Innovation and Entrepreneurship From the Bottom Up

*Nancy C. Roberts[a] and Carrick Longley[b]

Department of Defense Analysis, Naval Postgraduate School, Monterey CA 93923
[a]nroberts@nps.edu [b]ctlongle@nps.edu

Abstract

Innovation, the evolution of an idea through its development into practice, and entrepreneurship, the energy driving the idea's movement through its many iterations over time, have relied more on a bottom up rather than a top-down process in the latter half of the 20th century. For example, the engine of change in Silicon Valley, California has been the hundreds of small groups of entrepreneurs working in labs or in their own living rooms and garages to launch the next generation of products and industries. Unfortunately, not all communities, regions and countries have such an enabling context to seed entrepreneurs and their innovative ideas. Indeed, many still are constrained by government rules and regulations, lack of institutional resources, and are hampered by a model of innovation that is linear and driven by the top. We live in such a community—a small lab in a university setting within the Department of Defense. The new idea, developed by the second author, is called Lighthouse. Having gone through several iterations, it is now in the design phase of the innovation process and has been undergoing field tests to great acclaim. The innovation process is not over, nor will it be for a while. And there is danger ahead. Bureaucratic knives are sharp and they can cut quickly and without warning. We think we have learned something about how to launch an innovative idea from the bottom up and to protect a new idea in hostile terrain. Despite our public sector frame of reference, we would like to share with those in the business community who come from environments that are less than hospitable in order to give them some insights how they too might navigate the tricky currents of the innovation process.

Introduction

How does an entrepreneur in a large bureau innovate from the bottom up in a context that is change resistant, and even when change does occur, it tends to be top-down driven and rewarded? What does it take to push a new idea through the innovation process to ensure a successful innovation in this context? These questions form the backdrop to our case study of Lighthouse—a new tool and capability for data collection and analysis. Our goal is to document the entrepreneurial and innovation processes that enabled a university student to launch what some are calling a "game changer" in how the military collects and analyzes data in its field-based operations.

From an organizational perspective, these questions are important for several reasons. Virtually all studies of military innovation point to the difficulty of innovating in organizations that are "intrinsically inflexible, prone to stagnation, and fearful of change" [1, p. 919]. As Stephen Rosen [2] notes,

not only are large bureaucracies difficult to change, "they are *designed not to change*" (p. 2, emphasis added). Furthermore, all major innovation models in the military have been found to follow a similar pattern. All assume innovations require pressure from external authority, and when initiated, they are kick started from the top down [1].

Yet there are empirical cases of innovations from the bottom up, although not widely acknowledged as such. For example, the Marine Corps' innovative small wars doctrine is considered to be the result of a bottom-up process that occurred outside formal channels through an informal discourse among a small number of middle-ranking and junior officers in the Corp's schools and journals for the purpose of advancing a new doctrinal focus—the Advanced Base Mission [1]. This case and others have led Adam Grissom of Rand to suggest the beginning of a "Kuhnian moment" where the apparent anomalies of bottom-up innovations are growing and rendering the field's prevailing assumptions and frameworks about top-down military innovation inadequate to describe empirical reality. Thus he sees a conceptual and theoretical void to be filled, but foresees two challenges that must be addressed for the effort to be successful. First, researchers need to build an empirical foundation of bottom-up innovation on which models and hypotheses can be developed for comparison and testing. And secondly, they must develop conceptual models of military innovation that identify the necessary and sufficient conditions for bottom-up innovation to occur.

We take up these challenges by presenting an empirical study of bottom-up military innovation—a case study of Lighthouse, an innovative idea developed by Captain Carrick Longley the second author of this paper. Although the case is ongoing, we are able to distill the basic elements of entrepreneurship and innovation that work in tandem to propel the innovative idea through time. Process studies such as this are rare in the innovation literature in general (e.g. Roberts and King [3]) and even more rare in the military literature. Those that do exist are retrospective and reliant on archival data. In this instance, we have first-hand reports and documentation of an on-going process as it evolves through time. Thus, our case analysis will be an initial attempt to create a conceptual model of military innovation that identifies the necessary conditions for bottom up innovation to occur. In stark contrast to the top-down, mandate-driven, innovation efforts characteristic of military organizations, this case demonstrates an alternative model that represents a growing trend in military organizations—a bottom-up, entrepreneurial-driven model of change. Our follow-on research [4], a complement to the necessary conditions outlined in this paper, will document what we believe to be the sufficient conditions for innovation to be successful.

Section One of the paper introduces our conceptual framework in which we embed this study of entrepreneurship and innovation. It draws on both the private and public sector literature and lays the foundation for the case in Section Two. The case analysis follows in Section Three. Here we identify the basic elements of what we believe are the necessary conditions for bottom up entrepreneurship and innovation to be successful in large bureaucratic organizations.

Conceptual Framework

Entrepreneurship has a long lineage. As a well-established concept in business and government, it has appeared in many guises in its 150 year history. Despite the multiplicity of definitions in the literature, there is general agreement that those who start up new, innovative organizations in the

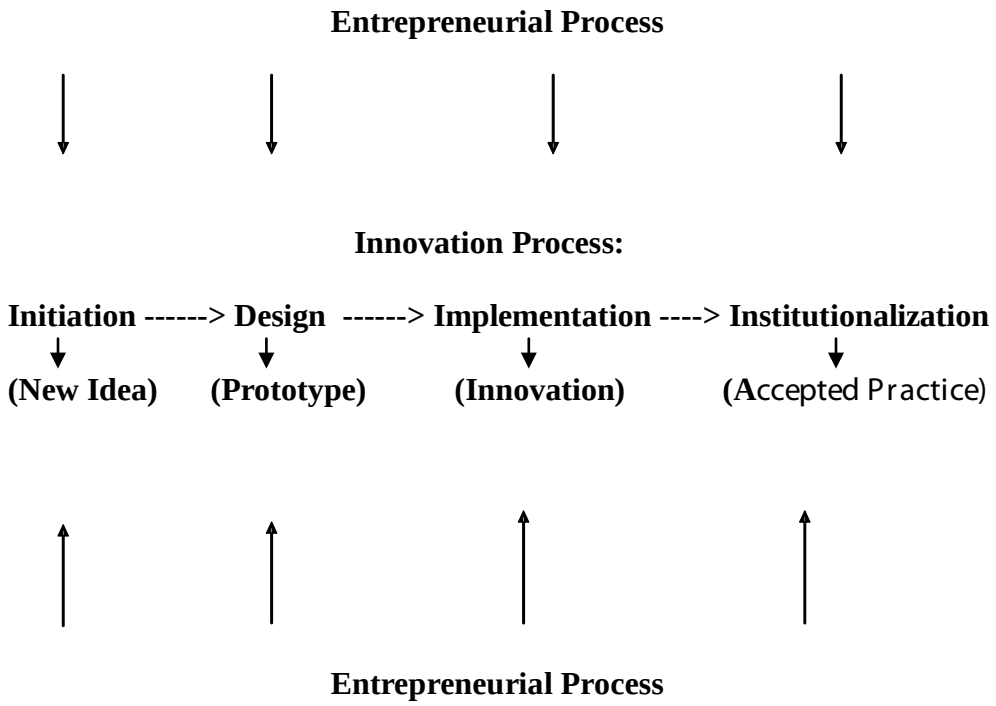
private sector are business entrepreneurs [5, 6]. Those in the public sector who establish new public organizations are considered executive entrepreneurs [7, 8, 3], and those who craft new ideas and implement them as innovative public policy are referred to as policy entrepreneurs [9, 8, 3].

A fundamental understanding of entrepreneurship, whether it is business or public-sector entrepreneurship, begins with the innovation process. Innovation is the translation of a new idea from its initial state to its actualization in practice as a full-blown innovation [10]. The innovation process begins with a new idea. The idea can be a new technology, a new service, a new product, or even a new administrative procedure or process [11]. Classification of an idea as 'new' depends on its context. An idea is considered to be new if it is perceived to be new by the relevant unit of adoption [12, p. 10]. Sometimes new ideas originate in a particular setting. In other instances, a new idea is adapted or even borrowed from another setting and then applied in the entrepreneur's own context [13].

The development of the *new idea* and the association of the idea with some need, problem, or concern, mark the first phase of the innovation process, often referred to as initiation or creation [14, 8, 3]. Initiation is followed by the design phase that translates the idea into a more concrete and *tangible form* (such as a prototype, model, or position paper). Completion of the design phase requires the approval of powerholders and gatekeepers whose resources and support are necessary to proclaim the new idea as new *invention, law, statute, policy, or program*. Implementation follows the design phase when the new idea is tested in practice to ascertain how well it functions. New ideas that survive implementation are described as *innovations*; ideas that do not survive are considered to be failed ideas [8, 3]. Institutionalization is the final phase when the new idea becomes *accepted practice*. Thus, we can think of the innovation process consisting of a series of hurdles or transformations that move the new idea from an initial state and to its final state.

The horizontal dimension in Figure 1 represents the process graphically, although it is important to note that the innovation phases do not imply a sequential logic in the idea's trajectory. We know, for example, that the more novel an innovative idea, the more overlap there tends to be among the phases. What this means in practice is that when people work on highly original, innovative ideas, they may be engaged in both initiation and design or design and implementation at the same time.

Figure 1: Interactive Processes of Entrepreneurship and Innovation



The vertical dimension in Figure 1 represents the entrepreneurial process. Entrepreneurs are the creators and drivers of the innovative idea as it moves through time. In order to push their ideas forward, they engage in a set of activities to promote and protect their ideas and give them shape and form. The range of their activities can be extensive depending on how well known the idea is, how much resistance there is to it, and the level of support it attracts. One way to think of the vertical dimension is to view it as representing an entrepreneurial activity structure. Table 1 illustrates the activity structure of a group of public entrepreneurs who were advocating radical policy change. Four basic categories subdivided their activities: creative/intellectual activities; strategic activities; mobilization and execution activities; and administrative and evaluative activities. Taken a whole, the activities resulted in a relational field of energy to protect the new idea, defend it against its detractors, and nurture it through the vagaries of the innovation process.

Table 1

Activity Structure of Public Entrepreneurs

Creative/Intellectual Activities

1. Generate Ideas
   * invent new policy ideas
   *apply models and ideas from other policy domains

2. Define Problem and Section Solution
   *define performance gap
   *identify preferred solution alternative

3. Disseminate Ideas

Strategic Activities

1. Formulate grand strategy and vision

2. Evolve political strategy

3. Develop heuristics for action

Mobilization and Execution Activities

1. Establish demonstration projects

2. Cultivate bureaucratic insiders

3. Collaborate with high profile individuals/elite groups

4. Enlist elected officials

5. Form lobby groups and coordinate efforts

6. Cultivate media attention and support

Administrative and Evaluative Activities

1. Facilitate program administration

2. Participate in program evaluation

Taken as a whole, the model describes innovation in global terms, stating the necessary conditions for innovation to occur. If a new idea is not created, designed, and implemented, it will not be able to attain the developed status we attribute to an innovation. In contrast, public entrepreneurs often go through a much messier process that follows no predetermined set of activities. As Kingdon [9] reminds us, "events do not proceed neatly in stages, steps, or phases…. Participants do not first identify problems and then seek solutions for them; indeed, advocacy of solutions often precedes the highlighting of problems to which they become attached" (p. 215). In fact, some would advocate this messiness, by encouraging public entrepreneurs to work implementation issues while they are creating and designing new policy [15].

Thus, the innovative idea vector and the entrepreneurial vector are interrelated. They work in tandem to produce innovation. The innovation vector tracks the various manifestations of the new idea (idea, prototype, innovation, accepted practice) as it moves through the processes of initiation, design, implementation and institutionalization. The unit of analysis of the innovation process is the new idea. The entrepreneurial vector tracks the entrepreneurs who galvanize support for and counter resistance to the innovative idea as it move through time. The unit of analysis for the entrepreneurial process is the entrepreneur and the relational network of activities he/she develops in support of the innovative idea [8, 3, 16].

This model provides several conceptual advantages. First, it enables us to distinguish between entrepreneurship and innovation. While related, entrepreneurship and innovation are two different processes. Entrepreneurs are the necessary but not sufficient element for innovation to occur. Their creativity and initiative spark the development of new ideas. They are the catalysts that propel the innovative idea forward and mold and shape it through the innovation process. At the same time, entrepreneurs fail or succeed to the extent their ideas attract support and resources from others. At some point, the innovative idea takes on a life of its own and has to be treated as separate from the entrepreneur who gave it life. In fact, the ideal situation is when others begin to call the innovative idea their own. Thus, the entrepreneur and the innovative idea need to be treated as two related but conceptually distinct entities [8, 3].

The entrepreneurship-innovation model also enables us to make finer-grained distinctions between individual and collective forms of entrepreneurship. Individual entrepreneurship relies on the exploits of a single individual who works through all phases of the innovation process. Acting independently, she generates a new idea, creates its design, and oversees its translation and implementation into practice. In contrast, collective entrepreneurship draws on multiple people to husband and shape an idea through initiation, design, and implementation into a full-blown innovation. Probing collective entrepreneurship more deeply, we find its expression can take one of two forms: *team entrepreneurship* or *functional entrepreneurship* [8, 3, 16]. *Team entrepreneurship* occurs when multiple entrepreneurs join forces and work together to push an idea through *all* phases of the innovation process. Although each person is an entrepreneur in his own right, all decide it is more advantageous to pool their resources and act in concert with other entrepreneurs. *Functional entrepreneurship*, on the other hand, occurs without the presence of a single entrepreneur. It occurs when experts from different functional areas of expertise coordinate their efforts and resources in order to push a new idea into practice [8, 3. 16].

Case Study:
Building Lighthouse—a Field-Based Data Collection and Analysis System

Introduction

In 2007, I, Carrick Longley, led an operational control element of Signals Intelligence Marines in Ramadi, Iraq. The Anbar Awakening had occurred earlier in the year and resulted in a major de-escalation of the violence. The de-escalation gave U.S. security forces a greater opportunity to assist Iraqis in rebuilding their lives, and from my perspective, much of the military's success during this time period was due to the shift from kinetic targeting operations to non-kinetic operations. Non-kinetic operations emphasize tribal engagements, governance, economics, and information gathering and analysis of the sociopolitical context rather than the direct use of military force.

U.S. military's ability to conduct non-kinetic operations presented significant challenges. The biggest of these was the ability to understand the needs of the local population. Despite a decade engaged in Overseas Contingency Operations (OCO), the US military had difficulties in understanding the sociopolitical landscape or the 'human terrain' as we call it. So, over the course of twenty-four months, I would embark on a journey that would lead to multiple iterations, tests, and redesigns of a new idea—a technical system and methodology that could enable the war fighter to better understand the socio-cultural environment.

The innovation idea would take on a life of its own as several prototypes and system designs were created, tested, redesigned and supplanted by better, cheaper, and more comprehensive solutions during the project's evolution. From early 2008 until mid-2011, the project would undergo four name changes, two platform redesigns, a partnership and subsequent dissolution with a commercial organization, the demonstration or test of the project throughout Southeast Asia, the US, and Afghanistan, and the presentation of the system to nearly 40 senior executive and general officers throughout the Department of Defense and foreign militaries. To date, the innovative idea is the design phase of the innovation process and moving toward implementation in the field.

The Context

I arrived at the Naval Postgraduate School (NPS) in April 2008. My first three quarters focused on getting up to speed in calculus, physics, and computer science, as these were all necessary prerequisites in the Information Warfare Systems Engineering (IWSE) curriculum. Having spent my undergraduate years as a Spanish major, I had to bury myself in books to make sense of the formulas and applications necessary to begin 'real' graduate work. Up to this point in my military career, I had spent a significant amount of time in classrooms and subjected to an unending supply of PowerPoint slides, so I was eager to get involved in some actual field research. I heard about a program called the Common Operations and Applied Science and Technology Studies (COASTS). Jim Elhert, an Information Sciences Research Associate in the IS department, ran it and conducted half the experiments in California and the other half in Thailand. The idea of spending time in the field (to include Thailand) immediately peaked my interest. I contacted Jim about how I could join the effort.

Jim invited me to the second field experiment (FEXII) being held by COASTS at Camp Roberts, just outside of Paso Robles, California, where I was introduced to several individuals working with the COASTS program. As my interests were in communications, I was immediately drawn to the network engineers with whom I spent several days talking about potential thesis topics for my master's degree. At the end of the FEX, I had an idea. I wanted to integrate small level tactical radios with commercial off the shelf cellular phones in an attempt to create a 'hybrid' communications network. The idea came from my frustrations in Iraq, where, in 2007, we had difficulty sending very short situation reports from positions only a few kilometers apart to the command and control center at Camp Ramadi. This poor information flow prompted me to think about how we could integrate more advanced technology into the communication system.

After leaving FEXII, I immediately began to shop my idea around the department to see if there was any interest in the project and to find some potential funding sources. I needed to purchase equipment, schedule travel, and most importantly, find a sponsor who felt the work was relevant and useful enough to foot the start-up costs. After a month or so of this effort, it became apparent to me that while my idea was interesting, it lacked the substance and long-term impact I envisioned. I then turned to the senior Information Warfare students and asked them for a "rudder check." Major Eric Eldridge and Major Chris Ieva, two Marine officers who were in the senior Information Warfare curriculum, suggested I take a look at the work the Common Operational Research Environment (CORE) Lab. Perhaps it might be interested in what I was doing as there seemed to be some overlapping interests. With this in mind, in the spring of 2009, I pulled the name of Dr. Nancy Roberts from the Lab's website and emailed her to ask for an appointment.

The New Idea

Dr. Roberts met with me one morning a few days later. I told her about an idea I had for collecting and transmitting information in the field using smart phones (my idea had evolved a bit since I left FEXII). She was enthusiastic (the first professor on campus to express such interest) and said the CORE Lab had been trying to start up efforts in this direction. The Lab would definitely lend financial support to my efforts. She also suggested I meet with Chief Warrant Officer 3, Chad Machiela, a student in the Defense Analysis Special Operations Low Intensity Conflict (SOLIC) curriculum. As an Army Special Forces student with a considerable amount of time spent deployed and operating at the small unit level in the field, she thought he would be an ideal person to help me develop my idea. Chad and I immediately connected; he understood my frustrations in the field. While in Iraq, I witnessed several smart Marines spending an inordinate amount of time attempting to clean and process data to get it into the appropriate format for analysis. These analysts spent nearly 80% of their time (or more) manipulating and formatting data and approximately 20% of their time actually doing analysis. I thought their process was a huge waste of time and severely limited the efficiency of our analytical cell. What was needed was the design of a system to collect, process, and structure socio-cultural data for analysis. I named my idea the Human Terrain Analysis and Collection System (HTACS).

The Human Terrain Analysis and Collection System (HTACS). I was delighted when Chad agreed to help me. I also needed programming support for HTACS. Although I had the technical wherewithal to develop and integrate the system, I had to turn to another IW student who had the programming experience. He also agreed to join the effort. In the meantime, Chad

shared a framework he had developed in Dr. Anna Simons' class on the Anthropology of Conflict. I took Chad's framework and developed it into a mockup unit called "military geography" which is seen in Figure 2. It would serve to illustrate how data could be gathered and formatted during field operations rather than waiting until units returned to base. Making sense of their hand-written notes and putting them into some format (which was never consistent across the operators) was time consuming and error prone, and made our work in the Intel cells much more difficult.

Figure 2: Mockup of the HTACS Military Geography Form

The team's next step was to get some funding. The Information Warfare curriculum came up with money for us to purchase several iPod touches (as cell phones were too expensive). We then developed a mockup for demonstration purposes to be used during an upcoming field experiment in Thailand which would be part of an exercise called Crimson Viper. Crimson Viper would be the technology precursor to an even later exercise called COBRA GOLD. COBRA GOLD is an annual bilateral military exercise held between the Royal Thai Armed Forces (RTArF) and the US military.

During Crimson Viper in the spring of 2009, I set up a booth to discuss the new idea. Although HTACS was only a mockup at this point, the team was searching for a demonstration site and testing ground for the work we were doing in partnership with the CORE Lab. We began to get interest from several organizations, especially the Marine Corps. Col De Guzman, the Marine Force Pacific Operations Officer, liked the work we were doing, but thought the name of our new idea needed to be changed from HTACS to something more 'vanilla.' The notion of collect-

ing data on humans did not sit well with many people. Following the exercise, we officially renamed HTACS to be the Multi-modal Information Support Tool (MIST).

Multi-modal Information Support Tool (MIST). We continued to shop around the new idea, now renamed MIST, to find an appropriate sponsor. Chad and I traveled to the Office of Naval Research Global (ONR-G) in Tokyo, the Office of Defense Cooperation (ODC) in Cambodia, and met with and briefed several US and Thai agencies in Thailand. In the meantime, we also continued to build briefs and mockups, but still hadn't created a functioning system. Although we continued to get strong demand signals everywhere we briefed, we had yet to find one 'sponsor' that would help transition the new idea as a concept to the new idea as a prototype.

Back in Monterey in the summer and fall of 2009, I took two of the CORE Lab courses—Geospatial and Temporal Dimensions of Dark Networks (DA3600) and Dark Networks (DA4600). At this point I saw how my new idea could be linked to advanced methods of geospatial and social network analysis. I envisioned field operators collecting and formatting data through the use of drop-down menus as illustrated in the military geography unit above. Once the data were collected and formatted, they then could be analyzed using advanced analytical methods such as geospatial and social network analysis.

During this same time frame, I also fully architected how I thought MIST could be designed. Although it was more than a simple mock up at this point, I still had not come up with a good, low-cost way of producing a prototype. My original partnership with the IW student, who had signed on to do the programming, had split apart. Due to personal issues, he was unable to be fully engaged in the project. Without anyone else to back me up, and little time to pull my project together for my thesis, it became clear I would have to learn enough programming to pick up where he left off.

In the meantime selling MIST to higher authorities was taking more of my time. Chad and I maintained a heavy briefing schedule on campus and a travel schedule throughout the States and abroad. Through our contacts with the CORE Lab, we had the opportunity to brief senior executives and military senior leaders such as the Commander of Special Operations Command, Admiral Eric Olson. Jim Ehlert's new position in the US Pacific Command (PACOM) as a Naval Postgraduate School liaison, opened up other opportunities, especially contacts with Special Operations Pacific (SOCPAC), a command very interested in getting a working prototype of MIST. It stepped in to try to find appropriate funding within the Department of Defense, first with the Navy Irregular Warfare group at the Office of the Secretary of Defense (OSD) and finally to the Counter Narcotics Technology Program Office (CNTPO) in Dahlgren, Virginia. As with many unsponsored projects like ours, finding resources takes a considerable effort. Thankfully, another opportunity also opened up. In late 2009, Colonel Dave Maxwell, the strategic advisor group lead for the US Army Special Operations Command (USASOC), heard about MIST. He liked it so much he invited Chad and me fly out to Fort Bragg, North Carolina in February of 2010. He arranged a briefing to the Commanding General of USASOC, Lieutenant General John Mulholland. LTG Mulholland loved the idea of MIST and directed his staff to start the process for incorporating it into the Special Forces training pipeline. To kick off the effort, he wanted a prototype to be part of ROBIN SAGE, the last exercise in the SF training course.

Chad and I returned to Monterey. We continued work on MIST exploring how to introduce it to USASOC and SOCPAC. Both initiatives represented funding and testing opportunities for our prototype. But there was one nagging concern—our new idea was not operational. We had no prototype to test.

From Idea to Prototype

In early spring 2010, I came across the Open Data Kit (ODK) software set—an open-source data collection and repository system developed out of the University of Washington. I thought it might be a way to take MIST from an idea to a prototype. Quickly reading up on the ODK suite, I was able to develop a functioning MIST prototype by the late spring just in time for the upcoming Thailand exercise, called Combined Operations Afloat and Readiness Training (CARAT). My plan was to test the MIST prototype during this exercise. The ODK suite enabled us to deploy the military geography framework on an Android phone (the main screen can be seen in Figure 3), transmit the data to an aggregation server, and display the data visually in Google Earth.

Figure 3: ODK Collect

Just before the exercise, MIST went through another name change. Since MIST referred to several organizations already in place, the name left many people scratching their heads in confusion. So at the advice of Jim Ehlert, we changed the name to the Field Information Support Tool (FIST), a name that held for the remainder of 2010.

Field Information Support Tool (FIST). I went to the Sattahip Naval Base in Thailand during CARAT Thailand 10 in May of 2010. My purpose was to collect data for a notional humanitarian disaster. Specifically, I wanted to demonstrate how I could use FIST to geo-locate several hospitals, pharmacies, and medical clinics on a map. I called the demonstration prototype FIST-Light (since it was not a fully functioning prototype at this point). The demonstration was a success. We had our proof of concept—the ODK worked as a data collection tool for the first time in a field environment. On the heels of CARAT Thailand, FIST was featured in the Naval Postgraduate School newsletter that circulated a massive monthly situation report (SITREP) within the DOD. I began receiving daily emails about FIST with suggestions of applications from humanitarian assistance to combat operations in Iraq and Afghanistan.

Shortly after CARAT in Thailand, I got some more good news. After the CORE Lab briefing for Brigadier General Vincent Stewart, the Marine Corps Director of Intelligence, and Major General Melvin Spiese, then Commanding General of Marine Training and Education Command, I was told to submit an extension package to remain aboard NPS for an additional two years. Dr Roberts had strongly advised that I stay at NPS to see FIST through a critical period in its development. Before leaving for Singapore, I received my extension (an unheard of two-year extension with an option of enrolling in the Information Sciences Doctoral program) and diligently worked to get our system ready for Pacific Endeavor (PE).

I continued to refine the ODK collection system for FIST and prepare for our next operational demonstration—the Multinational Communications Interoperability Program (MCIP) Pacific Endeavor to be held in Singapore during August of 2010. In addition, Jim Ehlert encouraged me to continue working with Kestrel Technology Group, with whom he was affiliated. I had met Kestrel Technology Group during FEXII and he wanted me to incorporate FIST's collection capability into two of Kestrel's systems - FusionView and FusionPortal. At this point, FIST had no external funding and still was reliant on the CORE Lab and Jim Ehlert for travel and equipment.

During PE10, I picked up another FIST team member—Captain Derek Snyder, another USMC student at NPS. He traveled with me to Manila where we collected notional disaster data. We sent our data and reports through a cellular network to the Changi Command and Control Center in Singapore. Again, we demonstrated the utility of FIST and the write up of its success circulated widely throughout the Department of Defense.

Shortly after PE10, USASOC sponsored a test of FIST in Afghanistan with Chief Warrant Officer Machiela, who had returned to the field to lead the effort on the ground. The goal was to demonstrate FIST's viability and utility in support of the Village Stability Operations (VSO) in and around Kandahar. For three months, Chad took a handful of phones to Afghanistan to use FIST as a data collection tool and then illustrate how CORE's advanced analytic methods could be used to analyze the data and give immediate support to counter insurgency operations on the ground. The three-month effort gave FIST even greater exposure and validated its use at the tactical level. Once the news of these pilot tests circulated, requests for assistance poured into the CORE Lab.

After Chad returned from Afghanistan, we learned that SOCPAC had been successful in getting funding from the Counter Narcotics Technology Program Office (CNTPO) in Dahlgren, Virginia. This was one of the two funding initiatives that we had been pursuing. The contract was awarded in November 2010 and work was to begin immediately. However, there was a complication. In the time between the funding request and its approval, things had changed. The research sponsored by SOCPAC and Jim Ehlert in the Pacific, supported by Kestrel Technology Group, had morphed into the development of an information and knowledge management system, although they still wanted FIST as part of their system. Research sponsored by the CORE Lab and USASOC continued to view FIST as socio-cultural data collection and analysis system.

To keep the two funding and program initiatives separate, we again changed our name. This time it was from FIST to OpenFIST. The openness underscored what we believed to be our prototype's value-added contribution—the use of commercial off-the-shelf and open-source technologies (e.g. ODK) in combination with CORE Lab's research methodologies (e.g. social network analysis and geospatial analysis). It had the additional advantage of being entirely government-owned and operated which, when fielded, would make it a very low-cost innovation for the Special Operations and Marine Corps communities' operational needs.

OpenFIST. OpenFIST was the fourth name change and it triggered considerable consternation among the various communities involved. However, we felt it was important to differentiate what the CORE Lab and I were doing in contrast to the project sponsored by Jim Ehlert, SOCPAC and Kestrel Technology Group. Unbeknown to us, Kestrel Technology Group had gone ahead and filed for trademark rights to FIST. As a contractor, the company ultimately expected to sell its product to the government and obviously make a profit. The CORE Lab and I did not see this arrangement as providing the best value for the Department of Defense. I certainly would have found it difficult to explain to the Marine Corps that I was working on a system owned by a private company that would then turn around and charge the Marine Corps large sums of money for its use. And since we had other funding and field test options, e.g. Afghanistan and the counter-gang operations in Monterey County (another proposal that had received funding), the CORE Lab and I decided to follow a separate path, despite the loss of funding that SOCPAC offered.

So early in 2011, I continued development on our prototype. I adopted a new series of commercial and open-source software platforms in order to provide a more comprehensive, flexible data collection and processing system than was previously offered by the FIST-Light or FIST-Kestrel products. In addition, we moved from the Android platform back to the iOS platform and integrated newer technology that was more secure, flexible, and dynamic than the previous iterations. But given the consternation over the name change and continued fallout, some of which were not-so-veiled threats of lawsuits, we again changed the prototype's name.

Lighthouse. We needed to rebrand our prototype. The renaming of OpenFIST to Lighthouse was done to highlight the open-source data collection tools we had developed and to signal their broader applications. To us it represented a **new capability**—an integrated data collection system working in concert with the analytic methodology espoused by the CORE Lab. Since our original purpose remained the same, we thought the symbol of a lighthouse would convey the image we want to portray—illuminating social networks to enable our troops to navigate the human terrain.

The team behind Lighthouse continues to analyze every component and process of the prototype to determine new and better ways to design an effective system for collecting, processing, and analyzing data and ultimately helping ground-level troops to deal with the complex socio-cultural environment in which they operate. Lighthouse is on tap to redeploy to Afghanistan on a much larger scale. Initiatives are underway in California to use Lighthouse for a counter-gang initiative in concert with the Department of Homeland Security. We expect the prototype to continue to evolve as its design matures, but we are racing against the clock. Given the frequent rotation of service members, I have a year left before I return to operations. In that time

frame, Lighthouse has to be developed into a stable system that can be implemented in the field. Although I have designed the majority of technical work, Lighthouse still needs a team of engineers with the technical prowess and passion to guide it through the complex organization we know as the Department of Defense. Without dedicated oversight, it risks falling by the wayside before it achieves ultimate success as fully developed innovation.

Case Analysis

To date, we have found six necessary conditions for bottom-up entrepreneurship and innovation in large bureaus in our study of Lighthouse: entrepreneurial problem solvers; new ideas; collective entrepreneurship; critical start-up resources; innovation incubators; and idea champions.

Entrepreneurial problem solvers begin the innovation process. There are many terms in the literature to describe creative, innovative people in the public arena: public entrepreneurs; policy entrepreneurs; executive entrepreneurs; bureaucratic entrepreneurs; and political entrepreneurs. Bureaucratic entrepreneurs are in formal positions in the bureaucracy, but they are not in executive positions. Although considered to be a leader in the Marine Corp, Captain Longley commands units within the larger organization so the term that best describes his activities is bureaucratic entrepreneur. Were he to serve in an executive position and run a separate, stand-alone organization, he would be called an executive entrepreneur. (For a fuller description of the different types of entrepreneurs see Roberts [8]).

Entrepreneurs zero in on things that aren't working and try to fix them. When easy fixes elude them, they launch a search process for better ways of doing things. The search can take them in many directions. In this case, it took Carrick Longley to a graduate program in Information Systems where he could search for solutions to the information management problems he saw in the field. Problem solvers also are determined. We see evidence of this determination when Longley had to learn calculus, physics, and computer science as part of his program requirements and then computer programming when his initial partner dropped out of the project. As inveterate problem solvers, what others might call "roadblocks" they see as just things to get over, around, and past in the search for a solution to a problem that they think needs to be solved.

Entrepreneurial problem solvers also are idea people. **New ideas** are identified and sorted based on their potential to solve their problem. This is where the creativity characteristic of entrepreneurs comes in. When one new idea doesn't pan out, e.g. the initial idea of integrating small level tactical radios with commercial off the shelf cellular phones in an attempt at creating a 'hybrid' communications network, then another takes its place e.g. the idea of collecting and transmitting information in the field using smart phones. Constantly scanning the environment and ever alert to new opportunities, Carrick easily transitioned away from a proprietary, complex information management/knowledge management system. Instead, he found the Open Data Kit (ODK), an open-source technology to build his prototype that was cheaper and easier to use.

The sole entrepreneur working by himself against all odds is a heroic notion, but not a very realistic one in large, complex bureaus. Entrepreneurial tasks and activities, similar to those of the policy entrepreneurs summarized in Table 1, are wide-ranging and require a broad base of

expertise. Others need to lend a hand. Thus we find **collective entrepreneurship** rather than individual entrepreneurship is more likely when engaged in bottom-up entrepreneurship and innovation. (See Roberts and King [3] for a discussion of the different types of collective entrepreneurship, pages 10-18 and Chapter 7).

In this case, the team included Chad Machiela who helped develop the cell phones' drop-down menus informed by his understanding of Anthropology and his extensive experience in social network analysis and geospatial analysis. Derek Synder signed on to evaluate the innovative idea during the demonstrations and field tests. His feedback provided importance guidance for prototype redesigns. The programmers also played an important back-up role when Carrick was pulled away to conduct field tests and market his prototype to gatekeepers whose approvals would be required to move his innovative idea forward.

No innovation, bottom-up or top-down, occurs without **critical resources**. Two were particularly significant in this case: **time and seed money**. Time is important in the military since personnel have short rotations before they are on to their next assignments. Carrick only had two years in his master's program before he was expected to leave for his next unit. Two years is very little time to complete a rigorous curriculum, in addition to moving a new idea through initiation, design and implementation in a very large, complex bureau. Fortunately, he was able to extend his program of study which gave him another two years in the hopes of working through at least the design phase of the innovation process. Seed money was also important. Although his innovative idea was not expensive compared to large-scale military projects, it did require funds for travel and equipment. Luckily, Carrick connected with organizations and units that had slack resources to invest in him and his ideas.

As incubators of innovation, three organizational entities provided Carrick funding and intellectual support. He landed at the **Naval Postgraduate School** in Monterey, California, a military university whose mission, in part, was defined as a hub for technological innovation. This context offered a receptive and inviting space to test his ideas in ongoing field demonstrations and exercises that were regular features of campus activities. **The Defense Analysis Department,** populated by an interdisciplinary group of scholars in fields that include Economics, Political Science, Mathematics, History, Anthropology, Sociology, Organization Theory and Entrepreneurship, was a fertile ground for inquiry. Known for its innovative thinking in counter insurgency, the department attracted a group of students and faculty who saw themselves as a counterweight to the military's traditional ways of thinking. Chad Machiela had just graduated from this program when he met Carrick, and as was noted earlier, he played a key role in developing modules for data collection as illustrated in Figure 2. In addition, through his methodological training, honed through his exposure to the CORE Lab courses, he expertly demonstrated what could be done in the field when new data collection and management tools were paired with the CORE Lab's analytical techniques. Thus, the third entity in the trifecta of incubators was the **CORE Lab**, a recent start up founded by two entrepreneurial faculty members—Doug Borer and Nancy Roberts—who understood the need for new methods and technology to support field operations. The Lab served as a hub of innovation within the Defense Analysis Department and attracted students from other departments around campus, who, like Carrick, were looking for safe havens to test their ideas.

And last, but not least, bottom-up entrepreneurship and innovation needs **idea champions**, people whose job it is to run interference for the entrepreneur and his idea as they wend their way through the maze of hierarchical checkpoints and gatekeepers. Many served in this role: Mr. Jim Elhert and Dr. Nancy Roberts signed on as Carrick's thesis advisors and helped him give shape to his ideas and designs; Brigadier General Vincent Stewart and Major General Melvin Spiese provided "top cover" and high-level support when Carrick's requested an unheard of two-year extension at NPS; from his vantage point of strategic advisor group lead for the US Army Special Operations Command (USASOC), Col. Dave Maxwell pulled Carrick's new idea from obscurity onto the decision agenda where it came to the attention of Lieutenant General John Mulholland whose extensive field experience enabled him to immediately see its value and import.

Conclusion

Lighthouse, a new innovative idea and capacity for field-based data collection and analysis, has had a circuitous path through the initiation and design phases of the innovation process. At this juncture, all indicators suggest we are at the end of the design phase and moving toward implementation. Yet we know that new technologies can surface and force a recycling back into idea generation and design phases as happened in earlier iterations of Lighthouse. We also are aware that the design process can be truncated at any point. Serious budgetary cutbacks are underway throughout the Department of Defense. Retrenchment can choke off seed money and mostly importantly, the time needed for idea development and design. Lighthouse does have the advantage in this regard since, in an economic downturn, it is hard to argue against an innovative idea that utilizes low-cost, off-the-shelf technology and gathers enthusiastic support from the field, not only in military communities, but those working in other agencies such as US Aid and the Department of Agriculture. Still, implementation is the point of failure of many innovations and unless and until this idea is accepted into practice, a declaration of success is premature [17, 18]. At this juncture, we offer our conceptual framework of bottom-up entrepreneurship and innovation as a work in progress, that while not yet complete, lays out what we believe are the necessary conditions for success in large complex bureaus. Future research will explore the sufficient conditions. Taken together, it is our hope that these twin pillars of theory construction will move us closer to filling the conceptual and theoretical void in the literature.

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