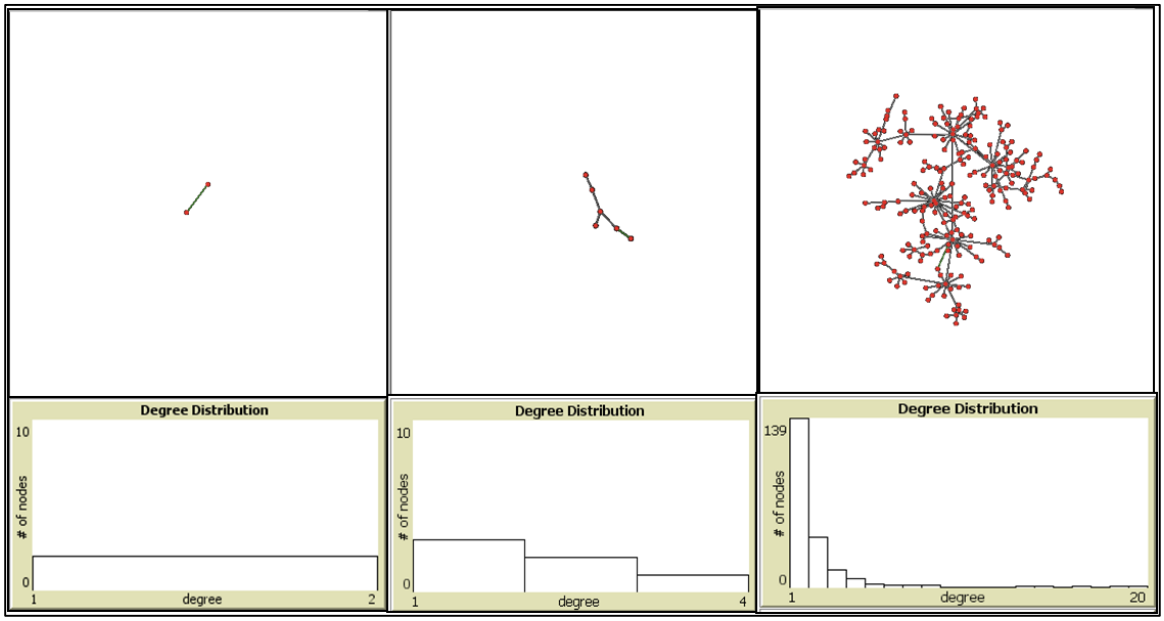

Figure 6 - Network Growth with Preferential Attachment. As members join the network, their distribution may begin linearly, but it later demonstrates long-tailed distribution.

Note: Created using Uri Wilensky, *NetLogo Preferential Attachment Model*, NetLogo (Northwestern University, Evanston, IL: Center for Connected Learning and Computer-Based Modeling, 2005), http://ccl.northwestern.edu/netlogo/models/PreferentialAttachment.

Groups work together, to process in parallel, the conditions of the environment and seek solutions to novel situations. Norms and cultures transmit historically beneficial information from the top down, while genetics and experience transmit from the bottom up. Socialization provides the starting orientation for individuals to fulfill their individual motivations, generally emergent in the order as indicated by Maslow's hierarchy. Similarly, Olson highlights that while individuals participate in groups because of their advantage, it is in pursuit of their individual

[212]For more information see Ruth Benedict, *Patterns of Culture* (New York: Penguin Books, 1934), 234; As discussed in Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 222.

fulfillment. Groups hold together by their participants' common desire to solve similar problems. Because of the power of parallel processing the group provides, it is up to the individual to interact socially, especially in unfamiliar circumstances. When the motivating problem no longer applies to a large enough segment of the group, it breaks away and forms a new group – just as described in network theory's description of hub growth. Swarm Intelligence describes this type of collective problem solving.[213] Swarm intelligence is especially sensitive to the communication between nodes, which is a product of distance – physical and/or cognitive.[214] Strength, number, and immediacy of interactions represent a framework of distance in both dimensions.

Social psychologist Bibb Latané addresses how strength, number, and immediacy of interactions create clusters and subpopulations of groups that network theory predicts in Social Impact Theory (SIT).[215] SIT explains how physical distance helps to shape culture. Incorporating principles of complexity into SIT led to the creation of Dynamic Social Impact Theory (DSIT). DSIT outlines five propositions and six derivations that explained, "self-organizing properties can lead initially random distributions of social attributes to become clustered in space and correlated, with less popular elements becoming consolidated or reduced in frequency but surviving in minority subgroups." [216] Strength, immediacy, and number of interactions relates not only to spatial and temporal relationships. Robert Axelrod developed a similar trinity of proximity, activation, and space to describe interactions in cognitive distance and time. Axelrod's interpretation is significant because it acknowledges properties of information distribution and the

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[213]Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 293–294.

[214]Ibid., 425.

[215]Ibid., 237.

[216]Latane, "Dynamic Social Impact: The Creation of Culture by Communication," 13.

technology's ability to "reduc[e]barriers to interactions across space and/or time."[217] Using both Latané and Axelrod's perspectives on distance, DSIT provides a framework to understand technology and individual characteristics on groups. DSIT's five proposition of individual differentiation, location stability, proportionality of social influence, self-organization, and influence distribution combine with the integrating capabilities of technology and individual differentiating tendencies to impact the future operational environment.

DSIT's first proposition is that "individual human beings differ with respect to a multitude of demographic, physiological, and psychological variables."[218] This is of course a primary consequence of the model of individual motivations proposed earlier in the monograph. Individuals, as supported by the capabilities of technology are reaching higher levels of motivating needs, which are by their very nature, more individualistically defined. Latané points out that an individual's "credibility, willingness to exert influence, or power to affect other people" are particularly important class of individual differences that help to determine an individual's influential strength.[219] Earlier, the effect of personalized media, tailored searches, and self-selected social media circles were shown to be able to affect bias in a way that could harden attitudes and increase partisanship. If true, then this makes the individual and neighboring individuals particularly strong internally to their own small group. While this gives small groups great collaborative power, it also makes them more susceptible to internal groupthink and mob psychology.[220] External to the small group, the hub is relatively less willing to compromise and

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[217]Axelrod and Cohen, *Harnessing Complexity*, 79.

[218]Latane, "Dynamic Social Impact: The Creation of Culture by Communication.," 14.

[219]Ibid.

[220]Sunstein, *Infotopia How Many Minds Produce Knowledge*, 223; Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 410–411.

susceptible to polarization. This makes collaboration amongst groups more difficult.

The second proposition of DSIT is that "individuals have relatively stable locations in space." [221] While this statement is true of agrarian and even industrial social groups, this proposition has less meaning in a world increasingly experienced remotely. While DSIT acknowledges technology's capability to enable movement through greater transportation capabilities, it still finds these movements are too infrequent to be a compelling factor. The result of this relative immobility is that individuals in physical communities are more willing to adapt their desires in order to conform to their neighbors. However, in a world increasingly dominated by information technology, propinquity is shifting from the spatial to the cognitive through *virtual communities*.

If it is difficult to make the leap that virtual communities are influential, first consider that in many ways, all communities are virtual constructions of the mind. While there are physical places and people we interact with in a very objective way, the bond created with those agents comes from the assumption of shared experience. What defines *us* versus *them* are the degrees of repeated exposure.[222] One's capability to relate to others is dependent on their "theory of mind" – the ability to anticipate others thoughts and feelings and in turn understand others' reflection upon yourself.[223] Technology's increasing ubiquity causes a higher number of individuals to be more likely to identify with a virtual community, rather than their physical community.[224] Virtual communities represent a unique opportunity to achieve level of belongingness and esteem for

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[221]Latane, "Dynamic Social Impact: The Creation of Culture by Communication.," 14.

[222]Tuan, *Space and Place*, 50.

[223]J. J. C. Smart, "The Mind/Brain Identity Theory," in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Winter, 2012. http://plato.stanford.edu/archives/ win2012/entries/mind-identity/ (accessed February 18, 2014).

[224]Carr, *The Big Switch*, 124.

those on the margins of society.[225] Latané is right to derive that immediacy of interaction means that those closest to individuals are most likely to influence them, at least in a spatially dominated world.[226] Through the cognitive/informational lens, the immediacy principle means that individuals are more likely to reach across borders to align along ideological lines. This is as true for independent acting charities and issue groups as it is for terrorist organizations. This also helps us understand that the operational environment is increasingly marked by individuals that pursue goals in two dichotomous planes: a rugged physical-world derived landscape and a virtual-world dancing landscape.[227]

The third component of DSIT is that social influence is proportional to a function of strength, immediacy, and number of sources. The metaphor of social force fields describes this influence, similar to Vroom's force of expectation. There is a physiological basis for the idea of *impact*. Canadian neuropsychologist Donald Hebb postulated that neural cells assemble as they receive sensory input from the environment. Repeated iterations lead to positive and negative correlations that build emergent behaviors. Cell assemblies that support the "needs satisfaction" through positive feedback continue development. The continuous chemical-electrical activity of

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[225]This is discussed throughout Friedman, *The World Is Flat*.

[226]Latane, "Dynamic Social Impact: The Creation of Culture by Communication.," 15–16.

[227]John H. Miller and Scott E. Page, *Complex Adaptive Systems an Introduction to Computational Models of Social Life* (Princeton, NJ: Princeton University Press, 2007), chap. 12. In figure 12.2 the authors point out that: "As nonlinear interactions increase in a system, the numbers of peaks and valleys increase as well and the landscape becomes more rugged. Agents with limited search abilities can get trapped easily on local optima when the underlying landscape is rugged. " Dancing landscapes are rugged landscapes that change over time. While physically derived landscapes can also be thought of as dancing, their rate of change is much slower than virtually derived landscapes. Therefore, physical-world derived landscapes are more accurately as relatively rugged landscapes. The term is reduced in this monograph for simplicity and contrast.

the brain forms patterns through conditioned experiences that create structures of cognition and enables learning.[228]

This process provides a physiological point of origin for the macro observations of Boyd's OODA loop because it explains how actions observed in the environment help shape the heuristics the mind uses to make decisions. This provides a critical bridge between individual and social minds. There is significant debate on the exact mechanism, but there seems to be agreement that the phenomenon of neural recognition, processing, and mirroring is based on the impact of inputs.[229] This idea played a key role in Holland's adaptive behavior formulations discussed previously.[230] Whether it is physical force, energy, or information, the criteria of impact gives a pattern of appraisal of the environment's influence on any particular system. This operates similarly on the influence of the environment on social groups as it does on the human mind. This also suggests extension from the physical to the virtual community.

The previous section identified how individual motivations are becoming more particularized as technology increases those individuals' ability to meet lower needs more readily. As Latané derives, influence is proportional to the distance between individuals.[231] The shift in importance from physical to virtual presence means that information distances become more important as effects of strength, immediacy, and number increase on the individual in that domain. The previous discussions clearly pointed to technology's growth as increasing the

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[228]This is a reoccurring theme and a primary finding of Donald O. Hebb, *The Organization of Behavior: A Neuropsychological Theory* (Mahwah, NJ: L. Erlbaum Associates, 2002).

[229]Gregory Hickok, "Eight Problems for the Mirror Neuron Theory of Action Understanding in Monkeys and Humans," *Journal of cognitive neuroscience* 21, no. 7 (July 2009): 1229–1243; P. B. Pascolo, P. Ragogna, and R. Rossi, "The Mirror-Neuron System Paradigm and Its Consistency," *Gait and Posture* 30 (October 2009): S65–S65; Giacomo Rizzolatti and Laila Craighero, "The Mirror-Neuron System," *Annual Review of Neuroscience* 27, no. 1 (2004): 169–192.

[230]Holland, *Adaptation in Natural and Artificial Systems*, 59–65.

[231]Latane, "Dynamic Social Impact: The Creation of Culture by Communication," 17.

immediacy and number of sources of influence in virtual communities. As people choose their communities based on their alignment with their individualized beliefs, they reinforce those beliefs. This causes an intensified experience of reinforcing influence. Individuals and groups in the future operational environment may hold more *intense* beliefs than ever before.

The fourth component of DSIT says, "iterative, recursive outcome[s] of individual influence processes will lead to the global self-organization of socially influenced attributes and the emergence of group-level phenomenon."[232] The theory goes on to find that this occurs because individuals become more like their neighbors in spatial clusters, which causes attributes to become correlated, and minorities will decrease in number due to their greater exposure to interactions of the majority – except where protected by the internal homogeny of clusters.[233] The result is a less uniform or heterogeneous environment.[234] The enabling characteristic of this spatially based community is the relatively immobile nature of the individuals. In a virtual community, a very similar topology of the environment occurs along ideological pathways discussed in proposition two. In Latané's scenario, immobility means that individuals must adapt their goals to fit into the constraints of the environment. In a virtual community, individuals are more likely to find new neighbors to match their needs.

The reason this heterogeneous pattern persists is that these systems retain the ability to self-organize around individual's preferential attachment and toward successful and numerous instances. In physical communities, strength, immediacy, and number of influences emerge from the neighbors closest to a given individual. In a virtual community, the interconnected individuals can selectively search for one another in a directed way. Clusters form around the most vocal or

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[232]Ibid., 18.

[233]Ibid., 19–21.

[234]Also called a rugged landscape. See, Page, *Diversity and Complexity*.

heavily indexed individuals in the information space, instead of the physical space. This allows correlation of interests along similar needs, as opposed to changing needs to fit the space. Acknowledging Latané and Axelrod's contributions to social influence, Kennedy and Eberhart demonstrate that sociograms can meaningfully depict the distribution of cognitive space and the distances representing the similarities of agents/groups.[235] A well-known example of this kind of heterogeneous topology, in the virtual world, is in the distribution of nodes and hubs in the World Wide Web.[236]

This heterogeneous distribution has several influences on the future operational environment, especially since virtual-world transcend nation-state and other borders of authority.[237] First, it shows how individualized tendencies can form groups that protect minorities better than if they were not in groups. The greater differentiation in space means that there are more borders of difference between groups and therefore increased potential for conflict. Since the particular distribution of groups is dependent on iterations of interaction, the increased pace of technology allows higher rates of turnover. This transforms the rugged landscape to a dancing landscape. Finally, initially existing large groups face increasing pressure toward fragmentation as they compete with these dynamics. This is especially true as reality is defined by two separate problem spaces, the physical and the virtual. Individuals and groups, who straddle both of these spaces, face increased demand for their resources between differing topologies.

The final proposition of DSIT is that "social influence will be incremental for

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[235]Kennedy, Eberhart, and Yuhui, *Swarm Intelligence*, 425.

[236]Barabási, *Linked*, 56–57.

[237]This is one reason the Global War on Terrorism calls into question so many traditional assumptions, such as military action inside sovereign territory. As highlighted with Dr. Alex Ryan, discussion with author, March 17 2014.

unimportant issues, catastrophic for important ones."[238] A derivation that "incremental influence processes will lead to convergence; nonlinear influence processes will lead to continuing diversity" expounds on this proposition.[239] This phenomenon is represented by a unimodal uniform-like distribution for unimportant issues and a bimodal long-tailed distribution for important issues. These distributions have been shown to be accurate in various studies of compromise and disagreement. Even when designed to reach consensus, such as deliberative groups, individuals often increase the extremity of their positions.[240] The combined tendencies of individuals and technology not only support this phenomenon, it exasperates it.

Why is there a difference between the uniform and long-tailed distributions? There is a significant difference between the cultures of physically derived communities and virtual communities. The norms and culture that form through physical communities display a characteristic of cultural inertia. Often the cultural norms that are felt the strongest are the results of repetitively proven or high consequence experiences. The strength of these norms provides a social buffer that prevents social change that might be harmful if undertaken too rapidly.[241] The strength that culture holds on individuals is a combination of its ability to meet needs and its prevalence in individuals' experience. While externally differentiating, culture provides internally stabilizing integration, which makes it particularly suited to meet maintenance needs.[242] However, because maintenance needs are not motivating, individuals are only latently committed to many

[238]Latane, "Dynamic Social Impact: The Creation of Culture by Communication," 21.

[239]Ibid., 23.

[240]The is a central and reoccurring finding to Sunstein, *Infotopia How Many Minds Produce Knowledge*.

[241]Brown and Duguid, *The Social Life of Information*, 52.

[242]Johnston, *The Allure of Machinic Life*, 41. In this passage, early cybernetics pioneer Ross Ashby discussed how feedback provides systems the capability to maintain homeostasis, or system stability. Culture's influential and coercive means provides feedback to maintain the groups coherence inside its definitional boundaries.

cultural facets.[243] A truly adaptive culture is one that meets maintenance and motivational needs of its constituent members. As structures such as rules come into existence to meet maintenance needs, the structures themselves require maintenance. For example, the lower physical and security needs are incorporated into the functions of the state in the form of welfare and defense responsibilities.[244] While these functions are essential to the survival of individuals, their status as maintenance needs may mean they are taken for granted, underestimated, or undervalued until they are threatened.[245] This is why when groups such as nations develop they accumulate higher levels of responsibilities. Many groups find that more money means more problems.[246]

The relatively low mobility of individuals in space combines with effectiveness of adaptive schema to create cultural inertia in physical communities.[247] In other words, people continue to conform to cultural norms, even though they may not match their motivational needs because of mobility barriers. In virtual communities, these barriers to exit are much lower,

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[243]Olson, *The Logic of Collective Action Public Goods and the Theory of Groups*, 48; Hatch, *Organization Theory: Modern, Symbolic, and Postmodern Perspectives*, 121. In this context, Olson is describing the participation of individuals in markets and the tendency to free ride as return on investment lowers in larger groups. Here the metaphor is extend to make culture a market of adaptive schemas. In Mary Jo Hatch, *Organization Theory: Modern, Symbolic, and Postmodern Perspectives* (New York: Oxford University Press, 2006), 121, Catz and Kahn show how that maintenance factors can be carried out separate from motivational activities in organizations. This can lead to differentiation inside of organizations. This supports the idea of fractionalization that network theory predicts.

[244]Wenda K. Bauchspies, *Science, Technology, and Society: A Sociological Approach* (Malden, MA: Blackwell Pub, 2006), 96.

[245]Maslow, *Motivation and Personality*, 33.

[246]Steven Borowiec, "More Money, More Problems in South Korea," *The Diplomat*, http://thediplomat.com/2012/09/more-money-more-problems-in-south-korea/comment-page-1/ (accessed February 17, 2014); Michael Deacon, "PMQs Sketch: Mo' Money, Mo' Problems," *Telegraph*, 15:35, sec. politics, http://www.telegraph.co.uk/ news/politics/pmqs/10633892/PMQs-sketch-Mo-money-mo-problems.html (accessed February 17, 2014).

[247]Latane, "Dynamic Social Impact: The Creation of Culture by Communication.," 15.

meaning that those who do not like the rules can leave.[248] The inherent strength of the well-connected virtual community hinges on the continued identification of its constituent members. In a counterintuitive way, virtual communities are very strong, until they simply no longer are. This issue, when graphically depicted, resembles power law growth followed by a crash.

Individuals' needs become increasingly complex, resource intensive, and increasingly particular, with less commonality between members. As the goals of these groups are met, the common ground between their members is increasingly shed. Because of the low barriers to exit, members are free to explore an increasingly connected environment for new alliances that meet their emergent needs. Unless a group adapts to these increasingly intensive and particular needs, it too will crash.

This is why the future operational environment is a dancing landscape increasingly dominated by rapid change. As particularized needs form in individuals, they rapidly form with long-tailed growth. In a success scenario, those needs are quickly met, and the original concerns become taken for granted maintenance needs. New particularized needs emerge from individuals, which are less likely to be shared within the community. This causes a rapid fractionalization of the group. In a failure scenario, the community is unable to meet needs, so maintenance never develops, again leading to a rapid fractionalization of the group. In both scenarios, rapid long tailed or power-law type integration and differentiation occurs via the capabilities provided by technology. Because of the lack of traditional buffers, cultural inertia is less likely to form, decreasing the chance that individuals may sustain their associations with the group. Adaption for the virtual community is difficult because the cost of defection is lower than the cost to attempt organizational change. This interpretation support DSIT's assertion that continued diversity

[248]Esther Dyson, *Release 2.0: A Design for Living in the Digital Age*, 1st ed. (New York: Broadway Books, 1997), 8.

overcomes pressures of uniformity. The corollary, when incorporating technological growth, is that these changes occur at an increasingly rapid pace, which increases heterogeneity. The tempo of the dance increases.

An extension of this concept says that as groups desire continued mobility to meet their higher needs, they desire increasing levels of stability in meeting their previously achieved maintenance needs. One possibility is that these individuals will search for stable groups that will accept those requirements. The state, whose primary concern is to maintain stable growth, encounters increasing pressure to become the repository of requirement. Without parallel increases to provide resources in those efforts, states must pursue other adaptive plans or face "death by a thousand cuts." While, this is just one of a number of possible emergent scenarios, its likelihood increases because of the dominance of technological effects.

The characteristics of technology, individuals, and groups combine to create an operational environment that is prone to less compromise, ideological alignment, intensification of beliefs, conflicting diverse viewpoints, and unstable structures. Left to its natural path, the operational environment system seems primed for negative consequences. Yet every risk contains the possibility for equal or greater opportunity. As agents in this complex adaptive system, it is important to understand the propensities of the system, and prepare to act in a way that leads to continued development.

DISCUSSION: LEARNING THE STEPS OF A FASTER DANCE

At each level of the operational environment, technology represents a catalyst of accelerated change that leads to second, third, and deeper effects. Technology not only enables individualistic pursuits, it exasperates their characteristics. The ability for technology to compress time and space means actors that would have previously never made contact are increasingly likely to discover one another. While there is a great multiplicity of individual proclivities, the

large size of the world's population suggests that others will share overlapping interests. Leveraging technology to communicate allows ideas to become a predominant organizing nucleus, rather than family background, geography, or other factors. Because these groups can self-regulate their members, they can remain more ideologically focused than those formed around spatial or temporal limitations. As Olson suggests, the relatively smaller groups are already more cohesive than larger groups. Large groups were prevalent because they alone had the necessary resources to accomplish many big things. However, technology intervenes by increasing the potential and lowering cost to the small group. The result is a multiplicity of groups, guided by the individualistic motivations of their constituents, organized around increasingly narrow interests, spatially and ideologically distributed, changing constantly to seek individual advantage, together.

As the effects of technology aggregates from the micro to the macro, five interrelated trends mark the future operational environment. The integrating capabilities of technology allow human nature to fulfill its differentiating tendencies. This differentiation causes a heterogeneous operational environment, dominated by a rugged landscape of many small groups and fewer large groups. These numerous small groups will align as necessary to meet transient goals, leading to progressively greater alliance configurations. The competing requirements of this multiplicity of groups means that large groups come under increasing pressure to form larger alliances to prevent fragmentation within themselves. Combined with sensitivity to early developmental conditions, first, second and third wave groups will experience absolute growth, but remain relatively disparate in their conditions. Instability results from high rates of growth, persistent relative differences, competition for scarce resources, and increasing resistance to change. Countering these tendencies is the propensity for decreased population growth with development over time, improved absolute conditions, capability for increased efficiency, and increased capability for communication.

Coming full circle, a comparison with the *Joint Operating Environment: 2010* adds perspective to these findings. The document highlights a variety of influences and outcomes in the future operating environment. When viewed through the lens of technology, individuals, and groups, the report's findings fall into three general categories: physical world, virtual world, and colliding world scenarios. In each of these groupings, the underlying interactions described in this monograph are apparent in the following description of emergent instances.

Physical world scenarios are those based on technology, individual, and group interaction play out in physical communities. Some of the issues *JOE:2010* discusses include population growth, demographic shifts, energy use, natural resource depletion, climate change, and weapon proliferation. Each of these trends reflects the growing desire for consumption combined with the capability to consume. Allenby and Sarewitz describe technology as having Level I, Level II, and Level III effects. Level I effects are "the immediate effectiveness of the technology itself as it is used by those trying to accomplish something."[249] *JOE: 2010* identifies communication technology and weapon proliferation as two classes of Level I technologies that provide opportunity and risk in the future operational environment. Electromagnetic pulse weapons, robotics, nanotechnology, space-denial, laser weapons, biotechnology, weapons of mass destruction (WMD), and nuclear proliferation illustrate possible future applications.[250] The binding thread of this technological differentiation is the growth of capability and reduced cost of Moore's Law. The need seeking tendencies of individuals and groups determine the implementation of these technologies.

Technology also demonstrates Level II and Level III effects in the operational

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[249]Allenby and Sarewitz, *The Techno-Human Condition*, 37.

[250]United States Joint Forces Command, *JOE:2010*, 53–55.

environment. These levels are the consequences of Level I artifacts. A vaccine is Level I technology, its distribution system is a Level II technology, and its effect on demographics and society a Level III technology.[251] For example, technological innovation and lowered costs improved health care to many parts of the world. Many of these health improvements were the results of well-intentioned aid programs from the west. The compartmentalization of development meant that many of the necessary supporting system required for a fully developed state were not in place. This led to several unintended consequences. The greater abilities of health care meant that one barrier to higher population carrying capacities quickly disappeared. Without accompanying social, cultural, and economic adaption the result are demographic pyramids in developing countries. The large youth populations' demands for increased opportunity in these nations put strain on fragile first and second wave societies that have limited means to match the maintenance or motivation needs.

Meanwhile, many developed third wave nations face inverted population pyramids. Victims of their own success, their demographics are less capable of supporting the maintenance needs of aging populations. The younger populations' needs increase generationally as higher development transforms previous motivations to maintenance factors. In turn, higher requirements for economic growth emerge. This sets up an attraction in these systems, drawing disaffected populations from first and second wave societies to third wave societies. Phenomenon such as increased outsourcing of labor and increased immigration to third wave societies emerge. While this is a natural adaption of the macro system to distribute resources, third wave population resentment results in many cases.

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[251]Allenby and Sarewitz, *The Techno-Human Condition*, 40.

George Friedman discusses this phenomenon in the United States, in *The Next 100 Years*. In it, he discusses how abundant resources and the population boom in the 1920s acted as fuel for economic growth.[252] As the twenty-first century progresses, aging population demographics and expectations for high standard of living amongst the population combine for a sudden increased demand for immigrant labor.[253] This trend somewhat buffers by the first wave transition from industrial to information-based economy. If innovation and productivity are limited in their potential, then the requirement for labor remains. Europe, with more advanced gerification than the United States', provides a glimpse of this possible future. Immigration from Eastern Europe, Turkey, and Africa increase pressure on social systems and culture. Reactions have ranged from multicultural inclusion on one side, to increased nationalism, immigration skepticism, xenophobia, and even racism.[254] The findings of this monograph indicate that human nature and network effects help to understand why these phenomenon are persistent, even with continued upward development. Clearly, there is potential for increased instability under these circumstances.

These population trends also bring a number of questions concerning the use of natural resources, especially energy resources, and their effect on the environment. Certainly, rising population pressures the allocation of resources such as water, food, and arable land.[255] However,

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[252]Friedman, *The Next 100 Years*, 120.

[253]Ibid., 133.

[254]Jens Rydgren, "Immigration Sceptics, Xenophobes or Racists? Radical Right-Wing Voting in Six West European Countries," *European Journal of Political Research* 47, no. 6 (2008): 737–765; Khalid Koser, "Why Europe's Immigration Nightmare Is Only Beginning," *CNN*, http://www.cnn.com/2013/10/30/opinion/europe-immigration-debate-koser/index.html (accessed February 25, 2014); Gavin Hewitt, "Immigration Fears Spook British Government," *BBC*, http://www.bbc.co.uk/news/world-europe-25087153 (accessed February 25, 2014); Joel Kotkin, "Who's Racist Now? Europe's Increasing Intolerance," *Forbes*, http://www.forbes.com/sites/joelkotkin/2010/10/18/whos-racist-now-europes-increasing-intolerance/ (accessed February 25, 2014).

[255]United States Joint Forces Command, *JOE:2010*, 30–32.

non-renewable resources are limited even in stable populations. While this causes continued difficulties, market forces have historically resulted in the innovations necessary to reduce these tensions in the long term.[256] However, history also shows that short-term micro and meso level conflicts may still result inside of the macro trend toward greater development. As *JOE:2010* indicates, "[s]erious violence resulting from economic trends has almost always invariably arisen where economic and political systems have failed to meet rising expectation."[257] The discussion in the monograph pointed out how these individual expectations rise and how they may be corrupted. More importantly, it demonstrated that technology drives these processes at increasing rates. Intensification of expectation and needs not only raise the total amount of resources needed, but the competition for those resources. Military forces will cut budgets and assume more risk in periods of low conflict, yet these respite periods may not last as long as historic inter-conflict periods.

If the frequency of major events intensifies on par with the increased tempo of technological proliferation, then states will be challenged to maintain adequate resources to address the multiplicity of challenges unilaterally. Rapid change creates the conditions for more alliances,[258] while existing institutions optimize their constituent members' roles. The North Atlantic Treaty Organization's (NATO) survival after the Cold War is indicative of the need for continued risk sharing without a specific threat. The institutions integrating capability provided for continued growth in the region. NATO also exhibits optimizing tendencies as well, as

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[256]Discussed throughout Simon, *The State of Humanity*.

[257]United States Joint Forces Command, *JOE:2010*, 18.

[258]Hatch, *Organization Theory: Modern, Symbolic, and Postmodern Perspectives*, 307.

demonstrated through its "Smart Defence" agenda.[259] Through cooperation of its member states, priorities develop that allow each nation to specialize its defense capabilities to niches inside the overall requirements.[260] While this significantly reduces the cost to any particular state, the resulting force may not be strong enough to act on its own.[261] The integration made possible by NATO leads to the differentiation of its military forces. Further integration of capability might provide the differentiation necessary to spur development of a more substantial European Union military force.

By their very nature, alliances require commitment from their members, which means issues for one partner may come to influence others. This may play a significant role in not only future military policy, but in areas of economic, political, and social issues. For example, while there is significant disagreement on issues such a climate change in the United States, many nations have concluded that it is a human caused event. As these states take action, they may begin to pressure the United States for more substantial changes. The influence of these groups depend in great part in the complex interdependencies shared with the nation and the value they provide to meeting the dominant needs of the nation. Alliances are not in the realm of nations alone. Non-governmental organizations (NGO), multinational corporations (MNC), and special interests organizations are emergent groups that represent adaptive schema representing increasing heterogeneous and specialized needs. The connectivity technology provides allows the formation of any number of novel "joint ventures, strategic alliances, consortia, and

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[259]North Atlantic Treaty Organization, "NATO - Smart Defence," *NATO*, http://www.nato.int/cps/en/natolive/topics_84268.htm (accessed February 25, 2014).

[260]As discussed in Johnston, *The Allure of Machinic Life*, 375; For more information see Howard Rheingold, *Smart Mobs: The next Social Revolution* (Cambridge, MA: Basic Books, 2003).

[261]Joshua Foust, "'Smart Defense': Should Europe's Militaries Specialize?," *The Atlantic*, http://www.theatlantic.com/international/archive/ 2012/05/smart-defense-should-europes-militaries-specialize/257328/ (accessed February 25, 2014).

associations"[262] which may or may not respect state sovereignty.[263] This causes difficulties in applying traditional authorities and enforcement, requiring negotiation and agreements to operate trans-boundary.

Where agreement is possible, larger networks or alliances form. The heterogeneous demands on the state make it increasingly difficult to achieve consensus, especially with an increasingly demanding fractured populous. Fueled by technological interconnectivity, small groups will rise with power-law type growth. Existing networks whose traditional integrating capabilities may experience power-law collapse. The variety of their interests means that there will be many more small groups than large group, generally displaying long-tailed distribution. Unique challenges may require increasingly novel networks, possibly making for strange bedfellows. Disagreements amongst allies in different fields of interest increase, as opposed to shared interests against a common foe. As Nassim Taleb would state, Extremistan, not Mediocristan dominates the modern world.[264] These trends are not limited to the physical world, but extend to the virtual world as well.

Virtual world problems are actions by individuals and groups that occur nearly exclusively in the cyber domain. If geography dominates the physical domains, then cyber domain is concerned with the technologies and agents in virtual and imagined communities. Issues in this area include internet communities, virtual economies, virtual currencies, virtual infrastructure, hacking, and information warfare. In its current relationship, the virtual world is still very connected to the physical world in many respects. As technology proliferates, more physical world activities transition to a virtual only existence. Department of Homeland Security,

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[262]Toffler and Toffler, *War and Anti-War*, 293.

[263]United States Joint Forces Command, *JOE:2010*, 39.

[264]Taleb, *The Black Swan*, 61.

United States Cyber Command, and commercial security services are each concerned with protecting the digital realities on which are physical world resides. In the coming years, as virtual applications proliferate, the importance of virtual-only areas will only increase. Yet in the near term and in the future, the majority of focus is where these worlds collide.

The intersection of physical and virtual worlds is where innumerable bifurcations intersect in a multiplicity of possible interactions. Cyberspace "fracture[s] physical barriers,"[265] disturbing our understanding of traditional time-space relationships. As *JOE: 2010* points out, "[t]he advances in communication and information technologies will significantly improve the capabilities of the Joint Force."[266] Information technology extends command and control while weapons systems achieve greater effective distances, allowing more distributed operations.

However, "many of those same advances also will be available to America's opponents, who will use them to attack, degrade, and disrupt communications and the flow of information."[267] Weapons proliferation is a Level I effect, but Level II and III effects are just as, if not more, potent. Militias and *super-empowered* individuals and groups represent increasingly effective power structures outside the state. Insurgencies in Afghanistan[268] and Iraq use cell phones,[269] while social media is increasing integrated in revolutions from the Arab Spring[270] to

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[265]United States Joint Forces Command, *JOE:2010*, 36.

[266]Ibid., 34.

[267]United States Joint Forces Command, *JOE:2010, 34*.

[268]"Afghan Taliban Use Phones for Propaganda," *BBC*, March 30, 2012, sec. Asia, http://www.bbc.co.uk/news/world-asia-17563068 (accessed February 25, 2014).

[269]Jacob N. Shapiro and Nils B. Weidmann, "Is the Phone Mightier than the Sword? Cell Phones and Insurgent Violence in Iraq" (Princeton University, October 2, 2013), https://www.princeton.edu/~jns/papers/SW_Cellphones_28OCT2013_Full.pdf (accessed February 25, 2014).

[270]Philip N. Howard et al., *Opening Closed Regimes: What Was the Role of Social Media During the Arab Spring?* (University of Washington: Project on Information Technology and Political Islam, 2011), http://pitpi.org/wp-content/uploads/2013/02/2011_Howard-Duffy-Freelon-Hussain-Mari-Mazaid_pITPI.pdf (accessed February 25, 2014).

Ukraine.[271] Information technology is one method of directing Level II operations and Level III social movements.

The eruption of social media activity in revolutions is an acute occurrence of a larger phenomenon of interconnectedness. Unregulated virtual currencies, such as Bitcoin, provide a means to fund illicit activities with less oversight than traditional means.[272] Increasingly communicating though encryption technology and on the restricted access side of the internet known as the *darknet*,[273] agents are creating a trend of *shadow globalization*.[274] Individuals and groups can use the relative anonymity of these systems to "recruit, train, organize, and connect" amongst themselves.[275] As illicit groups come into greater contact, they form alliances and composite organizations between state, non-state, and criminals that work together.[276] This represents another example of network formation, allowing the rapid formation of organizations. Connectivity encourages the formation of many of these groups, whose aggregation of capability represents a drain on the resources of traditional legitimate organizations.

"Blurring between simple categories of conflict," these composite groups are likely to reorganize their differentiated capabilities in execution of hybrid warfare.[277] Noting that hybrid

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[271]Pablo Barberá and Megan Metzger, "How Ukrainian Protestors Are Using Twitter and Facebook," *Washington Post*, n.d., http://www.washingtonpost.com/ blogs/monkey-cage/wp/2013/12/04/ strategic-use-of-facebook-and-twitter-in-ukrainian-protests/ (accessed February 25, 2014).

[272]Sadia Afroz et al., "Honor Among Thieves: A Common's Analysis of Cybercrime Economies" (Drexel University, February 24, 2014), https://www.cs.drexel.edu/~sa499/ papers/ecrime13.pdf (accessed February 26, 2014).

[273]Nicolas Christin, "Traveling the Silk Road: A Measurement Analysis of a Large Anonymous Online Marketplace" (Carnigie Mellon University, February 17, 2014), http://www.andrew.cmu.edu/user/ nicolasc/publications/Christin-WWW13.pdf (accessed February 26, 2014).

[274]United States Joint Forces Command, *JOE:2010*, 61.

[275]Ibid., 65.

[276]Ibid., 61.

[277]United States Joint Forces Command, *JOE:2010*, 66.

warfare is as old as war itself, *JOE: 2010* points out its use today is particularly threatening because of its "combination of lethal technology and the protracted and population-centric nature."[278] Made possible by low cost technology, connectivity of communication, and the increasing particularized demands of individuals, these threats are more likely to proliferate in the future.

These groups can use the inherent strengths of small groups against the high requirements that large groups maintain. As recent experience in Afghanistan and Iraq demonstrate, the resources that a large group must expend to maintain system stability are exponentially higher than a small group must expend to cause instability, even in first or second wave societies. Balanced second wave structures underlie many of the systems on which the third wave relies. Homeostasis or moderate growth relies on leanly built, tight tolerance systems. Cities are one example of a complex system with many overlying networks: energy, transportation, water, food, and labor to name a few. As opposed to defeating in armed conflict, these groups can "plan, execute, receive feedback, and modify their actions, all with considerable agility and synchronization."[279] Targeting key hubs can lead to a cascade failure in dependent systems. In developed nations, these crashes cause significant issues, in weak states they may lead to total collapse. As urbanization intensifies, the potential for devastating effects increases.

Recruiting membership into these groups is even easier in the future operational environment as well. Disaffected individuals tied to the physical constraints of first and second waves societies still suffer from unmet physical and safety needs. Third wave societies, if mismanaged, will become increasing victims of their own success. March and Heath describe

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[278]Ibid.

[279]United States Joint Forces Command, *JOE:2010*, 52.

this as the "hedonic treadmill," the result of the continued satisfaction and immediate wanting of greater needs.[280] they goes on to explain that this," 'predisposition of dissatisfaction' is, of course, a strong stimulus for search and change in situations where it exists."[281] A primary finding of this monograph is that this treadmill not only exists, but its speed and incline buttons are jammed in the increase position. This leads to wider searching, directed at the increasingly particularized needs of individuals. The positive feedback cycle of fundamentalism and radicalism feed off these tendencies. Likeminded individuals form small networks that can use interconnected technology to find other disaffected, unsatisfied individuals. Meanwhile, disaffected individuals are using targeted searches to seek those who can sympathize with their circumstances. Using technology to bypass traditional limitations of time and space makes finding each other easier than ever before.

Nor are the traditional pictures of the disaffected individual appropriate to the future operational environment. Increased capability to meet needs allows for greater independent living. This has led to increased instances of individual living, which reduces the physical proximity of traditional spousal, family, and cultural context.[282] This does not mean a reduction in socialization in general. One phenomenon, known as glocalization, leverages technology to enable acute physical association. In day-to-day life, this allows people to find hobby groups, organize a flash mob, or friends to find when a great event is happening. In places like Egypt,

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[280]March and Heath, *A Primer on Decision Making*, 22.

[281]Ibid., 23.

[282]Eric Klinenberg, "Living Alone Means Being Social," *The New York Times*, February 4, 2012, sec. Opinion / Sunday Review, http://www.nytimes.com/2012/02/05/opinion/ sunday/living-alone-means-being-social.html (accessed February 25, 2014).

social media allowed protestors to mobilize protests.[283] Additionally, while links to physical communities remains strong, there is a drift to a substitution of virtual communities in their place.[284] The trend toward individual living is not limited to the developed world; Chinese, Indian, and Brazilians have shown the same propensity. The integrating property of technology maintains socialization, in an increasingly differentiated form.

An interconnected world is more aware of its environment than ever before, to include the differences between have and have-nots. Due to *sensitivity to initial conditions,* individuals and groups who begin with the slightest advantage at the beginning may end up with enormous advantages after multiple iterations.[285] First noted as the Matthew Effect, today it is commonly referenced as accumulating advantage. [286] As significant as this phenomenon is in individual instances, its effect on society is even more dramatic. Toffler's description of agrarian, industrial, and post-industrial landscapes provides a poignant description.[287] The west, who emerged into the second wave, before other regions of the globe, received the benefits of accumulated advantage. As technology spreads, rather than decreasing the relative gap between societies, the differential actually *increases*. Communication technology allows the various waves of society to more readily compare their relative circumstances. This exasperates the possibility for the continued

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[283]Russell D. Howard, "Opinion: Digital Revolutions Gives New Life to Swarm Tactics," *USNI News*, May 28, 2013, http://news.usni.org/2013/05/28/opinion-digital-revolutions-gives-new-life-to-swarm-tactics (accessed February 27, 2014).

[284]Lee Rainie, "Social Isolation and New Technology," *Pew Research Center's Internet and American Life Project*, November 4, 2009, http://www.pewinternet.org/ 2009/11/04/social-isolation-and-new-technology/ (accessed February 27, 2014).

[285]Johnston, *The Allure of Machinic Life*, 139.

[286]Robert K. Merton, "The Matthew Effect in Science: The Reward and Communication Systems of Science Are Considered," *Science* 159, no. 3810 (January 5, 1963): 56–63 The term "Matthew Effect" stems from the biblical verse Matthew 25:29; "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken even that which he hath."; Also see Malcolm Gladwell, *Outliers* (New York: Little, Brown, 2008).

[287]Toffler, *The Third Wave*.

interstate conflict, on traditional ideological and economic differences. Irregular groups representing segments disaffected populations use the gaps in technological employment and the cultural obligations that developed countries overlay on them. As the *JOE: 2010* states, "irregular adversaries will use the developed world's conventions and moral inhibitions against them."[288] While the laws of war justifiably restrain the United States, these enemies are not compelled to respect the same limitations.[289]

This discussion represents a fraction of the findings in *JOE: 2010* and the accumulated findings of the authors cited in this monograph. The signs of technology's increasing dominance in the future operational environment are clear. Equally clear are the importance of the underlying tendencies of human nature and their transmittance through groups. The interaction of these tendencies increasing play out in the intersection of physical and virtual communities, creating a dancing landscape of opportunity and risk. Survival in the future operational environment depends on the ability to adapt rapidly to these changes.

CONCLUSION: NO WALLFLOWERS, TIME TO DANCE

Learning to navigate complexity requires the development of reliable tools. This paper has acknowledged some of the inherent methodological weaknesses in trying to synthesize various interdisciplinary perspectives. Among the many purposes of this monograph is the desire to extend models in a way that help to predict a possible future of the operational environment. Through this process, technology's integrating tendencies provided a *resource bath* that enabled individuals to interact in a way that created greater levels of complex development. If this concept

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[288]United States Joint Forces Command, *JOE:2010*, 65.

[289]Ibid.

is valid, simulation, observation, or empirical study are possible choices for testing.

If the various properties outlined could be quantified, they could then be set in motion by agent-based models (ABM) that could simulate their behavior. Through rigorous iteration of various scenarios, possible futures could be objectively measured and studied. Another choice for observation reevaluates the trends outlined as the future passes. Over the next five to ten years, the findings might be refuted, calling the underlying principles or their connection in question. While adequate for hypothesis testing, it does little to prepare us for the future environment. Empirically speaking, compelling evidence continues to emerge. Significant rigorous work explaining the role of dissipation, differentiation, and development continues to emerge, balancing this monograph's philosophical approach. For example, Doctor Jeremy England's findings are part of a growing body of mathematically rigorous explanations of how dissipation and replication create higher levels of self-organized structure.[290]

Regardless of the specific outcomes of more in-depth findings, the consequences of complexity are still evident. More uncertainty and more instability is not a harbinger of disaster – quite the opposite. As good commanders know, risk presents an equal chance for opportunity. As Schrödinger, Prigogine, Boyd, and many others posited, the potential for organizing and development depends on the drive towards entropy and chaos. We can see now why the operational environment will only increase in complexity for the near future. To prevent a chaotic future, we must be prepared to accept a certain level of impermanence and adapt at an increasing pace. On one hand, we must be clear on what is truly non-negotiable; otherwise, we will spread our resources so thin to accomplish nothing, spinning us into chaos. On the other, inflexibility in

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[290]Natalie Wolchover, "A New Thermodynamics Theory of the Origin of Life - Simons Foundation," last modified January 22, 2014, https://www.simonsfoundation.org/quanta/20140122-a-new-physics-theory-of-life/ (accessed February 14, 2014).

our actions will steer us toward a rigidity that will push us toward insignificance. Whether by design, intuition, luck, or a combination of all three, the United States and its military have many advantages.

The ability of the United States to lead the third wave of human development results from it accumulated advantage in the second wave. A combination of rich resources, growing population, and rule of law contributed to its industrial might. Since development in a complex environment depends on the ability to experiment, fail, and recover, this material edge provides a continuing benefit. In general, democracies are the most efficient form of government in a complex competitive world of chronic change.[291] Communism failed because it understood the capability of technology,[292] but denied human motivations.[293] Similarly, radical, fundamental Islam recognizes the potential for technology but it seeks to deny its use by its followers for development. Denying the natural tendency of human growth instead of using resources for positive development condemns the ideology to system closure, and entropic death. Regimes that establish overly rigid systems face varying degrees of the same fate. Unlike many other nations, the generality of the United States Constitution provides simple system rules that allow for flexible adaptive schemas necessary for development in changing conditions. The people of the United States use this flexibility to create diverse, innovative solutions to respond to these changes.

As a reflection of the nation's character, but also incorporating its own history and culture, the United States military is positioned to face the complex future operating environment. The American way of war may sometimes seem like a runner stumbling from the starting blocks,

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[291]Bennis, *The Temporary Society*, 4.

[292]Friedman, *The World Is Flat*, 235.

[293]Simon, *The State of Humanity*, 644; Garreau, *Radical Evolution*, 198.

yet our forces practice adaption in nearly every major conflict. Observing from outside the system, an unknown World War II German general once remarked, "The reason that the American Army does so well in wartime is that war is chaos, and the American Army practices chaos on a daily basis."[294] In recent years, the military has incorporated fundamentals of complexity in its doctrine and operations.

The increasing use of joint integration, formalized by Goldwater-Nichols Act and proven in our most recent wars represents an integration of diversity. Combined arms operations, task organization, warfighting functions, and the Army's operating concept are just a few additional instances of incorporating diversity to address the complexities of the operational environment. Inside of the operational concept, the Army Core Competencies of Combined Arms Maneuver (CAM) and Wide Area Security represent emergent phenomenon constructed from varying combinations of key capabilities. Together, these competencies adapt to meet the challenges of emergent risks, such as the aforementioned hybrid threat.

Likewise, the philosophy and warfighting function (WfF) of mission command, blends the organizing science of control, with the differentiating art of command. The philosophy of mission command is a prime example of the various principles of complexity. The commander develops strong small networks by socialization of common interests, thereby *builds cohesive teams through mutual trust*. The *shared understanding* created allows for networks, acting as agents, to coordinate actions without centralized control, under the auspices of the *commander's intent*, communicated through general *mission type orders*. Understanding that the environment is uncertain allows the commander to *accept prudent risk* as his unit, acting as semi-autonomous agents *exercise disciplined initiative*. Without this limited release of authority, the unit would

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[294]Jim Lace, "Nothing Went According To Plan," *Time*, August 15, 2003, http://content.time.com/time/nation/article/0,8599,443808,00.html (accessed February 26, 2014).

calcify into a closed system and quickly overcome by events. Clear intent helps set adaptive search criteria to acceptable parameters and trust allows the deviance necessary to react to unforeseen circumstances. Mission command as a WfF provides the integrating capability of technology to balance the bifurcating possibilities of the philosophy. It completes the developmental cycle presented in the fundamental systems model. When adequately executed it allows for the rapid execution that can outpace the enemy's OODA process.[295]

The tenants that support mission command include flexibility, adaptability, depth, integration, synchronization, and lethality.[296] Using the fundamental systems model as a template, flexibility, adaptability, and depth represent tenants of differentiation and growth. They each represent capabilities of potential choice as they give the commander options to respond to the uncertainties of particularities in the operational environment. They provide bifurcation of possibility. Synchronization and integration are the organizing and integrating side of the model, which ensures the optimization of the chosen path toward maximum potential for success. Combining both sides of the cycle develops the unit toward an appropriate level of lethality for the mission at hand. The operational tenants represent a developmental cycle for successful missions, especially in a complex environment. Tools such as operational frameworks and warfighting functions provide the organizational capability to communicate and socialize the results of the operational design.

Professional education and training must communicate the intricacies of these tools to ensure their proper use. Our experience has shown there are potential pitfalls without it. Too often

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[295]See Headquarters, Department of the Army, Army Doctrine Reference Publication (ADRP) 6-0, *Mission Command* (Washington, DC: Government Printing Office, 2012), chap. 2–3 for more information on the doctrinal concepts outlined in this paragraph.

[296]Headquarters, Department of the Army, Army Doctrine Publication (ADP) 3-0, *Unified Land Operations* (Washington, DC: Government Printing Office, 2011), 2–12.

though, these rich methods are reduced to strictly analytical purposes. This is demonstrated when staffs use warfighting functions, operational/mission variables, and other tools as checklists. The checklist mentality is indicative of over-organization and lack of synthesis, which closes the system at hand and prevents development of plans. While doctrine and professional education provide the necessary integration and organization, increasingly complex situation require increasing levels of differentiation and growth. Obtaining differentiation and growth is unlikely inside of the system itself. Therefore, the Unites States military should increase opportunities for advanced civil schooling, partnership with industry, interagency broadening assignments, and other non-traditional experiences, to increase the likelihood of serendipitous interactions. Outside perspectives can help ensure that doctrine's flexibility maintains pathways to novel solutions.

Imbalance toward the lower half of the model appears in instances of over-control or micromanagement. The power of networks is in distributing capability to the differentiated agents in a given system, which is most familiar with the novel circumstances encountered at any particular time. Technology allows commanders to pull information increasingly from the network, luring them control operations more centrally. This fundamentally pushes the network from a distributed system to a traditional hierarchy, which reduces the advantages of diversity. While the consequences of distributed operations are capable of tremendous risk in a ubiquitous media environment, they also provide tremendous opportunity. Trust becomes a key factor, requiring commanders to develop mechanisms of judgment to temper the tendency of over-control.

The distributed nature of the future operational environment and the resulting hybrid threat requires revisiting concepts such as center of gravity. Networks are a combination of interacting nodes, whose relationships are in constant flux. A network's center of gravity, from a strictly physics standpoint exist in the intersection of the nodes' effects, which is a calculated abstract. It is not possible to strike an abstraction; the source of the force must be addressed.

From a network perspective, finding, fixing, and attacking critical nodes is required. In an adaptive system, this means the remaining nodes form new centers of gravity. This does not dismiss the seminal works of Clausewitz; rather it acknowledges the circumstances of his time as a particular instance of a phenomenon. Attacking and destroying the opponents force is possible in traditional warfare, because once the fielded force was sufficiently destroyed, the centralized control authority recognized that the state of being necessary for continued resistance no longer existed and acted under socialized rules of behavior (in this case surrender). Irregular warfare recognizes this reality and has adapted by not presenting a dense center of gravity to concentrate effort. As these forms of warfare increase their capability through technology, incorporation of diverse approaches by friendly forces is imperative. As with any CAS, adaptive agents must sense the environment they are in so they can adjust appropriately.

Awareness of the environment is critical in other forms as well. When developing strategic plans and operational campaigns, it must be acceptable to communicate the relationship between resources and goals. Our analytical tools effectively determine many deep causes to failures in systems, especially in stability operations. We quickly assess that poverty, famine, ethnic division, and other cultural factors contribute to the problems we face. The tendency is to try to address these problems head on. In Afghanistan and Iraq, this led to massive reengineering of government, economy, infrastructure, education, and other areas. If these efforts fail to take hold, it is not due to a lack of understanding of the issues. Rather it represents a failure of synthesis.

Jumping a society to a higher level in the hierarchy of development is hypothetically possible, but it requires tremendous resources. Time is normally a limiting factor, because the political capital required for expeditionary operations is difficult to maintain both domestically and amongst allies. This is especially true in amongst increasing diverse and particularized individuals and groups. In order to resolve the tension between time and development, rapid

growth is required. Research is that while growth is a positive aspect of development, when experienced rapidly it is potentially destabilizing.[297]

Secondly, even if development does take place it must be sustainable after the withdrawal of forces. Bypassing a natural progression of growth and organization disrupts the ability of inherent networks of reinforcing relationships to occur. As difficulties are encountered after withdrawal, the societal system is likely to default to the rules, norms, and cultured most strongly ingrained or to the influences of agents with the highest proximity. This is unlikely to be the rapidly emplaced structures of allied effort, unless a strong continuing influence is in place. This is why generational change is often cited as a necessary condition for change; as each generation emerges into the societal system, their proximity to previous realities are decreased. This violates the attraction in the system toward short duration efforts. It is possible to overcome these limitations, but again it requires a tremendous amount resources or energy, increasing with the scale of the society. In a complex system, the introduction of massive energy is likely to trigger unforeseen consequences, which in turn require additional resources to address. The potential for an uncontrollable spiral is high. The lesson learned through hard experience is that resources are often a limiting factor in the codependent relationship between policy, strategy, and operations.

Resource constraints are likely to produce unintended emergent effects as the nation prepares to drawdown the military. Congressional procedures for good stewardship of government funds produce Level II and Level III effects in efficient coordination of doctrine, organization, training, material, personnel, and facilities. At the largest levels, budget constraints within discretionary spending pits defense against competing maintenance and motivational factors in the state, which Congress and the President are answerable to equally. Resources are

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[297]Mancur Olson, "Rapid Growth as a Destabilizing Force," *The Journal of Economic History* 23, no. 4 (December 1, 1963): 529–552.

not adequate to deal with the increasing contingencies emergent in a complex world. Decision makers are forced to assume risks, with no true winners. Even though experience has shown that unity of effort is necessary, competitive pressures between government agencies and the joint force are high. This creates a natural attractor that causes agents toward protection of their internal resources. It will become difficult to continue to bridge divides to overcome protectionism at all levels, as this is a natural tendency of the organizational system cause not by irrationality, but conflicting rationalities.

We have more tools than ever to control our destiny, but the margin of error is slim and growing slimmer. Sensing the conditions of the environment, acknowledging our decision making biases, acting decisively, yet being prepared to change course are the skills that we need to face the complex environment. Development is acting in a way that balances growth with integration, differentiation with organization, in a way that leads to something higher, not something the same. Time and again, the United States demonstrates the strength of the nation, but strength is an increasingly *simple* solution in complex world. The growing emphasis on resiliency provides a tool to navigate *complicated* problems to return robustly to a level of development we have already achieved. Both strength and resiliency are necessary, but not sufficient. To develop in an ever-changing complex world, we must adapt in ways that leave us better than we were, in times of advantage or adversity.[298] With an open-minded approach to our foundational doctrine, the United States and its military has the means to provide solutions to complex problems in our nation's future, not just to survive, but to develop to increasing heights.

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[298]Nassim Nicholas Taleb, *Antifragile: Things That Gain from Disorder* (New York: Random House, 2012).

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