A Case Study in Expeditionary Community Development

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While advances in physics are propelling us beyond Moore's law, the most stunning transformations in technology development arguably are occurring in the human dimension. It is time to accelerate the social dimension of innovation by harnessing communities that are as selective as they are open, that are as committed and trustworthy as they are flexible and trusting. Science provides a model for intentional communities to coalesce around a shared intensity of purpose and to make systematic progress both within and across ventures. This paper presents a collective biography of the longitudinal development of people and systems across disparate programs of R&D in which changing constellations of outside technical experts and indigenous operational experts developed each other as much as the systems that brought them together.

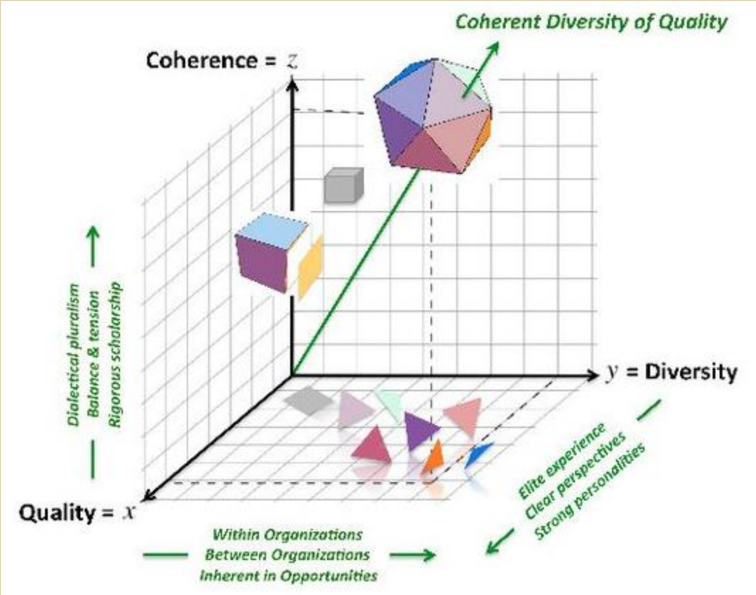
Beginnings of a New Paradigm

Our story begins prior to 9-11 in a relatively obscure corner of the U.S. Army, a Project Manager unit responsible for Soldier systems (PM Soldier) in U.S. Army Acquisitions. COL Bruce Jette was the PM Soldier. He was unusual in the sense that he had obtained a Ph.D. from MIT. One of his interests was the Land Warrior program that was developing body-mounted systems including computers and communications to augment Soldier performance. The objective was enhanced situation awareness: "Where am I, where are my buddies, where is the enemy?" At the time, the Defense Acquisition System had not caught up with the rapid developments in the commercial sector pertaining to agile development and continuous beta. It was not well positioned to take advantage of Moore's Law, the attendant doubling of computational power every two years, and the accelerating developments in commercial computing technology. The Land Warrior system was languishing amid the burden of unnecessarily bulky systems and ponderous processes that frustrated in-stride adjustments. COL Jette sought a way out of the programmatic and technological logjam.

Through a combination of serendipity and inspired initiative, COL Jette discovered Exponent Inc., an engineering firm in the Silicon Valley with many colleagues having similarly elite training and degrees from MIT, Caltech, and other top-tier universities. Exponent was a company that worked almost exclusively in the commercial market conducting failure analysis on a wide variety of systems, ranging from simple to exceedingly complex, that had encountered problems in a natural operating environment ("science in the wild"). Exponent's commercial clients always demanded quick answers to tough problems as well as continuing due diligence that could survive the rigors of the legal process. With his colleagues at Exponent, COL Jette demonstrated an alternative approach to development of the Land Warrior system that utilized rapid prototyping and experimentation with Commercial Off-The-Shelf (COTS) components, and he did so with unprecedented speed. On the scale of weeks and months they were able to achieve both incremental and revolutionary progress in understanding the art of the possible with technology and even in stimulating ideas about tactics, techniques, and procedures.

From the vantage point of history, COL Jette's fundamental innovation was not technological. His innovation was in the ad hoc aggregation of people, processes, and tools to co-create knowledge and to reveal potential capabilities that would have been difficult to codify in a needs statement *a priori*. This caught the eye of COL Hank Kinnison, then TRADOC Systems Manager

Soldier at Ft. Benning (TSM are now referred to as Capabilities Managers or TCM). Like COL Jette, COL Kinnison was a visionary and a man of action. COL Kinnison saw the potential impact of rapid prototyping and experimentation on the development of military operational and organizational concepts. He thus saw the potential for a more integrated approach to integration of materiel and non-materiel capabilities, an approach that independently was being codified in the Defense Acquisitions System and the Joint Capabilities Integration and Development System (JCIDS). After Kinnison retired from the US Army and joined the Wexford Group International, he saw the opportunity to accelerate and promulgate the outside innovation he had experienced with COL Jette and Exponent. A close and long relationship developed between Wexford and Exponent that was both fruitful and insightful for the US Army.



Blending Outsiders and Insiders in Task-Organized Team

The work of COL Jette with Exponent and Wexford transformed overnight, after 9-11, from being a promising curiosity to an institutional exigency for the US Army. The Vice Chief of Staff of the Army designated COL Jette to lead an ad hoc group for rapid acquisitions that eventually became the Rapid Equipping Force (REF) in 2002. There is a critical lesson to be learned in this move. The personal initiative, some might say daring, of a super connector and his expeditionary community can grow into something more formal. It can be institutionalized. It is difficult to imagine that the Vice Chief would have been able to act as quickly and confidently without the foundation of a proof of concept that had been provided by the prior improvisational co-creation of an improbable community of Army insiders and outsiders. An expeditionary process had been demonstrated, and it became established because it was repeatable and valuable. But questions remained about how this new capability could co-exist with more pervasive processes of larger US Army organizations and their established Defense providers.

Implicit Handoffs from One Super Connector to Another

Later in 2002, Kinnison (with Wexford) and I (with Exponent) took a step in the direction of demonstrating an interaction between the proven processes of legacy organizations and the promise of innovative co-creation in ad hoc organizations. We created the Wolfpack Enterprise from the foundation of the relationship between Exponent (fewer than 700 employees at the time) and Wexford (fewer than 50 employees at the time). The Wolfpack included four other companies that were nontraditional with respect to military technology development. Because of its innovative approach, the Wolfpack was able to compete successfully with established Defense providers with revenues in excess of $10B annually and orders of magnitude larger with respect to the number of employees. In particular, along with the new Eagle Enterprise, the Wolfpack was awarded a contract in the new Objective Force Warrior effort that involved an innovative collaboration among US Army Research, Development & Engineering Command (RDECOM), the US Army Acquisition Command (specifically the new PEO Soldier), and the US Army Training & Doctrine Command (TRADOC). Again, super connectors and their relatively tiny entourage of leaders were able to effect change and show the art of the possible [1].

The innovation of the Wolfpack was in bringing a scientific approach to technology development. Kinnison and I realized that Exponent's untapped expertise was in rapidly identifying hypotheses about performance of systems in the wild and using models, mockups, prototypes, and test beds to subject those hypotheses to empirical tests. The insight for Army stakeholders was that science need not be ponderous and that it can leave an enduring legacy for replication and generalization by others. Kinnison hired retired military personnel who had deep understanding of the Special Operations Combat Development model in which collaborative envisioning, COTS prototyping, and field assessment were common. The trust relationships that developed with Exponent's scientists allowed them to take this to the next level of scientific rigor and thus to promulgate science in the wild. We developed processes for rapid innovation including "Combat Application Teams" and "Quick Look" events, for example, which have been continuously improved upon and adapted to this day. From the time of the Wolfpack Enterprise, these methods of collaboration have been proven in teams operating concurrently from coast to coast in the United States in a wide variety of projects.

Expeditionary TDA in the wild and system-of-systems design.

The OFW effort, in particular, considered everything that a Soldier potentially carries into a mission. In an eight-month period, over one-thousand products from over two-hundred vendors were assessed by teams arranged in eight capability areas including (a) energy and power; (b) sensors and sensing systems, (c) knowledge and smart systems (d) netted communications; (e) human perception and performance; (f) protective clothing and equipment; (g) load carrying; and (h) weapons, munitions, and explosives. All of these expeditionary teams included significant participation of people who had not worked with the DoD. We needed clear conceptual frameworks to coordinate the concurrent activities of these disparate and geographically distributed teams. The personnel in these teams did not report to leaders of the Wolfpack through a common inherited organizational structure. In other words, we had to lead without authority. The only option for coordination was through laws of attraction to others through common or complementary motivations. We created experiences and promoted ideas that drew an improbable group of colleagues together as a community with a shared intensity of purpose.

The central idea was science in the wild in which the collective talent and creativity of a diverse team focused as much on development of a suitable operational test bed as on the technology to be assessed. The experiences enabled by science in the wild involved working together in the development and use of these testbeds. The attraction is in the novelty and insight that always attends the opportunity to observe through the lens of colleagues who have very different backgrounds and expertise. Shared experiences and collective intelligence in this work transcends oral and written communication that otherwise tend to stymie progress in diverse working groups. In our approach, there is quick and satisfying return of new knowledge from arduous work, and the unnecessary frustration of cross-cultural communication is minimized.

Science in the wild turns technology assessment into an event. As such, it is inherently holistic. It defragments the assessment of technologies that ultimately must be used together. In the OFW effort, integrated assessment of technologies was implicit in the requirements for interface compatibility and noninterference given the objective of Soldier load reduction with a notional 20x improvement in performance. Design and evaluation of such a system-of-systems would have been impossible without an operational concept, architecture, and use cases for various missions. In a sense, assessment events require a script. The script itself can become the focus of co-creation and collective intelligence in the team. The OFW system-of-systems, for example, necessitated an approach to squad formation effectiveness that, at the time, was innovative. This second-order (unplanned) innovation has had cascading effects on future work by various technical, operational, and programmatic leaders who were involved in the OFW effort.

Bill McDonough was a one of these leaders who replicated and shaped the approach. He connected groups of scientists and engineers from Exponent with operators from Wexford in the Advanced Concept Uniform program under the PM Soldier for Clothing and Individual Equipment (PM-CIE) and in various ad hoc efforts. Individuals are mentioned here because the most important lesson in these anecdotes is the power of interpersonal relationships when they are tied to verifiable actions on the ground that they both reflect and influence. These working relationships transcended funded projects, continued between them, and have remained long after programs have come and gone. The super connectors continue to learn, adapt, form new networks, and they take the approach to new situations.

Synergistic Technical, Operational, and Programmatic Due Diligence

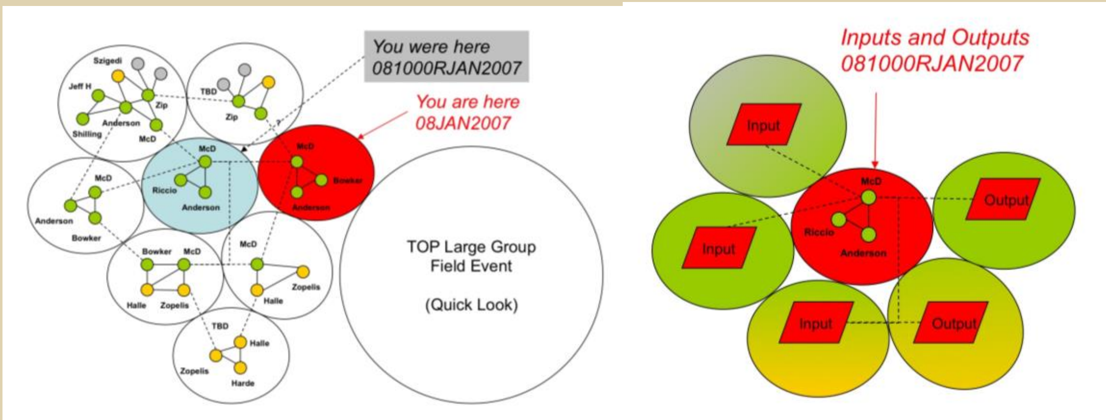
In 2005, McDonough and I joined the Wexford Group to develop a more formal business line in technical-operational-programmatic due diligence. The TOP approach guided task-organization of small agile groups inside Wexford as well as alliances with R&D firms that had specialized expertise for various problems at hand (i.e., the right people for the right problem at the right time). McDonough continued to focus the TOP approach on technology problems while, with other colleagues, I adapted the TOP approach to training, education, and leader development.

Prototype for a Joint Light Weight Tactical Vehicle (JLTV).

McDonough's work with Wexford, after the OFW effort, included further innovation in system-of-systems design informed by mission-specific requirements for a team of Soldiers. In particular, starting in 2006, McDonough organized a multi-faceted community to assess designs for a Joint Light Weight Tactical Vehicle (JLTV). TARDEC was the primary stakeholder because they were running a "bake off" that included an incumbent for armored personnel carriers as well as nontraditional providers. The AWG and JIEDDO were involved as stakeholders and proponents for the assessment of McDonough's team of teams. He also included active duty personnel from the 101st Airborne Division as well as retired NCO as facilitators. On the technical side, the expeditionary community included Ph.D.-level experts in ergonomics, bioengineering, biomechanics, human movement science, perception, and cognition.

We employed modeling and simulation rooted in field-based walkthroughs and measurements to facilitate communication and collaboration in the expeditionary community. We also developed qualitative methods to track progress across collaborative events that occurred in the field and, more often, remotely. The confluence of all these perspectives resulted in the insight that the vehicle design had to consider the kit that a team of Soldiers would carry with them for a specific mission. The methodology provided a way to take this into account both qualitatively and quantitatively in assessment of the design alternatives. The important point here is that the combination of prototypes (even incomplete mockups), field-based measurements, and modeling can be utilized in empirical evaluations and collaborative design of vastly greater design alternatives and re-combinations.

The advancement of the TOP methodology beyond the work of the Wolfpack was enabled by a longer period of performance and a greater number of iterations for design exploration and assessment. The advance was incorporation of agile systems engineering methodology to document issues on which to focus critical community interactions as well as insights and actions from such interactions. The agile aspect of this qualitative methodology was to make it collaborative (as opposed to delegating it to a systems engineer) and keep it simple as possible in any particular collaborative event. Documentation for particular events focused on cause-effect relationships (e.g., change proposals) between a manageable number of prior and subsequent events and, correspondingly, between overlapping groups of participants.



Tracking issues across changing constellation of community participants.

In addition to ensuring systematic progress, the agile documentation helped harness the changing constellation of participants (using the right people at the right time for the right problem) by grounding all the relevant subgroups of the expeditionary community in concrete action items or design considerations. McDonough and I were responsible for keeping track of the evolving and decentralized evolution of the documentation. We provided the holistic view, as needed, to particular subgroups convened at particular points in time for particular purposes. Advancements in holistic documentation and collaborative journaling were taken up in my subsequent TOP expeditions with communities involved in developing non-materiel capabilities (e.g., training and education).

From Materiel Capabilities to Non-Material Capabilities

Our pivot from materiel capabilities to non-materiel capabilities is instructive. By 2004, the most serious problems in the Global War on Terror (GWOT) pertained to asymmetric warfare including the individual and collective challenges of ambiguity, multiplicity of missions, rapidly changing roles in trans-extremis conditions, and adaptive leadership in Joint Interagency Intergovernmental and Multinational operations (Meigs, 2003; Kilcullen, 2006; Petraeus, 2006). To respond to these challenges, we formed a community including different kinds of technical, operational, and programmatic stakeholders. The ad hoc community included behavioral and social scientists with recent experience in education and leader development in the commercial sector, scientists and unit leaders from the Army Research Institute of the Behavioral and Social Sciences (ARI), the Asymmetric Warfare Group (AWG), and active duty personnel from numerous Army posts as well as retired Army officers and noncommissioned officers (NCO) who were involved in training, education, or leader development [2, 3, 4].

The work and reputation of the Wexford Group had become widely known by 2004. The blend of officer and NCO expertise from special operations and conventional military operations in field-based assessment and training was a compelling value proposition as the AWG and the Joint IED Defeat Organization (JIEDDO) were being established. Wexford became instrumental in the development of these organizations. There was essentially a super collision of super connectors that attracted diverse communities of practice scattered across the nation and outside the continental United States to stimulate and promulgate innovation. Kinnison, the visionary for Wexford’s transformation and its impact, also brought a small number of scientists and engineers into Wexford after 2004. He was a proponent for the technical connectors who created the TOP offering, and he shaped the influence of military operational exigencies on science as well as the influence of science on military operations.

In 2008, the TOP approach to ad hoc expeditionary communities advanced to a higher level of maturity. With the AWG and the Wexford Group, CSM (Ret.) Morgan Darwin and MSG (Ret.) Scott Flanagan had been working on a new approach to training that was explicitly focused on developing basic Soldier skills and values required for the ambiguous and rapidly changing circumstances of counterinsurgency operations. We discovered each other, ostensibly by coincidence, because of the opportunities for legitimate peripheral participation in the distributed team of teams created by the super connector, Kinnison, at the Wexford Group. Darwin and Flanagan became aware of the scientific definition and measurement of Warrior Ethos and Army values in my work with a different set of colleagues. I realized that there was an opportunity to scale a TOP community of practice as my colleagues and I had done in the Wolfpack enterprise.

The AWG leadership took notice of the initial concept demonstrations for the measurement of intangible attributes such as confidence, initiative, and accountability in tactical marksmanship training. They realized the power this combination of science with novel approaches to training the trainer, specifically in promulgating lessons learned from the Special Operations community throughout the broader community of ground forces. COL Robert Shaw, the AWG Commander at the time, had the foresight to commission a monograph from this new "science team" that would provide technical gravitas to their work and thus facilitate communication and coordination with TRADOC. At the same time, the science team benefitted from this opportunity to document its work at an unprecedented level of breadth and detail for TOP expeditionary communities [5, 6].

Collaboration in an expeditionary community unencumbered by distance.

The most noteworthy characteristic of the monograph on [Outcomes Based Training and Education]() (OBTE) was that it was a living document that provided a wide variety of stakeholders with visibility and opportunities for influence early and often throughout the development of new capabilities. In a sense, it was a collaborative journal of an improbable diversity of experts across a continuingly changing constellation of participants in a geographically distributed expeditionary community. This rigorously documented collaboration is as innovative in the scientific community as it was in military training, education, and leader development. It is an innovation in open science or citizen science that is auspicious for a new [Defense Innovation Base]().

Since the time the monograph was produced, there has been accelerating interest in open science because of the rapid explosion of web-based tools for collaboration as well as knowledge-sharing and, not coincidently, because of the dramatic increases in the number and demographic variety of people using such tools. We appear to be at another a tipping point [7] in the potential for expeditionary communities in the contemporary innovation environment to the extent that these tools can unleash connectors with an effect that is vastly greater than the value of the tools themselves.

Multi-Local Collaboration

After the work for the AWG, our expeditionary communities continued to develop practices based on lessons learned from prior work and on emerging practices in the commercial sector. Darwin, Flanagan, and I next explored the lessons that could be learned by two communities working on related problems in different places. Flanagan was applying OBTE to land navigation in one set of localities while Darwin was applying OBTE to classroom education elsewhere in the Army. They agreed to have regular conversations a couple of times a week for thirty minutes or less (“hot washes” in Army parlance, “scrums” in Agile development). The intent was to provide the two teams with *visibility* into events on the ground in each locality (engagement) and *opportunities for influence* upon those events. These have been the two key principles of community organization and collaboration since the work of the Wolfpack Enterprise in OFW.

The objective then was for one's observations and opinions to become grounded in the reality of someone else. The interpersonal influence that occurs in such grounded dialogue has consequences beyond the dialogue. More importantly, in the context of a habitual relationship, these consequences are visible to all participants in the ongoing dialogue. Thus they are accountable to each other and their respective influence. This is accountability to be enjoyed, not to be dreaded, because it strengthens a relationship and guides initiative in the context of it. It brings the second-person standpoint to peer-to-peer interactions among people who are embedded in different situations. It thus blurs the distinction between presence and remoteness as well as between first-hand and second-hand experience.

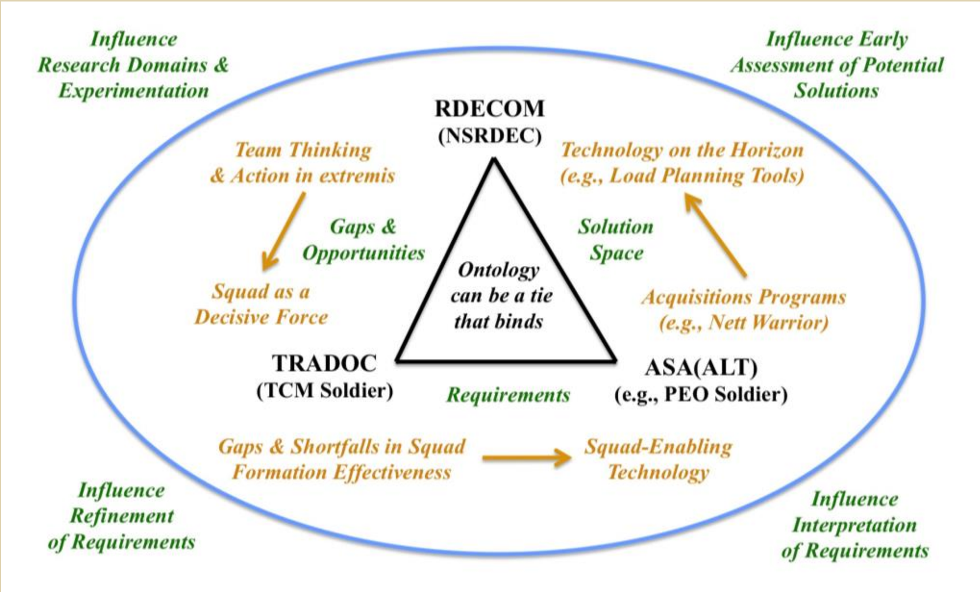
This profoundly changes the nature of professional interaction from the climate of a brainstorming session to one in which initiative in a conversation is balanced by accountability consistent with the values we explored in the work for ARI and the AWG. This is true dialogue in which the participants can learn from each other. It is authentic dialogue to the extent that observations and conjectures are verifiable in the concurrent activities in which at least some of the participants are involved.

Audio recordings of the conversations in this work were summarized, in text of fewer than 750 words, consistent with best practices for blogging in 2010. Building on the developments in our work on the JLTV, a framework was used to identify and track systematic developments in the conversation. The framework was possible because of the level of abstraction developed in the OBTE monograph that revealed connections between ostensibly different kinds of events in field-based training and classroom education.

Ontologies and Boundary Objects for Expeditionary Communities

In 2012, the Natick Solder Research, Development & Engineering Center (NSRDEC) tasked Aptima Inc. to identify paths for coordinated utilization of biomechanics and cognitive psychology in development of Soldier systems. Self-organization of an expeditionary community occurred in this effort because of our prior work in OBTE. An aspect of this work is especially noteworthy even though it is not unique. This is the ability to exploit synergies between different projects. The ad hoc community in the work for NSRDEC, for example, was able to exploit synergies with independent work for ARI and TRADOC as well as with independent connections to the relevant acquisitions community (PEO Soldier) outside of these funded projects.

The force multiplication in this context was not required for compliance with the statements of work. It was irresistible knowledge aggregation in the context of an ideal collaboration among three elements in a fundamental triad of organizations (i.e., Science & Technology, Acquisitions, Training & Doctrine). This is what informal communities can do when grounded in a variety of funded programs of research and when utilizing extra-procedural activity with a balance of initiative and accountability. In a sense, this is crowdsourcing of opportunities that are beyond the ability of isolated government agencies to tackle. The drivers behind this are deeply personal in the hidden Defense Innovation Base. While a funding stimulus is critical, motivations are not limited to financial reward. Third-party super connectors can harness this potential.



A fundamental triad of Science & Technology, Acquisitions, Training & Doctrine.

The particulars of the work with NSRDEC were tricky because some of the most difficult problems of communication and coordination arise in communities with participants from different scientific disciplines [8]. Concept maps can be useful in such trans-disciplinary collaboration in general [9]. In the development of materiel or nonmaterial capabilities, the relevant concepts tend to address action and constraints on action in which people are involved; they are inescapably tied to the human dimension. Thus the relevant concepts tend to require a natural philosophy historically associated with ontological realism [10, 11]. It is difficult to develop such ontologies from an armchair and, in the context of operational practice, impossible to realize without a tight collaboration between scientific and operational experts.

Visible objects and events minimize the need for common terminology in collaborative reflection in a diverse community. They provide *boundary objects* that enable effective communication across disciplines [12]. Field exercises and walkthroughs can be a powerful method for visually intensive collaboration and shared situational awareness in such groups (Quick Look events). The work for NSRDEC utilized such methods to stimulate collaborative reflection. The result was a periodic table (an ontology) for human movement tasks that provided a compact translational device between science and operational practice. Equally significant, it provided a common ground for trans-disciplinary analysis involving biomechanics and cognitive psychology as well as numerous sub-disciplines in human movement science.

Collaborative reflection and Quick Look events led to a list of human movement concepts described in ways that would be recognizable and understandable both to Soldiers and scientists from a variety of disciplines. For the most part, the concepts were described in the language of everyday experience. In particular, the concepts refer to observable behavior that is sufficiently familiar experientially to be associated with common words or phrases. The two-part ontology juxtaposes a practical framework of concepts expressed in everyday language with a more esoteric framework that reveals linkages to powerful scientific paradigms. While nesting has esoteric (epistemological and ontological) significance in the scientific community, it is a practical exigency for science that is relevant to Soldiers. It is a reason for science that can translate between different domains of application and, in particular, to collaboration with Soldiers. The relevance of this insight is not unique to the military.

The ontology was used to curate and aggregate hundreds of scientific publications of otherwise nonobvious relevance to Soldier tasks. The particular citations in the resulting library make these connections concrete but, in most cases, the connections might be overlooked without the ontology. The ontology helps outsiders become informed consumers of knowledge from an unfamiliar discipline of scholarship. Moreover, it helps insiders look at their own discipline through a different lens. In both ways, this approach to transdisciplinary integration fosters innovation. The transdisciplinary library, and the mapping between Squad-level tasks and scientific paradigms, represents knowledge that highly experienced Soldiers should have when they have mastered their craft. A conclusion of this expeditionary work was that formative measures that help assess and improve this knowledge should be a priority. In other words, training and education must be integrated and developed with capabilities provided by technology. The relevance of this insight also is not unique to the military.

Broader Expeditions Though Communities of Innovation

Since 2012, my colleagues and I have explored expeditionary communities of innovation in the commercial sector. Community expeditions have been undertaken in transnational logistics and transportation security, healthcare in sub-Saharan Africa and the Middle East, and online videogames. The work in multiplayer online games is especially auspicious for community organization in TDA. Multiplayer games take situated collaboration into virtual worlds. As in the physical world, these games ground interpersonal interactions among gamers in events that they both influence and reflect. The best games are extraordinarily motivating and stimulate surprising amounts of participation and practice. While the outcomes in the games may not have the gravitas of the real world, the social interactions during and around gameplay can be powerful [13].

The same sensibilities and assessments can be applied to online social games and to shared experiences in the physical world such as those that have been the focus of outcomes based training and education (Riccio et al., 2010). Serious gamers take an interest in each other, in some cases over many years, and influence each other's lives outside of games to the extent that their gameplay is explicitly based on shared values with respect to which gameplay is consistently assessed. This cascading effect was observed informally in OBTE as well. Such effects are commonly observed, and certainly claimed, in other intentional communities. This should be a long-term objective of innovation in both the commercial and government sectors because success of innovation will depend on the relationships that organize around it.

Furthermore, serious games could be a valuable test bed for conducting web-based prototyping, experimentation, and quick looks. In principle, games could approach the value of physical settings that have been critical in the expeditions of innovation conducted by communities with a shared intensity of purpose. In the jargon of videogame scholars, the best games are characterized by urgent optimism, blissful productivity, epic meaning, and weaving a tight social fabric [14]. These will be useful criteria by which communities of innovation can be organized and evaluated because they reflect emotional and motivational drivers for learning without the necessity of co-location or physical presence in a cost-intensive setting. The potential for enormous cost savings has long been recognized in the pursuit of optimal federations of live, virtual and constructive (LVC) training in the military [15, 16].

The rapidly developing state of the art for collaborative learning in the online games industry is an example of venture acceleration that is possible when innovation is selectively open to expeditionary communities of people with a shared intensity of purpose and trust relationships that extend beyond the moment of an isolated problem-solving exercise. While advances in physics are propelling us beyond Moore's law, the most stunning transformations arguably are occurring in the human dimension of technology development. It is time to accelerate the social dimension of innovation by harnessing communities that are as selective as they are open, that are as committed and trustworthy (intentional) as they are flexible and trusting.

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