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RESEARCH ARTICLE

Governance, Innovation, and Information and Communications Technology for Civil-Military Interactions

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Civilian and military participants in relief and stability operations rely upon Information and Communications Technology (ICT) to collect, analyze, store, display, and share information that is critical for these civil-military interactions. This article investigates ICT innovation in these operations over time. As researchers in the sociology of technology school might predict, ICT innovation for relief and stability operations emerges in a distributed fashion, within clusters of specialty expertise that migrate across interconnected technology systems and across humanitarian and military activities. Major events such as natural disasters have punctuated the development of ICT for civil-military interactions, often driving community learning and coherence. Among the many stakeholders in the United States, the federal government in particular has played an important role in shaping the ICT ecosystem through policies and engagements. Government policies and changes in the field of action in the 1990s created imperatives for the US military in particular to collaborate with civilian agencies on ICT innovation. Civil-military information sharing gaps persist today due, in part, to institutional factors.

Introduction

Across the spectrum of operations that involve civilian and military interactions, from disaster relief to conflict prevention to post-conflict reconstruction, information is power. 'Information,' noted British Red Cross senior media officer Sharon Reader in the midst of the response to the 2010 Haiti earthquake, 'can be as important as food and water' (Magee 2010). ICT supports goals that range from health care delivery, to employment (and reducing the cost of doing business), to fostering better state-society relations (Wentz et al 2008). In the recent generation of relief and stability operations, information and communication technology (ICT) systems are increasingly central to both strategy and operations. ICT systems—hardware, software and networks—enable sensing, storing, computing, visualizing, modeling, navigating and communicating of various types of information:

- Socio-cultural information, which informs analysis of underlying and proximate causes of conflict, key leaders, and possible paths to stability;
- Geographic data facilitates assessment, logistics, and navigation;
- Visual representation of information in graphical forms, which enables practitioners to share a common operating picture of the environment;

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Information sharing made possible by new or improved ICT systems is vital to coordination and deconfliction of the many civilian and military agencies now active in conflict prevention and response to disaster, both natural and man-made. Components of these systems include laptop computers, personal digital assistants (PDAs), communication radios, cell phones and cellular networks (including WiFi access to Internet and phone service), satellite systems for Internet or telephone service, Global Positioning System (GPS) receivers, Geospatial Information System (GIS) and other mapping tools, collaboration software linked with or without wires, video conferencing, and VoIP over the Internet and other Internet Protocol (IP) networks, websites and portals. Deployable ICT packages for commercial satellite communication and turn-key Internet or information services are now available from several companies and non-governmental organizations (NGOs) (Wentz 2006). United Nations (UN) agencies manage their own information networks, as do formal military alliances.[1] ICT technologies are ubiquitous and 'democratizing,' in that they are available to and likely to be employed by both military and civilian personnel (Mancini 2013).

Until very recently, to talk about ICT innovation was to focus on exclusive government proprietary technologies, often developed under secrecy protocols, that later spawned commercially-available technologies. In recent years, this view has become increasingly obsolete. Many technologies that were once exclusive to military and other government agencies, such as satellite imagery and geographic positioning, are now widely available (Jones 2002). Moreover, changes in state procurement policies have shifted much of the innovation in these realms to the civilian sector. The implications of this 'open innovation' era of technology competence, provision, and governance include a number of unintended consequences.

In the following sections, I treat ICT innovation in relief and stability operations as a social construct, brought about by both official government actions and those of a community of 'tech volunteers' interacting with the state, and one another. In the ecosystem of complex relief and stability operations, military operators, government bureaucrats, international agencies, private industry, and non-profits including this voluntary tech community cross-pollinate ideas, artifacts, and applications; together, these efforts provide the raw materials for the eventual agreement on technical standards. This community also tends to take action in response to crises, although many members do so without differentiating between the various origins of crisis (e.g. war vs. natural disaster). In short, the story of ICT innovation for complex operations is one of innovation distributed across interconnected systems and realms of activity. Major events such as natural disasters punctuate this story, often compelling the evolution of community learning and coherence. Finally, state actors across the federal government grapple today with an expanded and changing operating environment. The US military Civil Affairs approach to Civil Information Management seeks a balance of insulation from and openness to the fluctuations in the civilian realm. In short, they aim to seize opportunities provided by ICT, while minimizing the hazards.

Innovation

Prior research on innovation is relevant to understanding the emergence of relief and stability operations ICT innovation, and the particular role of the state in it. Academic literature traditionally depicts innovation as an 'idea, practice, or object perceived as new by an individual or other unit of adoption' (Rogers 2003). But the arc of innovation studies has broadly shifted from a popular focus on *invention* or 'new to the world' to a view of *innovation* as both novel and impactful. Current innovation studies recognize that beyond invention of new artifacts like the QWERTY keyboard or the metric system, innovation involves a social process that becomes widely adopted, creating various impacts in that process. This view has developed across many disciplines and policy realms.

In the 1980s, scholars from several disciplines came together over interest in innovation in large and interdependent systems. Academic literature traditionally depicted technology as an exogenous driver of change. The 'sociology of technology' school, by contrast, depicted technological forms themselves as outcomes of social processes. These scholars highlighted how institutional, political and cultural factors helped dictate the shape of technology, calling attention not only to 'diffusion,' but to the broader mechanisms by which diffusion occurs. For example, in a landmark comparative national study of electrification between 1880 and 1930, Thomas Hughes (1983) broadened the lens of the history of technology to take in a wider process of the evolution of large distributed technology systems. Hughes saw technology as a system made up of both artifacts (in his case, generators, relays and lamps), and social structures (incumbent technologies and actors, social needs and geographic distribution). Hughes found that social factors proved more consequential in the development of electrical grids than mechanical or scientific factors. Variation across national systems in key architectures for grid components and the national traditional 'style' for engineer training accounted for variations in the forms of 'electrical power.' Hughes focused on the work of 'system builders,' the changing array of actors that provided impetus, expertise, and implementation across five moments that characterize large-scale technological systems: invention, development, innovation, technology transfer, and commercialization.

A key question for innovation researchers is how innovation spreads within and across organizations (Lundblad 2003). Innovation is a social process; in many cases, highly networked individuals perform a key role in diffusion (Hajek et al 2011). Users develop standards that decrease friction across systems (Constant 1980). During experiments, users notice variance and develop new consensus for policy and practical action. In this way, 'a wide range of actors comes to a locally enforceable agreement that certain social/technical relations are appropriate and workable' (Law 2012: 127).

Three models for thinking about technological innovation (Constant II 1987) center upon what is to be explained. The first, a community of practice model, is useful to explain technological development and revolution. In this model, well-defined communities, often composed of practitioners with diverse disciplinary training, are concerned with functional failure. The second model focuses on organizations, replete with economic and bureaucratic imperatives for entrepreneurship, economic and organizational growth. The third model, a systems perspective, embraces the other two in order to understand the development of large-scale sociotechnical systems.[2] This systems approach offers a broad view of innovation that re-engages wider societal dynamics and forces beyond the immediate development of the technology.

In a critique, Langdon Winner (1980, 1993) noted that many technological advances are artifacts of power, arising from the needs of privileged social groups. Winner cautioned against neglecting politics, a recurring theme in technology innovation studies. The social function of ICT innovation in stability operations, as we see below, shifts over time with politics, in particular, changes in the US (and global) paradigm of stability operations and peace building that redefined the roles of civilian and military actors in these missions.

ICT Innovation and the State

States shape innovation, as demonstrated by a comparative study of the Information Technology (IT) industry by Daniel Breznitz (2007). Specifically, state power is often needed to address market failures in expensive and high-risk industrial research and development. The state also plays a role facilitating the 'inherently collective' nature of the innovation process itself: 'Innovation is iterative and cooperative in nature,' Breznitz writes; 'Therefore, there is a significant role for public actors in facilitating, enhancing, and maintaining innovative activities' (2007: 191). Among the many contributors to ICT innovation for relief and stability operations, the US Government, given its presence and tremendous market power, plays an outsized role. From the earliest days of ICT development, US Government policy and actions recognized its advantages of advanced systems for both peace and war. To illustrate, in 1995, American diplomats chose Wright-Patterson Air Base in Dayton Ohio as the site for talks with Parties to end war in Bosnia. In the 'Nintendo' room, the Americans displayed to delegates a real-time, three-dimensional map of the disputed territory. They sought to graphically represent 'Total information, which for many today means total power'(Gray 1997: 19). At that time, the US military dominated the information technology space, thanks in part to Cold War US government investment in the ICT sector and in academic research, and with close ties with leading firms and R&D capacity.

For decades, the US government internally supported the development of ICT, particularly those with military applications. The 1990s marked a significant shift in the state's role, both in the development of ICT and its use in the field.

The US federal government role in ICT innovation shifted functionally and normatively in a single generation from 'spin off' from the government to the private sector, to 'spin in' from the private sector to government (Guttieri 2000). Soon after, the Pentagon–by far the most powerful government actor in this field–developed a new conception of stability operations. It emphasized the need for civil-military collaboration for stability operations, which were defined as efforts 'to maintain or reestablish a safe and secure environment, provide essential government services, emergency infrastructure reconstruction, and humanitarian relief' (US Department of Defense Under Secretary of Defense for Policy 2009). Today there are many more relevant players in the information technology ecosystem, due in part to US government policy changes since the end of the Cold War. These changes, described below, shifted the locus and form of invention, development, innovation, tech transfer, and commercialization, including the linkages and forms of this division of labor.

Spin-off to Spin-in

US Department of Defense requirements are a major driver in almost any industry military procurement touches. Many scholars have traced the evolution of federal-commercial linkages in changing rules of procurement (Leslie 1992). Throughout the Cold War against the Soviet Union, the United States expended considerable resources toward largely secretive technological innovation. Science, linked to war forever by the development of the atomic bomb, had become 'a ward of the state' (Leslie 1992: 199). President Dwight D. Eisenhower played a part in establishing organizations for military, industrial and academic/scientific cooperation about which he would later, famously, warn the American public in his well-known comments on the 'military-industrial complex' (Melman 1974: 263).[3] These were also social networks among industry, academia and the military. Government agencies such as the National Science Foundation and the Office of Naval Research offered sizable contracts for research. The most often cited of the Cold War innovations was the Advanced Research Projects Agency (ARPA) (later named the Defense Advanced Research Projects Agency (DARPA). ARPA was established in the 1960s to organize interdisciplinary work in materials science research at major universities (Barber 1975).[4] ARPANET, a network of four computer nodes established in 1969, formed part of the critical foundational infrastructure for the Internet (National Science Board 1998: 8–6).[5] The Cold War era brought many 'scientific artifacts' such as the electronics, guidance systems, structural engineering and manufacturing technologies that revolved around the intercontinental ballistic missile (Leslie 1992: 208). In some cases, high-end government procurement dollars lured manufacturers away from lower end, more competitive, products (Noble 2011). The overall impact of US government promotion of information technology, mechanical engineering and materials research was a period of commercial success, with 'spin-off' of technology from government research by NASA, the Department of Energy and the Department of Defense building a robust generation of commercial firms.

It is no coincidence that high technology bastions like Silicon Valley in California and the Massachusetts Miracle along Route 128 include Stanford University and MIT, beneficiaries of the former 'Gunbelt' of federal military funding for research. Many researchers went into business for themselves and hired former students to run their new labs, spinning off dozens of new companies (Saxenian 1994; Siegel and Markoff 1985; Blank 2008).[6] In sum, much of the story of US technological innovations is about the role of the state establishing linkages across the civil and military realms. Many government-funded technological developments supported both warfighting and non-warfighting operations.

The US Department of Defense is consistently the largest single US government investor in research and development, investing about $65 billion in FY 2013, not counting the Department of Energy spending (Hourihan 2013: 25). Direct production is not the only tool available for the state to spur innovative new technologies. The state can also regulate industry, or signal entrepreneurs to move into a desirable area. The extent of government intervention to promote a field such as ICT may be less significant than the type of intervention selected (Evans et al 1985). Policy shapes the relationships, and politics, among the participants in the innovation realm.

Procurement and government research are vulnerable to budget cuts as a general rule (Plumer 2013). Historically, US government funding for technological innovation of all sorts, including ICT, has experienced both booms and busts, often alongside the Pentagon's budget. In an era of declining resources shortly after the Cold War, the DoD made two game-changing revisions to how it would move forward. In 1993, Deputy Secretary of Defense William J. Perry convened leaders of the defense industry for a meeting that became known as the 'Last Supper' (Deutch 2001). Perry signaled the end of an era of big spending, and encouraged defense contractors to consolidate in order to reduce their reliance on defense. Many acquisitions followed between 1993 and 1998. Perry emphasized that the US Department of Defense would become one of many clients to civilian producers. Suppliers were encouraged to pursue civilian applications to their systems, and not to depend upon defense contracts. Research and development investments did not appear to suffer from these changes. In fact, total R&D expenditure in the US hit a record high in 1997 at $205.7 billion, driven largely by corporations. Industry R&D moved from two-thirds of the national total in the 1970s to nearly three-fourths in the late 1990s (National Science Board 1998).

Secretary Perry's other major policy change was to the DoD's own procurement system. Rather than completing paperwork to justify purchases from civilian providers, it was from this point expected that commercial off-the-shelf (COTS) purchases would be the norm, and the DoD would now need paperwork to justify any deviation from commercially-available technology (New York Times 1993; Constantine and Solak 2010). During the Cold War, the DoD strictly controlled systems development, but later gave prime contractors responsibility to manage their technology supply chain. Reforms sought timely acquisition and use of commercial technology, establishing the ability to purchase from commercial companies, to reduce the cost of doing business. The shift to the civilian sector was also a necessity given how information infrastructure to power, communicate, and coordinate was replacing road and rail in importance (Van Creveld 1991). The Pentagon also recognized that these technologies were becoming obsolete every 2–3 years. Given that the DoD's timelines for development of new systems was more like 10–15 years, expecting a life-span of about 40 years, the Pentagon needed a way to keep pace (Reynolds 2006).

Nearly 20 years after Perry's tenure, much has changed in the ICT world. In 2010, President Barack Obama announced, 'We're expanding scientific collaboration with other countries and investing in game-changing science and technology to help spark historic leaps in development' (The White House 2012). Government programs like Patents for Humanity in 2012 began to provide incentives including accelerated Patent and Technology Office processes for innovators of technologies that are applied to humanitarian issues (Lanham 2013). Ashton Carter, currently President Obama's Undersecretary for Defense for Acquisition, Technology, Logistics (AT&L) has commented on DoD reliance on outside sources, observing that $400 billion of the DoD's $700 billion budget was 'contracted out' (2011). Meanwhile, private sector initiatives such as Humanitarian Free and Open Source Software (HFOSS), SocialCoding4Good (SC4G), Benetech, FrontlineSMS and the Guardian Project seek to draw upon technology innovator volunteers to address peace and humanitarian concerns (Nelson et al 2014). These innovators typically use open source software, and many are designed to match experts and problems in the humanitarian domain (Boss 2012).

In sum, the spin-off era gave way to a new era of spin-in, shifting the center of gravity in many fields, including ICT innovation. In contrast to Cold War concerns about military influence in civilian science and industry, the US military became instead 'a tentacle of the civilian technology market' (Gombert 1998: 19). The US military-industrial complex generated many modern technologies, but the military became increasingly dependent upon the civilian sector for growing proportions of new technology. This shift was also apparent in the military's approach to stability operations in general.

Rethinking War

A second paradigm change, from the perspective of the military, was taking place in the nature of war itself. As the Cold War drew to a close, the international security environment was troubled by conflicts within states as much as between them. As civil conflicts, they were more akin to the small wars of America's past experience in the Philippines and Cuba than the kind of major conventional war the US military had prepared to fight against the Soviet Union. Fighting in small units and even face-to-face, accompanied by provision of humanitarian and civil administrative services, had become more common than large scale wars with armor and air power. The United Nations, with few exceptions, had historically confined peacekeeping primarily to impartial, lightly-armed troops to observe negotiated settlements; this changed in the 1990s (Guttieri 2004). In order to stem the bleeding in places like Mozambique, East Timor, Cambodia, Somalia and Bosnia, UN troops became more deeply involved in new ways with new missions. In 1992, UN Secretary-General Boutros Boutros-Ghali introduced the concept of *peacebuilding* as a synergy across spheres of assistance – social, economic, humanitarian, security, and political-administrative to build and sustain peace (Boutros-Ghali 1992: 17). A larger number of civilian agencies became engaged in peace missions than ever before. Non-governmental organizations also grew in number and significance in conflict zones.

The US military entered an era of stability operations, peacebuilding, humanitarian assistance, disaster relief, and prevention. At the time of the 1995 peacekeeping mission in Bosnia, the US was reluctant to engage non-state actors, particularly after a failed humanitarian intervention in Somalia two years before. Although many in the US military hoped that the US would avoid involvement, the Clinton Administration committed to missions in both Bosnia and Kosovo alongside allies in the North Atlantic Treaty Organization (NATO). After terrorist attacks on the United States on September 11, 2001, the Bush Administration invaded Afghanistan and Iraq, leading to large-scale nation-building projects. In the meanwhile, tsunamis, hurricanes, and earthquakes around the globe also increased demand for both military and civilian action. Not only did US forces need to communicate with one another, they found it vital to effectively share information with partners in the field of operations.

In headquarters and in the field, many came to recognize that the ability to achieve mission objectives in Afghanistan and Iraq required civil-military cooperation. Many US military and policy leaders began to view stability operations as a 'whole-of-government fight' that would 'leverage interagency, joint, and multinational cooperation,' and 'enhance the capabilities and legitimacy of a host nation' (Barno 2009). In 2005, the Department of Defense redefined stability operations as 'military *and civilian* activities [emphasis added],' and more importantly, as 'a core US military mission' of equal importance to combat operations (DoD 2005). The document, Directive 3000.05, sought to clarify the mission of the military, and to provide a new understanding of its relationship to civilian agencies. In December 2005, Bush signed National Security Presidential Directive 44 (NSPD 44), making the State Department the lead for coordinating US reconstruction and stabilization efforts (USG 2005).[7] These policy and doctrinal changes added to the imperative for the military to more effectively share information with other US government, Host Nation and international agencies, as well as non-governmental agencies in the field.

The military's Civil Affairs personnel not only support civilian agencies and nonmilitary stakeholders, they engage in collaborative planning and coordination with them, typically through a Civil Military Operations Center (sometimes called a Humanitarian Operations or Humanitarian Assistance Center). The Army's Civil Affairs Operation manual in 2006 added Civil Information Management (CIM) as a core task for Civil Affairs (the others are Populace and Resources Control, Foreign Humanitarian Assistance, Nation Assistance and Support to Civil Authority) (United States Headquarters Department of the Army 2006: 1–1).[8] The Civil Affairs Operations staff uses the CIM process to be sure that there is a common operating picture with the civil component. The 2011 Civil Affairs Operations field manual defines CIM as follows:

> CIM is the process whereby civil information is collected, entered into a central database, and internally fused with the supported element, higher HQ, and other USG and DOD agencies, IGOs, and NGOs.... Civil information is information developed from data with relation to civil areas, structures, capabilities, organizations, people, and events within the civil component of the commander's operational environment (Headquarters 2011: 3–10).

The CIM process is particularly important to the DoD capacity in ICT because the increased presence and importance of nonmilitary elements brings with it increased data, and increased information sharing requirements. At the same time, the various partners also bring ICT capabilities that add to the noise. The community of practice associated with ICT innovation in stability operations emerged as a powerful force.

Communities of Practice

Several communities of practice spanning different agencies, specialty expertise, and events formed and were consequential for the evolution of ICT since the early 1990s. Bill Wood, for example, was a geographer who was enthusiastic about the potential of remote sensing and geographic information in response to humanitarian crises, and a government bureaucrat in position to do something about it. Wood helped to negotiate the release of Shuttle Radar Topography Mission data for humanitarian efforts – a long desired dream of the humanitarian community. In 2002, while concurrently Deputy Assistant Secretary for Analysis and Production at the Department of State, and Geographer of the United States, Wood established a Humanitarian Information Unit (HIU) within the Bureau of Intelligence and Research to help coordinate response to crises.[9] The Department of State, as the USG clearinghouse for the release of data, has taken many experts seconded from other organizations such as the National Geospatial Agency to build policies and systems in the HIU. After the US invaded Iraq, Wood helped to develop GIS-based tracking of reconstruction projects for the Department of Defense-led Coalition Provisional Authority (AAG: 29). Wood's biography encapsulates the important and non-obvious relationships among technological innovation, humanitarian relief, and stability operations that have shaped military ICT in recent years.

Some years before the HIU was established, a number of other humanitarian networks were making use of Internet portals to support their work in the field. In 1994, the Overseas Development Institute established the Humanitarian Practice Network as 'an independent forum for policy-makers, practitioners and others working in or on the humanitarian sector to share and disseminate information analysis and experience, and to learn from it' (Humanitarian Practice Unit). The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) established a digital information service, ReliefWeb in 1996. In 1997, US Pacific Command was using web-based technology for a Virtual Information Center to capture open source information. The Commander, Admiral Dennis C. Blair sought to apply the technology to security cooperation in the Pacific; he established the Asia-Pacific Area Network in 2000. Knowing that many non-governmental organizations are cautious about cooperation with the military, the portal was commercial, with a '.org' address, to promote information sharing. However, the humanitarian community remained wary of military initiatives. The APAN site was slow to take off, until events brought the communities closer together.

Also in 2000, the US Navy conducted its major exercise in the Pacific involving more than 22,000 troops, 200 aircraft and 50 ships. That year, at the initiative of Vice Adm. Dennis McGinn, Commander of the Third Fleet, it also included a component called Strong Angel that included top officials from the UN High Commissioner for Refugees, UNICEF and the UN World Food Programme. One public affairs officer noted,

> As much as it's important to keep humanitarian operations neutral, the unfortunate reality in the post-Cold War world is that... we need each other more and more... We're dealing in [sic] countries where there's no real authority and rule of law. In many cases, we couldn't do our job without the military (quoted in (Essoyan 2000)).

At that time, Dr. Linton Wells II served as Principal Deputy Assistant Secretary of Defense (Command, Control, Communication and Intelligence). For him, the role of ICT in the exercise, including communications, simultaneous translation, and David Warner's crisis mapping was a harbinger of more integrated ICT in future.[10]

In Afghanistan after 2001, the US-led coalition sought ways to use ICT to stabilize a new post-Taliban government. The first order of business was to enable communications between the central government in Kabul and provincial governments. The US Agency for International Development (USAID) funded a radio network that provided that link until a nationwide ICT system could be established. The number of subscribers to

Afghan ICT grew 'from essentially nothing to over 2.5 million… in four years' (AEI: 28). But war zones were not the only arena of action.

In December 2004, an earthquake in Indonesia caused a tsunami that affected the entire region. The event killed nearly three hundred thousand people and rendered five million homeless. The event also prompted further interactions between civil-military ICT communities, resulting in new linkages and overall closer working ties. PACOM responded quickly after the tsunami, but soon recognized that its traditional military command structure did not accommodate the 90 NGOs also involved in the relief effort. PACOM turned to the APAN website, because it was unclassified and commercial. APAN 'became a primary source for NGOs,' one observer has written, 'vital for involving nontraditional security partners, who are essential in humanitarian assistance operations that cover a broad area and cross national borders' (Dorsett 2005). Websites of the DoD's Center of Excellence in Disaster Management and Humanitarian Assistance, the UN Joint Logistics Center and USAID's Office of Federal Disaster Assistance were among many sources of timely information and reach-back to experts for those responding to the crisis. USAID Disaster Assistance Response Teams sent information officers. The National Geospatial Intelligence Agency provided satellite imagery to give pictures of ports, communication networks, and the damaged areas, but commercial imagery was more easily and quickly shared.

The Asian tsunami response showed that government bureaucracies were 'the weakest link in the information chain' (Martin 2007). Lin Wells, despite a high-level position in what was now called the Networks and Information Integration directorate of the DoD, met roadblocks as he sought to send ICT experts David Warner and Eric Rasmussen to Southeast Asia.[11] They finally arrived to find that Navy aircraft carriers were not sharing information with anyone who did not ask for it; the NGOs had not realized they needed to ask. They also learned that bandwidth for transmission was a problem, as was permission for US military helicopters to share it with NGOs. As Acting Secretary in 2004–5, Wells stood up Contingency Support and Migration Planning (CSMP) to address contingencies involving NGOs and to rationalize the use of ICT among the Coalition Provisional Authority, US military, Iraqi government and private sector.

Citizen-led efforts gained steam, some of them inspired by government failures during the response to Hurricane Katrina. Lois Clark McCoy of the National Institute for Urban Search and Rescue (NIUSR) gathered a 'who's who' of industry, military and government leaders in ICT for crisis response. NIUSR lists assisting 'in the transfer of technology from federal labs and the military into the realm of domestic first responders and emergency managers' among its contributions.[12]

Dr. Wells notes that 'for every innovator, there are bureaucratic obstructions' (Wells 2013). However, by 2009, Wells succeeded in changing the game, much as Perry had done some years before with a policy directive. Working as the Pentagon's Chief Information Officer, Wells introduced a new DoD policy to 'resource ICT capabilities to share spectrum or bandwidth… provision ICT capabilities and associated unclassified data and voice services for US task forces to support civil-military partners in stabilization and reconstruction, disaster relief, and humanitarian and civic assistance… enable connection to or provision of Internet service and voice capability' to the extent authorized by law and 'when it is determined to be in the best interest of the DoD mission, and when the access is not in conflict with host nation post, telephone, and telegraph ordinances' (DoD 2009).

In the intervening years, many more disasters struck the Pacific Region, and APAN supported responses.[13] In 2010 APAN shifted regionally to support the response to the earthquake in Haiti. That year, APAN was renamed All Partners Access Network. In

2011, the DoD announced a new Unclassified Information Sharing Service as 'an enterprise service centrally funded for all Combatant Commands (COCOMs) to use with mission partners in their respective areas of responsibility,' using APAN as 'a baseline' (APAN date unknown).

The response to the earthquake in Haiti in 2010 is widely discussed as a 'new media success story,' fueled by citizen engagement. The Fletcher School at Tufts created a live crisis map. A report notes some of the innovations:

> Relief workers crowd-sourced information—and acted on it: reports of trapped people and medical emergencies collected by text were plotted on an online map then used by relief workers. In one example, the US Marines brought water and sanitation devices to a camp after receiving reports that drinking water was in short supply. SMS texts broadcast critical information to Haitians: cell phone companies, relief groups and media created and used the code 4636 to send messages to tens of thousands about important public health issues. Volunteers created open-source maps as guides: using handheld GPS devices, volunteers created up-to-date maps to help guide humanitarian groups and the public trying to navigate affected areas (Targetted News Service 2011).

One of those deploying was David Kobia, a Kenyan software developer and founder of Ushahidi, a crisis mapping platform and open source software provider with origins in mapping the Kenyan election violence of 2007. Kobia has described the creation of Ushahidi as, 'a response to being helpless in other ways.' Using web-enabled and mobile tools, Ushahidi revolutionized humanitarian response. 'The percentage of people that participate increases exponentially during a limited period of time,' Kobia has observed, 'It is easier at that point to build the crowdsource effort required for a crowdsourcing tool' (Vericat 2010). The crowdsourcing of earthquake data analysis, for example, complements the efforts of agencies like the Red Cross, who previously acted as the primary source of information.

Non-state volunteers as well as government agencies quickly applied ICT tools to the challenges of analyzing, communicating, navigating and managing supply chains. New technology has not proved to be a panacea, and has sometimes complicated efforts, but the introduction of large-scale virtual civilian response marked the beginning of something new. Many researchers today focus on social media 'scraping,' in which programs are written to analyze Twitter feeds to extract tidbits of data and separate noise from chat.

The Crisis Mappers Standby Task Force that started with Haiti was renamed the Standby Volunteer Task Force (SBTF). The SBTF provided the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) support for a crisis in Libya in 2011:

> More than 150 digital volunteers maintained a live map over a four-week activation period, collecting, geo-referencing, analysing and verifying large volumes of crisis information related to these specific categories. The live–but private and password-protected–map was launched within hours of the request. A public map was later made available, but without personal identifying information and with a 24-hour time delay for security reasons (IFRC 2013: 76).

In 2012, OCHA launched a Digital Humanitarian Network (DHN). Civil-military experiments meanwhile continue, at places like Camp Roberts, in California, where the Harvard Humanitarian Initiative, Geeks Without Bounds, Random Hacks of Kindness, OpenStreetMap, iRevolution.net and others try out new technologies. The RELIEF exercises, led by the Naval Postgraduate School and sponsored by the Office of the Secretary of Defense (OSD) Advanced Technology and Logistics (AT&L) aim to 'give industry a better idea of requirements and government people a better idea about what is in the world of the possible' (Buettner 2013). Ray Buettner, who now runs the program first developed by David Netzer, observes that 'the collaboration itself, rather than the tech, may be more important.' Policies that were deliberated at Camp Roberts were applied when Hurricane Sandy struck the US Eastern seaboard. OpenStreetMap and thousands of volunteers became involved. The Navy's Civil Air Patrol high resolution imagery of the affected areas was imported into MapMill for the crowd to analyze and rate by triage as 'OK,' 'not OK,' or 'Bad' to help guide FEMA deployment (iRevolution 2013). Likewise, the State Department's Humanitarian Information Unit, after deliberations at Camp Roberts, has been able to share information on the crisis of refugees and internally displaced from the 2011-onward Syrian conflict.

Another key hub for the community of tech volunteers is San Diego State University, where Dr. Eric Frost and colleagues at the Immersive Visualization Center (VizCenter)[14] have convened a series of Humanitarian Assistance and Disaster Relief events. In 2011, X24 Europe involved US government and approximately 90 other partners from non-governmental and private sector organizations, including more than 49,000 people from 92 nations. The aim of the exercises is to demonstrate and test the use of ICT–low-cost, off-the shelf, collaborative tools, to build 'situational awareness.'

If these exercises are building a Common Operating Picture, it is not clear that the military's Civil Affairs community and the Civil Information Management (CIM) system are players in it. The CA community is 'still building CIM data processing management [DPS],' according to an officer involved, 'CIMDPS genesis is continuity of data problem' (Army CIM Officer 2013). The CIM initiative is still building acquisition processes that can create the most possible options that connect to what people are actually using for their collection, coding, display and exchanges. The energy in the Army Civil Affairs world is a focus on data repository with legacy data that is sharable among the Army communication systems (classified/non-classified). The CIM effort today is focused on establishing standards, only partially resolved by the National Information Exchange Model, an xml-based info exchange built within the US government.

Internal coordination remains the immediate problem for the Civil Affairs community. They have yet to resolve conflicts within Army communication systems. They are still curating the data generated over ten years of war: 'We need to link together so that we can see the bigger picture down the road and not put it in a desk drawer,' one officer laments (Army CIM Officer 2013). As for what's next on the horizon, it is to realize 'what people use day-to-day for communications and data and bring it into our systems.' That this gap persists, after the vast progress in the exercise and field environments over time, demonstrates the power of institutional barriers that remain. The US government is both open, in the general sponsorship of innovation, and closed, in the ability to absorb rapid changes from the civilian realm. Given the turbulence of innovation, it is understandable that the military would seek to stabilize its systems, but by the time programs of record are established, these may not be relevant to the new ICT environment.

Contingency, as many innovation researchers emphasize, is important. Public policy injects incentives and disincentives to the system that alter the trajectory of innovation and its diffusion. The process of testing and evaluation, exercises and field experience all contribute to coherence of community and momentum of technological system development. Events such as major disasters punctuate the evolution of learning and coherence among the diverse community of

ICT practitioners. However, a more vigorous policy approach to ICT in stability operations appears needed for emerging capabilities to contribute to their potential.

Conclusion

This paper reports original and detailed data on the development of ICT in the modern period, with particular focus on the role of US government actors. This review highlights intended and unintended actions and impacts in stability operations–a field with a complex history (Guttieri 2014). In this research, I structure these data with concepts and arguments from innovation studies. The focus on system-builders and the evolution of large-scale technologies systems provides a way to thread together the variety of actors and expertise that have shaped ICT in different historical and institutional moments.

Social construction of technology offers another valuable perspective on the ecology of ICT innovations for stability operations. The social function of ICT innovation has grown at the same time that changes in the US (and global) paradigm of stability operations and peace building included greater roles for both military and civilian participants. The state played a role in shaping the ecology in two ways: first, the Pentagon shifted from spinning-off technology innovation to spinning it in from the civilian sector. This shifted ICT invention, development, innovation, and overall division of labor. Second, the US military shifted from a nearly-exclusive focus on major combat operations to engagement in stability operations. Together, these shifts opened the space for other actors in innovation and in conflict zones. It created a distributed system for innovation across public and private sectors and activities related to stability operations.

As a major participant in stability operations, the US military continues to bring new tools and approaches. But other actors and activities matter in the stability operations realm of practice. A community of practice, as innovation research predicts, has been often key to ICT innovation and diffusion in stability operations. New technologies and approaches emerge in related realms of activity, such as disaster relief, that then make their way into core ICT programs and initiatives. Field exercises provide venues for development, testing, and sharing applications of new technology and policies that are lacking. Real world events have also triggered action and development of greater coherence. As the operating space for these activities are so interconnected, innovations on one domain quickly migrate to other domains of humanitarian and military activities. Despite initiatives such as the military's Civil Information Management and the State Department's Humanitarian Information Unit, information sharing gaps persist, largely for institutional reasons. The Army's Civil Information Management initiative grapples with an expanded and changing ICT environment, aiming to seize opportunities and minimize the hazards of new ICT.

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Notes

1. The US Government manages a multinational military information network – The Coalition Enterprise Regional Information Exchange System (CENTRIXS) – that provides multilevel secure virtual private networks (VPN) for collaboration with allies.
2. Constant suggested that the study of connections between 'cultures of technology, organizational cultures, and society at large' be a subject of future research (Constant 1987: 234).

[3] Many of these began during World War II. General Eisenhower, as US Army Chief of Staff in 1946, formulated the doctrine of government-business partnership.

[4] These were MIT, Harvard, Brown, Northwestern, Stanford, Cornell, Chicago and the University of Pennsylvania.

[5] The Internet is a meta-network that includes subnetworks and applications (the World Wide Web, e-mail, etc.) The National Science Foundation network (NSFNET) replaced ARPANET in 1990. By 1995, the Internet was fully established and NSFNET was decommissioned.

[6] High-power radar, electronic countermeasures and satellite technologies are some of the defense innovations In Silicon Valley, government funding supported university laboratory research that led to many of the crucial companies like Lockheed, Sylvania, and General Electric to the area to hire academic researchers and work again, under defense contracts.

[7] The Department of State in 2004 established an Office of the Coordinator for Reconstruction and Stabilization (S/CRS) to 'lead and coordinate [US government] efforts to assist in stabilizing and reconstructing countries or regions in, or in transition, from, conflict or civil strife.' The S/CRS was absorbed into the Bureau of Conflict Stabilization Operations in 2012.

[8] This Field Manual was updated as FM3–57 in 2011.

[9] The HIU is in effect today a multi-agency organization with the DoD, the National Guard Association's Humanitarian wing, and the President's Emergency Program Response to AIDS in the health sector. The lead director is a senior civil servant from USAID. The HIU convenes conferences and responds to requests for geospatial products. Although it is non-deployable, the National Geospatial Agency (NOA) is in daily contact. The Department of State gives final approval for release of unclassified imagery. See: https://hiu.state.gov/Pages/Home.aspx.

[10] See David Warner, AntZ: Complex Data Visualization at http://www.youtube.com/watch?v=gtSk9HFyiG8 As the Acting Assistant Secretary and DoD Chief Information Officer from March 8, 2004, Dr. Wells remained engaged in the Strong Angel 2 and 3 exercises in 2004 and 2006 that applied lessons of Afghanistan, Iraq, and Hurricane Katrina. Strong Angel 4 focused on procedures for sharing information outside the wire.

[11] Eric Rasmussen is a medical doctor with ties to the military, United Nations, and private sector networks such as InSTEDD, founded in 2006 from the TED Prize.

[12] NIUSR is supported by a 2250-person Advisory Panel who contribute reports in addition to funding. See NIUSR 'Who Are We?'

[13] 2006: mudslides and typhoons in the Philippines, earthquake in Indonesia; 2007 a tsunami in the Solomon Islands, cyclone in Bangladesh; 2008 Burma, typhoon in the Philippines; 2011 earthquake in Japan. https://community.apan.org/hadr/p/hadr_history.aspx

[14] See http://vizcenter.net/x24/more.html.

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