Fostering Interagency Collaboration for Upstream *Counterproliferation*

by Matthew D. Rautio

The proliferation of emerging and disruptive technologies, such as additive manufacturing and gene editing, is changing the way we think about national security. Such trends in science and technology inevitably increase the likelihood of hostile nations or non-state actors acquiring weapons of mass destruction (WMD). These emerging, novel threats have proved particularly vexing for the existing landscape of U.S. security bureaucracies. Absent major restructuring of the government to protect against future threats, significantly higher levels of proactive interagency collaboration will be required to successfully respond to the challenges posed by new technologies. Given these three premises—the threat of massively destructive (or disruptive) weapons, the lowering of the proliferation threshold, and the mismatch between these threats and the Cold War-legacy structure of U.S. government bureaucracies—the key to successful counter proliferation lies in fostering interagency collaboration before crises emerge.

Derek W. Lothringer, Matthew S. McGraw, Leif H.K. Thaxton, and I developed and tested a concept of collaboration aimed at increasing transparency, sharing resources, and fostering interdependence across the full range of interagency actors.[1] Our definition of effective collaboration requires extensive sharing of information, assets, responsibilities, and consequences, both good and bad. While this requirement may appear to be an obvious formula for maximizing organizational efficiency, it is not always the norm within the U.S. national security bureaucracy, where budgets, authorities, jurisdictions, and personalities too often work against whole-of-government efforts to achieve common policy objectives.

We used a formal collaborative methodology called "opportunity analysis (OA)" to examine the dynamics of interagency collaboration at a major U.S. Embassy in Asia. The embassy team participated in a scenario-based, table-top exercise (TTX) to elicit multiagency approaches to counter a proliferation network smuggling sensitive nuclear technology. We used the formal collaborative

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process to facilitate and expand collaboration among the agencies represented in the country team. Our research, while not exhaustive, highlights effective methods to encourage collaboration and demonstrates the benefits of expanded collaboration in counterproliferation (CP) policy and operations.

The proliferation threat is poised to grow as new technologies create new ways to make WMD.

Weapons of Mass Destruction are the Only Existential Threat

Weapons of mass destruction represent one of the few existential threats to national sovereignty. It is for this reason that countering the spread and use of nuclear, chemical, and biological weapons has been a consistent priority for U.S. policy since Manhattan Project scientists warned policymakers that the proliferation of nuclear technology was inevitable.[2] Since the invention of the atomic bomb in the 1940s, the U.S. government has used a mix of policy tools, including treaties, alliances, technology controls, and sanctions, to limit the number of nations possessing such capabilities.

The U.S., along with international partners, has been largely successful in blunting the proliferation of WMD. 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.[3] Nonetheless, several countries have covertly developed WMD capabilities, often with the aid of illicit procurement networks designed to evade national and international nonproliferation efforts. The best example is the A.Q. Khan proliferation network, which procured goods and services on behalf of Pakistan's nuclear program and then sought new customers by offering to supply Iran, North Korea, Libya, and others.[4]

The proliferation threat is poised to grow as new technologies create new ways to make WMD. For example, the nuclear fuel cycle necessary to produce nuclear weapons traditionally involves large industrial facilities that have a significant footprint. Nuclear reactors and enrichment and reprocessing plants are easily identified and provide important clues to a nation's intentions. Iran's Natanz enrichment facility, for example, became the focus of international nonproliferation concern. Advancements, such as additive manufacturing, commonly known as "AM" or "3D printing," could make it possible for illicit suppliers and nations harboring covert programs to evade international controls and conceal their activities.[5] In the biological realm, new gene-editing techniques, such as clustered, regularly-interspaced, short-palindromic repeats (CRISPR), might lower the bar for scientific skills required to enable countries and even nongovernmental organizations (NGOs) to explore biological-weapon concepts. Many powerful new technologies are not controlled by governments, which makes WMD acquisition easier and harder to detect.[6]

The U.S. government relies on the combined efforts of the executive branch agencies to implement and enforce U.S. policies, laws, and treaties. In practice, this combined policy body is referred to as the interagency (IA). The participants in the IA process may change depending on the issues, but for national security matters, the group normally reflects the members of the President's National Security Council (NSC).[7] The President and chief White House advisors empower the executive agencies to formulate and implement policy directives and priorities. This formula for national security policy is essentially unchanged since the National Security Act of 1947 created the current government organization.[8] For nonproliferation and CP policy, the IA normally includes representatives from the full range of diplomatic (State Department), military (Defense),

intelligence community (Central Intelligence Agency [CIA], Director of National Intelligence [DNI], Defense intelligence Agency [DIA]), law enforcement (Justice, Federal Bureau of Investigation [FBI] , Homeland Security, Commerce) and financial (Treasury, Commerce) agencies. The interagency process determines how the different authorities and capabilities that exist throughout the government can be combined to form effective nonproliferation and CP strategy.[9]

The fall of the Soviet Union inspired new thinking in the form of Cooperative Threat Reduction programs to address the threat of "loose nukes" but did not create an immediate need for departmental reorganization to counter or combat emerging CP threats.[10] As a result, there are gaps among departments organized to counter Cold War-style, peer-competitor threats and new threats emanating from a radically-changed, global security environment.[11] Since 2001, the Global War On Terrorism, in particular, required the IA to adopt new strategies and explore new approaches. Not surprisingly, however, hostile nations and terror groups have adapted to assertive U.S. military actions and learned to exploit what General Joseph L. Votel, then commander of U.S. Special Operations Command, described as a gray zone. just below the U.S. response threshold.[12] Operating in the gray zone enables U.S. adversaries to exploit bureaucratic boundaries within the IA. These gaps also exist for nonproliferation and CP and are exacerbated by the use of new technologies.

Old CP/WMD Bureaucratic Divisions of Labor No Longer Effective Against New Threats

The existing national security bureaucracies, designed in the immediate wake of World War II, were structured for a world that no longer exists.[13] Built at the apex of interstate diplomacy and industrialized warfare, they have been slow to react to—or even recognize—the new threat environment.[14] Today's adversaries actively exploit departmental seams across the range of U.S. government agencies.[15] Given the nature of this challenge, IA collaboration is increasingly essential to address dynamic threats, such as the proliferation of WMD.

Expansive and rapid technological innovation is outpacing the speed at which decisionmakers are able to react to crisis.[16] 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 constitute a "wicked problem," as no single agency or department in the U.S. government has the capacity or understanding to tackle them alone.[17] The problems are compounded in the steady state when no crisis is spurring the IA into action.

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We argue that expanding collaboration between relatively autonomous U.S. government agencies in the steady state enables more layering of authorities, experience, and institutional knowledge to frame nuanced options and support comprehensive action and policy.[18] As Brigadier General Terence J. Hilder wrote, "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."[19] In light of the changing threats and status quo agencies. we see a need for enhanced IA collaboration prior to a crisis.

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Changing Proliferation Threats: Modern Procurement Networks and DIY Technologies

As proliferation networks search for new ways to provide their customers with illicit access to controlled technologies, one potential disruptive innovation is the emergence of additive manufacturing or 3D printing. The leading industry guide, Wohlers Associates, describes additive manufacturing as, "the process of joining materials to make objects from three dimensional data, usually layer upon layer, as opposed to subtractive manufacturing methodologies."[20] 3D printing, a term used interchangeably with additive manufacturing, refers to the production of metal, plastic, and even biological objects from a single device driven by an electronic design file to fuse raw material inputs using a direct energy source (often a laser).[21] Many industries are in the midst of a revolution that is forcing them to adopt strategies to incorporate the disruptions in economies of scale, supply-chain management, and retail manufacturing brought about by 3D printing.[22] 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.[23]

Additive manufacturing is one example of an emerging technology 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.[24] 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.[25] Government experts, such as Bruce Goodwin, contend that within five to ten years, the advancements in 3D printing of metal, when combined with high-speed computing, will lower the threshold barrier for making uranium enrichment centrifuges and, eventually, nuclear weapons.[26] The combination of the two—the ability to print centrifuges for enriching uranium and the ability to print weapon components—is potentially world changing.

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 future. Singapore, for example, is investing $400 million in a five-year, advanced-manufacturing project focused on 3D printing.[27] The Chinese government is pledging to invest $245 million over the next seven years to become the global additive-manufacturing leader.[28] While additive manufacturing is having 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 national and international export controls to simply print their own parts. Proliferation networks might use 3D-printing technology to open new global markets for proliferation and facilitate new threats to world order.[29] 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 for whom ideology may run deeper than rational deterrence can hope to reach.[30]

Opportunity Analysis as a Means to Expand Collaboration

Given that antiquated bureaucratic structures align poorly against emerging technology threats, inaction becomes the default position. As observed by David Kilcullen, political and defense leaders are simply too overwhelmed and overtasked to do anything more than manage

current crises.[31] 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 address this lack of bureaucratic inertia, we explored how a formal collaboration tool could energize U.S. CP policy.[32]

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, IA collaboration; however, these efforts are difficult to reproduce or sustain. 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 CP community of practice.

We applied OA as a formal collaboration process that divides and analyzes complicated problems. It enables an interdisciplinary and multiorganizational 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 to replace organization-specific jargon. It enables a diverse group to organize, communicate, and operate to discover opportunities. These opportunities could be missed when relying on ad hoc collaboration alone.[33] 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 CP 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 (see Figure 1, page 40). Through the OA process, a team focuses on one alternative future at a time and looks for opportunities to create pathways for action.

The OA process enables enhanced collaboration by identifying each organization's RICCAAAPP "recap") components, described below, and aligning them against a particular problem:

- **Responsibility**. Having the specific charge to execute a particular action.

Ad hoc collaboration, the present norm in the IA, suffers from limitations without the forcing function of crisis.

- **Influence.** Ability to effect action through a third party to accomplish one or more of the above elements or to act independently to accomplish counter-WMD (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.

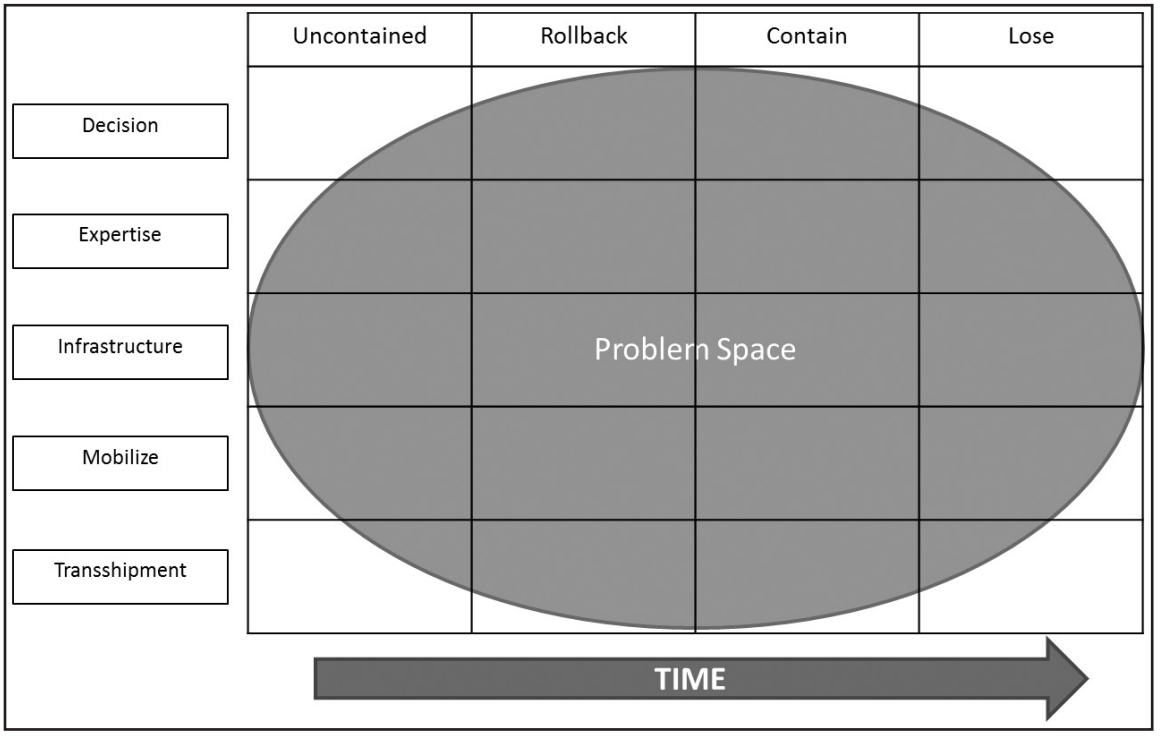

Figure 1. OA Nodal Dissection Technique at Macro Level

- **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.[34]

The agency RICCAAAPPs are collectively known as mission enablers. The OA process facilitates the identification of RICCAAAPPs and provides a structure for identifying collaborative opportunities to apply them to complex problems such as CP (see Figure 2).

By methodically considering the relevant attributes of the organizational contributors and matching them against the relevant aspects of the problem, collaboration opportunities emerge. 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.

Other factors also influence the potential for IA collaboration. In October of 2014, the OA methodology helped a cross-functional IA team in Washington, DC, develop a strategy in support of U.S. Central Command (USCENTCOM). Based on our observations of that exercise, we developed a hypothesis about possible limiting conditions. In this case, the OA occurred near the headquarters of the agency representatives, which had at least two effects. First, the participants were physically close to their bureaucratic headquarters, including their bosses and colleagues. 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 headquarters might lessen the dampening effect. Second, not all the participants in this OA exercise had a higher authority to authorize or facilitate, let alone enforce collaborative policies that might diverge from established policy. Those that did benefitted in tangible ways. Perhaps a venue that

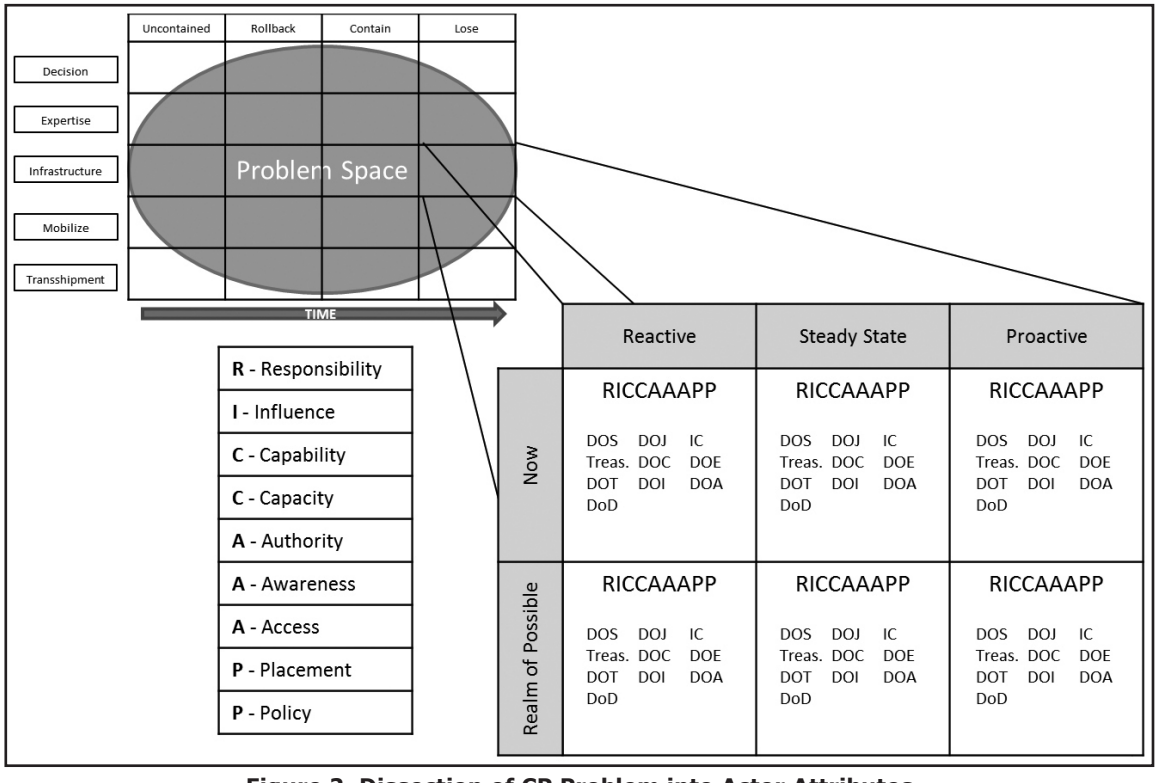

Figure 2. Dissection of CP Problem into Actor Attributes

included access to an entity possessing some attributes of a third-party authorizer and enforcer would allow for more innovative collaboration concepts. Finally, the participants in this exercise did not know one another personally. We wondered if pre-existing personal relationships might similarly result in higher levels of agency collaboration.

Based on these ruminations, the notion of an embassy team emerged as a venue to explore these arguments. Multiagency teams in embassies operate far from their organizations' headquarters; they function under the authority of the ambassador; and they work in close proximity to one another for extended periods. 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 of authority normally found in an embassy; the same may go for committing an organization to a joint decision made in the field. Therefore, we expected the transparency dimension of collaboration to increase in an embassy venue and the resource sharing and interdependence dimensions to decline.

To explore these arguments regarding the use of formal collaborative processes and the venue of collaboration, we conducted an exploratory field study. Such field studies provide both limited deductive and inductive insights. In such studies "variables co-vary as expected but 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."[35] This approach fit the needs of the OA study for many reasons. First, hypothesizing that the use of a formal process would increase collaboration among an interagency 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), was to search for the pathways by which such a set of conditions produces increased collaboration (the causal "mechanisms" of the study). Further, such mechanisms may emerge in unexpected ways, and the exploratory field study allowed for such inductive results. Though inferences and generalizations from such a study may be limited, its results provide the springboard for further studies and tool refinement.

The Singapore OA Exercise

We developed an embassy-level exercise to examine the application of the OA process by an IA team to a challenging, CP problem involving emerging technology. To execute the study, we first sought to establish a "baseline" of expected value of collaboration, grounded in the results of the earlier USCENTCOM exercise. We then developed a plan of qualitative data gathering to include an extensive set of interview questions to derive insights from our embassy collaboration scenario.

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The proliferation of WMD is a complex, global problem. Countering it effectively requires extensive sharing, delegation, communication, and understanding of other interests or, in our terminology, transparency. We devised a scenario that involved global proliferation networks, state sponsors, 3D printing, and a tangled mess of criminal and legitimate behavior. The OA took place at the U.S. Embassy in Singapore and involved representatives of the relevant law enforcement, defense, diplomacy, and other entities under the auspices of the ambassador.

The most significant features of the OA, as noted by TTX participants, were the use of a common language, the enabling of open and honest discussion, and the group consensus about which organization would take the lead in implementing agreed strategies. One participant in the Singapore OA TTX commented on the increased transparency enabled by the OA methodology: "…by listening [and understanding] various organization's perspectives, capabilities, and resources, we were able to better understand how we can support, which in turn created an atmosphere conducive towards proactive engagement."[36] Another OA TTX participant remarked on how highlighting one organization's weakness provided insight as to how another organization could step in to 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 gaps in an interagency context, it encouraged discussion of potential issues and problems between agencies and departments.[37]

We observed the utility of using common 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 helped agency representatives discuss their capabilities and weaknesses and avoid confusion. By focusing on information and capability gaps that exist within the seams of the IA partners, the OA process encouraged discussion of the differences between agencies and departments and effectively drew out mutually-acceptable ideas about how to address shortcomings. Due to the scenario focusing on steady-state initiatives (as opposed to crisis), the IA group identified which organization was best suited to take the lead or support as the scenario

unfolded.

Of particular note was the extent to which the seasoned, IA group lacked understanding of RICCAAAPPs in the CP mission space. Dispensing with acronyms and with OA to facilitate dialog, the group found value in the CP role in the steady state. Many assumed DoD capabilities were limited to crisis operations. All parties gained new awareness of what each agency brings to the table in terms of RICCAAAPP. The structure of the process and user-friendly communication tools (we used SharePoint) facilitated real-time information-sharing that brought about transparency, which increased collaboration among the participants. Transparency proved to be the dimension of collaboration most significantly increased through OA. The exercise provided the opportunity for participants to uncover areas ripe for substantial joint benefit simply through the systematic revealing of their attributes and how they could be applied to a common problem. The venue greatly benefitted the OA process via the pre-existing, personal relationships among the embassy working group members, as well as the signal of approval from the Ambassador.

Resources provided by an organization and from outside sponsors are key elements affecting the commitment to a collaborative effort. Working from the collective understanding that collaboration is not possible without people, money, and time, participants noted what aspects of the OA most impact the sharing of resources. In this case, key factors included the personnel selected to support the collaborative effort, minimal funding requirements, and the connection of the OA exercise outcomes with managers and decisionmakers at agency headquarters. 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."[38] The pooling of scarce resources and reassurance that field representatives would not make unauthorized expenditures were important.

Allowing each agency to control its people and resources was crucial. We encouraged broad involvement from all relevant organizations and at multiple levels. Some organizations had representation from the strategic, operational, and tactical levels, helping to facilitate vertical collaboration and coordinate requests for resources. The fact that there was no need to increase funding to participate in the collaborative process was helpful. The main expense was the time commitment required.

We observed that resource-sharing showed a mild increase in the OA, relative to the other dimensions of collaboration. The sharing of significant resources by the Ambassador provided a clear signal to the participants of his support for the effort to expand collaboration, despite the limitations on personnel inherent at an embassy. The embassy venue, in this case, may have limited some aspects of collaboration, as opposed to locating collaboration efforts in Washington, where personnel and resources may be more abundant.

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Another key variable for collaboration was interdependence. Understanding and trusting other agencies is necessary to achieve whole-of-government approaches. For our TTX, we included academic institutions, industry partners, and a variety of relevant governmental bodies in the scenario. Within this complex landscape, individual participants had to work with multiple agency representatives to identify collaborative

courses of action. Taking directly from the response of one OA TTX participant on inter-organizational 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.[39]

...personal relationships greatly enhanced collaborative efforts.

Increased transparency led to more positive attitudes toward interdependence throughout the process. Use of a common language, the shifting of lead roles between agencies and departments given 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 the words of one participant, the OA "improved awareness and appreciation for policy and how academic alliances could be used as an instrument of national power to assist and solve seemingly intractable problems."[40] Representation from different levels within organizations improved awareness vertically, so that a broad span of stake holders could better understand the actions being considered in the field.

For some, the process highlighted their own limitations, especially with respect to the steady-state conditions before a crisis. The OA process showed them how it was in their interests to collaborate and let other agencies take the lead. Without the OA discovery process to illuminate mutually-beneficial outcomes, institutional bias greatly diminishes the willingness to admit deficiencies and lend resources to ensure a competitor's success. In Singapore, this tension was evident in the different approaches pursued by law enforcement, diplomacy, and defense. One participant summarized: "We were encouraged to piggyback off other organizations' comments and efforts; to use their actions as a springboard for other ideas."[41] The combined strategy developed by the group was affirmed by consensus to be greater than the sum of the individual parts.[42]

Finally, personal relationships greatly enhanced collaborative efforts. The OA process deepened preexisting professional relationships, which extended from the field reps to managers located in various home institutions.[43] The combination 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.[44] 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 could 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.[45]

Over the course of the Singapore OA exercise, we observed increases in individual and organizational collaboration, measured in terms of transparency and interdependence. Over time, the participants developed more understanding of the other agencies RICCAAAPPs and

collectively built integrated strategies to cope with the scenario. The fact that the scenario involved several challenging elements—unfamiliar technology being used in an innovative way by a sophisticated proliferation network—invited the country team members to consider new approaches based on an expanded understanding of their combined power.

New Collaborative Methods Are Needed to Enable U.S. Policy to Keep Pace with Rapidly Evolving Technology Threats

Weapons of mass destruction remain one of the few existential threats to U.S. national security and economic prosperity. Nation state and non-state threats echo a rhetoric indicating the possible use of WMD; although, the timeframe for such attacks remains unclear. The U.S. IA process is made up of stove-piped, hierarchical organizations. These departments and agencies, each with its own mission, goal, and culture, have evolved to value fiscal accountability, program support, and other bureaucratic priorities along with their missions.[46]Adversaries of the U.S. may have the ability to exploit vulnerable seams between interagency departments and their missions. As General 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.[47]

We explored the use of OA to achieve the type of coordination called for by General Votel. Widespread diffusion of emerging and disruptive technology is lowering the barrier for countries and groups to acquire such high-leverage capabilities, some of which may meet the definition of WMD. For the most part, these emerging technologies will make positive contributions to human welfare. Old control techniques based on export control regulations and international agreements may not be applicable to the new global realities. Additive manufacturing printers, for example, are not being controlled in the way that nuclear-fuel-cycle equipment was restricted under the auspices of the Nonproliferation Treaty, the International Atomic Energy Agency, and the Nuclear Suppliers Guidelines.[48] Similarly, innovations in cyber warfare, genomics, or drones are not controlled by any international code. In this environment, the old institutions charged with safeguarding our security must adopt new methods to reenergize an old bureaucracy to defend against new threats.

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A formal collaborative process, such as OA, can develop multiple, collective approaches to emerging technology issues. Of the nearly 170 steady-state (non-crisis or pre-crisis) CP approaches developed in Singapore, most centered around diplomatic and law enforcement outreach programs. These approaches sought to leverage industry engagement to establish norms and standards for the transfer of potentially dangerous goods. In time, such norms and standards could encourage a degree of self-regulation, which emerged as a goal for the Singapore-based additive manufacturing community. Without laws or treaties to restrict trade in these technologies, self-interested self-regulation arose as a possible bulwark against unfettered proliferation. Through the OA

process, the embassy team devised a joint engagement strategy aimed at educating companies and partner nations to deter, detect, and stop illicit trade in emerging WMD-related technologies such as 3D printing. The strategy would employ stepped up communication, visits, and informational briefings for companies involved with 3D printing. One idea was to conduct an OA. including government and the private sector, to promote broader awareness of the potential proliferation problems associated with a broad range of merging technologies. The goal would be to encourage a high degree of self-regulation for technologies that are not subject to legal controls. We would expect to see the same types of expanded collaboration, transparency, and interdependence take root among self-interested companies as we saw among governmental actors, drawing the private sector into the collaborative interagency strategy and strengthening the coalition of law enforcement, defense, and intelligence partners in the CP enterprise.

We are aware of inherent "selection effects" in our research. The embassy working group was already a cohesive team prior to the OA exercise, and they had the explicit endorsement of the Ambassador to participate. The outcome of the process—in this case, 169 distinct concepts developed through the OA process—was no doubt influenced by existing relationships and the supportive environment. Nevertheless, we were encouraged by the measurable improvements in collaboration and would expect to see comparable results in other circumstances where multiple entities share a common mission. For further research, we would like to see OA performed by other embassies and among other parts of the U.S. government focused on other issues. For example, how might OA help promote more effective strategies toward counterterrorism issues, such as the fight against Islamic State of Iraq and the Levant (ISIL), human smuggling, or nuclear deterrence?

Finally, as members of the Special Operations Command (SOCOM) community, we learned important lessons about how we are perceived by other members of the CP community, including the DoD. As the result of a recent change in the Unified Command Plan that transfers DoD responsibilities for CP from Strategic Command to SOCOM,[50] SOCOM is deeply engaged in a process to enable them to execute this mission. Our OA research has direct relevance for this process, and the lessons we drew apply to SOCOM's role and participation with its IA partners. During both the October 2014 USCENTCOM exercise and the August 2015 Singapore exercise, a common perspective expressed by IA colleagues suggests a limited awareness of DoD and particularly Special Operations Forces (SOF) RICAAAPs. For that matter, SOCOM itself may not be fully aware of the extent of its own capabilities relevant to CP and how they complement those of other agencies.

We concluded that the OA process, which started over twenty years ago as a SOF method for identifying CP target nodes,[51] possesses significant potential for guiding both SOCOM and the U.S. government through the changes in technology and in global access to that technology that challenge our governmental structures. Innovative collaboration is necessary to adapt to innovations in technology, global business, and the ways they are changing WMD proliferation. ***IAJ***

NOTES

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