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COUNTERING WEAPONS OF MASS DESTRUCTION: A PRELIMINARY FIELD STUDY IN IMPROVING COLLABORATION

by

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March 2016

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The proliferation of emerging and disruptive technologies such as additive manufacturing continues unabated. Such trends vastly increase the likelihood of a pernicious non-state actor acquiring weapons of mass destruction in the near future. In addition, these emerging novel threats have proved particularly vexing for the existing U.S. bureaucracies. Absent the major restructuring of the government, significantly higher levels of proactive inter-agency collaboration will be required to successfully respond to these grave challenges. In this project, we first operationalized a concept of collaboration in terms of increases in transparency, resource sharing, and interdependence across inter-agency actors. In other words, actors are deemed to be collaborating when they share information, make assets available to one another, and become jointly invested in (and responsible for) the resulting decisions. Second, we explored if the use of a formal collaborative process and the choice of venue would have significant impacts on the degree of collaboration observed. A preliminary field study conducted at the U.S. Embassy in Singapore confirmed our intuitions regarding increased collaboration, and provided the springboard for additional research, as well as for a number of policy recommendations.

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requirements for the degree of

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ABSTRACT

The proliferation of emerging and disruptive technologies such as additive manufacturing continues unabated. Such trends vastly increase the likelihood of a pernicious non-state actor acquiring weapons of mass destruction in the near future. In addition, these emerging novel threats have proved particularly vexing for the existing U.S. bureaucracies. Absent the major restructuring of the government, significantly higher levels of proactive inter-agency collaboration will be required to successfully respond to these grave challenges. In this project, we first operationalized a concept of collaboration in terms of increases in transparency, resource sharing, and interdependence across inter-agency actors. In other words, actors are deemed to be collaborating when they share information, make assets available to one another, and become jointly invested in (and responsible for) the resulting decisions. Second, we explored if the use of a formal collaborative process and the choice of venue would have significant impacts on the degree of collaboration observed. A preliminary field study conducted at the U.S. Embassy in Singapore confirmed our intuitions regarding increased collaboration, and provided the springboard for additional research, as well as for a number of policy recommendations.

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LIST OF ACRONYMS AND ABBREVIATIONS

AM	additive manufacturing
BIS	Bureau of Industry and Security
CIA	Central Intelligence Agency
CWMD	countering weapons of mass destruction
CP	counterproliferation
CPWG	Counterproliferation Working Group
CT	counterterrorism
DHS	Department of Homeland Security
DIMEFIL	diplomatic, information, military, economic, financial, intelligence, law enforcement
DOC	Department of Commerce
DOD	Department of Defense
DOS	Department of State
DPRK	Democratic People's Republic of Korea
FBI	Federal Bureau of Investigation
FLETC	federal law enforcement training center
FSI	Foreign Service Institute
IA	U.S. Interagency
IAEA	International Atomic Energy Agency
IAWG	interagency working group
IND	improvised nuclear device
IOA	Interagency Opportunity Analysis
ISIL	Islamic State Iraq and Levant
LOE	lines of effort
NCPC	National Counterproliferation Center
NCR	National Capital Region (Washington, DC)
ODTAAC	outside declared theater of active armed conflict
OSD	Office of the Secretary of Defense
PSI	proliferation security initiative
SOCOM	Special Operations Command

SOF	Special Operations Forces
TCO	transnational criminal organization
TRAC	Threat Reduction and Arms Control
TTX	tabletop exercise
USG	United States government
USCENTCOM	United States Central Command
USSOCPAC	United States Special Operations Command Pacific

LIST OF DEFINITIONS

Additive manufacturing: The automated process of turning digital design into three-dimensional products.[1] From industry, it is the process of joining materials to make objects from three dimensional data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.[2]

Countering weapons of mass destruction (CWMD): Efforts against actors of concern to curtail the conceptualization, development, possession, proliferation, use, and effects of weapons of mass destruction, related expertise, materials, technologies, and means of delivery. Also called CWMD.[3]

Counterproliferation: Those actions taken to reduce the risks posed by extant weapons of mass destruction to the United States, allies, and partners. Also called CP.[4]

Collaboration: When people from different organizations (or units within one organization) produce something together through joint effort, resources, and decision making, and share ownership of the final product or service.[5]

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[1] Jennifer Snow, "Entering the Matrix: The Challenge of Regulating Radical Leveling Technologies" (master's thesis, Naval Postgraduate School, 2015), 1.

[2] "What Is Additive Manufacturing." Informational. *Wohlers Associates*. Accessed December 10, 2015. https://www.wohlersassociates.com/additive-manufacturing.html.

[3] Chairman of the Joint Chiefs of Staff. Joint Publication 3–40: Countering Weapons of Mass Destruction. Department of Defense. Washington, DC, 2014.

[4] Chairman of the Joint Chiefs of Staff. Joint Publication 3–40: Countering Weapons of Mass Destruction. Department of Defense. Washington, DC, 2014.

[5] Russell M. Lindon, Working Across Boundaries, San Francisco, CA: John Wiley & Sons, Inc. (2002), 7.

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I. INTRODUCTION

> [As] we tackle the many threats to our national security, we must never lose sight of nation's enduring strengths—or of the opportunities to make a brighter future and better world for our children.
>
> —Secretary of Defense Ash Carter[6]

Some crises can be construed as simply the result of a series of missed opportunities to collaborate. The U.S. government (USG) is constantly reacting to national security crises on multiple fronts, and the most frightening type of crisis the nation could face is one in which its most dangerous adversaries acquire weapons of mass destruction (WMD) or significantly enhance their current stockpile. The White House acknowledges the gravity of such a scenario: "No threat poses as grave a danger to our security and wellbeing as the potential use of nuclear weapons and materials by irresponsible states or terrorists."[7] Disturbingly, the likelihood of such a crisis increases every day as rapidly emerging technological innovation and diffusion mechanisms lower the barriers for entry into the WMD club.[8]

Neither the Department of Defense (DOD) nor any other specific U.S. agency bears full responsibility for devising a strategy to deter innovative adversaries from achieving strategic effects including the use of WMD. The existing national security bureaucracies, designed in the immediate wake of World War II, were structured to counter other nation state bureaucracies.[9] Today's threats are much more agile and often operate below a U.S. response threshold. Built at the apex of interstate diplomacy and industrialized warfare, they have been slow to react to—or even recognize—the relevant

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[6] Carter, Ashton, "Message from Secretary Ashton Carter to all DOD personnel," Secretary of Defense Message Washington, D.C.; February 17, 2015.

[7] White House, "National Security Strategy 2015."

[8] Jennifer Snow, "Entering the Matrix: The Challenge of Regulating Radical Leveling Technologies" (master's thesis, Naval Postgraduate School, 2015).

[9] U.S. Congress, *The National Security Act of 1947* (1947).

attributes of the emerging threat environment.[10] Further, today's adversaries actively exploit such departmental seams across the range of USG agencies.[11] Given the nature of this challenge, interagency collaboration will prove crucial to mitigating over-the-horizon threats and ultimately limiting the proliferation of weapons of mass destruction. As noted by John Arquilla, "We can't control everything, but we can control how we organize, communicate, and operate."[12] This thesis explores how a formal collaborative process can enhance such counterproliferation efforts.

A. WEAPONS OF MASS DESTRUCTION AND THE NEED TO COLLABORATE: DESCRIBING THE PROBLEM

Weapons of mass destruction are one of the few existential threats to U.S. national security and economic prosperity. Despite the loss of the World Trade Center and over three thousand citizens 14 years ago, New York City is once again a bustling center of economic health. In comparison, approximately 70,000 people were killed instantly, nearly 43 square miles were affected by radiation, and 100% of the 50,000 buildings in Nagasaki were destroyed in August 1945 following the use of a nuclear weapon at the end of World War II.[13] An improvised nuclear device (IND)[14]—a type of WMD actively sought by terrorist groups—can produce a similar explosive yield.[15] References to WMD can be found in every National Security Strategy Report since the

[10] Douglas T. Stuart, *Creating the National Security State: A History of the Law That Transformed America* (Princeton University Press, 2012).

[11] Amy Zegart, *Flawed by Design: The Evolution of the CIA, JCS, and NSC* (Stanford University Press, 2000).

[12] John Arquilla, personal communication with authors, 3 October 2015.

[13] "The Atomic Bombings of Hiroshima and Nagasaki," Atomicarchive.com, 1998, http://www.atomicarchive.com/Docs/MED/med_chp9.shtml.

[14] According to Ferguson and Potter, an improvised nuclear device (IND) is a nuclear weapon made with fissile materials acquired from nontraditional means—to include criminal activity, extortion, etc.—and crude fabrication of an explosive device to gain nuclear yield.

[15] "It is generally assumed that successful INDs would have yields in the ten to 20 kiloton range (the equivalent to 10,000–20,000 tons of TNT), while INDs that fizzled—i.e., did not detonate fully—might still produce a nuclear yield that could cause very significant damage. A 20 kiloton yield would be the equivalent of the yield of the bomb that destroyed Nagasaki and could devastate the heart of a medium-sized U.S. city, while causing fire and radiation damage over a considerably wider area" (Charles D. Ferguson and William C. Potter, *Improvised Nuclear Devices and Nuclear Terrorism*, WMD Commission, Stockholm, Sweden, 2006).

Goldwater-Nichols Act of 1986 directed the report to be published by the Executive Cabinet.[16] This pervasive concern is not invalid: according to the International Atomic Energy Agency (IAEA), between 1993 and 2013, over six hundred incidents of theft or losses of fissile material have been reported, with no conclusive determinations of whether the items were sold.[17]

It can be argued that the United States, along with international partners, has been largely successful in blunting the proliferation of WMDs. This argument is supported by the fact that there are only ten nations with declared nuclear weapons programs, despite the technology's 70-year history.[18] Nonetheless, international actors have found means to illicitly develop such programs. The A.Q. Khan network, which developed Pakistan's nuclear program, for example, has demonstrated the path to illicit nuclear proliferation.[19]

The proliferation threat is poised to grow rapidly as the challenge evolves over the next few years. New disruptive technology has a significant impact on illicit proliferation of WMD and the USG's agility to respond to new and emerging threats. The nuclear fuel cycle has traditionally proven to be resource intensive and require a significant production footprint, but advancements like additive manufacturing, commonly known as "AM" or "3D printing," offer alternative methods that can be diffused to a broader range of adversaries and can create critical components for boutique nuclear programs.[20] Those

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16 Barry Goldwater and Flyt Nichols, *Goldwater-Nichols Department of Defense Reorganization Act of 1986*, 1986.

17 Evan Perez, Michael Martinez, and Cosmin Stan, "FBI Helped Thwart Nuclear Smuggling Plot in Moldova," CNN Politics, October 8, 2015, http://www.cnn.com/2015/10/07/politics/fbi-helped-thwart-nuclear-smuggling-plot-in-moldova/.

18 "Nuclear Weapons: Who Has What at a Glance," *Arms Control Association*, October 2015, http://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat.

19 Gordon Corera, *Shopping for Bombs: Nuclear Proliferation, Global Insecurity, and the Rise and Fall of the AQ Khan Network* (Oxford University Press, 2009).

20 Alexander Gerschenkron, *Economic Backwardness in Historical Perspective: A Book of Essays* (Cambridge: Belknap Press of Harvard University Press, 1962); John Arquilla, "Patterns of Commercial Diffusion," in *Diffusion of Military Technology and Ideas*, ed. Emily O. Goldman and Leslie C. Eliason (Stanford, CA: Stanford University Press, 2003); Michael Roberts, *The Military Revolution, 1560–1660: An Inaugural Lecture Delivered before the Queen's University of Belfast* (Marjory Boyd: Belfast, 1956), 32; Dr. Leo Blanken, conversation with authors, October 2015.

pieces of the puzzle that used to require national-level industrial efforts may be possible to complete in a disused warehouse in the coming years.

The U.S. Interagency (IA) is the president's authorized means of implementing and enforcing U.S. policies, laws, and treaties. In the vacuum created after the fall of the Soviet Union in the 1990s, there seemed no immediate need for departmental reorganization or resource pooling to counter or combat emerging counterproliferation threats.[21] As a result, there are gaps between departments organized to counter an outdated Cold War peer-competitor threat.[22] The IA has made significant strides in coordination and cooperation since 2001; however, terror groups and observant nation-states have learned to exploit what General Votel, commander of USSOCOM, describes as a "gray zone" just below the U.S. response threshold where fissures in the IA are vulnerable.[23]

Given these three premises—the existential threat of WMDs, the precipitous lowering of the proliferation threshold, and the mismatch between these threats and the Cold War-legacy structure of USG bureaucracies—the key to counterproliferation may lie in fostering IA collaboration before crises emerge.

B. THE EVOLVING PROLIFERATION THREAT

Since 1949, the United States has wielded national power to prevent the proliferation of strategic weaponry through passive and active measures.[24] A blend of strategies of retaliatory deterrence, deterrence by denial, economic pressure, and legal

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[21] Emily Goldman, *Power in Uncertain Times: Strategy in the Fog of Peace* (Stanford University Press, 2010).

[22] The National Commission of Terrorist Attacks on the United States, also known as the 9/11 Commission, confirmed the stovepiped nature of the USG institutions; see *9/11 Commission Report* – in Lit Rev.

[23] Statement of General Joseph L. Votel, U.S. Army, Commander, United States Special Operations Command Before The House Armed Services Committee, Subcommittee on Emerging Threats and Capabilities, Washington, DC, U.S. House of Representatives, 2015, 7, http://fas.org/irp/congress/2015_hr/031815votel.pdf.

[24] Henry Sokolski, *Underestimated: Our Not-So-Peaceful Nuclear Future* (Arlington, Virginia: Nonproliferation Education Center, 2015); Albert O. Hirschman, *National Power and the Structure of Foreign Trade* (Berkeley, CA: University of California Press, 1980); Mills, "All Elements of National Power: Re-Organizing the Interagency Structure and Process for Victory in the Long War," 2006.

arms-control regimes are but a few examples of such efforts.[25] Despite these measures, WMD still pose an existential threat to U.S. security. Further, there is a growing concern that the barrier to developing and owning such weapons will lower drastically as new technologies emerge, making existing methods of deterrence and CWMD less and less effective.[26] Disruptive innovation, rapid technological advances, and diffusion of innovations to a broader population could undermine defense and political strategies if nothing is done to improve efforts against such threats.[27] Three-dimensional additive manufacturing, combined with cyber connectivity, is an area in which technology advancement is outpacing the U.S. bureaucratic agencies' abilities to defend against potential threats.[28] The result is limited awareness and action to realize or react to threats

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[25] T. C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 1966); "1971 Pentagon Papers," National Archives and Records, 1971: 412–429, accessed November 10, 2015, http://www.archives.gov/research/pentagon-papers/; Alexander L. George and Richard Smoke, *Deterrence in American Foreign Policy: Theory and Practice* (New York: Columbia University Press, 1974); G. T. Allison and P. D. Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis*, 2nd ed. (New York, NY: Addison-Wesley Publications, 1999); Brian Bates and Chris McHorney, *Developing a Theoretical Model of Counterproliferation for the 21st Century* (Lewiston, NY: Edwin Mellen Press, 2000); Andrew Grossman, *Neither Dead nor Red: Civil Defense and American Political Development during the Early Cold War* (Routledge, 2001).

[26] Zachary S. Davis, "Strategic Latency and World Order," *Orbis*, 2014, 69–84; Chairman of the Joint Chiefs of Staff, *Combating Weapons of Mass Destruction* (Washington, DC: USGPO, 2014), http://www.dtic.mil/doctrine/new_pubs/jp3_40.pdf.

[27] Roberts, *Military Revolution, 1560–1660*; Arquilla, "Patterns of Commercial Diffusion"; Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Boston, MA: Harvard Business School Press, 1997).

[28] Bruce Goodwin, "Additive Manufacturing and High-Performance Computing: A Disruptive Latent Technology," Center for Nonproliferation Studies, September 8, 2015, http://www.nonproliferation.org/additive-manufacturing-and-high-performance-computing/; Anne Sneed, "Moore's Law Keeps Going, Defying Expectations," *Scientific American*, May 19, 2015, accessed November 10, 2015, http://www.scientificamerican.com/article/moore-s-law-keeps-going-defying-expectations/; Rose Brooke, "China Flexes Muscles in 3D Printing Race," *TCT Magazine*, 2013, http://www.tctmagazine.com/3D-printing-news/china-flexes-muscles-in-3dp-race/; Liat Clark, "Disarming Corrupter Distorts 3D Printing Files for Sharing of Banned Items," *Wired*, November 5, 2013, http://www.wired.co.uk/news/archive/2013-11/05/disarming-corruptor; RedEye on Demand Hanson, "Top Five Benefits of Additive Manufacturing (You Never Considered)," Manufacturing.net, February 19, 2013, http://www.manufacturing.net/articles/2013/02/top-five-benefits-of-additive-manufacturing-you-never-considered; Brian Krassenstein, "The Moore's Law of 3D Printing…Yes it Does Exist, and Could Have Staggering Implications," Print.com, 2014, http://3dprint.com/7543/3d-printing-moores-law/; "A Third Industrial Revolution," *The Economist*, 2012, http://www.economist.com/node/21552901; Wohler Associates, *Wohlers Report 2015*, 2015, http://www.wohlersassociates.com/2015report.htm; Connor M. McNulte, Neyla Arnas, Thomas Campbell, "Toward the Printed World: Additive Manufacturing and Implication for National Security." 2012, accessed November 10, 2015, http://www.worldcat.org/title/toward-the-printed-world-additive-manufacturing-and-implications-for-national-security/oclc/862234020.

until they become crises. As observed by David Kilcullen, political and defense leaders are simply too overwhelmed and overtasked to do anything more than manage current crises.[29] If current methods of ad hoc collaboration and interorganizational challenges are not overcome, the next crisis just might be the nightmare of the "nuclear 9/11."

To delineate the aspects of this challenge, we provide some context and background on the evolution of counterproliferation efforts in U.S. foreign policy. We begin by providing some basic background, terms and doctrine in regards to this topic. We next look at the attributes of disruptive innovation models from the private sector, and how largely unforeseen challengers can threaten traditional market leaders. Finally, we focus in on one example of such a disruptive—additive manufacturing—and its grave implications for WMD proliferation.

C. CWMD DEFINITIONS AND DOCTRINE

It is useful to pause and provide some basic definitions before proceeding. Weapons of mass destruction are defined as chemical, biological, radiological, nuclear, or high-yield explosives, and there have been a number of concerted efforts to counter malign actors' acquisition of WMD expertise, technology, and material and weapon proliferation.[30] Joint Publication 3–40 introduces a WMD construct of three applicable lines of effort: 1. prevent acquisition; 2. contain and reduce threats; and 3. respond to crises.[31] The overarching strategy to meet these three Lines of Effort is identified in military doctrine as preparation.[32] The act of preparation must take place in the steady state, where we focus our analysis. The term counterproliferation (CP) falls under the

[29] David Killcullen, "Psychological Warfare and Deception," lecture, Naval Postgraduate School, August 13, 2015; Michael R. Eastman, "Whole of Government Is Half an Answer," *InterAgency Journal* 3, no. 3 (Summer 2012), 31–39; Sean M. Roche, "Is It Time for an Interagency Goldwater-Nichols Act?" *InterAgency Journal* 4, no. 1 (Winter 2013), 12; Ralph O. Doughty and Ralph M. Erwin, "Building National Security through Interagency Cooperation: Opportunities and Challenges," *Changing Mindsets to Transform Security* (Washington, DC: United States Institute for National Strategic Studies, 2013).

[30] Chairman of the Joint Chiefs of Staff, *Combating Weapons of Mass Destruction*; John Arquilla D. Ronfeldt, *Networks and Netwars: The Future of Terror, Crime, and Militancy* (RAND, 2001); National Commission on Terrorist Attacks, *The 9/11 Commission Report* (Norton and Company, 2004).

[31] Chairman of the Joint Chiefs of Staff, *Countering Weapons of Mass Destruction*, iii.

[32] Ibid., I-3.

umbrella of CWMD as it pertains to the DOD mission. The IA generally uses the term counterproliferation and counterproliferation of weapons of mass destruction (CPWMD) but not CWMD.

D. DISRUPTIVE INNOVATION AND PROLIFERATION

To characterize the novel nature of current proliferation threats, we explore the "disruptive innovation" literature from the world of private sector competition. Disruptive innovations endanger existing markets or other arenas of competition. Often introduced by market outsiders, they may render existing value streams and sources of power obsolete. In short, disruptive innovations may rapidly and unexpectedly endanger an established order.[33] An organization cannot stop the birth of disruptive innovations; hence, identification of the new threat and prevention or preparation for its diffusion is paramount.[34] The advancement of atypical tactics and affordable new technology often outpaces a bureaucracy's ability to prepare, identify or respond to threats in both private and public sector. This is ideal for new companies breaking into a large market—and for nefarious actors in search of WMD programs/materials. The need for more aggressive and effective ways of identifying and addressing new threats is only increasing. Just as the survival of commercial enterprises relies on their ability to identify such threats, it can be argued that the survival of nations depends on similarly enhanced threat assessment.

E. MARKET DISRUPTION

Clayton Christensen articulated a powerful theory of market disruption in 1997 with his book *The Innovator's Dilemma*, wherein he explains that *disruptive innovation* is not a breakthrough that makes good products better.[35] Historically, firms invest in innovation through improving existing products and charging higher prices to boost profit; "however, by doing so, companies unwittingly open the door to 'disruptive

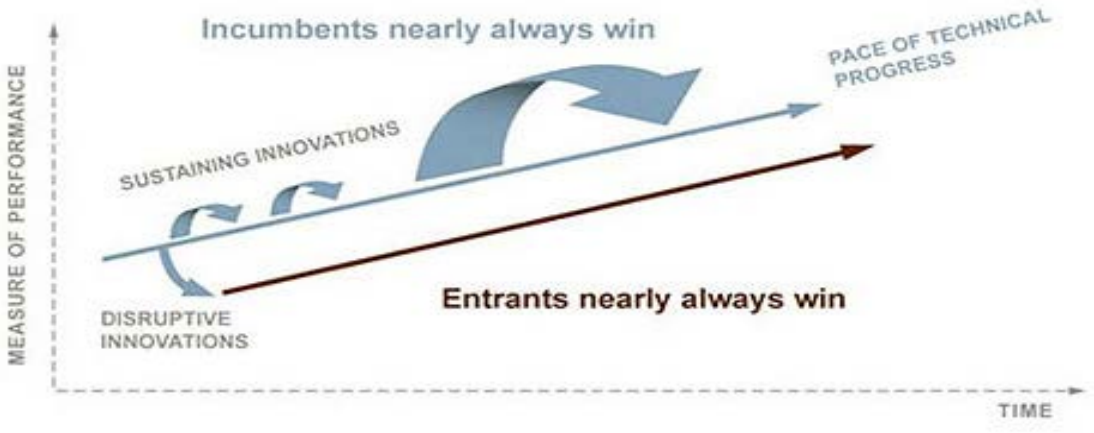
[33] Arquilla, "Patterns of Commercial Diffusion."

[34] Roberts, *Military Revolution, 1560–1660.*

[35] The Innovator's Dilemma received the Global Business Book Award as the best business book of the year (1997); and in 2011 The Economist named it as one of the six most important books about business ever written; Christensen, *Innovator's Dilemma*.

innovations' at the bottom of the market. An innovation that is disruptive allows a whole new population of consumers at the bottom of a market access to a product or service that was historically only accessible to consumers with a lot of money or a lot of skill."[36] (See Figure 1.)

Figure 1. Disruptive Innovations Entry Point Model



Source: "Disruptive Innovation," Clayton Christensen, July 10, 2012, accessed October 8, 2015, http://www.claytonchristensen.com/key-concepts/.

Disruptive innovation, as Clayton Christensen describes in his article "Disruptive Innovation," is a:

> phenomenon by which an innovation transforms an existing market or sector by introducing simplicity, convenience, accessibility, and affordability where complication and high cost are the status quo. Initially, a disruptive innovation is formed in a niche market that may appear unattractive or inconsequential to industry incumbents, but eventually the new product or idea completely redefines the industry.[37]

Disruptive innovations allow for smaller actors outside the established market to grow rapidly while not being observed by the established industry leader until it is

[36] "Disruptive Innovation," Clayton Christensen, July 10, 2012, accessed October 8, 2015, http://www.claytonchristensen.com/key-concepts/.

[37] Christensen, "Disruptive Innovation."

already too late.[38] The principle can be applied to multiple arenas, to include national security. An increased capability to assess threats is necessary to prevent, or at the very least be aware of, the introduction of simplicity, convenience, accessibility, and affordability to the market for WMD.

F. THE DISRUPTORS

Apple, with the introduction of computers for personal use, exemplified this strategy and quickly went from an unnoticed business in a garage to a worldwide market leader in a relatively short period of time.[39] Unveiling of the new Apple motto, "Think different," in 1997 revealed Steve Jobs as a disruptive innovator.[40] Notably, he didn't say "think better." Looking to gain competitive advantage in the market, Apple accepted lower gross margins and simpler, less attractive products and services compared to traditional performance measures. Large firms like IBM that dominated the mainframe market did not see a reason to venture outside of their core competencies and focus on lower tiers of the market.[41] Apple Computer's used disruptive innovation to break into the personal computer industry:

> Apple … began selling its early computers … as … toy[s] for children. At that point, the product wasn't good enough to compete with the minicomputers, but Apple's customers didn't care because they couldn't afford or use the expensive minicomputers … Within a few years, the smaller, more affordable personal computer became good enough that it could do the work that previously required minicomputers. This created a huge new market and ultimately eliminated the existing industry.[42]

IBM clearly did not see Apple as a threat to their bottom line. Yet by embracing what initially was a smaller market, Apple lowered the barriers to entry and eventually reached a much broader market. Table 1 depicts several examples where disruptive innovations

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[38] Gerschenkron, *Economic Backwardness in Historical Perspective.*

[39] Christensen, "Disruptive Innovation."

[40] Walter Isaacson, "The Real Leadership Lessons of Steve Jobs," *Harvard Business Review,* April 1, 2012, accessed October 8, 2015.

[41] Gerard J. Tellis, *Unrelenting Innovation: How to Build a Culture for Market Dominance* (San Francisco: Jossey-Bass, 2013).

[42] Christensen, "Disruptive Innovation."

allowed weaker competitors to surprise and disadvantage leaders within their respective market/environment.

Table 1. Examples of Disruptive Innovations

Disruptor	**Disrupted**
Apple	Mainframe Computers, Phones, Music Industry
Netflix	Movie Rental Industry
Uber	Transportation Service Industry
Airbnb	Hospitality Industry
Use of Civilian Airliners as Bombs (9/11)	U.S. National Defense Strategy
Additive Manufacturing (3D Printing)	Manufacturing Industry

Just as disruptive threats in the marketplace are often hidden at the bottom of the market, vulnerabilities to national security might be found hiding in the institutional seams of the interagency. The national focus on maintaining a technological lead and employing new advancements as soon as they are ready may not be the best course of action to counteract these vulnerabilities.[43] Prior to 9/11, the United States was (and still is) investing billions of dollars in the F-35 joint strike fighter to combat national security threats, while the enemy was buying a commercial airline ticket and conducting an operation that inflicted massive damage. Yahyah Ibrahim calls 9/11 "the greatest special operation of all time."[44] Considering the cost-benefit analysis of the 9/11 attacks from Al Qaeda's perspective, they clearly possessed an "absolute advantage." Juan Carlos Zarate's observations illustrate this point;

> In total, the amounts used specifically for the attacks reached only half a million dollars—a modest investment for the mass destruction that was to follow …. Al Qaeda's investments would result in the most devastating

[43] Leo J. Blanken and Jason J. Lepore, "Slowing Down to Keep the Lead in Military Technology," in *Defence and Peace Economics* 22 (Taylor & Francis Online, 2010): 317–334.

[44] "F-35 Joint Strike Fighter: Observations on Program Progress," U.S. GAO, April 14, 2015, accessed October 13, 2015, http://www.gao.gov/products/GAO-15-429T; Yahyah Ibrahim, "The Greatest Special Operation of All Time," *Inspire,* 2011, Accessed October 8, 2015.

> terrorist attack on U.S. soil in history. The resulting destruction, economic aftermath, and response would cost the United States billions of dollars.[45]

Most strategies currently in place focus on strengthening the areas in which the U.S. is already leading, but that this is not the effective way forward.

An organization's willingness to expand beyond its core competencies can result in groundbreaking insights and solutions. In the global marketplace, companies are utilizing new collaborative strategies to do just that. Christensen notes that "one of the main benefits of [these strategies] is that [they allow] firms to reach beyond their organizational boundaries and tap the outside expertise of a broader set of individuals than they could otherwise reach."[46] Identifying the vulnerabilities within the seams of the interagency (like the unseen, lower-tier threats in the marketplace) through a formal collaborative process can result in prevention or delay of a wider population gaining access to WMD.

G. ADDITIVE MANUFACTURING

We now turn to one potential disruptive innovation that may have grave consequences for the global proliferation of WMDs. Wohlers Associates describe additive manufacturing in their 2015 report as, "the process of joining materials to make objects from three dimensional data, usually layer upon layer, as opposed to subtractive manufacturing methodologies."[47] 3D printing, a term used interchangeably with additive manufacturing, refers to the production of metal, plastic and even biological end-parts from a single device driven by an electronic design file to fuse raw material inputs using a direct energy source (often a laser).[48] Industry will require revolutionary strategies to

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[45] Juan Carlos Zarate, *Treasury's War: The Unleashing of a New Era of Financial Warfare* (New York, NY: Public Affairs, 2013).

[46] "Disruptive Innovation," Christensen Institute.

[47] "What Is Additive Manufacturing." Informational. *Wohlers Associates.* Accessed December 10, 2015. https://www.wohlersassociates.com/additive-manufacturing.html.

[48] Hod Lipson, and Melba Kurman, *Fabricated: The New World of 3D Printing* (Indianapolis, IN: John Wiley & Sons, 2013); Irene J. Petrick, and Timothy W. Simpson, "Point of View: 3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition," *Research-Technology Management*: 12–16, 2.

match disruptions from additive manufacturing in economies of scale, supply chain management and retail manufacturing.[49] Rapid prototyping through additive manufacturing has already drastically lowered time and costs to achieve breakthroughs in biotech development, information technology and materials engineering, just to name a few.[50]

Additive manufacturing is an emerging technology demonstrating exponential growth that is outpacing Moore's Law, the computing term referring to the observation that the number of transistors in an integrated circuit has doubled approximately every two years.[51] To place this in context, if a 3D-printed toy takes four hours to print today, it will take just seven minutes and 30 seconds to print by 2025.[52] Government experts like Dr. Bruce Goodwin contends that within 5 to 10 years, the advancements in metal 3D printing, when combined with high-speed computing, will lower the threshold barrier for fabrication of nuclear weapons and enrichment technology available to threat actors.[53] The potential national security threats become evident as one gains understanding of the current state of commercial additive manufacturing.

Further, consider the commercial aspects of additive manufacturing. The U.S. is not the leader in this technology—the UK and Germany are, with Asia poised to take over this industry in the near future. Singapore, for example, is investing $400 million in a five-year advanced manufacturing project focused on 3D printing.[54] The Chinese government is pledging to invest $245 million over the next seven years to become the global additive-manufacturing leader.[55] We propose the U.S. re-evaluate its investment in

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[49] Stephanie S. Shipp, et al., *Emerging Global Trends in Advanced Manufacturing* (Alexandria, VA: Institute for Defense Analysis, 2012).

[50] J.-P Kruth, M.c. Leu, and T. Nakagawa, "Progress in Additive Manufacturing and Rapid Prototyping." *CIRP Annals - Manufacturing Technology*: 525–40.

[51] R. Hiremane, "From Moore's Law to Intel Innovation—Prediction to Reality," *Technology* 1 (2005).

[52] Krassenstein, "Moore's Law of 3D Printing."

[53] Lucibella, *Manufacturing Revolution May Mean Trouble*.

[54] Brooke, "China Flexes Muscles."

[55] Wohler Associates, *Wohlers Report 2015*.

this emerging industry technology to remain economically competitive as well as implement appropriations to support the identification of new threats to national defense.

While additive manufacturing has positive effects on multiple industries in the global marketplace (shipping, manufacturing, and medical, to name a few), the potential threats to global security cannot be ignored. Actors like North Korea and Iran could easily circumvent inspections and bypass international nuclear-weapon-program and export controls. Further, sales of complete nuclear weapons programs are not unheard of; 3D-printing technology could open new global markets for proliferation and completely rewrite the script of the world order.[56] With the diffusion of additive manufacturing, barriers to obtaining WMD would be drastically lowered, not only for states but for proxy and non-state entities—those entities for whom ideology sometimes run deeper than rational deterrence can reach.[57]

H. WHY INTERAGENCY COLLABORATION?

Expansive and rapid technological innovation is outpacing the speed at which decision makers are able to react to crisis.[58] The U.S. government does not currently have the agility to effectively address the speed of exponential technological advancements; it lacks the capacity and expertise to deeply analyze the diverse range of potential dangers. The complexity and scale represented by such a diverse spectrum of WMD threats constitutes a "wicked problem," as no single agency or department in the USG has the capacity or understanding to tackle them alone.[59] The CWMD problem is compounded in

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[56] D. Albright and C. Hinderstein, "Unraveling the AQ Khan and Future Proliferation Networks," *Washington Quarterly* 28, no. 2 (2005): 109–128.

[57] R. Jervis, "Rational Deterrence: Theory and Evidence," *World Politics* 41, no. 2 (1989): 183–207; N. Gershenfeld, "How to make almost anything," *Foreign Affairs* 91, no. 6 (2012): 43–57.

[58] Marc Goodman, "From Crowdsourcing to Crime-Sourcing: The Rise of Distributed Criminality," Big Think, 2011, http://bigthink.com/future-crimes/from-crowdsourcing-to-crime-sourcing-the-rise-of-distributed-criminality.

[59] Horst W. J. Rittel and Melvin M. Webber, *Dilemmas in a General Theory of Planning* (Berkeley: Institute of Urban & Regional Development, University of California, 1972); H. Brenton Milward and Joerg Raab, "Dark Networks as Organizational Problems," 2003, accessed November 10, 2015, http://www.hks.harvard.edu/netgov/files/talks/docs/03_06_06_seminar_millward_dark_networks.pdf; J. Conklin, *Dialogue Mapping: Building Shared Understanding of Wicked Problems* (John Wiley & Sons, 2005); K. Menkhaus, "State Fragility as a Wicked Problem," *PRISM* 1, no. 2 (2010), 85–100.

the steady state because no single organization is given priority to lead until there is a crisis. Collaboration between relatively autonomous USG agencies enables a layering of authorities, experience, and institutional knowledge to frame nuanced options to support comprehensive action and policy.[60] As Brigadier General Terence J. Hilder said, "The root issue of interagency woes is the absence of an effective interagency process to drive policy integration and synergy within the departments of the Executive Branch."[61] Based on the outlined conditions we see a need for enhanced interagency collaboration prior to a crisis; therefore, we developed our research statement and narrowed our scope of research to counterproliferation efforts in the steady-state.

I. RESEARCH STATEMENT AND QUESTIONS

Might a formal collaborative process enhance U.S. counterproliferation (CP) efforts? In exploring this, several nested research questions arose:

1. How can the interagency improve its collaboration?
2. Do collaboration processes overcome some aspects of organizational stove-piping?
3. What type of collaboration process would be useful to enhance U.S. counterproliferation efforts?
4. How can we measure the results of the collaboration process?
5. What are the results from the collaboration process?
6. Can a formal collaboration process change attitudes towards cooperation and information sharing.
7. Can a formal collaboration process introduce opportunities for broader and longer-term changes required across the counterproliferation community of practice?

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[60] D. McGregor, "The Human Side of Enterprise," *Reflections* 2, no. 1 (1966): 6–15; E. L. Trist, "Collaboration in Work Settings: A Personal Perspective," *Journal of Applied Behavioural Sciences* 13 (1983): 268–278; Barbara Gray, *Collaborating: Finding Common Ground for Multiparty Problems* (Jossey-Bass, 1989); Barbara Gray and D. J. Wood, "Collaborative Alliances: Moving from Practice to Theory," *Journal of Applied Behavioral Science* 27, no. 2 (1991): 3–22; S. Allison, D. Mackie, and D. Messick, "Outcome Biases in Social Perception: Implications for Dispositional Inference, Attitude Change, Stereotyping, and Social Behavior," *Advances in Experimental Social Psychology* 28 (1996): 53–93.

[61] Terence J. Hildner, "Interagency Reform: Changing Organizational Culture through Education and Assignment," Army War College, Carlisle Barracks, PA, March 2007.

8. What role does third-party enforcement play in fostering IA collaboration?

9. Does language matter? Can a process grounded in academic vocabulary transcend the broad range of departmental terminologies?

10. What is the degree of risk posed to WMD proliferation of the growing adoption of additive manufacturing capabilities?

J. SCOPE OF RESEARCH

This research describes the enhancement of collaboration to better support counterproliferation in the "steady state." Counterproliferation is a subset of countering weapons of mass destruction (CWMD) and is an expansive and diverse function, spanning the elements of U.S. national power—diplomatic, information, military, economic, financial, intelligence, and law enforcement (DIMEFIL)—and it permeates through the entire IA. IA efforts to coordinate, cooperate, and collaborate to counter the proliferation of WMD materials and technologies reside largely in the steady state. "Steady state" refers to a system in equilibrium. It is a widely used term in economics, electrical engineering, chemistry, physics, government, medicine, and many other fields to indicate a stable condition that remains "constant over time, but that constant state requires continual work."[62] With respect to the scope of counterproliferation, we have limited our spectrum of study to the steady state, rather than crisis response, which has received considerably more attention.[63]

Instead of examining current or past proliferation technologies with associated U.S. policy, we elected to examine additive manufacturing as a disruptive innovation that may lower the barrier for entry for restricted nuclear technology and materials. This technology has the potential to increase the speed of proliferation by networking communities of expertise together. In online open-source communities, groups of experts can convene discussions with relative anonymity. Cryptocurrencies can be used to transfer funds between organizations online, challenging threat finance and enforcement agency efforts to track large sums of money used by proliferation networks and

[62] Jason Steele, "Steady-state Vs. Equilibrium in Biology," *SeattlePi*, 2015, http://education.seattlepi.com/steady-state-vs-equilibrium-biology-6085.html.

[63] A. J. Ryan, "Interagency Collaboration by Design," *InterAgency Journal* 3, no. 3 (2012): 21–30.

transnational criminal organizations (TCO).[64] Do-it-yourself biologists can conduct unrestricted experiments. Developments in additive manufacturing move forward at a pace where the government security apparatus cannot maintain awareness; given Goodwin's prediction regarding 3D printed WMDs within a decade, U.S. adversaries may soon have the ability to print a nuclear weapon.[65] Additive manufacturing technologies will increasingly challenge export-control policies and make it difficult for counterproliferation professionals to track WMD supply-chain patterns.

Our research analyzes how the interagency may collaborate to dissuade, deter, deny, disrupt, degrade, or defeat an adversary of the United States who plans to acquire and use WMD.[66] More specifically, we operationalize the term "collaboration" by arguing that there are three necessary dimensions to the concept: transparency, resource sharing, and interdependence. We then explore the use of a formal collaborative process to facilitate collaboration among two or more USG organizations. Similarly, we develop and assess the impact of venue upon the degree of collaboration observed. We tentatively support our claim with field exercises that show how a formal collaboration process can enhance steady-state counterproliferation efforts through increased transparency, resource sharing, and organizational interdependence.

K. OUTLINE OF PROJECT

The document proceeds as follows. We begin with a review of the sizable literature that seeks to explain collaboration. This work spans the disciplines of organizational theory, managerial economics, as well as political science.

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[64] Howard Altman, "SOCOM Tracking Money That Funds Violent Extremists," *TBO-The Tampa Tribune*, March 29, 2015, http://www.tbo.com/list/military-news/altman/socom-tracking-money-that-funds-violent-extremists-20150329/.

[65] Michael Lucibella, "Manufacturing Revolution May Mean Trouble for National Security," APS News, March 2015, http://www.aps.org/publications/apsnews/201504/revolution.cfm.

[66] Collaboration differs from cooperation, which is defined as "agreed resource exchange," which is not necessarily reciprocal or directed toward a common goal (Thomson and Perry, 2006). Coordination is a deconfliction of the use of time and space. Collaboration, cooperation, and coordination are all necessary in interagency partnerships.

Then, we formulate arguments as to how IA collaboration can be improved using business models and techniques. More specifically, we draw from best business practices of high tech industry; the "integrated product teams" within these companies draw together disparate divisions across the firm to work on a common problem. We mimic this approach by utilizing a custom-built formal collaborative process called Opportunity Analysis (OA). Further, we make arguments concerning the venue in which collaboration is attempted.

We then describe and analyze the results of a field exercise conducted at the U.S. embassy in Singapore. Initial outcomes are measured through the collection of qualitative data gleaned from participant responses to ascertain whether the dimensions in our model increased or decreased due to the formal OA process. Further analysis of participant's ongoing processes and interactions produced evidence of whether the existing collaboration, regularly conducted by the CPWG, was enhanced or not.[67]

Drawing from the conclusions of our research, we make recommendations for expanding awareness of the counterproliferation mission space, including ways DOD can serve in a number of supporting roles to IA partners.[68] Several examples of such recommendations are:

- Concerted efforts are required to find and utilize a common vocabulary among interagency participants.
- There exists a need for increased outreach to the interagency counterproliferation community of practice.
- A virtual collaboration space for the counterproliferation community that exists on a single platform to permeate the variety of classified and unclassified networks.
- Institutionalization of a formal collaborative process across the U.S. Interagency.

[67] Department of State, "Embassy Singapore Finds Value in Use of Interagency Opportunity Analysis to Tackle Complex Issue," cable, September 23, 2015.

[68] In doing so, we seek to directly support the 2015 SOCOM CDR guidance to expand awareness of CWMD functions across the IA to better determine how, collectively, mission enablers can be applied to defeat the nation's adversaries.

Nuclear weapons pose an existential threat to the United States. Improved collaboration reveals opportunities to identify threats posed by disruptive innovations. Improvements to transparency, interdependence, and resource sharing mitigate vulnerabilities across institutional seams. The cost of unimproved collaboration, accepting the way we currently do business in the IA, could be catastrophic. We now turn to the concept of "collaboration," defining it, examining theories of collaboration, and finally crafting a rigorous operationalization of it to discipline the remainder of our analysis.

II. EXISTING LITERATURE ON COLLABORATION

There are copious writings regarding inter-organizational behavior in the private and public sectors that provide the foundation for our exploration of interagency collaboration. First, we set out to define collaboration as it pertains to our effort. We then distill the literature and separate it into two veins that best capture the dynamics under study here: the impact of lack of information and the impact of divergent interests. The first approach explores the role of information in allowing increased collaboration when distributional conflicts are absent. The second approach examines bureaucratic politics and theories of organizational culture that focus on divergence of actor preferences and how the resulting competition may inhibit effective interagency collaboration. The combination of these theoretical approaches provides a more complete picture of foundational challenges to collaboration. We then operationalize the concept by focusing on three primary dimensions of collaboration: *transparency*, *resource sharing*, and *interdependence*.

A. DEFINING COLLABORATION

There are many definitions of collaboration to be found within the broad literature on the subject. Barbara Gray offers her definition as, "Collaboration is a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible."[69] Reflecting on the need to collaborate in order to overcome wicked problems, Denning states, "Collaboration is a synergistic coordination in which the collaborators create new [observations], new possibilities, new futures, and new concerns."[70] We find Lindon's definition for collaboration the most useful basis for our analysis: "when people from different organizations (or units within one organization) produce something

[69] Gray, *Collaborating: Finding Common Ground*. 5.

[70] Peter Denning. "Resolving Wicked Problems through Collaboration." In Handbook of Research on Socio-technical Design and Social Networking Systems, edited by Brian Whitworth and Aldo De Moor. Vol. 2.(Hershey, NY: Information Science Reference, 2009), 721.

together through joint effort, resources, and decision making, and share ownership of the final product or service."[71] Stemming from this definition, we focus on three dimensions of collaboration: transparency, resource sharing and interdependent action. In other words, what become important are actors creating a "collaborative advantage" to overcome vulnerabilities from a lack of transparency, resource sharing and interdependent actions.[72]

There are many ways to describe the foundations of how and why individuals and groups choose to collaborate. We developed our core approach through the lens of microeconomics. The first component that emerges within this approach is the importance of information.[73] Uncertainty from a lack of information can serve to create friction between groups, even when a common goal is desired. The second component is incentives; the impact on actor behavior which stems from the relative distribution of material resources amongst the actors.[74] We now examine each of these two factors in turn before building a rigorous operationalization of the concept.

B. THE ROLE OF INFORMATION

The "lack of information" approach can be conceptualized as a coordination problem. Rational actor models are based on the notion of actors being in a stable equilibrium in which no actor has a unilateral incentive to defect (change strategies).[75] Given that games can have multiple equilibria, there may be conditions under which a 'Pareto superior' outcome becomes attainable—defined as one in which every actor would experience absolute gains.[76] In such conditions, transparency among actors could

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[71] Russell M. Lindon, *Working Across Boundaries*, San Francisco, CA: John Wiley & Sons, Inc. (2002), 7.

[72] Chris Huxham, *Creating Collaborative Advantage* (Thousand Oaks, CA: Sage Publications, 1996).

[73] Anthony Downs, *Inside Bureaucracy* (Little, Brown, and Co., 1967), 9–10.

[74] David Kreps, *Microeconomic Foundations I: Choice and Competitive Markets* (Trenton, NJ: Princeton University Press, 2012).

[75] See the attributes of the Nash equilibrium concept in Robert Gibbons, *An Introduction to Applicable Game Theory* (Princeton University Press, 2007).

[76] Powell, "Absolute and Relative Gains."

allow them to coordinate on the new, superior outcome, with no distributional gains issues. The question then is what inhibits the appropriate level of information sharing?

We can conceive of this conscious limiting of information flows as strategic games that actors play against rivals, as well as their political overseers.[77] This may include such information as how much budget is needed to accomplish tasks, how well it is performing, and what issues it is suited to tackle. Because of these dynamics, actors often fail to share the types of information amongst themselves that would allow for joint gains from collaboration. The "message distortion problem," for example, makes transparency a critical issue and a challenge to collaboration.[78] Leaders must wade through vast amounts of information to identify what is accurate and relevant for decision-making, but the act of sharing information through collaboration with adjacent agencies is impaired by limited visibility of information within individual organizations. Compounding this, the nature of bureaucracies is to limit external communications out of fear of exposing poor internal behavior, failures, or the true costs for the organization to execute its mission.[79] Information flow and unfettered communication, therefore, present a fundamental challenge to collaboration among such entities.

In response to these challenges, a range of trust-based literature informs our approach to information sharing.[80] Trust may evolve from interactions between two or more parties where transaction costs and reputation are critical in determining levels of

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[77] A. Dixit and Nalebuff, *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life* (W.W. Norton & Company, 1993); R. L. Rife, *Defense Is from Mars, State Is from Venus: Improving Communication and Promoting National Security* (Carlisle Barracks, PA: Defense Technical Information Center, 1998); N. Roberts, "Wicked Problems and Network Approaches to Resolution," *International Public Management Review* 1, no. 1 (2000), 1–9; D. Cohen and L. Prusak, *In Good Company: How Social Capital Makes Organizations Work* (Cambridge, MA: Harvard Business Press, 2001); T. Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (New York, NY: Harper Collins, 2009).

[78] Downs, *Inside Bureaucracy*, 9.

[79] William A. Niskanen, *Bureaucracy and Representative Government* (Chicago: Aldine, Atherton, 1971).

[80] N. Coleman, *Foundations of Social Theory* (Belnap Press, 1994); R. Hardin, *Trust* (Cambridge, U.K.: Polity Press, 2006); T. C. Schelling, *The Strategy of Conflict* (Harvard University Press, 1981); O. Williamson, "Calculativeness, Trust, and Economic Organization," *Journal of Law and Economics* 36, no. 1 (1993): 453–486.

collaboration.[81] In organizational trust relationships, strategic alliances—where actors cooperate rather than acting opportunistically—form to pursue mutually beneficial goals.[82] Unlike personal relationships, inter- and intra-organizational relationships can presume trust; category-based trust, which is grounded on a trustee's membership in an organization, facilitates this.[83] Role-based trust, also presumptive, is based on an individual's role in an organization.[84] These forms of trust provide insight into interagency efforts to collaborate across the shared counterproliferation mission space. There are indications of informal trust networks among hierarchical organizations where key stakeholders find value in collaborative relationships.[85] We utilize the insights from this literature in the shaping of our arguments in the next sections.

C. THE ROLE OF INTERESTS

The "divergent interests" approach examines conditions where, even if complete information is achieved, competing interests may hinder collaboration among actors. This is known as distributional conflict.[86] The likelihood of competing interests and skill sets has the potential to foster competition rather than collaboration, which may be beneficial,

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81 Gregory A. Bigley and Jone L. Pearce, "Straining for Shared Meaning in Organization Science: Problems of Trust and Distrust," *Academy of Management Review* 23, no. 3 (1998): 405–21; Roderick M. Kramer, *Trust in Organizations: Frontiers of Theory and Research* (Thousand Oaks, CA: Sage Publications, 1996).

82 T. K. Das and B. S. Teng, "Between Trust and Control: Developing Confidence in Partner Cooperation in Alliances," *Academy of Management Review* 23, no. 3 (1998): 491–512.

83 Roderick M. Kramer, "Trust and Distrust in Organizations: Emerging Perspectives, Enduring Questions," *Annual Review of Psychology* 50 (1999): 569–598; J. Orbell, R. Dawes, and P. Schwartz-Shea, "Trust, Social Categories, and Individuals: The Case of Gender," *Motivation and Emotion* 18, no. 2 (1994).

84 B. Barber, *The Logic and Limits of Trust* (New Brunswick, NJ: Rutgers University Press, 1993); R. M. Dawes, *House of Cards: Psychology and Psychotherapy on Myth* (Free Press, 1996); Kramer, "Trust and Distrust in Organizations."

85 Tharsi Taillieu, *Collaborative Strategies and Multi-Organizational Partnerships,* Leuven: Garant, 2001.; Cunningham et al., *Too Big To Fail: The U.S. Government Counter Weapons of Mass Destruction Enterprise* (Monterey, CA: NPS Press, 2014).

86 Powell, "Absolute and Relative Gains"; R. Axelrod and R. Keohane, "Achieving Cooperation under Anarchy: Strategies and Institutions," in *Neorealism and Neoliberalism: The Contemporary Debate,* ed. David Baldwin (Columbia University Press, 1993); Y. Ben-Haim, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd ed. (Academic Press, 2006); Naoki Rhee Ando and Dong Kee, *Antecedents of Interorganizational Trust: Joint Decision-Making, Cultural Adaptation, and Bargaining Power* (2001), http://www.freepatentsonline.com/article/Journal-Asia-Business-Studies/201494947.html; Schelling, *Arms and Influence*.

depending on the nature of the issue.[87] The two main factors that lead to such competition are bureaucratic politics and differences in organizational cultures.

The "bureaucratic politics" literature focuses on the inherent nature of bureaucratic entities to compete over budgets, authorities, and relative prestige.[88] Simply stated, interagency organizations in the steady state may have nothing to gain by cooperating.[89] The result is a lack of motivation to collaborate unless the forcing function of an exogenous event, such as a crisis, is introduced.[90] Anthony Down's seminal work on these organizations identifies the fundamental characteristics of bureaucratic behavior and how these traits create challenges for the nimble interagency collaboration necessary to counter novel emerging threats.[91] More specifically, mature interagency institutions naturally exhibit inertia; leaders within these organizations have been acculturated and incentivized to both adhere to the entities' original missions and view the environment through the organizations' value structures. Such linear thinking creates independent organizations that are not incentivized to creep outside their respective "lanes." These lanes promote priorities for each agency, which then receive the greatest allocations from budgets, resources, and individual efforts.

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87 Lindblom, "The Science of Muddling Through"; Hocevar, Jansen, and Thomas, "Inter-Organizational Collaboration: Addressing the Challenge"; Ryan, "Interagency Collaboration by Design"; L. Blanken and J. Lepore, "Unpacking the Various Meanings of Redundancy: From Refining the Concept to Military Planning," In *Defense and Security Analysis*, vol. 28:4 (2012), 326–342.

88 William A. Niskanen, *Bureaucracy and Representative Government* (Aldine Transaction, 2007); G. Allison and M. Halperin, "Bureaucratic Politics: A Paradigm and Some Policy Implications," *World Politics Vol. 24, Supplement: Theory and Policy in International Relations* (1972), 40–79; R. Axelrod, *The Evolution of Cooperation* (New York, NY: Basic Books Inc., 1984); R. Axelrod, *The Complexity of Cooperation* (Princeton, NJ: Princeton University Press, 1997); B. Skyrms, *The Dynamics of Rational Deliberation* (Cambridge, MA: Harvard University Press, 1990); Dennis D. Riley and Bryan E. Baermann, *Bureaucracy and the Policy Process: Keeping the Promises* (Lanham, MD: Rowman & Littlefield, 2006); Tatsuro Ichiishi, *Cooperative Extensions of the Bayesian Game* (New Jersey: World Scientific, 2006); N. Roberts and R. T. Bradley, "Stakeholder Collaboration and Innovation: A Study of Public Policy Initiation at the State Level," *Journal of Applied Behavioral Science* 27, no. 2 (1991): 209–227; Hocevar, Jansen, and Thomas, "Inter-Organizational Collaboration: Addressing the Challenge"; Ryan, "Interagency Collaboration by Design."

89 R. B. Myerson, "Nash Equilibrium and the History of Economic Theory," *Journal of Economic Literature* 36 (1999), 1067–1082.

90 Roberts and Bradley, "Stakeholder Collaboration and Innovation"; Ryan, "Interagency Collaboration by Design."

91 Anthony Downs, *Inside Bureaucracy* (Little, Brown, and Co., 1967).

A new issue that represents a potential threat but does not fall within any agency's priorities rests in the seams between agency lanes.[92] Beyond the simple "quest for increased budget" story often emphasized by the bureaucratic politics literature, the study of organizational culture, conversely, examines intrinsic and extrinsic reasons for distributional conflict between actors.[93] The competing values framework outlines how organizational cultures develop based on internal and external factors.[94] Internal need for control, in contrast with decentralization of authority, breeds differences in how individuals within the organization interact. Driven by external requirements, organizations differ on the value of unconstrained creativity versus durability and accountability.[95] Cultural differences serve to exacerbate distributional conflict by increasing the perceived relative-gains dilemma while simultaneously reducing effective communication between actors. Differences in lexicon can complicate even simple communication between interagency partners, and having been socialized within individual agencies, organizations may view one another as rivals due to differing visions

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[92] See, for example, Morton Halperin's concept of "organizational essence" in his work *Bureaucratic Politics and Foreign Policy* (Washington, DC: Brookings Institute Press, 1974).

[93] F. Heidler, "Social Perception and Phenomenal Causality," *Psychological Review* 51 (1944), 358–374; Powell, "Absolute and Relative Gains"; S. P. Robbins and T. A. Judge, *Essentials of Organizational Behavior* (Saddle River, NJ: Prentice Hall, 2001).

[94] K. S. Cameron and R. E. Quinn, *Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework* (San Francisco, CA: Jossey-Bass, 2011).

[95] J. R. Hackman and G. R. Oldham, "Motivation through the Design of Work: Test of a Theory," *Organizational Behavior and Human Performance* 16, no. 2 (1976), 250–279; M. Weber, *Economy and Society*, ed. C. Wittich (Berkley, CA: University of California Press, 1978); Massarik, "Collaboration in Organizations"; H. Mintzberg, *In and Around Organizations* (Englewood Cliffs, NJ: Prentice Hall, 1983); C. B. Perrow, *Complex Organizations: A Critical Essay* (New York, NY: McGraw Hill, 1986); J. P. Kotter and J. L. Heskett, *Corporate Culture and Performance* (Free Press, 2011); A. D. Smith and C. Zeithaml, "Garbage Cans and Advancing Hypercompetition: The Creation and Exploitation of New Capabilities and Strategic Flexibility in Two Regional Bell Operating Companies," *Organization Science* 7, no. 4 (1996): 388–399; C. J. Hill and L. E. Lynn Jr., "Is Hierarchical Governance in Decline? Evidence from Empirical Research," *Journal of Public Administration Research and Theory* 15 no. 2 (2004): 173–195; V. H. Vroom, *Work and Motivation* (New York, NY: McGraw Hill, 1994); C. Anderson and C. E. Brown, "The Functions and Dysfunctions of Hierarchy," *Research in Organizational Behavior* (2010), doi:10.1016/j.riob.2010.08.002.; T. E. Dolan, "Revisiting Adhocracy: From Rhetorical Revisionism to Smart Mobs," *Journal of Future Studies* 15, no. 2 (2010), 33–50; G. Jones, *Organizational Theory, Design and Change* (Saddle River, NJ: Prentice Hall, 2010); L. J. Schimmoeller, "Leadership Styles in Competing Organizational Cultures," *Leadership Review* 10 (2010), 125–141; J. Greenberg, *Behavior in Organizations, Student Value Edition*, 10th ed. (Upper Saddle River, NJ: Prentice Hall, 2011).

of strategy and policy based on cultural norms and perceived competition.[96] These factors can make interagency collaboration tricky at best.

Clashing interests create the largest barrier to collaboration amongst IA partners. As we will explore below, some of aspects of divergent incentives may be beyond the scope of our analysis to remedy (for example, competition over budget). Some impacts of divergence may be malleable, however, within the scope of our analysis. For example, the cultural driver of divergent interests may be ameliorated through the process of collaboration that is chosen, as well as within the venue that is selected. Further, including actors from multiple levels of authority may assist in reducing the real – or perceived – differences of interest that may exist amongst bureaucratic entities.

D. OPERATIONALIZATION OF COLLABORATION

To operationalize collaboration for this study we identified three dimensions with measurable indicators. These dimensions are transparency, resource sharing and interdependence.[97] We argue that each is a necessary condition for true collaboration, and we build a rigorous operationalization of the concept to discipline our coding of collaborative efforts (see Appendix A).

The first dimension of collaboration is transparency. Increased transparency can serve to overcome issues that arise from a lack of information and leads to increased trust between actors. The interagency can be described as a system of what Litterer would define as "task or work groups" where bounded rationality inhibits communication and information sharing, but "relationships and processes are key."[98] Increased willingness to

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[96] Maryan Rodriques, *Effective Business Communication* (Concept Publishing Company, 2003); E. Lank, *Collaborative Advantage: How Organizations Win By Working Together* (Palgrave Macmillan, 2006);

S. K. Mandal, *Effective Communication & Public Speaking* (Jaico Publishing House, 2006).

[97] Stephen G. Haines, *System Thinking & Learning*, Amherst, MA: HRD Press (2000); Peter M. Senge. *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York, N.Y.: Doubleday/Currency, 1990.

[98] Joseph A. Litterer, *The Analysis of Organizations*, New York, N.Y.: John Wiley & Sons, Inc. (1973) 52, 233–235; Herbert Simon, "Rational Decision Making in Business Organizations." (Nobel Memorial Lecture), *American Economic Review* 69, no. 4 (1979): 493–513; Haines, *System Thinking & Learning*, 31.

share information, veracity of information and the speed it is delivered increases transparency and shared knowledge between groups.[99] Therefore, increased transparency is something that should be observed in collaboration

The second dimension of collaboration is resource sharing. Edith Penrose's contribution to the resource-based view of strategic management provides greater understanding of the inherent challenges to inter-organizational sharing of resources.[100] Component distinctions are made between services, physical assets, time, and human capital within the model. Each organization's goal of creating and/or maintaining a competitive advantage through firm-specific isolating mechanisms can be beneficial to gaining dominance within the private sector, but present challenges to efficient collaboration in nonprofit, public sector engagements.[101] The prioritization of resources is dependent on desired outcomes. Therefore, when organizations contribute precious resources to a joint effort, this is an instantiation of collaboration.

The third dimension of collaboration is interdependence. This refers to the degree to which an organization is willing to stake its fortunes or reputation to a joint decision, effort, or outcome. In other words, it is the degree of risk an organization is willing to assume in order to attain desired collaborative outcomes.[102] When organizations are willing to tie their bureaucratic fortunes to outcomes that are the result of joint effort, then, we argue, collaboration is being observed.

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[99] Karl E Weick., and Karlene H. Roberts, "Collective Mind in Organizations: Heedful Interrelating on Flight Decks." *Administrative Science Quarterly*: 357; Peter M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization*. New York, N.Y.: Doubleday/Currency, 1990.

[100] Edith Tilton Penrose, *The Theory of the Growth in the Firm*, Oxford, England: Blackwell, 1959.

[101] Bindu Arya and Zhiang Lin. "Understanding Collaboration Outcomes From an Extended Resource-Based View Perspective: The Roles of Organizational Characteristics, Partner Attributes, and Network Structures." *Journal of Management*, (2007), 697–723.

[102] Sandra Murray and John G. Holmes, *Interdependent Minds: The Dynamics of Close Relationships*. New York, NY: The Guilford Press, 2011.

E. CONCLUSION

The purpose of this literature review is to utilize insights from the relevant bodies of work to examine methods and environments that can optimize networks, organizational structures, and inter-organization collaboration in support of the CWMD mission in the steady state. This requires identifying processes that promote cooperation and laying out the costs and benefits of each.[103] Drawing from existing processes that seek to gain collaborative solutions, we utilize a formal process to overcome the steady-state gap in collaboration that exists when there is no emergent crisis.[104] Further examination of current interagency frameworks supports identifying extant environments where a collaboration model could be immediately useful.[105] The following section explores insights from the private sector regarding collaboration to formulate some insights as to how the use of a formal collaborative process and the venue in which the process is utilized may lead to the enhancement of collaborative outcomes.

[103] Rife, *Defense Is from Mars*; Cohen and Prusak, *In Good Company*; B. J. Andersen and Tom Fagerhaug, *Root Cause Analysis: Simplified Tools and Techniques*, 2nd ed. (Asq Quality Press, 2006); Thomas, Hocevar, and Jansen, *A Diagnostic Approach to Building Collaborative Capacity in an Interagency Context* (No. NPS-GSBPP-06-013), (Naval Postgraduate School Monterey, CA: Graduate School of Business and Public Policy, 2006); Brown, *Change by Design*; Ryan, "Interagency Collaboration by Design"; N. Roberts, "A Design Approach to Wicked Problems," paper presented at the 10th International Conference of the Triple Helix, University of Bandung, Indonesia, 2011; S. Doorley and S. Witthoft, *Make space: How to Set the Stage for Creative Collaboration* (Hoboken, NJ: John Wiley & Sons, 2012); T. Seelig, *inGenius: A Crash Course on Creativity* (New York, NY: HarperOne. Stanford Center for Professional Development, 2012).

[104] Opportunity Analysis is a formal collaborative process designed and facilitated from the Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological, CWMD Systems Portfolio

[105] S. Dorman, *Inside a U.S. Embassy: How the Foreign Service Works for America*,

2nd ed. (Washington, DC: American Foreign Service Association, 2005).

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III. LESSONS GLEANED FROM THE MARKETPLACE ABOUT THE UTILITY OF A FORMAL COLLABORATIVE PROCESS

> An organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive advantage.
>
> —Jack Welch[106]

A. INSIGHTS FROM THE PRIVATE SECTOR

We borrow from emerging business models to identify how firms overcome collaboration challenges. The use of private-sector models to analyze bureaucracies is an emerging mode of inquiry that provides crucial insights. As observed by Alexander Cooley, "both economic firms and political hierarchies are forms of complex social organization that, when organized, administered, or delegated according to similar logics, will face common problems and challenges … by applying [a] firm-type model to political settings, one can better understand how individual administrators, regardless of their exact functions … will behave."[107] Therefore, to meet the challenge of scoping the complex problem of collaborative interagency responses to counterproliferation into a manageable system for analysis, we have applied some tools from microeconomics.[108] More specifically, the emerging field of organizational economics has been tailored to fit the needs of this problem set. As Robert Gibbons notes, "Economic models that take their underlying assumptions seriously must deliver a post-Weberian view of organizations: rule violations, unimplemented decisions, subverted inspections, parochial interests, and

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[106] Jack Welch. BrainyQuote.com, Xplore Inc, 2015. http://www.brainyquote.com/quotes/quotes/j/jackwelch173305.html, accessed December 7, 2015.

[107] Alexander Cooley, *Logics of Hierarchy: The Organization of Empires, States, and Military Occupations* (Cornell University Press, 2005), 7.

[108] Gregory N Mankiw, *Principles of Microeconomics* (Mason, OH: South-Western Cengage Learning, 2012).

undermined missions will be persistent problems, not exceptions."[109] These are the precise aspects of bureaucratic organizations put under the microscope here.

Meeting the current counterproliferation challenge relies on disparate, specialized, well-meaning actors working in parallel toward a common goal.[110] The result, however, is an exponential number of complicated scenarios and outcomes dependent on any number of actors who may or may not collaborate. Regularly, actors work apart and without knowledge of complementary or parallel efforts.[111] At other times, competition creates friction when agencies attempt to obtain relative gains, to the detriment of the common goal.[112] The complex nature of business can be described in the same fashion. Inside large organizations, departments work individually due to the efficacy of discipline specialization.[113] To overcome structural faults within the company, managers may implement policies that drive individual departments to work together toward a common goal.[114] We have used these private-sector insights from the "lean thinking" management approach to better understand the complexity of emerging WMD threats.[115] More specifically, thinking of collaborators as integrated teams, and conceiving of the collaboration process as a series of "inputs" and "outputs" sets the stage for the use of the formal collaborative process.

The chapter proceeds as follows. We utilize insights from the private sector to reconsider the "inputs" and "outputs" of the counterproliferation effort. We then

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[109] Robert Gibbons, "Team Theory, Garbage Cans and Real Organizations: Some History and Prospects of Economic Research on Decision-Making in Organizations," *Industrial and Corporate Change* 12, no. 4:756.

[110] William W. Mendel and David G. Bradford, *Interagency Cooperation: A Regional Model for Overseas Operations* (Fort McNair, Washington, DC: National Defense University Institute for National Strategic Studies, 1995).

[111] National Commission on Terrorist Attacks, *9/11 Commission Report.*

[112] Powell, "Absolute and Relative Gains"; Eben Kaplan, "Examining Counterterrorism Culture," Council on Foreign Relations, November 6, 2006.

[113] Carlos J. Jarillo, "On Strategic Networks," *Strategic Management Journal* 9, no. 1 (1988): 31–41.

[114] Alfred D. Chandler, *Strategy and Structure: Chapters in the History of the American Industrial Enterprise* (MIT Press, 1969); Oliver E. Williamson and Sidney G. Winter, eds., *The Nature of the Firm: Origins, Evolution, and Development* (Oxford University Press, 1993).

[115] James P Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, (New York, NY: Simon and Schuster Inc, 1996).

introduce "Opportunity Analysis" as a formal process that seeks to enhance collaboration. We then explore the impact of venue on collaboration: how environmental factors may influence the degree of collaboration observed. Finally, we lay out a research design that will allow us to empirically assess the arguments we have generated in this chapter.

B. THE UTILITY OF INTEGRATED TEAMS

One strategy for overcoming the challenges of multidiscipline teams comes from companies developing new integrated technology.[116] High-technology markets often employ integrated product teams (IPTs) to collaborate to identify root causes or potential failures before, during, and after systems are designed.[117] IPTs can resemble multidisciplinary integrated IA counterproliferation working groups so the analysis of IPTs is relevant to the development of IA collaboration strategies. IPTs include engineers, marketers, financial managers, accountants, designers, and manufacturers (among others) to lower overall costs by reducing friction and mitigating potential failure. Such teams facilitate communication, the oversight of partner requirements, and locate waste from identical cost drivers. IPTs incorporate and share lessons learned to raise awareness of existing and parallel efforts within the company. The net effect is increased consideration of complementary requirements, bolstered communication, and cooperation to effectively reduce the time and cost to find solutions to complex issues.[118] Understanding how IPT's improve collaboration assists in analyzing interagency challenges posed by bureaucratic politics, a lack of information, or competing organizational cultures.

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116 Tyson R. Browning, "Process Integration Using the Design Structure Matrix," *System Engineering* 5, no. 3 (2002): 180–193.

117 Rene G. Rendon and Keith F. Snider, *Management of Defense Acquisition Projects: Project Management Concepts* (Reston, VA: American Institute of Aeronautics and Astronautics, Inc., 2008).

118 David S. Veech, *Manufacturing: Yesterday, Today and Tomorrow* (Lexington: University of Kentucky Center for Robotics and Manufacturing Systems, 2001).

C. RECONSTRUING THE "INPUTS/OUTPUTS" OF COLLABORATION

Drawing from best business practices of defense acquisition and the use of IPTs, we reconceive the process of collaboration (see Figure 2) to analyze the flow of counterproliferation missions within the IA system to identify where decision-making and problem-solving capabilities can be improved within a business context.[119] The value of this model is in characterizing the counterproliferation mission space in a novel manner that is appropriately simplified and scoped for interagency collaborative response.

A common approach to characterizing the flow of an organization's mission to seek improvement is the SIPOC model (Figure 2).[120] The method simplifies a complex system into a directional flow of basic steps to support analysis.[121] This "chunking" technique breaks down any system into five distinct parts: Suppliers, Inputs, Process, Outputs, and Customers (SIPOC). To demonstrate this concept relevant to the interagency, we have developed the Interagency CP Collaboration Concept Model (Figure 2). The model scopes what areas can be identified and addressed to improve outcomes. Importantly, it also identifies what areas are "out of scope" and potential aspects of the problem that are related and may need to be addressed at a later date.

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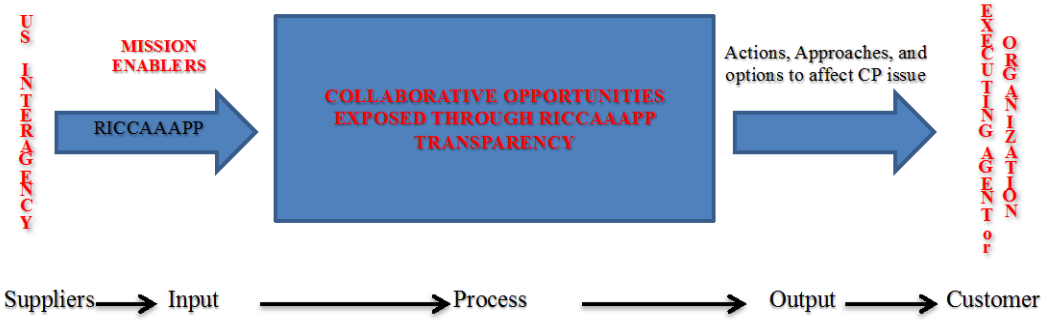
[119] The Governor's Office of Accountability & Performance**,** *Lean Transformation Report: 2012 and Beyond* (Washington, DC: GAO, 2012).

[120] Uday Apte, "Ops Management/LSS DMAIC Methodology."

[121] Ibid.

Figure 2. Interagency CP Collaboration Concept Model



Adapted from Uday Apte, "Ops Management/LSS DMAIC Methodology" (lecture, Naval Post Graduate School, Monterey, CA, September 3, 2015).

For our application to the counterproliferation system, the suppliers are the numerous and distinct agencies who contribute to U.S. counterproliferation efforts. The distinct mission enablers and specialties each agency contributes to the counterproliferation mission set are the inputs. When two or more agencies come together to identify how these inputs can be blended, this interagency collaboration is the process. The outputs of this process can be defined as military, political, law enforcement, intelligence, or other actions and policies that effect counterproliferation policy. Finally, the customer is those agencies carrying out actions or who may be affected, including but not limited to the executing agent or organization, the executives charged with accountability of the mission, and even the American public.

To overcome the gaps between agency lanes, collaboration allows agencies to address vulnerabilities through increased transparency, sharing of resources, and interdependent actions. With the emerging disruptive-technology challenge of upstream counterproliferation, coupled with its misalignment with traditional USG bureaucratic structures, interagency collaboration in the steady state is a crucial area of concern. The synthesis of relevant business literature has now set the stage for the introduction of a formal collaborative process as a response to the evolving proliferation threat.

D. INTRODUCING A FORMAL PROCESS: OPPORTUNITY ANALYSIS

Ad hoc collaboration, the present norm in the IA, suffers from limitations without the forcing function of crisis. There are instances of productive ad hoc interagency collaboration; however, these efforts are difficult to reproduce or sustain.[122] An effective collaboration process can overcome some aspects of organizational stove-piping. It can change attitudes toward cooperation and information sharing and introduce opportunities for the broader changes required across the counterproliferation community of practice. We seek to assess the impact of one such process here. Opportunity Analysis (OA) is a formal collaboration process that divides and analyzes complicated problems. It allows an interdisciplinary and multi-organizational team to analyze a problem set using unconstrained thinking, dialogue, and collaborative software. The process breaks down large, 'wicked' problems into digestible pieces. OA uses common language, predominately academic, to replace organization-specific jargon. It enables a diverse group to organize, communicate and operate in order to discover opportunities. These opportunities could be missed when relying on ad hoc collaboration alone.[123]

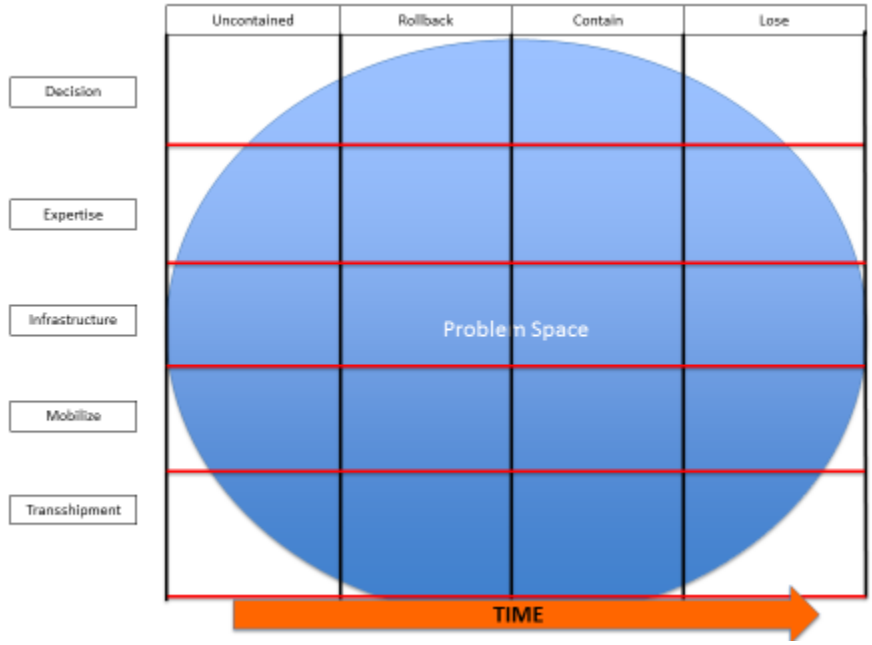
OA is grounded in the U.S. special operations pathway defeat (SOPD) methodology that was developed for planning the upstream defeat of WMD. This method accounts for the equities of each department or agency in the shared counterproliferation mission space. OA goes farther than SOPD by framing alternative futures and discovering opportunities to enable or prevent those futures. OA uses an alternative-futures pathway analysis with a nodal dissection technique to divide and analyze a problem. Through the OA process a team focuses on one alternative future at a time and looks for opportunities to create pathways for action. The nodal dissection technique

[122] *Merriam Webster,* s. v. "ad hoc."

[123] Scott et al., *Opportunity Analysis for U.S. Embassy Singapore: Additive Manufacturing as a Disruptive Technology and its Implications for WMD Proliferation,* (Washington, DC: OASD CWMD Systems, 2015).

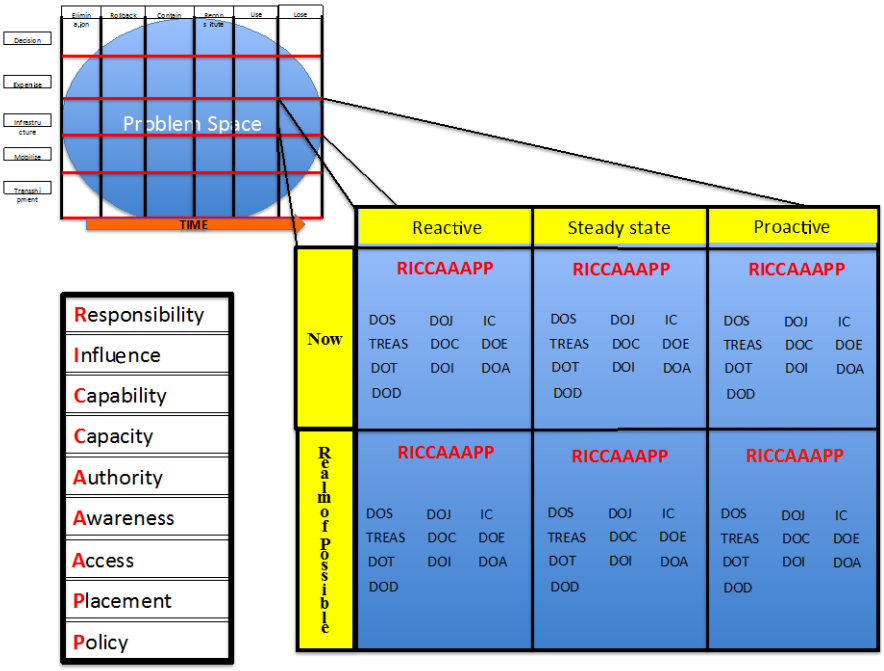
examples in Figures 3 and 4 illustrate how OA divides up the problem for a systematic analysis of each future and pathway.[124]

Figure 3. OA Nodal Dissection Technique Macro (Example)



[124] It is important to note that the terms included in Figures 3 and 4 are notional and tailored to the specifics of one field study. The attributes listed in Figure 4 (RICCAAAPP) were designed for USG interagency entities, but are flexible to other organizational frameworks as needed in future studies.

Figure 4. OA Nodal Dissection Technique Micro (Example)



The OA process enables enhanced collaboration between the participants by bringing a separate and distinctive approach to the application of the categories of RICCAAAPP. Each organization's RICCAAAPP (pronounced "recap") components, collectively known as Mission Enablers, are compared alongside other organizations' enablers to identify collaborative opportunities to more effectively approach a complex problem:

- **Responsibility**: Having the specific charge to execute a particular action.
- **Influence**: Ability to effect action through a third party to accomplish one or more of the above elements or to act independently to accomplish CWMD objectives.
- **Capability**: The explicit abilities of regional and global resources with CWMD-specific technical capabilities, training, equipment, and readiness.
- **Capacity**: The depth and sustainability of regional and global resources to provide a specific capability to support CWMD operations for the required time or cycles of operations.
- **Awareness**. Cognizance of an issue or opportunity, combined with the speed and agility to move the information required to coordinate and

collaborate across an array of interagency, regional, or global partners to enable rapid planning and engagement.

- **Authority**: The existence of legal authorities to carry out the required actions.
- **Access**: Physical access to the point of action.
- **Placement**: Ability to achieve access through organizational position or nontraditional means.
- **Policy**: Department, national or international strategies, guidelines, or norms that enable, or at least justify, a CWMD action, including treaties, agreements, regimes, and the like.[125]

In sum, OA parses out complex challenges in a manner tailored to the range of IA partners. By methodically taking into account the relevant attributes of the contributors, and matching them against the relevant aspects of the problem, it is reasonable to expect a significant increase in collaboration. Further, the nature of the process itself is designed to increase the flow of information, as well as to erode cultural barriers among participants—providing additional potential mechanisms toward increased collaboration.

E. THE IMPACT OF VENUE

Beyond the absence or presence of a formal collaboration process, we develop further arguments regarding the venue in which such efforts take place. In October of 2014, the OA methodology helped a cross-functional IA team in the NCR develop a strategy in support of U.S. CENTCOM. Based on our observations, develop explored the limiting conditions of the given venue. Would it be possible to enhance the effects of the formal process by altering the venue in three ways?

First, the participants in the NCR were physically close to their bureaucratic headquarters. It may be the case that the culture and pressures of their home organization could create a formidable challenge to collaboration, whereas physical distance from the NCR might lessen the effect. Secondly, the participants in the NCR OA exercise had no higher authority to facilitate, let alone enforce, collaborative policies. Perhaps a venue

[125] Scott et al., *Opportunity Analysis for U.S. Embassy Singapore.*

with an entity possessing some attributes of a third-party enforcer would allow for more profound levels of collaboration.

Finally, the participants of the NCR exercise did not know one another personally. Pre-existing personal relationships might similarly result in higher levels of collaboration. Based on these ruminations, the notion of an embassy team emerged as a venue to explore these arguments. The teams in embassies exist far from their organizations' headquarters, they exist under the authority of the ambassador, and they work in close proximity to one another for extended periods in close quarters. Some trade-offs, however, stemming from venue selection may be expected. For example, the dedication of organization resources to a common effort may be controlled above the level authority to be found in an embassy; the same may go for locking an organization's reputation to a joint decision. Therefore, we may expect the transparency dimension of collaboration to increase more sharply in an embassy venue, than the resource sharing or interdependence dimensions.

F. RESEARCH DESIGN

To explore these arguments regarding the use of formal collaborative processes and the venue of collaboration, we conduct an exploratory field study. Such field studies provide both limited deductive and inductive insights. In such studies "variables co-vary as expected but at are at extremely high or low values [that] may help uncover causal mechanisms. Such cases may not allow [strong] inferences to wider populations … but limited inferences might be possible if causal mechanisms are identified."[126] This fits the needs of the current study for a number of reasons. First, hypothesizing that the use of a formal process would increase collaboration among an inter-agency working group is intuitive. The potential interactive effects that such a process may produce in an already high-performing embassy team, however, might be significantly higher. The purpose, then, beyond recording the increase in collaboration (the causal "effect" of the study), will be to search for the pathways by which such a set of conditions produces such

[126] Alexander L. George and Andrew Bennett, 2005, *Case Studies and Theory Development in the Social Sciences* (Cambridge, Mass: The MIT Press), 75.

increased collaboration (the causal "mechanisms" of the study). Further, such mechanisms may emerge in unexpected ways, and the exploratory field study allows for such inductive results. Though inferences and generalizability from such a study may be limited, its results provide the springboard for further studies and tool refinement.

An embassy-level exercise was designed to fulfill the needs of the exploratory field study, as the application of the OA process to the embassy's pre-existing team of IA actors would allow for the methodology to operate. Though observing higher levels of collaboration is intuitive in this case, causal mechanisms might be uncovered, interaction effects might be revealed, and future research questions developed. To execute the study, we first sought to establish a "baseline" expected value of collaboration, grounded in the results of the CENTCOM exercise. We then developed a plan of qualitative data gathering, to include an extensive set of interview questions (see Appendix B) to match our operationalization of collaboration established above (see Appendix A).

G. CONCLUSIONS

In sum, we hypothesize that the introduction of a formal process and the careful selection of venue serve to increase IA collaboration. A field study to explore these arguments was planned and conducted at the U.S. embassy in Singapore using OA as the formal process. The resulting exploratory field study is presented in the following chapter.

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IV. EXPLORATORY FIELD STUDY: INTERAGENCY OPPORTUNITY ANALYSIS

> We can't control everything, but we can control how we organize, communicate, and operate.
>
> —Dr. John Arquilla[127]

Based on the arguments developed over the previous chapters, we now proceed to an assessment. Through an exploratory field study, we now analyze the degree to which a formal process, as well as venue selection, might improve collaboration among interagency actors. The following summarizes our analysis of the formal OA collaborative process applied to counterproliferation efforts in a U.S. embassy.

Within regard to venue selection, we sought a country team willing to perform a table top exercise (TTX) to determine if OA improved collaborative outcomes. Through coordination with Special Operations Command Pacific (SOCPAC), we identified the U.S. Embassy to Singapore. The Singapore counterproliferation working group (CPWG) routinely works regional counterproliferation issues and determined that OA could potentially enhance their efforts.[128] The CPWG closely resembles an industry integrated product team (IPT), where multidiscipline members collaborate regularly to tackle complex real-world problems. Each member possesses a unique culture, lexicon, mission, and internal processes. Each CPWG member represents the suppliers within the counterproliferation process. All members would bring specific mission enablers, or inputs, into a collaboration process. The outputs, or options, can then be counted and measured for improvement, either quantitatively or qualitatively. Using the ambassador as the customer, we can then measure how well these outcomes are received.

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[127] Arquilla, conversation with authors.

[128] The U.S. Embassy to Singapore's CPWG has regional responsibilities in Southeast Asia and at times brings participants into the working group from other embassies. For this TTX, the CPWG gained participants from Washington, DC, to inform the members on policy and global concerns. It consisted of DOS, FBI, DOE, DHS-HIS, DTRA, DOD (Defense Attaché and SOCPAC). Not present at the TTX but members of the CPWG were RA and Treasury.

We partnered with the Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs (OASD-NCB), Office of the Deputy Assistant Secretary of Defense for Threat Reduction and Arms Control (ODASD-TRAC), CWMD Systems portfolio to develop a TTX designed to measure gains in steady-state collaboration between the CPWG's regular ad hoc processes and the formal OA collaborative process identified in the Interagency CP Collaboration Concept Model. To draw interest and drive collaboration, we developed a scenario using additive manufacturing, the disruptive technology described above, to ascertain its implications for WMD proliferation. A fictional, yet plausible, scenario was developed in which the government of Singapore is unaware of a North Korean proliferation network that is 3D printing nuclear fuel-cycle components inside Singapore. Such a development would enable North Korea's nuclear weapons program to circumvent and potentially defeat current means of indication and warning; sanctions, watch lists, and export-control enforcement would be rendered obsolete.[129] The U.S. Embassy to Singapore allowed the CPWG to support our efforts.[130] We facilitated the TTX over a five-day period, with the CPWG producing options as a result of the formal collaborative process. At the conclusion of the TTX, we briefed the outcomes directly to the ambassador and his executive team specific to the TTX scenario.

This chapter proceeds as follows. First, we describe the TTX and summarize its results to demonstrate the broad, whole-of-government approach derived through the OA collaborative effort. Next, we focus on the degree of collaboration fostered during the exercise. More specifically, we walk through the impacts the formal process had on three dimensions of collaboration, as realized by observations of impact on levels of *transparency*, *resource provision*, and *interdependence* among the participants. We then conclude the chapter by highlighting dynamics of collaboration that emerged through the

[129] An information support package (ISP) was developed for this exercise, containing expert analysis of trends in government, industry, and academia to characterize what is currently achievable with AM in relation to WMD development and to define potential trajectories of the future as AM capabilities and expertise mature and become more prevalent. It was clear that the possibility of DPRK and other adversaries applying AM to development of nuclear, chemical, and biological weapons development exists.

[130] The exercise was facilitated and supported by OASD (NCB), NPS, DTRA, SOCPAC, and Lawrence Livermore National Laboratory.

exercise itself. These new insights provide refinement to our arguments, and may serve as the basis for future research on collaboration.

A. ACTIONABLE SOLUTIONS SPECIFIC TO THE SCENARIO

The NPS and ODASD team were invited to brief the Honorable Kirk Wagar, U.S. ambassador to Singapore, on the initial outcomes of the CPWG's efforts and counterproliferation TTX. Through OA, the CPWG developed 169 distinct options to shape steady state approaches to nefarious aspects of additive manufacturing. These themes combine as the basis of a strategy for the country team. Taken from the DOS cable, written in response to the TTX, Ambassador Wagar stated:

> The clear conclusion is that when it comes to steady-state counterproliferation engagement, whether it be additive manufacturing, WMD, or an over-the-horizon threat, in a whole-of-government approach, diplomatic, intelligence, and law enforcement agencies are well positioned to actively engage in a wide variety of efforts, with DOD playing a supporting—albeit important—role. Understanding this dynamic holds potential to greatly enhance strategic planning across integrated country and national strategies and the optimal sequencing and deployment of USG resources.[131]

The 169 options were first organized into the elements of national power (DIMEFIL) with the intent of demonstrating which organization might be responsible for taking lead for collaborative actions. Through this particular organization of efforts, we identified that only 8% were military led options. Of the options, 34% were diplomatic in nature, 8% were information or strategic communication options, 6% were economic options that fell outside of law enforcement, only 6% centered on finance efforts,[132] 18% fell under intelligence requirements,[133] and 21% would be led by law enforcement. The ambassador viewed many of these options as falling within the context of political

[131] Department of State, "Embassy Singapore Finds Value in Use of Interagency Opportunity Analysis to Tackle Complex Issue," cable, September 23, 2015.

[132] The Treasury officer was not able to participate. If he had been, there may have been a greater number of financial options, changing the resulting percentages.

[133] No representatives from the Director of National Intelligence participated in the TTX. If a representative had been present, there may have been a greater number of intelligence options, changing the resulting percentages.

decision-making noting, “Sixty percent had a diplomatic component (either traditional diplomacy or an intelligence/information sharing component) and 21% focused on the role of law enforcement.”[134] This distribution is noteworthy, as the makeup of the participating group was comprised of over 20% military members and yet the outcome clearly denotes Defense as a minority agency to take lead in steady state options – the direct point articulated by the USSOCOM Commander.[135]

Once lead agencies are determined through initial binning into DIMEFIL, we categorize the range of options into six activity themes. The six activity themes coalesce into a strategy to deal with over-the-horizon threats posed by additive manufacturing. Many of the options produced by the CPWG have application to more than one of the themes, creating interdependencies across the interagency framework and requiring increased transparency and shared resources. The six themes identified were 1) increasing education to establish and maintain awareness, 2) conducting outreach, 3) building capacity, 4) shaping policy, 5) establishing norms, and 6) enforcing those norms. Each theme contained factors of DIMEFIL, and while this strategy is specific to additive manufacturing in Singapore, it is also applicable to many other counterproliferation concerns for the Singapore country team.[136]

The first of the themes, increasing education to establish and maintain awareness, centered on improving understanding of potential positive additive manufacturing uses, characteristics of the industry, and potential negative applications related to WMD and proliferation. Identifying actors in the public, private, academic, and international sectors leads to the second theme of outreach. Critical is U.S. government-agency appreciation of private industry stakeholders, those developing additive manufacturing and its relative technology and equipment, to ensure cooperation and awareness of market sensitivities to overregulation.

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[134] Department of State, “Embassy Singapore Finds Value.”

[135] Votel, “White Paper: The Gray Zone,” 7.

[136] Ibid.

Outreach to industry leaders, government institutions, and agencies—including national laboratories, the intelligence community, international business, and government actors—must be tailored and approached through appropriate channels.[137] In this theme, transparency through unity of effort and message is crucial to evoking a positive response and willingness to support building capacity. Options to mitigate the threat posed by additive manufacturing can be developed by working with stakeholders to ensure equities are considered before regulation or actions are taken that could impact global markets.[138] Further, outreach can deepen IA ability to identify or develop indications and warnings that increase awareness and deepen understanding of rapidly developing technology.

Many institutions within the U.S. government build partner capacity, but no agency should do this unilaterally.[139] When efforts are not synchronized or deconflicted, partner forces become overtasked and oversaturated with training events and scope of responsibility. As observed by the CPWG, many of the same foreign units become the focus of a wide array of training and capacity-building programs. Often a result of personal relationships, foreign politics, or limited capacity of the host nation, capacity building can lead to a watering down of capability. Coordinated efforts, prioritized through the country team mission, can tailor capacity-building efforts and maximize marginal gains through expensive programs.

The CPWG identified shaping U.S. policy to integrate additive manufacturing nonproliferation and counterproliferation themes as an aspect of overarching CWMD strategies. The speed and agility of U.S. policy development is often spurred by demand from those carrying out actions forward, like the military on the ground or the U.S. embassy team in a foreign state. Sending a demand signal to decision makers in

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[137] The Commerce Department, Bureau of Industry and Security website lists many of the programs available to industry and government entities to inform actors about export controls and U.S. requirements. The site can be accessed at http://www.bis.doc.gov/index.php/compliance-a-training/export-administration-regulations-training.

[138] Will Yakowicz, "Why Regulation Is Ruining the U.S. Economy," Inc., 2013, http://www.inc.com/will-yakowicz/why-regulation-is-ruining-us-economy.html.

[139] Examples of capacity-building programs can be found in DOD, DOJ, DOS, and DHS, to name a few. Often, the recipient of training is the same host-nation unit, group of individuals, or partnered agency responsible for multiple tasks including military, legal, law enforcement, and customs action.

Washington, DC could increase the speed of policy, allowing it better to keep pace with emerging and rapidly advancing technologies. Unfortunately, the capacity of the U.S. government, international intelligence, and law enforcement frameworks is not robust enough to observe and act on every threat. Dependence on industry and private actors to self-regulate emerges in the following two themes.

The CPWG identified a straightforward solution to the additive manufacturing issue: develop a code of conduct. If education and outreach can be bolstered by policy, international agreements, regimes and treaties, capacity building, and law enforcement frameworks then establishing a balanced and complimentary set of norms between government and industry can promote industry self-regulation. Capitalizing on existing methods of educating industry about the potential dangers of additive manufacturing, private industry can be incentivized to protect things like intellectual property or proprietary processes and equipment. This would reduce the resource burden on U.S. and international partners. This approach has been effective in several industries involving dangers from dual-use technologies.[140] If successful, government and industry can partner to decrease diffusion of technology barriers, increase indications and warning without overregulation, and minimize instances where enforcement is required through government resources.

The final theme, enforcement of norms, includes actions utilizing all available levers of national soft, hard and smart power to effectively combine multiple authorities, access, placement, and capabilities.[141] U.S. bureaucratic institutions are well positioned to align against threats that are visible and pose dangers to national security. The six-theme strategy developed by the CPWG increased awareness that led to whole-of-government options. Outreach and partnership with private industry avoids

[140] Richard Re, "PlayStation 2 Detonation: Controlling the Threat of Dual-Use Technologies," *Harvard International Review* 25, no. 3 (fall 2003): 46–50.

[141] The term "smart power" is defined as the ability to effectively combine both hard and soft power. Joseph S. Nye, "Public Diplomacy and Soft Power." *The Annals of the American Academy of Political Science,* vol. 616, no. 1: 94-109, 107.

overregulation while simultaneously increasing awareness, indications, and warnings, without burdensome requirements, budgets, or added layers of bureaucracy.[142]

> Additional investment in the development and execution of related exercises that brought together counterparts from Washington and relevant field offices—thereby linking research and development, policy, and implementing stakeholders—could provide a very powerful tool to identify solutions for issues of significant interest to the U.S. government. The exercise clearly demonstrated that the OA process effectively generates "soft power" feasible options for immediate implementation by senior policy decision makers.[143]

Specific to Singapore, the ambassador and his country team reflected on how such a strategy could promote the government of that country, both internally and as a regional leader. A key element is shaping the evolution of additive manufacturing in the commercial sector toward legitimate applications. Singapore is investing $400 million in a five-year advanced-manufacturing project focused on 3D printing, a fact highlighted through the OA process, increasing additive manufacturing concerns for regional U.S. missions.[144] This opens the opportunity to shape additive manufacturing proliferation concerns by leveraging Singapore's desire for prestige among regional competitors, as pointed out by Ambassador Wagar. Examining potential over-the-horizon threats to develop whole-of-government strategies, as through the OA TTX in Singapore, shows the utility of a formal process in tackling real-world issues and promoting strategic U.S. interest abroad.

B. ASSESSING THE IMPACT ON EACH DIMENSION OF COLLABORATION

Expectations of the CPWG's performance during the TTX were high. The team is inherently interagency and exercises a broad range of authorities on a daily basis. Members employ streamlined and agile decision making that is uncommon in larger

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[142] These trade-offs are explored in Samuel Bowles and Herbert Gintis, "The Revenge of Homo Economicus: Contested Exchange and the Revival of Political Economy," *Journal of Economic Perspectives* 7, no. 1 (Winter 1993): 83–102.

[143] Department of State, "Embassy Singapore Finds Value."

[144] Brooke, "China Flexes Muscles."

government organizations. Regional partners and leadership from Washington, DC were invited to participate, in an effort to increase networking for the CPWG core team and demonstrate how the OA process can enhance collaboration in an efficient and timely manner. These points need to be highlighted, that though marginal increases in collaboration were observed, the absolute results cannot be attributed solely to the factors under consideration here. In other words, the Singapore CPWG group's success may not be observed across all cases.

We operationalized the dependent variable—collaboration—using our three dimensions discussed above: *transparency*, *resource sharing*, and *interdependence* (see Appendix A). We anticipated a range of responses and observations, with an overall net benefit of enhanced collaboration. More specifically, we expected to observe increased awareness through the contributions from multiple perspectives and expected an improved willingness to share information and ideas to create greater transparency. Given the current fiscal situation and continued sequestration, the process was designed to minimize the need for additional funding and resources, but we expected strong views on the staffing and time requirements. This is why we chose one of the few existential threats to security—nuclear WMD. Interdependence was expected to increase primarily through greater awareness of mutual reliance among partners, as adjacent organizations' goals, capabilities, and weaknesses became apparent through increased transparency. We primarily examined the willingness to compromise, engage in a shared decision-making process, and form goal-directed partnerships based on requirements. The following is our analysis of each of these dimensions of the dependent variable:

1. Transparency

The proliferation of WMD is a complex societal problem. Countering it requires greater sharing, delegation, communication, and understanding of other interests or, in our terminology, transparency. The most significant features of OA that impacted transparency, as noted by TTX participants, were the use of a common language, the enabling of open and honest discussion, and the ability of the most viable organization to take the lead toward a solution (given the specific concept proposed). One participant of

the OA TXX at the U.S. Embassy to Singapore commented on the increased transparency enabled by the OA methodology, "by listening [and understanding] various organization's perspective, capabilities and resources, we were able to better understand how we can support, which in turn created an atmosphere conducive towards proactive engagement."[145] Another OA TTX participant remarked on how highlighting one organizations weakness provided insight as to how another organization could provide support,

> The construct of the exercise provided a setting for individual agencies to provide overviews of existing capabilities and weaknesses in a non-threatening way. By focusing discussion of weaknesses or gap in an interagency context, it encouraged discussion of potential issues and problems between agencies and departments.[146]

We observed the ability of an academic language, as opposed to organization-specific jargon and doctrine, to defuse biases and promote the sharing of ideas and information. The use of a common language permitted individual agencies to provide existing capabilities and weaknesses in a nonthreatening way. By focusing on information gaps within the seams of the interagency, the process encouraged discussion of potential problems between agencies and departments and effectively drew out the subtleties of each discrete idea. Due to the scenario focusing on steady state initiatives, the IA focused on respective organizational capabilities to take lead or support as necessary to achieve innovative solutions.

Of particular note was that the CPWG and the IA in the U.S. Embassy to Singapore lacked an understanding of what the DOD does in the counterproliferation mission space. Learning the DOD's role in the counterproliferation steady state was valuable for the IA; likewise, gaining awareness of what various agencies bring to the table during the preparation line of effort was valuable to the DOD representatives. The structure of the process and user-friendly communication tools (SharePoint) facilitated real-time information sharing that brought about transparency, which led to these

[145] Appendix C: OA TTX Participant Responses, U.S. Embassy to Singapore, 25 August, 2015

[146] Ibid.

conclusions on the part of participants. In sum, transparency proved to be the dimension of collaboration most significantly increased. The exercise provided the opportunity for participants to uncover areas for substantial joint benefit simply through the systematic revealing of their attributes. The venue location provided a notable interaction effect with the application of the OA process as the pre-existing personal relationships among the CPWG, as well as the signal of approval from the Ambassador fostered such unfettered exchange.

2. Resource Provision

Budgetary control and capital provision from leadership within an organization and from outside sponsors are key elements affecting the commitment of resources to a collaborative effort. Working from the collective understanding that collaboration is not possible without people, money, and time, participants noted what aspects of OA most impact the sharing of resources—personnel selected for the collaborative effort, minimal funding requirements, and connection of exercise outcomes with decision makers. An OA TTX participant observed, "in the current budget environment, it is very difficult to increase program funding levels and I don't see this process as changing that, unless it was because another organization was willing to redirect its resources to the greater inter-organizational effort."[147]

Choosing the right person for the job was crucial. We encouraged participant involvement from each organization, from top to bottom, to enhance the process. Some organizations had representation from the strategic, operational, and tactical levels, helping to facilitate vertical collaboration and create demand signals for resources. The burden to do so was lightened considerably as there was no visible need to increase funding levels in order to exercise the collaborative process. Aside from appropriate staffing, the most prominent resource draw noted by participants was the time commitment of dedicating staff to a collaborative effort in the preparation/preventative stage. One participant commented on time and space resources,

[147] Ibid.

> There is always room for improvement, and this exercise introduced some ideas for doing so, at a minimum by providing the space to focus exclusively on the issue for an extended period of time. The challenge of course is carving out such space with all the competing demands on our time. Figuring out a way to create such space would be a start.[148]

In sum, resource sharing proved to show a mild increase, relative to the other dimensions of collaboration. The sharing of significant resources by the Ambassador provided a clear signal to the participants. Resource commitment by actors at the embassy level is, however, constrained. The embassy venue, in this case, may limit increase in this dimension of collaboration, as opposed to locating collaboration efforts within the NCR.

3. Interdependence

In the interorganizational framework, the manifest function is collaboration that leads to goal congruence, indicated by the level of mutual reliance among entities. The most significant qualities of OA that impacted interdependence, as noted by TTX participants, consisted of understanding other agency authorities at different stages of discussion; greater understanding that the whole-of-government approach includes academic institutions, IA, and industry partners; and the importance of developing personal relationships through collaborative efforts. Taking directly from the response of one OA TXX participant on interorganizational collaboration,

> The main reward of collaboration within our organization is opportunity. Interaction with other organizations and groups gives us the ability to build relationships that will provide the unit with additional information, access, and placement. The relationships we establish extend our network and provide us with more intelligence gathering and analysis opportunities.[149]

A complementary effect, as evidenced by overlapping dimensions, was that increased transparency also led to more positive interdependence throughout the process. Use of a common language, the shifting of lead between agencies and departments given

[148] Ibid.

[149] Ibid.

the specific problem, and having representation from national, regional, and country-team levels all made it easier for participants to rely on other organizations. In one example, a participant stated that OA "improved awareness and appreciation for policy and academic alliance as an instrument of national power to assist and solve intractable IA problem sets."[150] The representation at different levels within the same organization improved awareness vertically so intra-organization members could better understand the requirements at each level of the organization. One participant remarked, "alternative future planning can be utilized for steady state problem solving; necessary to bridge NCR decision makers with country team operations; this process is one way to exercise and influence policy decision making."[151]

For some, the process highlighted their own limitations, especially left of crisis, and showed them that it was in their organizations' best interests to let other agencies take the lead. This realization stemmed from observing that authorities within other organizations can make a compromise on their side of the fence, strengthening a position on the other side. The ability to dual track between administrative and criminal procedures allowed flexibility without actual compromise.[152] Regarding the collaborative problem solving process, a participant noted, "We were encouraged to piggyback off other organizations' comments and efforts; to use their actions as a springboard for other ideas."[153]

Developing personal relationships as a byproduct of collaborative efforts was noted to be of high importance to improve organizational relationships, leading to greater transparency, resource sharing, and interdependence. The process helped develop these relationships and found one of the keys to "success [to be] pre-existing and mature relationships, making it important to capture human capital profile."[154] The combination

[150] Ibid.

[151] Ibid.

[152] Ibid.

[153] Ibid.

[154] Ibid.

of horizontal and vertical collaboration, made possible by organizational representation from varying levels, led not only to the development of relationships but to greater interdependence, making more effective collaboration possible.[155] A participant commented on the value of organizational relationships,

> Relationship-building is a critical piece in this puzzle. And I'm not talking about team-building exercises. I'm talking about the kind of "around the table" discussions that have taken place in a professional manner, where each person has the opportunity to establish her/his credibility and potential contribution, followed by on-the-margin discussions, whether around a table or at a social event. People will still need to represent the equities of their respective organizations, but relationships can eliminate or at least lower barriers that exist due to pre-existing organizational culture.[156]

In sum, the interdependence dimension of collaboration was the most difficult to observe from among the three dimensions. On the one hand, the need for increased interdependence was socialized to the participants through the collaborative process. The instantiation of such interdependence was, however, limited for a number of reasons. First, as argued above, the authority to endorse joint decisions may be held at a higher level of authority within each organization. Second, interdependence plays out over time. Given the short duration of the Singapore exercise, seeds of interdependence may have been planted that will take some months—or years—to mature. It is likely that more longitudinal observations will be required to ascertain overall changes in this dimension.

C. OPPORTUNITY ANALYSIS CONCLUSION

As evidenced by Ambassador Wagar's reaction, the introduction of a formal collaborative process enhanced U.S. interagency steady-state efforts against a potential over-the-horizon counterproliferation threat through increased transparency, resource sharing, and interdependent action. Over the course of the exercise, CPWG members collectively developed 169 distinct options to address potential counterproliferation uses

[155] During and after the OA, we referred to collaboration across departments and agencies at the national or regional level as "horizontal collaboration" and the regional–national collaboration as "vertical collaboration."

[156] Appendix C: OA TTX Participant Responses, U.S. Embassy to Singapore, 25 August, 2015

for additive manufacturing. Those options combined to form a potential strategy employ all elements of national power. The DIMEFIL approach closes information gaps and facilitates partnerships with government and industry to shape policy, capacity, norms, and enforcement frameworks while minimizing impacts to an expanding global industry. While some of these options would have coalesced through normalized ad hoc CPWG collaboration, the formal process deepened and broadened approaches that would have remained undiscovered.

Strategies that leverage and incentivize the government of Singapore offer U.S. representatives new approaches for building partner capacity and cooperation. While this cooperation is important to the mission of the Country Team, potential regional benefits may be realized by leveraging Singapore's role as regional leader.

Washington, DC leadership and IA partners with regional responsibilities augmented the CPWG during the TTX. Not surprisingly, collaboration between theater/regional partners was excellent. Unexpectedly, the combination of national-level representatives with the regional team resulted in far richer dialogue and a deeper appreciation of both the regional and national dynamics for the whole team, enhancing the vertical coordination of enablers and producing integrated options.

We received two important recommendations and critical insights from the U.S. embassy team that fell outside our intended research question. A deeper discussion will take place in the following chapter; however, they are relevant to this analysis and worth mentioning here. The first recommendation was to institutionalize a formal collaborative process, like OA, into all U.S. interagency training pipelines. This effort would synchronize future collaboration so that all IA players have a working knowledge of a shared methodology to increase outcomes in future efforts.[157]

[157] "Going forward, the Embassy's CPWG strongly recommends that OA and the results of this exercise be briefed to key offices in the U.S. government engaged in CP and other over-the-horizon threats, including at various training facilities such as the State Department's Foreign Service Institute (FSI), the FBI Academy, and the DHS Federal Law Enforcement Training Center (FLETC)." Department of State, "Embassy Singapore Finds Value."

The second recommendation was to conduct similar tabletop exercises in other interagency environments. Recognizing that OA is scalable, embassy team remarked that improvements in regional strategy would benefit from the introduction of other embassy teams and subsequent events held inside another country's embassy. Applied to the IA as a whole, we argue a formal process could improve outcomes where whole-of-government strategies and options tackle issues in the steady state before a crisis emerges—or post crises to future trajectories.

The first of two insights suggests the use of neutral language to overcome lexical and cultural friction is crucial to collaboration. Each agency brought biases and unique processes often inhibitive to collaboration. An academic approach, where acronyms and specific nomenclature were minimized, supported open discussion and unconstrained problem solving in which all members understood the inputs provided and how options related to individual efforts. This allowed free debate and discussion to diverge from institutional mindsets.

The second insight is the supporting role the Department of Defense can play in steady state efforts. Over the 15 years, the DOD has broadly increased capability and capacity to respond to a wide range of challenges. However, in addressing these challenges, DOD has become accustomed to primacy. In the steady state, Outside Theaters of Active Armed Conflict (ODTAAC) where diplomatic and law enforcement efforts largely lead, DOD can support other department and agency efforts. However, a resounding theme over the course of this research is a limited understanding of "how" to plug into DOD capability and capacity, especially as it pertains to SOF.

In the following chapter, we show diverse outcomes across the breadth of research—CWMD, technology, and bureaucratic institutions—affecting interagency collaboration in the counterproliferation mission space. The growth in complexity in the mission space, due to technology and to departmental authorities not aligning against modern threats, demands greater collaboration in a fiscally constrained environment. The formation of new bureaucracies as a response to nontraditional threats further complicates collaboration. Chapter V summarizes these challenges to instigate future

research, recommend approaches to breaching organizational barriers, and propose ways to enhance collaboration.

V. CONCLUSIONS

> We are one network; it is one of our greatest attributes and we must both leverage our innate ability to network internally and grow our network of partners and facilitators such that we continue to provide our commanders and decision makers with the best advice when called to do so.
>
> —General Joseph L. Votel[158]

Weapons of mass destruction remain one of the greatest existential threats to U.S. national security and economic prosperity. Nation State and non-state threats echo a rhetoric indicating likely WMD use against western targets, although the timeframe for such attacks remains unclear. The U.S. Interagency is made up of hierarchical organizations. These separate and distinct hierarchical departments and agencies, each with individual organizational missions and goals, have evolved into large stove-piped institutions of fiscal accountability and responsibility.[159] Adversaries of the United States may have the ability to exploit vulnerable seams between interagency departments. As GEN Votel writes, "The National Security Act of 1947 served us well, but in an era far removed from the Cold War, the United States needs a new construct for the 21st Century. There is widespread agreement that going forward, we will require an unprecedented level of Interagency (IA) coordination capable of synchronizing all elements of national power."[160]

Diffusion of emerging technology and disruptive innovation are lowering the barrier to entry for illicit networks and malign actors seeking WMD materials and technologies. However, these emerging technologies and disruptive innovations are predominantly positive contributions to the marketplace and society, which further complicates the issue from a security perspective. As a result, strict export control

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158 Joseph Votel, "White Paper: The Gray Zone," United States Special Operations Command, September 9, 2015, Introduction.

159 Krebs, "Organizational Hierarchy: Adapting Old Structures to New Challenges."

160 Votel, "White Paper: The Gray Zone," 6.

regulations on dual use technology and international agreements and frameworks regarding the proliferation of WMD-related tools and materials may be inapplicable. For instance, additive manufacturing printers could feasibly 3D print sophisticated equipment needed in the nuclear fuel cycle. While the international community closely scrutinizes the transfer of sophisticated nuclear fuel cycle equipment, the purchase of an additive manufacturing printer is nearly unnoticed and unregulated. To further exacerbate the issue, new technology significantly reduces signatures normally associated with identification a uranium production facility.[161] The effectiveness of existing controls and enforcement frameworks, which have been successful for many years, are slowly diminishing.

A formal collaborative process, like Opportunity Analysis, develops multiple collective approaches to the technology issue. Of the nearly 170 steady-state counterproliferation approaches developed in Singapore, most centered around diplomatic and law enforcement outreach programs. These programs leverage industry to establish norms and standards, suggesting a degree of self-regulation within the Singapore-based additive manufacturing community of practice, and partners with the multilateral effort to deter illicit or malign production of WMD-related technologies. This outreach, coupled with successive, scalable and varied Opportunity Analysis exercises between government and commercial enterprises, can contribute to broader awareness of activities in science, technology and marketplace spaces. These partnerships provoke early discussions to inform policy and strategy. Moreover, these discussions, relative to the U.S. marketplace, have the propensity to find balance between national security interests and marketplace innovations. Further, formal vertical and horizontal interagency collaboration affords more comprehensive assessments of malign networks by coalescing multiple complex inputs. The collective picture exposes respective departmental assessments and perspectives invisible to other government contemporaries. Broader, collective visibility allows for the development of multiple, comprehensive proactive, reactive, and steady-state approaches capable of being rapidly executed or developed into

[161] Kroenig and Volpe, "3-D Printing the Bomb? The Nuclear Nonproliferation Challenge."

a policy position or comprehensive strategy. The collaborative interagency strategy encourages synchronized multilateral engagements with partner nation commercial, law enforcement, defense, and intelligence partners.

Our research show the value of a formal collaboration process, like OA, to breach institutional boundaries and biases, and capable of forming a cohesive, interagency approaches to specific problems. These interagency team approaches achieve heightened transparency through the cultivation of trust, a willingness to expose mission enablers to inform interdependence benefits, and the value of resource sharing. In a time of fiscal constraints, when government reorganization is not likely and added bureaucracies create new obstacles for cooperation and collaboration, OA creates bridges across departmental fissures without compelling new layers of complexity. The scalability of OA allows for wide use of the collaborative process at tactical, action officer, staff, and national policy-making levels.

The choice of language emerged as a key factor in our study. In the OA TTX, we attempted to replace organizational specific language with the neutral – and in some ways "universal" – language of academia. This use of academic language had to two noteworthy impacts. First, it provided an actual common language that all could understand. Second, it defused the inherent conflict among organizations by not privileging one group. Our subsequent analysis showed that the language, concepts, and acronyms employed (or consciously not employed) during the exercise exerted a substantial impact on the outcomes. This result reflects the degree to which discourse, meaning, and power relationships are intertwined; in the language of the French philosopher Michel Foucault these are "knowledge-power" relations.[162] In this work, he argues that modern states develop micro-practices of discourse that contain and display power relations: "modern power touches individuals via the various forms of constraints constitutive of their social practices," and that these "practices [especially language] are more fundamental than belief systems when it comes to understanding the hold that

[162] Michel Foucault, *Power/Knowledge*, ed. Colin Gordon (New York: Pantheon, 1980).

power has on us."[163] For individual members of organizations, this "deep power structure" takes hold "to the extent that meanings become fixed or reified in certain forms, which then articulate practices, agents and relations, this fixity is power. Power is the apparent order of taken-for-granted categories of existence, as they are fixed and represented in a myriad discursive forms and practices."[164] Further, studies conducted of the relationships between bureaucratic organizations, with the intent of understanding how the Foucauldian notion of knowledge/power "has emerged as a pivotal concept in explaining the process by which certain organizational and institutional structures prevail over others."[165] These insights are crucial as interagency efforts move forward, as the defusing of the discourse/power conflict is a relatively cheap and easily manipulated factor that can be optimized in future collaborative efforts. As Foucault would argue, information sharing could potentially level the power of the actors in the network.

As expected, there was variation in gains among the three dimensions of collaboration, resulting from the choice of venue. There was an immediate willingness to share resources (staff and time) on the part of the Ambassador. OA significantly increased the level of transparency in horizontal collaboration, while some small gains were made in vertical collaboration due to the presence of decision makers from the NCR. Based on our interviews, we discerned that the creative solutions that resulted from the collaboration led participants to start thinking about what resource sharing and greater interdependence might look like in the future. Resource sharing, for an embassy, goes beyond traditional budgetary perspectives. Resource sharing is inclusive of personal networks and relationships that can be shared and leveraged to support the broader country team goals. The uncovering of different capabilities and authorities that occurred due to increased transparency led to a greater awareness for the need to increase the other two dimensions. Just like any relationship, interdependence and a willingness to share

[163] Nancy Fraser, 1981. "Foucault on Modern Power: Empirical Insights and Normative Confusions," *PRAXIS International* (3): 279.

[164] S. Clegg. *Frameworks of Power*. Newbury Park, CA: Sage Publications. 183.

[165] Dennis K. Mumby and Cynthia Stohl, 1991. "Power and discourse in organizational studies: absence and the dialectic of control," *Discourse and Society* 2(3): 313.

resources takes time. The more collaborative engagements that the IA takes part in with a formal approach to the process, we are likely to see more significant increases in all three dimensions over time.

The results from Singapore were gratifying; yet, the impact of 'selection effects', upon these results, cannot be ignored. The CPWG was a cohesive team prior to the exercise. As a result of Ambassador Wagar's influence on his country team, the team was incentivized to participate. The outcome of the process—in this case, 169 distinct concepts developed through the OA process—was influenced by existing efficiencies. While the intent behind the venue selection was to examine a formal collaboration process against a high performance team, like the CPWG, the positive outcomes also reflect the existing nature of the group. Therefore, the results of the Singapore exercise cannot be expected in all other venues—future research will be needed to scope out the precise marginal effect of applying OA within other sets of conditions.

In sum, this research paper has shown the degree to which U.S. Interagency steady-state collaboration can be enhanced for the counterproliferation mission space through the use of a formal collaborative process, as well as the venue in which collaborative efforts occur. These results are important, as the counterproliferation space is growing in complexity due largely to the diffusion of emerging technology and disruptive innovation coupled with the vulnerable seams of a Cold War-legacy bureaucratic system. This research supports the argument that vulnerability and threat assessments are enhanced through the use of a formal collaborative process such as Opportunity Analysis. Second, we confirm formal collaboration processes are effective tools, but may be have different impacts, contingent upon the venue within which such efforts take place.

A. RECOMMENDATIONS

Concerted efforts to find and utilize a common vocabulary among interagency participants at the Singapore tabletop exercise produced unanticipated results. We employed simple language based on the academic lexicon to permeate through organizational boundaries. Our collective observations confirmed the importance of

effective communication across interagency cultures. However, this experience is typically associated with greater familiarity of other organization's specialized terms, especially acronyms. More rigorous effort across the interagency is needed to reinforce the use of neutral lexicons. Follow-on research in this area will provide useful insights into the observed effectiveness of a common language among interagency partners.

A second, unexpected, result of the study is the degree of vertical collaboration potentially absent in modern constructs. The Washington, DC participants from the Departments of State, Commerce, Homeland Security, and the Federal Bureau of Investigation, respectively, provided necessary insights and atmospherics on current national policy deliberation that are less likely to be socialized at the U.S. embassy level. While the intent of our research was to observe horizontal collaboration across the Interagency, the unanticipated horizontal collaboration demonstrated is indicative of further academic research and increased emphasis inter-organizationally.

An important recommendation for the Department of Defense, with an emphasis on Special Operations Command, is the need for increased outreach and education to the interagency counterproliferation community of practice. During both observations, in the OCT 14 CENTCOM exercise and the AUG 15 Singapore exercise, a common perspective expressed by interagency colleagues suggests a limited awareness of DOD and SOF authorities, capabilities, and capacities that can be supportive of interagency efforts in the steady state CP mission space. Following a number of interjections provided by DOD and/or SOF professionals, interagency colleagues sought insight into accessing these authorities, capabilities, and capacities. In particular, SOF's on-the-ground insights from its global deployments may be valuable to other members of the IA.

B. WAY FORWARD

The interagency should move forward to improve counterproliferation and collaboration efforts by investing resources in the following areas: First, a virtual collaboration space for the counterproliferation community. This single platform needs to permeate the variety of classified and unclassified networks. Second, institutionalization of Opportunity Analysis across the diplomatic, military, and law

enforcement training centers for entry-level action officers provides a low-cost medium enabling collaboration without the expenditure of adding bureaucracy to the National Security apparatus. Lastly, SOF outreach to interagency programs, through existing Special Operations Support Teams and embassy points of contact, provide a low cost medium to rapidly educate interagency colleagues on existing authorities, capabilities, and capacity relevant to supporting IA.

1. Online U.S. Interagency Counterproliferation Collaboration Environment

In the near term, providing a more robust virtual collaboration space for counterproliferation-related forums may narrow existing fissures in both horizontal and vertical collaborative efforts. While email is the most common medium across the counterproliferation community, access to a secure platform for U.S. Interagency collaborators to connect serves to align interests through directories while expanding awareness through blogs and other modern social media tools. Platforms of this nature, some that already exists, require access to a number of unsecure and secure networks. Currently, CWMD Systems is forwarding similar efforts through the Constellation Program.

2. Institutionalization of Opportunity Analysis across the U.S. Interagency

OSD developed the OA process for CWMD environments, but the methodology can be applied to multiple arenas where interagency collaboration is required. Outcomes of OA exercises have formed flexible, multidimensional approaches, collectively leading to a scalable and comprehensive strategies to deal with complex issues like those presented. Given the baseline requirement of an education to work in a U.S. government profession, OA's use of academic lexicon is applicable to a wide range of departments and agencies interested in improving interagency collaboration by increasing transparency, interdependence, and resource sharing.

3. SOF Outreach to Interagency Partners

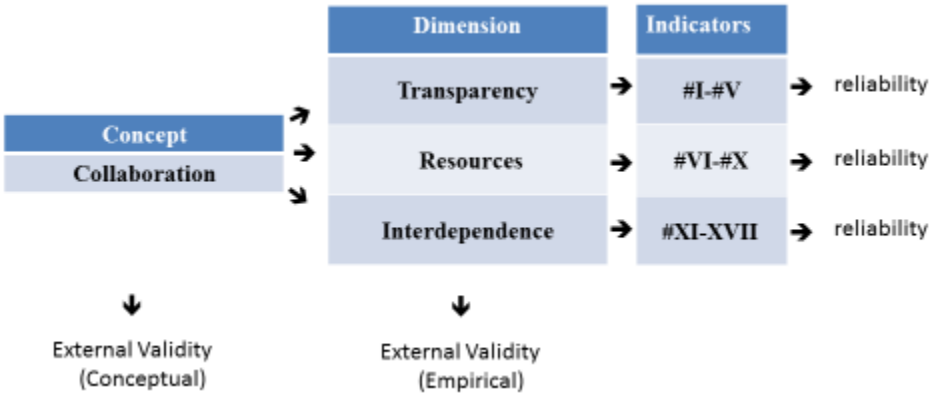
U.S. Special Operations Command operators are selected and trained to be aware of cultural sensitivities and perspectives. USSOF operators retain authorities and responsibilities—soon to grow with the discussion of USSOCOM taking on increased responsibility in the CWMD mission space—to conduct operations that support or can be supported by IA colleagues. However, the lack of understanding of SOF's authority, capability, and capacity among IA teammates suggest a need for more focused SOF outreach programs through the many liaison elements currently existing in the nation's capital and embassies around the world. Interactions with IA colleagues over the past year largely suggest a broad interest in accessing USSOCOM programs. Further, there is a generation of SOF and interagency actors who are very experienced in collaborative environments as a result of the recent wars in Iraq and Afghanistan. These individuals will begin to fill key IA roles and be able to capitalize from a formal process like OA. Additional research and development is recommended to refine the role of 'facilitator' within the OA process. In an effort to increase repeatability and application, a training course should be developed so that other organizations can become OA practitioners for interagency collaboration as well as intra-organizationally. Finally, our field study benefitted by taking place within a non-threatening, "academic" atmosphere. Future facilitators of OA should take note of this fact and plan accordingly.

Stemming from this research, efforts at fostering collaboration are moving forward and gathering steam. U.S. Congress, the National Security Council, Defense Innovation Unit Experimental (DIUx), academia, and influencers in the private sector have been exposed to the results of this field study. More work needs to be done, however, to synchronize our nation's efforts to confront future proliferation challenges.

APPENDIX A. CONSTRUCTING THE CONCEPT OF COLLABORATION

The term *collaboration* is often used informally; here, we use the work of Gary Goertz to operationalize the concept. He introduced the idea of a concept-indicator validity model (Figure 5), in which "the theoretical … structure of the indicator corresponds to that of the concept. If the correspondence is weak, then concept-indicator validity is low (and vice versa)."[166] This structure was, in turn, used to rigorously organize data gathered through a series of interviews, observations, and qualitative analysis of sources (see Appendix B).

Figure 5. Concept-Indicator Validity Model



A. DIMENSION 1: *TRANSPARENCY*

Transparent accounting for the management of financial assets and liabilities, in both the private and public sectors, is an obligation to the stakeholders;[167] by contrast, bureaucracies' historical view of the management of nonfinancial assets and liabilities has been to "increase the superiority of the professionally informed by keeping their knowledge and intentions secret. Bureaucratic administration … in so far as it can …

[166] Goertz, "Increasing Concept-Indicator Validity."

[167] Hochberg, Sapienza, and Vissing-Jorgensen. "Lobbying Approach to Evaluating the Sarbanes-Oxley Act of 2002."

hides its knowledge and action from criticism."[168] While anecdotal evidence suggests that complete transparency is unattainable within bureaucracies and interorganizational collaborations, the current trend is toward increasing transparency for more favorable outcomes.[169] The results are significant:

> Again and again, studies show that companies that rate high in transparency tend to outperform more opaque ones. In a global study of corporate transparency conducted in 2005, for example, the 27 U.S. firms that appeared among the 34 most transparent companies beat the S&P 500 by 11.3% between February 2004 and February 2005.[170]

That being said, transparency between organizations presents more challenges than full disclosure to stakeholders. Indicators I–V in our model represent what we found to be the most significant of transparency. Indicators include:

I. Willingness to share information

II. Willingness to delegate authority to facilitate information sharing

III. Effectiveness of communication tools and technology

IV. Effect on career advancement of participants

V. Understanding the relationship of the work of all participants

The willingness and/or need to share information within an organization is driven by the overall agency culture and subcultures.[171] Each requires "different data, information, or knowledge to do its work, has different abilities, different perspectives and ways of gathering information that require translation to other entities, and uses the outputs differently."[172] A clear understanding of these differences by all the players, especially the leadership, is key to effective interorganizational collaboration.

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[168] Weber, *Bureaucracy*.

[169] Comments on "Getting Just the Right Dose of Liquidity and Transparency," Knowledge@Wharton.

[170] Bennis and Goleman, *Transparency: How Leaders Create a Culture of Candor*.

[171] Drake, Steckler, and Koch, "Information Sharing in and across Government Agencies."

[172] Long and Fahey, "Diagnosing Cultural Barriers to Knowledge Management."

Leaders within government organizations often tout the importance of information sharing, but also recognize the vulnerabilities and the requirement to consider "substantial informational, technical, human, managerial, process, cultural, structural, strategic, and political barriers."[173] At the heart of the barriers is not only the individuals' willingness to share information but their incentive to do so. Career officials in government agencies must see room for advancement within the organization and believe their actions are leading them toward that end.[174] If they see that collaborative efforts are coupled with promotional opportunities, the willingness to delegate, share, and communicate effectively increases. The ability to do so within an interagency environment often relies on tools such as facilitators, proper workspace, and technology.

While sharing information certainly relies on technology, technology itself is not a necessity for effective collaboration,[175] which is why the technology component is combined with communication tools including the processes and facilitators of collaboration. "What is most sorely needed for collaborative solutions to complex societal problems is the ability to recognize and benefit from the contributions of multiple perspectives."[176] Undoubtedly, the proliferation of WMD is a complex societal problem that requires greater sharing, delegation, communication, and understanding of other interests, or, as we have come to know it, transparency.

B. DIMENSION 2: *RESOURCES*

In a 2014 report to Congress, the United States Government Accountability Office (GAO) listed the following key considerations for interagency collaborative mechanisms:

- Funding for the collaborative mechanisms themselves
- Staffing for the collaborative mechanisms
- Inventory of resources dedicated toward interagency outcomes

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[173] Caudle, "Promises, Perils, and Performance of Netcentric Bureaucracy."

[174] Halperin, Clapp, and Kanter, *Bureaucratic Politics and Foreign Policy*.

[175] Caudle, "Promises, Perils, and Performance of Netcentric Bureaucracy."

[176] Drake, Steckler, and Koch, "Information Sharing in and across Government Agencies."

- Leveraging of related agency resources toward the group's outcomes
- Pilot testing of new collaborative ideas, programs, or policies before investing resources[177]

The other key components of the GAO report were leadership, accountability, and outcomes, which point to organizational structure. While these elements were differentiated as implementation approaches to collaboration, within our concept-indicator structure, they do not independently indicate collaboration. Indicators VI–X of our model parallel the GAO's key considerations and fall under the dimension of *resources* as essential to collaboration. Indicators include:

VI. Willingness to invest resources to accomplish group goals

VII. Sufficient skilled personnel

VIII. Rewards connected to building enduring collaborative relationships

IX. Effect on future commitment of human/financial resources for collaborative training

X. Adequate structures for collaboration

Economist Steven Landsburg said, "Most of economics can be summarized in four words: 'People respond to incentives.' The rest is commentary."[178] We see this supported not only by the actions of individuals but by the organizations they represent as well. So while "building strong and resilient networks among individuals and organizations is a likely precondition for the eventual long-term substantive success of network projects," budgetary consequences play a large role in the level of resource provision an organization is willing to commit.[179] New functions within an organization are commonly evaluated by whether or not the added responsibilities will lead to budgetary increases or just more work for the same pay.[180]

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[177] "Managing for Results," GAO.

[178] Landsburg, "The Power of Incentives."

[179] Zhang and Dawes, "Expectations and Perceptions of Benefits."

[180] Halperin, Clapp, and Kanter, *Bureaucratic Politics and Foreign Policy*.

On the other hand, more money is not always the dominant incentive. Control over budgets is often more appealing than budget increases. "Organizations are often prepared to accept less money with greater control rather than more money with less control."[181] Budgetary control and capital provisions from leadership within an organization, in addition to sponsors outside the organization, are seen as key mechanisms affecting the commitment of resources to a collaborative effort.

C. DIMENSION 3: *INTERDEPENDENCE*

The third section of indicators deals with organizations' willingness to tie their fortunes to the group, and falls under the umbrella of *interdependence*. No organization can exist as an island; varying degrees of interdependence are inherent in interaction. Building off the functionalism theory made popular by Spencer, Durkheim, and Merton, Talcott Parsons described intended consequences commonly recognized as the *manifest function* of any organization.[182] In the interorganizational framework, the manifest function is defined as collaboration that leads to goal congruence, indicated by the level of interdependence among entities.

Notably, interdependence differs from resource commitment and transparency in that increased interdependence, while vital to collaboration, does not necessarily equate to enhancement of desired outcomes for the group and can actually detract from favorable outcomes. The negative possibilities of interdependence are considered within management literature, but indicators XI-XVII of our model are categorized by the potential positive aspects of interdependence and point to our third essential dimension of collaboration. Indicators include:

XI. Willingness to compromise own interests to achieve the groups' goals

XII. Willingness to engage in a shared decision-making process with other organizations

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[181] Halperin, Clapp, and Kanter, *Bureaucratic Politics and Foreign Policy*.

[182] John J. Macionis, *Sociology*, 9th ed. (Upper Saddle River, NJ: Prentice Hall, 2003).

XIII. Willingness to consider the interests of other organizations in planning

XIV. Willingness to commit to policies/recommendations emerging from collaboration

XV. Formation of partnerships based on requirements

XVI. Willingness to seek input from other organizations

XVII. Established goals for interorganizational collaboration

Multiple challenges stem from the inherent vulnerabilities of interdependence. Zhang and Dawes found that policy and legal barriers appear to present the greatest obstacles to substantive success of knowledge-networking projects.[183] The desire to maintain influence can "also lead organizations to avoid opposing a particular policy in the belief that to do so would reduce their influence on other issues."[184] Establishing goals early in the collaborative process directly affects the formation of partnerships and, consequently, the willingness of an organization to mitigate its concerns regarding trust.

Understanding the differences among agencies and the subcultures within agencies is central to identifying barriers and increasing willingness to engage in a shared decision-making process with other organizations.[185] Based on research by the Brookings Institute, we found it valuable to employ a facilitator for the formal collaborative process within the CPWMD schema.

According to the Brookings research, "successfully transferring, integrating, creating, and ultimately applying new, useful knowledge requires a collaborative 'capacity builder.' This person would coordinate network activities, handle internal and external problems, and ensure the provision of quality service. In the process, capacity builders would buttress network integration by communicating with partners,

[183] Caudle, "Promises, Perils, and Performance of Netcentric Bureaucracy"; Zhang and Dawes, "Expectations and Perceptions of Benefits."

[184] Halperin, Clapp, and Kanter, *Bureaucratic Politics and Foreign Policy*.

[185] Drake, Steckler, and Koch, "Information Sharing in and across Government Agencies."

coordinating activities, and building relationships."[186] The capacity builder used in our case studies was able to help organizational representatives foster the positive interdependence so crucial to goal congruence, not only for successful outcomes in the short term but potentially for sustained success for future engagements.

[186] Goldsmith and Eggers, *Governing by Network.*

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APPENDIX B. CONCEPT DIMENSIONS AND INDICATORS

After obtaining an Institutional Review Board determination, which concluded the present research was not "human subjects research," we utilized the following question set to interview exercise participants. This allowed for a data-gathering plan to align with the construction of our "collaboration" concept as outlined in Appendix A.

A. DIMENSION 1: *TRANSPARENCY*

Indicator I. Did the desire to achieve the group's goals increase your organizations' willingness to share information with other organizations?

Indicator II. Did this environment increase the willingness of your organizations' leadership to give people additional authority at lower levels to effectively share information with other organizations?

Indicator III. How effective were the communication tools and technologies at supporting your inter-organization collaboration?

Indicator IV. Will engaging in inter-organizational activities at work affect career advancement for those in your organization? If so, how?

Indicator V. What additional understanding did your organization gain regarding how their work relates to the work of other organizations with whom they collaborated?

B. DIMENSION 2: *RESOURCES*

Indicator VI. Was your organization willing to invest resources (e.g., funding, personnel, equipment) to accomplish inter-organizational goals in addition to its own?

Indicator VII. Was your organization provided with an adequate amount of personnel in order to commit the most appropriate representative(s) to participate in the inter-organizational collaboration?

Indicator VIII. In what ways were employees of your organization rewarded for investing time and energy to build enduring/additional collaborative relationships?

Indicator IX. In what ways might this exercise/event affect your organizations' commitment of human and financial resources to training with other organizations?

Indicator X. Did your organizations' position on the adequacy of structures (e.g., liaison roles, teams, task forces) for effective inter-organizational collaboration change?

C. DIMENSION 3: *INTERDEPENDENCE*

Indicator XI. Did the exercise affect your organizations' willingness to compromise its own interests in the interest of inter-organizational goals? If so, how?

Indicator XII. How was your organizations' willingness to engage in a shared decision making process with other organizations affected?

Indicator XIII. How did your organization consider the interests of other organizations in its planning?

Indicator XIV. How—if at all—would your organization commit to any recommendations or policies that emerge from such a collaborative effort?

Indicator XV. How effectively did your organization form or modify partnerships as requirements changed?

Indicator XVI. Did this collaboration prompt your organization to seek (more/less/no change) input from other organizations?

Indicator XVII. What goals (if any) were clearly established for inter-organizational collaboration?

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