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To Design or Not to Design (Part Four): Taking Lines out of Non-Linear; How Design Must Escape 'Tacticization' Bias of Military Culture

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Editor's Note: This essay is part four of a six part series on design.

Doctrine had to come to terms with the new geometry of the battlefield. Discussion raised many points [at Fort A.P. Hill TRADOC meeting on revising FM 100-5 in 1992]. Were diagrams useful in describing an intellectual concept? And should an intellectual concept be doctrine at all? [General Frederick M. Franks, Jr.] viewed the old standard, and dichotomy, of linear versus nonlinear warfare as a shibboleth, now without meaning...Franks thought no graphic was necessary for such a visualization...Doctrine was needed that would jolt the Army out of the old geometry of the battlefield.¹

The import of 'not-locally-made' theories of operational warfare not only hinted that [Israeli Defense Force] generals were not performing their duties appropriately, but also sent them back to school to study their very profession the hard way, by abstract meditation, profound reading, and reflective learning- activities that the majority of them had managed to avoid for generations."²

The fifteen pages of design doctrine in *FM5-0 Chapter 3 Design* introduces non-linear open system concepts while paradoxically recommending traditional linear methodology for transforming these dynamic open systems into the desired state. While the first eleven pages on design discuss open systems and their inherent tendencies to learn, adapt, and resist mechanistic action, section 3-58, *The Operational Approach*, resorts back to linear causality by recommending *lines of effort* as a method to depict transforming the system.³ Once again, Army design doctrine suffers an identity crisis in which holistic approaches to complex systems struggles with an institutional preference for tacticizing all levels of war.

¹ John L. Romjue, *American Army Doctrine for the Post-Cold War* (Fort Monroe: Military History Office, United States Army Training and Doctrine Command, 1997) 84. Romjue cites H.O. Malone, Jr. Chief Historian's notes on a Fort A.P. Hill meeting on 16 September, 1992. The subject of the meeting: FM 100-5 Off-Site Conference.

² Shimon Naveh, *Operational Art and the IDF: A Critical Study of a Command Culture* (Center for Strategic & Budgetary Assessment (CSBA), contract: DASW01-02-D-0014-0084, September 30, 2007) 3. Naveh describes how *Systemic Operational Design (SOD)* was not well received by the Israeli military institution due to similar anti-intellectualism and self-preservation processes that manifest in the U.S. Army today concerning design doctrine and theory.

³ United States Army Training and Doctrine Command, *Field Manual 5-0; The Operations Process*. (Headquarters, Department of the Army, 2010), 3-59; Alex Ryan, *The Foundation For An Adaptive Approach; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 72. Ryan discusses feedback and how scientists applied linear methods to complex non-linear systems which "only works up to a point."

With regard to linear approaches to transform a system, Army design doctrine demonstrates repetitive *tacticization* where military institutions “are inclined to apply knowledge they have acquired from their tactical experiences to their operational functioning sphere. In such cases, they either reduce the operational inquiry of potential opposition into a mechanical discussion or completely reject the need for a distinct learning operation.”⁴ Although criticizing the Israeli military, Shimon Naveh’s description functions in parallel with the U.S. Army’s own preference for lethal action:

This ignorance naturally emphasized an exclusive focus on tactics and an addiction to action. When an executive organ that is supposed to implement national strategy confines its conceptual and operational functioning merely to tactical patterns and action templates, it unconsciously prohibits any kind of learning discourse capable of engaging the relevant command agents functioning in the various logical environments.⁵

At the tactical level, and especially in simple problems or closed systems, linear processes generally are successful in transforming a system into the desired state. Furthermore, ‘To Design or Not to Design’ does not suggest that design theory should *replace* MDMP or JOPP and respective operational products for tactical execution, including tactical linear lines of operation/effort. Design enhances MDMP and JOPP by providing understanding and meaning; detailed planning and tacticization do not enhance design. “Design, by definition, takes place in *all military planning activities*, whether explicitly or not (emphasis added).”⁶

As Naveh and other design advocates stipulate, the military must avoid logical fallacies where tactical methodology creeps into design. “Speculative interpretations, uncritical employments of concepts and methods, and irresponsible use of language” that reflect today’s Army design doctrine’s identity crisis must be minimized.⁷ Army organizations must know when design is the proper tool for understanding a system, and when it is not.

⁴ Shimon Naveh, Jim Schneider, Timothy Challans, *The Structure of Operational Revolution; A Prolegomena* (Booz, Allen, Hamilton, 2009) 88; Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 43. Naveh explains how Clausewitzian theory tied linearity to destruction in warfare. “To guarantee the occurrence of the integral battle the strategy must be both linear and offensive;” Jeff Conklin, *Wicked Problems and Social Complexity* (CogNexus Institute, 2008. <http://www.cognexus.org> Last accessed 05 January 2011) 4. “Traditional thinking, cognitive studies, and the prevailing design methods all predicted that the best way to work on a problem like this was to follow an orderly and linear ‘top-down’ process, working from the problem to the solution.” Conklin addresses business and design approaches to complexity, yet his study transfers effectively to military operations; Australian Head Modernisation and Strategic Planning- Army, *Australian Army’s Future Land Operating Concept* (Australian Army Headquarters, Canberra, September 2009) 2.1. “Future studies often rely upon past data to extrapolate trends in a linear manner to their natural conclusion. Some long term strategic trends are stable and can be predicted with a high degree of confidence. Many trends defy linear patterns and unexpected events can and do occur resulting in strategic shock.”

⁵ Shimon Naveh, *Operational Art and the IDF: A Critical Study of a Command Culture* (Center for Strategic & Budgetary Assessment (CSBA), contract: DASW01-02-D-0014-0084, September 30, 2007) 23.

⁶ Chris Smith, *Solving Twenty-First Century Problems with Cold War Metaphors; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 101. Smith defines *design* as “an ongoing activity that seeks to understand a problem and prescribe a solution.”

⁷ Naveh, 4. Naveh criticizes the IDF with this passage; this four article series on Army Design considers his criticism analogous with valid U.S. Army criticism on similar grounds. The *Systemic Operational Design* discourse of the IDF in the late 1990s through the 2006 Hezbollah War appears to have many similarities with the U.S. Army and design methodology discourse in 2010 and as applied in *Operation Enduring Freedom*. Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) xv. In Naveh’s introduction, he establishes as part of his thesis the fundamental question “how did manoeuvre thinking become dominated by linear patterns?” In his exploration of the evolution of operational art, Naveh subsequently explains how military devotion to 19th century reductionism and tacticization forced military operations into a geometric and linear simplification that encouraged attrition-based warfare; Alex Ryan, *The Foundation For An*

In the first quote for this article on linear approaches, General Franks acknowledged that even the terms *linear* and *non-linear* had lost their meaning in military operational discourse in the post-Cold War era. The second quote that followed provides additional insight into how the U.S. Army understands the terms *linear* and *non-linear*. Naveh takes *problematizing's* role of the heretic to task with the Israeli Defense Force and explains how the military institution resisted design theory on the basis of self-preservation and professional vanity.

Like the Israeli military's institutional hubris, the U.S. Army suffered similar creative deterioration after enjoying several decades of Cold War era conventional threat. Throughout the entirety of the Cold War, military planners dealt with nearly absolute certainty a linear process that changed only in details and dates.⁸ A conventional nuclear war in Central Europe between the Soviet Union and the United States was, in retrospect, a much simpler and linear model to problematize against over any of the current complex challenges of today. Based on generational knowledge and institutional rigidity, can the U.S. Army describe or explain any military operation without a linear process?

Before 'To Design or Not to Design' covers *non-linear* concepts, the term *linear* requires definition. A linear system may appear to be complex and non-linear such as a swinging pendulum; however, "the equation of motion-like the system itself- is called *linear* because the equation consists of only *linear operations*."⁹ Pendulum behavior is governed by known laws; the system is closed and ultimately a linear and predictable process. From a military perspective, even the word *linear* conveys familiar geometrical connotations that support many tactical-level observations of phenomena such as a company of tanks moving across open terrain to seize an objective. True non-linear processes are different.

Non-linear systems are chaotic, but partially explainable through analogous discourse. Chaos mathematician Glenn James uses a dripping water faucet in *Chaos Theory; The Essentials for Military Applications*. Since fluid dynamics resist even the simplest modeling, they can only be measured through a variety of parameters such as time intervals between drops; "by isolating and controlling *one key parameter* and making one straightforward measurement, we can still come to understand, and perhaps manipulate, a very complicated system."¹⁰ Chaos does not equal dripping water faucets, nor does counterinsurgency equal weeding a garden. These metaphors do help convey concepts throughout an organization; the more complex the concept is, the more analogies potentially are necessary. Furthermore, complex systems are capable of

Adaptive Approach; Australian Army Journal For the Profession of Arms, Volume VI, Number 3 (Duntroon: Land Warfare Studies Centre, 2009) 88. Ryan discusses Australian military culture and *Adaptive Campaigning* (design) with regard to Australian doctrine. "It needs to review existing doctrine and define conditions where linear mechanical processes are good enough and-more importantly-when they are not."

⁸ Carl H. Builder, *The Masks of War; American Military Styles in Strategy and Analysis* (RAND Corporation: John Hopkins University Press, 1989); John Nagl, *Learning to Eat Soup with a Knife; Counterinsurgency Lessons From Malaya and Vietnam* (Chicago: The University of Chicago Press, 2002); Russell F. Weigley, *The American Way of War* (New York: Macmillan Publishing Co., 1973). United States Army Training and Doctrine Command, *Field Manual 6-22; Army Leadership; Competent, Confident, and Agile*. (Headquarters, Department of the Army, October 2006), 11-3. "Army operations *since the Cold War ended* have shown all organizations must be capable of adapting to rapidly changing situations...(emphasis added)"- Army doctrine implies here that the Cold War provided some level of stability.

⁹ Glen James, *Chaos Theory; The Essentials for Military Applications* (Newport: Naval War College, Center for Naval Warfare Studies, Newport Four article series on Army Design Number Ten, October, 1996) 13.

¹⁰ Ibid, 16-17; Alex Ryan, *The Foundation For An Adaptive Approach; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 84. Ryan accurately criticizes Chaos Theory in that complex systems resist efforts to control them- any attempts to reduce or eliminate complexity through acting on a system demonstrates traditional reductionist scientific approaches over holistic adaptive systems theory.

dynamically changing as fast as they are acted upon. Non-linear systems resist short-term prediction, and various phenomena within the system often act chaotically which leads to emergent behaviors and new patterns.¹¹ Since non-linear systems resist linear explanations, it is counter-productive for military professionals to apply linear lines of effort and expect to transform a complex system into a desired end-state.¹²

Current U.S. military doctrine use physical lines of operation and logical lines of operation in detailed planning. The U.S. Army adds another linear term to operational lexicon with *lines of effort*, as recommended in *FM5-0 Chapter 3 Design*. All of these methodologies have in common the fundamental adherence to linear causality. This four article series on Army Design defines linear causality in accordance with Aristotle's *Metaphysics* where "there are principles and causes which are generable and destructible without ever being in course of being generated or destroyed."¹³ In other words, A will exist if B occurs, and B will exist if C occurs. This linear causality established the benchmark for most western philosophy and science through the Scientific Revolution in the sixteenth and seventeenth centuries.

The notion that "the catastrophe could have been averted by removing that specific cause"¹⁴ reflects a core human desire to live in a world that is more predictable and explainable. This reductionist approach reflects a line of reasoning that rests upon the great successes of the Scientific and Industrial Revolutions, yet reductionism loses sight of metacognition. "Meaning, and explaining the "why" of a phenomenon, come from the context. The lower-level mechanics, the "how" of the phenomenon, have nothing to say about "why."¹⁵ 'To Design or Not to Design' will expound upon this infatuation with reductionism after addressing yet another glaring contradiction in current Army design doctrine.

FM5-0 Chapter 3 Design refers the reader to *Appendix B* for further information on *lines of effort*. Since *Appendix B* deals entirely with detailed planning (the Military Decision Making Process) that requires linear causality and mechanistic structure, this implies that conceptual planning requires an operational approach that functions in a similar linear and mechanistic fashion. The eleven pages covering the environmental frame and problem frame in *FM5-0 Chapter 3 Design* couch design in a category separate from detailed planning, yet under the operational approach Army doctrine prescribes using linear methodology prevalent in detailed planning. This contradiction fuels the discourse on whether military design is simply *Mission Analysis on steroids*, *Effects Based Operations by another name*, or indeed a valid methodology for understanding complex systems. The fourth article of 'To Design or Not to Design' explores this potent discourse over design and doctrine. To provide greater insight as to why *lines of*

¹¹ Anne-Marie Grisogono, Alex Ryan, *Adapting C2 To The 21st Century; Operationalising Adaptive Campaigning* (Edinburgh: Australian Department of Defence, Defence Science and Technology Organization, 2007) 5.

¹² Gerald M. Weinberg, *Rethinking Systems Analysis and Design* (Boston: Little, Brown and Company, 1982) 24. "No single 'approach' will suffice in a complex world, so stay open to new information and don't fall in love with the latest fad;" Mick Ryan, *Measuring Success and Failure in an 'Adaptive' Army; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 23.

¹³ Aristotle, *The Works of Aristotle: Volume 1, Metaphysics*. (Great Books of the Western World: University of Chicago, 1952), 549; Chris Smith, *Solving Twenty-First Century Problems with Cold War Metaphors; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 95. "It is a reductionist hypothesis that... makes a problem easy to deal with because it assumes that by addressing one or two things the 'solution to all other problems will follow automatically."

¹⁴ Nassim Nicholas Taleb, *The Black Swan*. (New York: Random House, 2007), 9.

¹⁵ Valerie Ahl and T.F.H. Allen, *Hierarchy Theory: A Vision, Vocabulary, and Epistemology* (New York: Columbia University Press, 1996) 18.

operation are misapplied to current Army design doctrine, linear causality requires further consideration.

The arrival of the Scientific Revolution transformed warfare from a smaller scale, expensive, and often localized affair of the wealthy and powerful into a new era where mankind could disassemble and control the physical world in ways unimagined previously. Antoine Bousquet used a clock metaphor to explain mechanistic warfare and how seventeenth and eighteenth century European war theory installed “order, regularity, and predictability”¹⁶ through science. The origins of military reductionism, mechanistic warfare, and linear causality stem first from this Scientific Revolution and the subsequent Industrial Revolution of the nineteenth and twentieth centuries. “The notion of an organic, living, and spiritual universe was replaced by that of the world as a machine, and the world machine became the dominant metaphor of the modern era.”¹⁷ Military operations reduced soldiers to pawns on a chessboard; every action was predictable and those messy details regarding human irrationality averaged out generally.

As a watch can be disassembled, examined as a series of individual parts, and re-assembled back into a functional item, warfare took the same approach through Frederick the Great’s and Napoleon’s great war machines and the military theory that subsequently explained their successes. While mechanistic and linear processes describe closed systems and conventional military conflicts for previous generations, they fail to account for adaptation and change. “Natural systems evolve new structures and functions; they create themselves in time.”¹⁸ Several levels of explanation may be required to understand complex systems. Hence, general system theory, Chaos theory, and post-modernism perspectives on complex systems are usually at odds with reductionism.

Current western military doctrine still devotes considerable attention to the mechanistic and linear principles of Antoine Henri de Jomini; most of the current principles of war found in U.S. Army Field Manual FM 3-0, Operations (2001) espouse the same doctrine and war methodology first penned by Jomini in the wake of the Napoleonic Wars.¹⁹ While Clausewitz differs from Jomini on many levels with regard to complexity and the interrelations between politics and strategy, both theorists continue to influence modern military doctrine including the new *FM5-0 Chapter 3 Design* with mechanistic, reductionist, and linear causality theory. Many

¹⁶ Antoine Bousquet, *The Scientific Way of Warfare; Orders and Chaos on the Battlefields of Modernity*. (New York: Columbia University Press, 2009) 37-38; Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 86-87.

¹⁷ Fritjof Capra, *The Web of Life*. (New York: Doubleday, 1996), 19; Valerie Ahl and T.F.H. Allen, *Hierarchy Theory: A Vision, Vocabulary, and Epistemology* (New York: Columbia University Press, 1996) 30. “Reductionism deals with complexity by narrowing focus on system parts so closely that they are forced to appear simple, at least when disaggregated.”

¹⁸ Ervin Laszlo, *The Systems View of the World; a Holistic Vision for Our Time*. (New Jersey, Hampton Press, 1996) 39; Jeff Conklin, *Wicked Problems and Social Complexity* (CogNexus Institute, 2008. <http://cognexus.org/wpf/wickedproblems.pdf> Last accessed 05 January 2011) 11-12. Conklin describes ‘tame problems’ and contrasts them with ‘wicked problems.’ To ‘tame’ a problem means that one reduces the complexity through linear approaches, mechanistic conceptualization, and teleological processes. “However, attempting to tame a wicked problem, while appealing in the short run, fails in the long run. The wicked problem simply reasserts itself, perhaps in a different guise, as if nothing had been done. Or, worse, sometimes the tame solution exacerbates the problem.”

¹⁹ United States Army Training and Doctrine Command, *Field Manual 3-0; Operations*. (Headquarters, Department of the Army, 2001), 4-11. The principles of war are also listed in Joint Publication 3-0, Joint Operations, II-2; Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 169. “The mechanistic approach prevailing in the west led Europeans to perceive the element of depth in the shallow terms of a limited battlefield. Out of this absurdity grew an inclination to apply the element of depth only when the combat situation demanded the encirclement or outflanking of a tactical entity deployed in linear configuration.”

military strategists and historians are quick to defend Clausewitz, however ‘To Design or Not to Design’ only addresses his emphasis on some general principles of warfare that remain in high regard by the U.S. Army in current doctrine.²⁰

Clausewitz’s *Concentration of Forces in Space* uses similar mechanistic principles by advising “the best strategy is always *to be very strong*; first in general, and then at the decisive point” (original emphasis)²¹. He goes on to discuss concentration of forces, and even quantifies the numbers of rival forces in a firefight where linear causality takes the form of rigid arithmetic where general rules regarding reserve forces and fresh troops are assembled and disassembled like a prescriptive war machine.²² Both Clausewitz and Jomini leave their marks upon modern military theory considerably, yet the nature of military institutions and their struggle to maintain relevance also contributes to this adherence to linear causality.

Historian Carl H. Builder argues in *The Masks of War* that military institutions are generally motivated towards institutional survival, sovereignty of the organization, and the continued idolization of self-defining behaviors, traditions, and structures.²³ Builder adds the interesting point that military institutions will continue these motives even if they conflict with those for the country overall. If linear processes in detailed planning and tactical doctrine reflect an institutional bias that rejects heretical problematizing that design offers on non-linear transformation, how can military design theory gain acceptance if tactical practitioners perceive design as a rival? Perhaps the reason FM 5-0’s design chapter suffers from over-tacticization is because tacticizing design methodology is the quickest method to eliminating a perceived rival. If design doctrine forces operational artists to apply tactical processes such as lines of effort in a linear causality methodology, proponents of ‘*design is just Mission Analysis on steroids*’ in essence gain the upper hand. Why does the military prefer linear processes so strongly?

Linear progression saturates many aspects of military planning and execution methods because non-linear processes are so difficult to understand. Nassim Taleb remarks in *The Black Swan*, “Linear relationships are truly the exception; we focus on them in the classrooms and textbooks because they are easier to understand.”²⁴ Military organizations model most learning through the reductionist and teleological structuring that dominate detailed planning doctrine,

²⁰ FM 3-0, viii. “Chaos, chance, and friction dominate land operations as much today as when Clausewitz wrote about them after the Napoleonic Wars. In this environment, an offensive mindset—the predisposition to seize, retain, and exploit the initiative to positively change the situation—makes combat power decisive.”

²¹ Carl Von Clausewitz, *On War*, (edited and translated by Michael Howard and Peter Paret; New Jersey: Princeton University Press, 1989) 204-205.

²² Ibid, 205. In Clausewitz’s chapter on *Unification of Force in Time*, he discusses at length a hypothetical tactical engagement where a thousand men face a force half in number, and then predicts losses based upon mechanistic formula that uses rates of fire and general injury percentages. While he makes a point on the importance of placement of the reserve force in time and space, he uses a linear causality logic that is entirely mechanistic and reflects closed system conceptualizing; Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 33-35. “Clausewitz’s analytical treatment of the mass phenomenon and his endeavor to formulate it as a universal principle conform to his general perception of the theory of war... thus, the mass is the operational remedy to the tactical pulverization, and numerical superiority is the main guarantee for victory [according to Clausewitz].”

²³ Carl H. Builder, *The Masks of War; American Military Styles in Strategy and Analysis*, (Baltimore: The John Hopkins University Press, 1989) 11,17; Anne-Marie Grisogono, Alex Ryan, *Adapting C2 To The 21st Century; Operationalising Adaptive Campaigning* (Edinburgh: Australian Department of Defence, Defence Science and Technology Organization, 2007) 3; Scott Winter, *Fixed, Determined, Inviolable; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 58. Winter echoes Builder’s sentiment discussing Australian military culture. “It is therefore not a single or homogenous culture, but a culture of sub-cultures that defines a military. This ‘density’ of culture has a profound effect on the ability of armed forces to accommodate radical change, as this in turn relates to the bureaucratic aspect of military culture.”

²⁴ Nassim Nicholas Taleb, *The Black Swan*. (New York: Random House, 2007), 89.

and have a similar abhorrence to non-linear approaches involving open systems. However, taking multiple perspectives on temporal and spatial system frames can provide greater understanding versus remaining permanently grounded in linear causality. “Our conception of time patterns our ideas, and different conceptions of time, used on different occasions, can be powerful tools for changing our points of view.”²⁵

Thomas Kuhn describes groundbreaking scientific transformations as ‘paradigms’ that often arrive unexpected, dismantle and replace the previously held scientific dogma, and leave in their wake the rest of the scientific community a series of new problems “for the redefined group of practitioners to resolve.”²⁶ Kuhn also warns of those practitioners of the challenged doctrine that will resist the arrival of the paradigm. “There are always some men who cling to one or another of the older views, and they are simply read out of the profession, which thereafter ignores their work.”²⁷ While Kuhn does not explicitly include military science in his book, his intellectual theory clearly encompasses paradigm shifts that relate to the science of warfare.

Design is a military paradigm that is currently transforming operational and strategic doctrine while challenging traditional linear causality. Those military practitioners who cling to the linear causality theories will continue to hold relevance at the tactical level and throughout detailed planning; however design theory may emerge as a dominant methodology for operational art as the 21st century progresses. The U.S. Army currently acknowledges the need for design by codifying it in doctrine, yet institutional resistance to open systems approaches reflects Kuhn’s warning of those that reject a paradigm shift because of self-interest and preservation.

The men that Kuhn warns of clinging to older views will continue to reject open system conceptual planning in modern U.S. Army military doctrine by resorting to the institutional alter-worshiping that Builder discusses. Although Builder describes the U.S. Army’s Cold War preoccupation with fighting the Soviets in Central Europe, his explanation continues to function today with the Army’s preoccupation with linear causality throughout conceptual planning. “That concept of war is most harmonious with the Army’s aspirations for the future, its perceptions of today’s realities, and its remembrance of yesterday’s glories.”²⁸ Closed systems approaches that worked for previous military organizations fail to explain non-linear systems that design associates with ‘ill-structured problems.’

²⁵ Gerald M. Weinberg, *An Introduction to General Systems Thinking* (New York: John Wiley and Sons, 1975) 194.

²⁶ Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago: University of Chicago Press, 1996) 10.

²⁷ Ibid, 19; Jeff Conklin, *Wicked Problems and Social Complexity* (CogNexus Institute, 2008).

<http://cognexus.org/wpf/wickedproblems.pdf> Last accessed 05 January 2011) 6. “Some readers might object to [non-linear approaches to problem solving that stress creativity and innovation]. Perhaps most folks in their organization have a strong sense of certainty about what is going on, a sense of confidence and pride in their knowledge of their business, and a sense that the problems the business is confronted with are quite manageable using the methodical application of well known rules and linear process logic.”

²⁸ Carl H. Builder, *The Masks of War; American Military Styles in Strategy and Analysis*, (Baltimore: The John Hopkins University Press, 1989) 142; Scott Winter, *Fixed, Determined, Inviolable; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 63. Winter uses the term ‘military conservatism’ to explain how during peacetime, Australian military organizations protect “the baby of tradition- the ‘fighter spirit’ and established and proven doctrine;” Chris Smith, *Solving Twenty-First Century Problems with Cold War Metaphors; Australian Army Journal For the Profession of Arms, Volume VI, Number 3* (Duntroon: Land Warfare Studies Centre, 2009) 94. Smith discusses Australian doctrine and their over-reliance on linear concepts and mechanical metaphors. “This linear tendency is, by and large, a by-product of the US Army’s post-Vietnam catharsis and its subsequent rediscovery of operational art in the 1980s, when mechanical systems were a dominant paradigm.”

Ludwig von Bertalanffy describes open systems in *General System Theory* as entities consisting of “parts in interaction. The prototype of their description is a set of simultaneous differential equations which are nonlinear in the general case.”²⁹ Bertalanffy goes on to describe open systems as capable of maintaining themselves “in a state of high statistical improbability, of order and organization.”³⁰ Such systems resist reduction and make any attempt at linear causality a futile effort. *FM5-0 Chapter 3 Design*’s prescriptive lines of effort, use of ‘end state’, and propensity for description over explanation hinders any operational approach that considers non-linearity.³¹ As an institution, the military must overcome this phobia of non-linear narratives and graphical depictions due to their unique qualities in describing ‘ill-structured problems.’

“The parts [can] be worked out, actually, logically, and mathematically, and then be put together...an equation describing the behavior of the total is of the same form as the equations describing the behavior of the parts.”³² One takes a broken watch apart, replaces components, and the watch will resume working when reassembled. *Lines of operation* structure a series of coordinated military actions across time and space that collectively focus towards the end-state. These lines “articulate the link among tasks, objectives, conditions, and the desired end state.”³³ A falcon that circles a field searching for mice to prey upon demonstrates how a *line of operation* functions. The falcon scans appropriate terrain in the right glide path until it locates prey. The falcon moves quickly to snatch the mouse up, and returns to a nest to feed. What would happen to the well-defined *line of operation* if a swarm of bees replaced the falcon, and the mouse with thousands of pollen sources in the diverse topography around a hive? The clear and linear process quickly descends into perceived chaos and disorder. Non-linear processes do not map well in straight lines, but are they exempt from understanding and pattern recognition?

Steven Johnson describes the myth of ant colonies in *Emergence; The Connected Lives of Ants, Brains, Cities, and Software* through explaining how swarming works. Like bees, ants work in colonies where a vast number of very simple creatures function through decentralization and only an awareness of their immediate surroundings. “The queen is not an authority figure. She lays eggs and is fed and cared for by workers. She does not decide which worker does what...it would be physically impossible for the queen to direct every worker’s decision about which task to perform and when.”³⁴ The ant queen does not attempt to direct the colony in the same manner that general officers should have no expectation that complex systems are susceptible to linear actions that produce specific and timely end-states.

Soldiers are not ants, and military operations are not equivalent to ant colonies; however, both share many similarities that challenge conventional military dogma about understanding complex systems and transforming them into a desired state. Ant colonies function in a decentralized manner that demonstrates emergent self-organizing behavior; an ant colony collectively ‘learns’ and adapts to conditions so that the colony finds food sources, defends

²⁹ Ludwig von Bertalanffy, *General System Theory; Foundations, Development, Applications*. (New York: George Braziller, 1968) 19.

³⁰ Ibid, 143.

³¹ Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 42. “Moreover, by claiming that strategic destruction is attained by the accumulation of tactical destructions he establishes a direct quantitative linkage between the various levels of conducting war, thus undermining the idea of synergism.”

³² Francois Jullien (translated by Janet Lloyd), *A Treatise on Efficacy Between Western and Chinese Thinking*. (Honolulu: University of Hawai’i Press, 2004), 19.

³³ United States Army Training and Doctrine Command, *Field Manual 5-0; The Operations Process*. (Headquarters, Department of the Army, 2010), 3-59.

³⁴ Steven Johnson, *Emergence; The Connected Lives of Ants, Brains, Cities, and Software*, (New York: Scribner, 2001) 31.

against threats, and continues colony existence without any leadership or linear processes. “*Local* turns out to be the key term in understanding the power of swarm logic...they think *and* act locally, but their collective action produces global behavior.”³⁵ Essentially, individual ants use pheromones and local awareness of what other ants in the immediate area are doing, and adjust their own behavior.

If a foraging ant comes across a trail with the chemical message ‘food this way’, that ant will join the route. If an ant encounters enough ants in the local area that instinct triggers ‘there are more than ten ants foraging, return to colony for new duty,’ the ant at a local level changes behavior. Holistically, the entire colony buzzes with local decisions and simple instructions that collectively produce self-organization and adaptation. Swarming is non-linear, yet all decentralized behaviors holistically direct the colony towards a desired state. Are military organizations capable of employing ‘swarm methodology’ to replace linear constructs with non-linear operational approaches in conceptual planning?

Design uses problematizing to explain how a system functions. As the second article of ‘To Design or Not to Design’ defined it, *problematizing* involves heretical questioning that challenges institutional tenets and core values of an organization. The very word ‘problem’ is often a misleading concept. Peter Checkland explains the difference between *structured* and *unstructured problems* in his General Systems Theory book, *Systems Thinking, Systems Practice*:

Structured problems...can be explicitly stated in a language which implies that a theory concerning their solution is available...and *unstructured* problems which are manifest in a feeling of unease but which cannot be explicitly stated without this appearing to oversimplify the situation.³⁶

Checkland assigns structured problems to the methodology of *hard* systems; his term nests with other design terms such as *closed systems* or *linear processes*. Once again, military organizations applying design cannot follow tacticized predilections of transforming unstructured problems with the same methodologies that function for structured problems. This is the basis for why linear transformative processes are unable to work with unstructured problems. There is no clearly definable *end state* against which planners engineer a sequence of actions, objectives, and observations.

A non-linear approach starts without a well-defined end-state. “General systems laws will never be used for precise conclusions without checking the insights they provide.”³⁷ Unlike simple problems or *hard systems* where there is “at the onset...a clear definition of the objectives,” ill-structured problems and complex systems face challenges where the “goals are often obscure.”³⁸ Unfortunately, FM 5-0 provides less than three pages of doctrine on the operational approach, and potentially sours the fruit by suggesting “using lines of effort that provide a graphic to articulate the link among tasks, objectives, conditions, and the desired end-

³⁵ Ibid, 74.

³⁶ Peter Checkland, *Systems Thinking, Systems Practice* (New York: John Wiley and Sons, 1981) 154-155.

³⁷ Gerald M. Weinberg, *An Introduction to General Systems Thinking* (New York: John Wiley and Sons, 1975) 41. “General system laws...are not designed to yield *answers*; therefore, they can afford occasionally to be wrong.” Weinberg addresses the input-output experimentation through framing and reframing system transformation; design requires a problematization methodology that emphasizes active learning and adaptation.

³⁸ Peter Checkland, *Systems Thinking, Systems Practice* (New York: John Wiley and Sons, 1981) 142, 149.

state.”³⁹ To confuse complex system adaptation with traditional reductionist military hubris even further, FM 5-0 offers the olive branch of joint integration by recommending designers to “draw upon the elements of operational design relevant to the situation.”⁴⁰ While ‘To Design or Not to Design’ focuses upon Army design doctrine and not Joint operational design, the elements of operational design clearly prescribe to Clausewitzian reductionist principles of war that are generally incompatible with holistic design applications.⁴¹

One element of Operational Design is relevant concerning linear causality and the tacticization of design methodology in Army design doctrine towards specific end-states. Operational design uses the term ‘anticipation’ and provides a telling definition:

Commanders and staff officers that tend to lean forward in anticipation of what they expect to encounter are more susceptible to deception efforts by an opponent. Therefore, commanders and their staffs should carefully consider all available information upon which decisions are being based. Where possible, multiple or redundant sources of information should be employed to reduce risk in the decision-making process.⁴²

Redundant sources of information generally do not aid anticipation in complex systems; this echoes observations from the first section of this four article series on Army Design on description. In holistic approaches to transforming complex systems, both Joint and Army doctrine prescribe what Checkland phrases “an unnoticed framework—a set of intellectual pigeon-holes-into which we pace the new knowledge we acquire”⁴³ Like traditional reductionist scientists, military organizations expect that the greater the amount of categorized information, the better the ability to anticipate change in a system. With adaptive systems filled with rivals that continuously learn, description is not nearly as essential as holistic explanation. Too much description may lead to a false sense of confidence in expecting a linear transformation sequence of objectives to occur in time and space exactly as an institution desires it to.

Non-linear approaches to transforming the observed state of a system towards the desired state require the unique *problematization* that the first and second articles in this series explained. Problematizing identifies tensions and difference between the observed state and the desired state. In order to exploit these tensions to transform the system towards the vision (desired state), a process of experimentation, learning, and adaptation should occur. Non-linear approaches are ideally suited for this process because unlike linear processes, non-linear transformations adapt and learn with the changing system. Adaptive rival actors integrate into non-linear approaches due to the relation of space and time; linear approaches plot all actions along a linear timeline that subsequently codifies the transformative process into a sequential methodology. Granted, Army planning and design doctrine discuss *reframing* which provides the transformation process flexibility; however the FM 5-0 description of *reframe* is essentially hitting the ‘reset button’ on the design product and dismantling the linear transformative

³⁹ United States Army Training and Doctrine Command, *Field Manual 5-0; The Operations Process* (Headquarters, Department of the Army, 2010), 3-59.

⁴⁰ Ibid, 3-67.

⁴¹ Joint Publication 5-0, *Joint Operation Planning* (26 December 2006) IV-2- IV-38. The terms ‘center of gravity’ echo Clausewitzian and Jominian universal principles of warfare even by the use of the word ‘gravity.’ Operational design uses ‘lines of operations’, ‘balance’, ‘end-state’, and ‘decisive point;’ all of which reflect teleological and reductionist military methodology instead of holistic systems theory.

⁴² Ibid, IV-28.5.

⁴³ Peter Checkland, *Systems Thinking, Systems Practice* (New York: John Wiley and Sons, 1981) 12-13.

approach in lieu of a new one. “Reframing involves significantly refining or discarding the hypotheses or models that form the basis of the design concept...reframing allows the commander and staff to make adjustments throughout the operations process.”⁴⁴ In other words, ‘reframing’ should not be tied to failures within linear processes; reframing is the natural progression from analysis to *problematization* (critical thinking) and synthesis. Tactical success may also include reframing because the system changes and adapts regardless. Were Army design doctrine to abandon tacticization of design methodology and shift from linear to non-linear transformative approaches, *reframing* would gain the valuable designation as a *theory* instead of a *procedure*.

The flexibility of representation of the lines of a diagram can tempt the designer into generating hybrids where sometimes the line means that stuff passes, sometimes that data pass and sometimes merely that time has passed...In any graphical display, interchanging whatever is represented from left to right with that represented up to down, or vice versa, will not distort the information, although it may make it more difficult to perceive because of display stereotypes.⁴⁵

Currently, Army design doctrine uses linear transformative approaches because they appear to work in the short-term; linear formats enjoy continued prominence in military organizations due to these *display stereotypes*. Referring back to military institutional bias cited earlier, the Army focuses the majority of its planning efforts on short-range processes, including design. A linear process such as a line of effort or operation starts off plausibly with immediate actions to transform the system, yet by placing these actions in a linear format across time and space, the designers remove learning and adaptation from the system.

For example, a task force over a 12-month deployment may apply a *security line of effort* that integrates a sequence of host nation and coalition raids, offensive operations, and other security-related operations with the desired end state of decreasing the level of violence and increasing host nation security capacity. If, at the end of 12 months, the overall number of enemy attacks in the region are significantly less, can the military organization subsequently state that they accomplished their transformation of the observed state into the desired state? At the tactical level and detailed planning perspective that deals with teleological and reductionist methodologies, the answer is likely an affirmative. At the operational level of war where holistic approaches convey understanding of the entire ecosystem of conflict, do they share the same opinion? This article proposes they would not.

Non-linear transformation processes require designers to function above time and space; some transformation may occur locally and sequentially which leads to tacticization. Designers need to resist this and address the ecological frame holistically.⁴⁶

⁴⁴ United States Army Training and Doctrine Command, *Field Manual 5-0; The Operations Process* (Headquarters, Department of the Army, 2010), 3-67.

⁴⁵ W.T. Singleton, *Man-Machine Systems* (edited by Open Systems Group), *Systems Behavior*, 3rd edition (London: Harper & Row Publishers, 1981) 129-130.

⁴⁶ Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 233. When explaining the rise of Soviet operational theory in the interwar period, Naveh explained the realization of Soviet tactical command limitations. “They realized that relying on a tactical mission as the sole focus attracting the entire attention of commanders at that level would have led to the degeneration of the essential cognitive tension and the decline of the system.”

Model building is not a straightforward, but rather, a highly creative activity. It is of necessity an *iterative* or *adaptive* process in which one moves from a state of little knowledge to one of greater knowledge- in other words, it is a process of hauling oneself up by one's bootstraps.⁴⁷

Straightforward linear processes work off the notion that all information is available at the beginning of the transformation process in order to link various objectives towards the fixed end-state. Non-linear approaches do not suppose that designers know enough information at the beginning of the transformative process to create such a rigid chain of linear causality towards a pre-determined ends.

Actions applied to the system regardless of time and space are considered 'inputs' while the transformation of the system subsequently become 'outputs.' Matching inputs to outputs require a holistic approach due to system complexity. From a tactical perspective over a 12-month or 15-month deployment cycle, the input-output system observations may indicate initial success, especially with short-range linear causality.

On the basis of such a continuum of evolving, elaborating levels of adaptive system...the *varying time span* required for exemplars of the adaptive system to map or encode within themselves changes in the variety and constraints of the environment; in the sociocultural case, the time span may be very short-days-or very long, but complicated by the fact that the relevant environment includes both intra- and inter-societal variety.⁴⁸

Conducting numerous raids in a short period often encourage the remaining rival actors to adapt and learn; only the irrational or ignorant would continue behaviors that failed to achieve rival objectives. Non-linear transformation approaches break from traditional linear ones by integrating input and output observations of an open system without the same inflexibility to temporal and space. Designers must "consider structure the way in which moving reality is translated...into an instantaneous and artificial observation: social and cultural structures are only the intersections in time and space of process in course of change and development."⁴⁹ Non-linear approaches to transforming systems increases the potential for understanding various patterns of phenomenon in an observed system, but some systems will resist comprehension regardless of endeavor.⁵⁰

Non-linear transformation approaches are alternative methodologies for military institutions to consider when facing *ill-structured problems*. At the operational level, design represents a holistic approach to understanding and explaining a complex system, yet tactical operators cannot simply receive these non-linear transformation approaches in lieu of detailed

⁴⁷ Gwilym M. Jenkins, *The Systems Approach* (edited by Open Systems Group), *Systems Behavior*, 3rd edition (London: Harper & Row Publishers, 1981) 157-158.

⁴⁸ Walter Buckley, *Society as a Complex Adaptive System* (edited by Open Systems Group), *Systems Behavior*, 3rd edition (London: Harper & Row Publishers, 1981) 181.

⁴⁹ *Ibid*, 187.

⁵⁰ Gerald M. Weinberg, *Rethinking Systems Analysis and Design* (Boston: Little, Brown and Company, 1982) 22. "No matter how much you know how or know when, there are some problems that won't yield to present knowledge, and some aspects of the problem nobody currently understands, so humility is always in order." Weinberg infers here the fallacy of human attempts to master everything. With linear approaches to these 'worst-case scenarios' of infallible problem systems, explanation falls short of understanding. Although non-linear approaches will also fail, the flexibility and adaptive nature of non-linear approaches cuts deeper into 'infallible problems' to further bound what is known from what is unknown. Essentially, non-linear approaches increase *understanding* of failure by their dynamic nature when compared with strict linear approaches.

planning and tactical linear processes. Army design doctrine does not articulate how designers convert operational synthesis into products appropriate for detailed planning; this four article series on Army Design proposes in the final section that Army design doctrine can convey understanding and directive guidance that represent non-linear approaches.⁵¹

In order to make the conceptual leap from operational to tactical, and design to detailed planning, a paradigm in military doctrine is suggested.⁵² Analogous concepts such as metaphors, homologies, and analogies are already prevalent in design theory while devoid in military doctrine. In order for the military institution to bridge the conceptual gap between operational design methodology and tactical detailed planning processes, an entirely atypical and potentially heretical form of doctrine requires establishment in lieu of fifteen pages of design doctrine in FM 5-0. The fifth article of 'To Design or Not to Design' explores how asymmetrical design doctrine could increase institutional understanding and appreciation of Army design methodology.

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⁵¹ United States Army Training and Doctrine Command, *Field Manual 6-22; Army Leadership; Competent, Confident, and Agile*. (Headquarters, Department of the Army, October 2006), 12-1. FM 6-22 addresses *strategic leadership* with an interesting discourse that echoes many non-linear considerations that this paper addresses. At the *strategic level of leadership*, strategic leaders “use their knowledge of the current force to anchor their vision of the future force in reality-grounded analysis. In a strategic environment of extreme complexity, ambiguity, and volatility, strategic leaders must think in multiple time periods and apply more adaptability and agility to manage change.”

⁵² Shimon Naveh, *In Pursuit of Military Excellence; The Evolution of Operational Theory* (New York: Frank Cass Publishers, 2004) 6. “Moving the system from a state of abstract, cognitive commonality to a practical course of positive progress can only be achieved by translating the overall aim into concrete objectives and missions for the system’s individual components.”