Innovation Symposium 2017: Transforming the Organization

Singularity University

MD5

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Acknowledgements

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Plenary Speakers

Peter Wicher, Director of Strategic Relations at Singularity University.

Dr. James Canton, CEO and Chairman of the Institute for Global Futures.

Nick Davis, Vice President of Corporate Innovation at Singularity University.

Colonel Don Wright, G3, Marine Corps Warfighting Laboratory.

Colonel Matt Sieber, Deputy Director, Capabilities Development Directorate, Marine Corps Combat Development Command.

Sponsors

Military District 5 (MD5) is a national security technology accelerator that seeks to reinvigorate civil-military technology collaboration and value creation through the development of entrepreneurs and intrapreneurs[1] solving high-tech problems in the interest of national security.

Singularity University is a think tank and business incubator composed of a global community that offers educational programs and tackles the world's biggest challenges by focusing on scientific progress and "exponential" technologies.

[1] An intrapreneur is an employee of a large corporation who is given freedom and financial support to create new products, services, systems, etc., and does not have to follow the corporation's usual routines or protocols. Dictionary.com, http://www.dictionary.com/browse/intrapreneur, retrieved 17 June 2017.

Executive Summary

There is a perception that the Marine Corps lacks the organizational energy to meet future force requirements. In the February 2017 issue of the *Marine Corps Gazette*, Captain Joshua Waddel took Marine Corps leadership to task for what he terms "its self-delusion regarding the organizational energy and innovative agility of our Marines and the depressive stagnation found within the Supporting Establishment."[2] Many of the issues he addressed were topics of discussion at this year's symposium.

The vision for the Marine Corps Warfighting Laboratory Innovation Symposium 2017 was to explore "Big L" Learning, or organizational transformation. The focus was on how the Marine Corps can improve its combat development process. Participants from across the Marine Corps were exposed to cutting-edge organizational concepts and asked to propose innovative solutions to enhance the combat development process.

Innovation is hard to define; Yale University Information Technology Services defines innovation as the process of implementing new ideas to create value for an organization. This may mean creating a new service, system, or process, or enhancing existing ones. Innovation can also take the form of discontinuing an inefficient or out-of-date service, system, or process.[3]

An Exponential Organization (ExO) is one whose impact (or output) is disproportionally large – at least ten times larger – compared to its peers because of the use of new organizational techniques that leverage accelerating technologies. The ExO paradigm is not just for business; it applies to all sorts of enterprises and organizations, from academia to non-profits to government. It is not just a system of commerce, but also a philosophy of action. Today, many potential adversaries (peer/near-peer competitors, non-state actors, and hybrid threats) are able to leverage resources, innovations, and flexibility at ExO levels. Today's Marine Corps thinks fast but moves slowly within too many stovepipes, creating gaps between capability development and operating force requirements. These gaps degrade interoperability and inhibit training at the user level, regardless of rank. The real question is not whether

[2] Waddell, Joshua, Captain USMC, Innovation and other things that brief well, Marine Corps Gazette, February 2017, Volume 101, Issue 2

[3] Yale Information Technology Services, What Is Innovation?, https://its.yale.edu/about/innovation-its/what-innovation, retrieved 8 June 2017

governments or militaries can become ExOs but whether or not they are able to fulfill their destiny to be true, fully functional, technology driven, high-performance, modern ExOs. [4]

Regardless of the future operating environment, it is time for the Marine Corps to disrupt itself before an enemy disrupts the Marine Corps. Marines must think differently about their identity as technology enhances human performance, both operationally and physically. Without the ability to innovate and transition from the current notion of core competency, the Marine Corps could become irrelevant.

The two-day symposium featured three keynote speakers who focused on the concept of the ExO and how its principles could enhance Marine Corps organizational effectiveness.[5] The speakers presented the exponential model from different perspectives to give the audience a basic understanding of its potential application to the combat development enterprise. Two active-duty speakers provided a synopsis of the Force Development Strategic Plan (FDSP) and the capabilities development process.

The attendees were divided into five working groups and, with the aid of facilitators assigned to each working group, tasked to focus on ExOs and propose answers to two sets of research questions: *"What would the Marine Corps look like as an ExO, and what is required to enable that?"* and *"Through the lens of the Force Development Strategic Plan (FDSP) and the Capabilities-based Assessment (CBA) process, what does the Combat Development enterprise look like under the construct of the ExO? To enable an exponential combat development enterprise, what changes are required in the supporting and related functions?"*

The working groups achieved consensus concerning a number of issues that merit consideration if the Marine Corps it is to become an exponential organization:

- Provide evaluation criteria to identify innovation among our Marines and make it a fitness report evaluation category.
- Provide new career and/or MOS road maps.
- Encourage innovation at lower unit levels, at least down to battalions and squadrons, and perhaps down to the company level.
- Review the commercial world and accelerate the process for acquiring COTS technology and equipment, especially to solve the problem of "Big Data".

[4] Ismail, Salim; Malone, Michael S.; and van Geest, Yuri; Exponential Organizations: why New Organizations Are Ten Times Better, Faster, and Cheaper Than Yours (and What To Do About It), Diversion Books, A Division of Diversion Publishing Corporation, NY, NY, 2014

[5] Speaker presentations and working group outbrief slides are available for download at http://www.mcwl.marines.mil/Symposium/.

- Establish a standing opposing force that is rapidly reconfigurable and provides a realistic, thinking, enemy perspective.
- Transform the Marine Corps system of global sourcing and outsource specific capabilities, such as cyber operations (both defense and offense), some logistics (such as transportation), and other capabilities.
- Fundamentally change the Manpower Management system.
- Establish an annual CD&I Roadshow similar to the manpower roadshow to explain the combat development process in a way that everyone can understand it and potentially contribute to its success.
- Incentivize units to reallocate excess funds without cutting funding from year to year due to an inability to commit all funds for a given fiscal year.
- Appoint a Chief Data Officer of the Marine Corps.
- Decentralize more decisions and capabilities to lower levels.
- Allow MEF commanders to approve and validate requirements after which HQMC supports the requirement by providing a solution.

Foremost among the symposium recommendations was the necessity to create a Massive Transformative Purpose (MTP), the higher, aspirational purpose of the organization. An MTP is not a mission statement; rather, it should be forward-looking and inspirational to every Marine. However, such an effort needs to start with identifying what have been unique strengths and "sacred cows" and then examining which of them should be considered for transformation. The ability to institute many of these recommended changes remains subject to the vagaries of institutions such as Congress, the Department of Defense, and the Department of the Navy, which control our actions and limit our ability to enact these changes. The challenge, then, is to act on those recommendations that are within each Marine's control. Marines must be prepared to take risks regarding the future course of the Marine Corps.

Introduction

"The world has progressed more in science and technology over the last few decades than in the last 4,000 years. There have been exponential advances in computation, sensors, communications, artificial intelligence (AI), and biotechnology, among numerous other areas. To ensure that the Marine Corps is able to meet the challenges of the future security environment, today's Marines must resist the complacency that can come with institutional inertia, and they must work to develop the capability to innovate at both individual and institutional levels".[6]

In 2016, the Marine Corps Warfighting Laboratory and the Marine Corps University hosted the Force Development 25 Innovation Symposium. The 2016 symposium emerged from the recognition that the Marine Corps must prepare for a future characterized by rapid and unpredictable change. The participants in that symposium recognized that *"[i]nnovation is characterized by risk, failure, and unpredictability. It requires leadership to create an environment that tolerates failure, can learn from failure, and allows failure to facilitate progress. It is natural to think that the unknown is the biggest obstacle to innovation while in fact, what is known—or the engineer's dilemma—is what actually holds innovation back."*[7]

One could argue that many current Marine Corps institutional processes are ineffective and could stifle performance, both in combat and in garrison. Current processes reflect an industrial-age model of efficiency from a time when innovation was largely the result of government research and development. Today, many potential adversaries (e.g. peer/near-peer competitors, non-state actors, and hybrid threats) are able to leverage resources, innovations, and flexibility at ExO levels. The Marine Corps must consider whether it possesses the appropriate organizational energy and focus to meet future force requirements given the current and forecast security environment. Some Marines believe that senior Marine Corps leadership is allowing existing institutional processes to stifle needed innovation across the Marine Corps. As a result, there is a perception that the Corps lacks the appropriate organizational energy to meet future force requirements.

Innovation Symposium 2017 was, in part, a response to that perception. The vision was to explore "Big L" Learning, or organizational transformation and, within that context, focus on how the Marine Corps can improve its capabilities development process. Participants from across the Marine Corps heard cutting-edge organizational concepts and collaborated with subject matter experts. Their challenge was to propose innovative solutions to enhance the capabilities development process in order to meet future warfighting challenges.

[6] 2015 Marine Corps Security Environment Forecast, Futures 2030-2045, Foreword, page i.
[7] 2016 U.S. Marine Corps Force Development 25 Innovation Symposium Anthology, page 8.

The Symposium

The symposium utilized the material featured in the book, *Exponential Organizations: Why New Organizations are Ten Times Better, Faster, and Cheaper Than Yours (And What To Do About It).*[8] According to the authors, an ExO is one whose impact (or output) is disproportionally large – at least ten times larger – compared to its peers because of the use of new organizational techniques that leverage accelerating technologies. Their premise is that an ExO is built upon information technologies that take what was once physical in nature and dematerialize it into the digital on-demand world to enable organizational change. One of the major characteristics of an ExO is creating a Massive Transformative Purpose (MTP), the higher, aspirational purpose of the organization. An MTP is not a mission statement; it should be aspirational.

An Exponential Organization (ExO) is one whose impact (or output) is disproportionally large – at least 10x larger – compared to its peers because of the use of new organizational techniques that leverage accelerating technologies.

The symposium included forward-looking individuals and organizations in the wider circle of business, defense, and the public sector to identify, develop, and encourage innovative thinking. The ExO authorities who introduced the concept challenged participants to think out of the box, disrupt the status quo, and be prepared to take risks regarding the future course of the Marine Corps.

The ultimate goals of the symposium were to:

1. Promote positive organizational transformation.
2. Improve innovation and future force development.
3. Inform the service and harness its efforts.
4. Enhance unity of effort and foster a community of interest.
5. Identify the systems and processes that prevent the Marine Corps from becoming an Exponential Organization (ExO) and make recommendations accordingly.

The symposium featured two plenary sessions. During the first, three keynote speakers addressed the concept of the ExO and described how its principles could enhance Marine Corps organizational effectiveness. Each speaker presented the exponential model from different perspectives to give the audience a quick, basic understanding of its potential application to the Marine Corps and the combat development enterprise. During the second plenary session, two active duty subject matter experts provided a synopsis of the FDSP and the combat

[8] Ismail, et al; op cit.

development process. Combat development is the approach to conceptualizing and developing the future force, to include how we train and educate Marines and Sailors. These presentations set the stage for more informed deliberations during the breakout sessions as each group wrestled with their task to develop innovative methods for the Marine Corps to function as an ExO.

Representatives from throughout the Marine Corps brought a wealth of experience and insights to the symposium. Participants brought their collective experience and expertise to the table to recommend exponential practices related to enhancing combat development. Areas such as acquisition, budgeting, procurement, contracting, and information technology (IT) processes were also open for consideration.

The first question was intentionally broad to help participants "break the ice" in their working groups and to enhance their understanding of the ExO concept, while determining its linkages to Marine Corps organizational structure. Participants were asked to discuss how an exponential warfighting force might think, fight, function, communicate, train, and equip itself to enable an ExO Marine Corps. Outputs for both research problems were presented in plenary session on day two.

Participants were divided into five working groups of approximately 25 individuals each. Symposium organizers selected the breakout group leads from the list of attendees and notified them in advance so they could prepare for their duties. Facilitators and recorders assisted each breakout group by managing the proceedings and capturing the essence of the deliberations.

Event leaders urged participants to bring their most innovative ideas to the breakout sessions and to think unconventionally. Each group was encouraged to divide into six sub-groups: think, fight, function, communicate, train, and equip. The facilitators gave each sub-group a specific amount of time to generate ideas and to post them on prepared posters. There was no specific guidance regarding topics, leaving each individual to generate ideas that conceivably fit within the parameters of the issue. The facilitators next tasked the larger group to categorize the most significant suggestions and to refine their thoughts and provide focus to their ideas.

After each breakout session, the working group leaders provided an overview of their group's discussions and significant ideas. Between working group deliberations, the Commandant of the Marine Corps (CMC) presented awards to the winners of the 2017 Marine Corps Warfighting Lab Innovation Challenge and the 2017 Marine Corps Training and Education Command Challenge. The symposium terminated with working group presentations on the second question and closing remarks.

An Alternative Discussion Method was used primarily for question number two to organize discussion points broken down by the problems they identified, some of the key insights regarding each discussion point, and working group recommendations.

None of these methodologies was prescriptive, although most groups utilized them to facilitate and record their discussions. Finally, the organizers conducted the symposium under the Chatham House Rule[9] to ensure quality participation and output from the attendees.

Day One Plenary Session

The following narratives are synopses of remarks presented by various speakers to introduce the symposium and to provide background information for attendees to consider during their working group deliberations.

Throughout Marine Corps history, there have been senior leaders who have effected positive change with long-lasting impact; speakers offered two recent examples. First, General Al Gray, the 29th Commandant, established the Marine Corps University and oversaw the writing and publication of Fleet Marine Force Manual-1 (FMFM-1), Warfighting. Second was General Charles Krulak, the 31st Commandant, who was instrumental in creating the still relevant concept of Operational Maneuver from the Sea (OMFTS) and the idea of the Three-block War. Both commandants effected positive change in the Marine Corps because they recognized that the security environment was changing and that the Marine Corps needed to change to remain relevant and successful. The current commandant is leading the effort to overcome the challenges of rapidly advancing technology and a far different world than existed even 20 years ago.

Given the Marine Corps' need to adapt, Marines who think differently, or out of the box, must be protected and encouraged by their leaders. This is something the Corps does not do as well as it should. Recruiting and retaining the right kinds of people to help make that happen will require challenging them while recognizing the need for compromise from both the institution and from the unorthodox thinkers themselves. Change is coming; Marine Corps leaders will have to take risks. Marines know that they must plan for today, but they must prepare for the next week and the next decade. Leaders need to weigh the advantages and disadvantages of encouraging and accepting "thoughtful insubordination" whereby orders may be questioned and better ideas offered. They should also consider whether recruiting and retention programs should change. For example, it may be prudent to introduce lateral accession, bringing in

[9] Chatham House Rule: When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed. https://www.chathamhouse.org/about/chatham-house-rule retrieved 20 June 2017.

subject matter experts for areas like cyber operations, and making them Marines, not in the current, traditional sense, but as people who can conduct operations unlike any that have been required of us before.

One presenter asserted that most people have linear minds in what has become an exponential world. The 20th century experienced a tremendous increase in computing power regardless of whether there was war or peace, boom, or recession, and regardless of who was in control of the government. In 1958 an integrated circuit contained two transistors; in 1971 that had increased to 2,300 transistors; and by 2016 to 150 billion transistors. Concurrently, Moore's Law[10] has held steady with a 10-fold increase in speed accompanied by a decrease in cost of 10 million times. In 1976, the first digital camera weighed 3.75 pounds, cost $10,000 and had a capacity of 0.01 megapixels. In 2017, a digital camera cost $10, weighed 0.03 pounds, and had a capacity of more than 20 megapixels. In other words, it had 1,000 times the resolution, was 1,000 times lighter, and 1,000 times cheaper. By 2025, a $1,000 laptop will probably be able to perform as many calculations per second as the human brain. By 2050, that $1,000 laptop will likely be able to perform as many calculations per second as the entire human population combined. The continuing exponential growth of computing power with its attendant increase in the number of chips and sensors has resulted in the accumulation of more data than we can handle while decreasing costs and increasing the number of calculations per second. In particular there are five terms that will impact the future environment and battlespace: "bio, nano, info, neuro, and quantum." With these predictions for continued exponential growth come great uncertainty and great potential, leaving us with unexpected, possibly unforeseeable, convergent consequences. (Figure 1)

Automobile manufacturers are already planning to eliminate internal combustion engines and build electric-powered cars. One of the compelling reasons for this goes beyond the burning of fossil fuels to the fact that an electric car has 90 percent fewer parts, making it exponentially cheaper and easier to maintain. Today, a $1.46 million LaFerrari can accelerate from 0–60 in 2.6 seconds; an $88,000 Tesla Model S P90D provides the same acceleration at a fraction of the cost.

With all this change comes accelerated acceptance of technological leaps. In 1904, cars were rarely seen in New York City traffic. By 1912, traffic counts showed more cars than horses for the first time and by 1917, automobiles had completely replaced horses in New York City.

[10] Moore's law is the observation that the number of transistors in a dense integrated circuit doubles approximately every two years. The observation is named after Gordon Moore, the co-founder of Fairchild Semiconductor and Intel, whose 1965 paper described a doubling every year in the number of components per integrated circuit, and projected this rate of growth would continue for at least another decade. https://en.wikipedia.org/wiki/Moore%27s_law downloaded 17 July 2017.

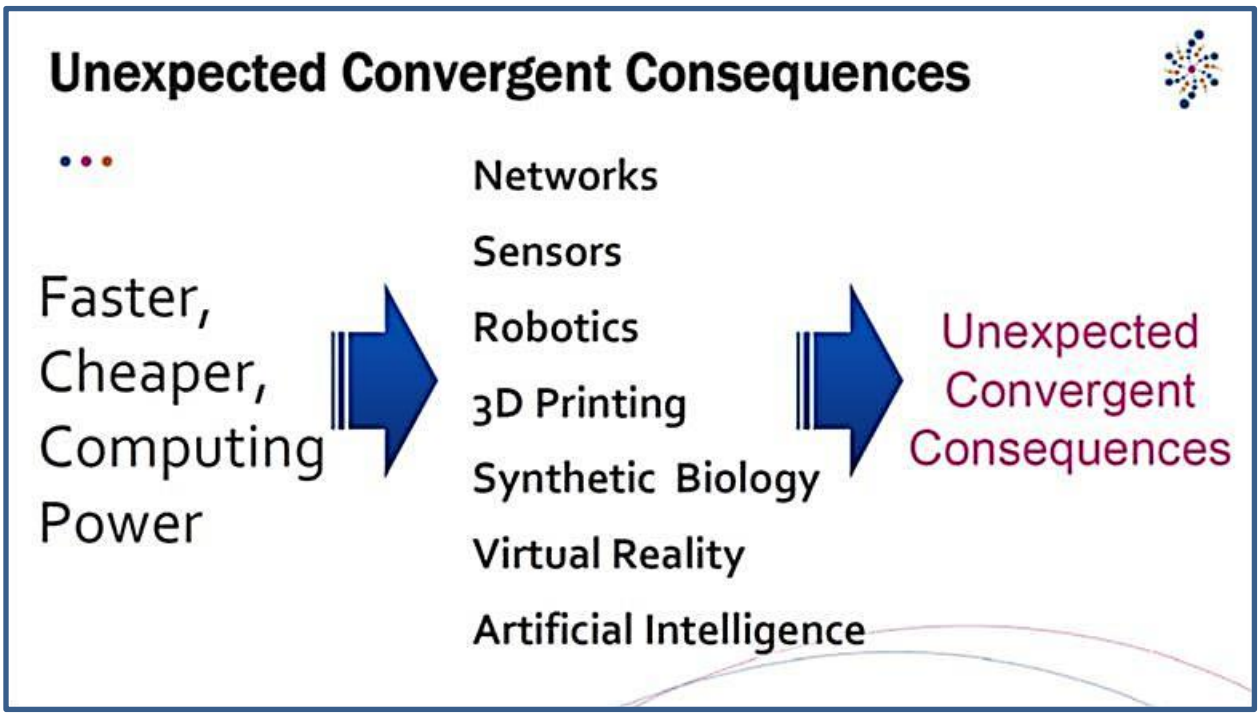

Figure 1: Unexpected Convergent Consequences

IBM's Watson became a household name after beating Ken Jennings, the longest running Jeopardy winner, in a showdown of trivial expertise. In 2016, Watson diagnosed a woman's rare form of leukemia in just 10 minutes after doctors had spent months trying to diagnose the cause of the woman's illness, demonstrating Watson's potential as the world's best medical diagnostician.

It is important to remember the caution rendered by Janet Yellen, Chair of the Board of Governors of the Federal Reserve System, that productivity growth, however it occurs, has a disruptive side to it. According to the speaker, this disruption will affect the future operating environment, particularly in the 15 to 20 cities where he believes conflict is likely to occur. The denizens of those cities may have very different mores and ethics than Americans, which must be taken into account when training Marines for complex operations in megacities. The speaker opined that this leads to three possible scenarios that can occur separately or simultaneously. First is the 'fortress economy', as reflected in the United Kingdom's ongoing separation from the European Union. In this scenario, nations look inward to take care of their own economic interests in the hope that more insularity will result in more agility and better security without the burden of international entanglements. Second is the "Geo-Chaos World," where organized conflict is the norm but may or may not include direct confrontation between nation states. Termed hybrid or gray-area warfare in these scenarios, the Law of War is nearly impossible to enforce, especially in the developing world. The third scenario is the "Collaboration World"

which features cooperative growth and development among nations. Finally, there is the possibility that any combination of these scenarios could intersect simultaneously, presenting an even more complicated, rapidly changing operating environment.

Regardless of the future operating environment, it is time for the Marine Corps to disrupt itself before an enemy disrupts the Marine Corps. This implies determining how to change before being surprised by an enemy. Marines must think differently about their identity as technology enhances human performance, both operationally and physically. Without the ability to innovate and transition from the current notion of core competency, the Marine Corps could become irrelevant.

Problem I Workshops

What would the Marine Corps look like as an Exponential Organization (ExO)? What is required to enable this?

Discussions focused on how the Marine Corps is organized and functions today, determining what an ExO actually is, and attempting to define the steps needed to become an ExO. The following paragraphs present the major items of discussion and thoughts expressed within the working groups.

DOCTRINE (or, the way it is). Today's enemy is operating and reacting more quickly than the Marine Corps, exposing gaps in the ability to accomplish missions. The Marine Corps must change, to include using more realistic and transparent readiness metrics.

Marines need to think more like members of a start-up organization and less like an industrial age work force. This will require investing intellectual capital to provide Marines a superior product that trumps the competition. It is time to think more agilely and "outside the box." Marines try to fit the box around the problem; instead, they should design a bigger box. Part of the solution is to view the world differently – for example, considering how a transnational, violent, extremist organization organizes, trains, and equips.

The Marine Corps is risk averse and often advocates a "zero defects" mentality. While failure in combat is unacceptable, the opportunity to fail in training is essential for professional growth and development. It is difficult to say "who" the Marine Corps is as an organization because, as one participant phrased it, the Marine Corps appears not to know where it is going. Despite technology changes, the Marine Corps process to identify requirements and its linear capability development continually chase and react to adversary innovation. Headquarters Marine Corps (HQMC) executes its role in organizing, training, and equipping via a linear, deliberate, traditional model. It needs to adjust to keep up with the pace of change. Today's Marine Corps

thinks fast but moves slowly within too many stovepipes. This creates gaps between capability development and operating force requirements. These gaps degrade interoperability and inhibit training at the user level, regardless of rank.

Bureaucracy and headquarters staff organizations operate comfortably at a pace that allows for informed rather than hasty decisions. This includes operating ahead of the pace of adversarial change. Each element of the organization must be able to convey its situation, position, and ideas to the rest of the organization to provide situational awareness among individuals, units, and headquarters elements, allowing for informed decisions.

Throughout the Marine Corps, there is a lack of awareness of internal and external Marine Corps innovation. Even at Quantico, Marines do not know what others in the same organization do, or which efforts they are supporting. The Marine Corps must spread the knowledge of current projects through a physical and virtual awareness campaign. Such a virtual campaign should function as a persistent awareness tool and encourage Marine Corps-wide collaboration for innovation.

ORGANIZATION. In the supporting establishment, HQMC and the Marine Corps Combat Development Command (MCCDC) should devise and embrace a flatter organizational structure. In theory, this will provide increased tactical and strategic situational awareness and promote effective enterprise-wide collaboration. A flatter organization could capitalize on networking tools to maximize the capabilities of individuals through activities like crowd sourcing. The Marine Corps relies upon a clumsy, hierarchal communication infrastructure and suffers information overload, resulting in suboptimal situational awareness. It must improve communications in order to increase the tempo of support to the operating forces and change some traditional methods of execution to function like an exponential organization. One attendee even suggested that the Marine Corps might consider eliminating the HQMC staff and integrating it with the Navy staff to become a naval staff to ensure naval integration and collaboration.

Turning to the operating forces, is it time to challenge the basic MAGTF construct? The MAGTF may not continue to be the answer. Assessment of the future operating environment suggests the need for a force of distributed, smaller units enabled by autonomous combat support and combat service support. Technology advancements should allow smaller, faster, and more lethal units. Conversely, the MAGTF is a proven approach and ultimately a distinguishing characteristic of the Marine Corps. Technology should allow MAGTFs to be smaller without losing capability and enable smaller MAGTFs than the traditional MEU. MAGTFs must collaborate internally and externally and emphasize more tailored air, ground, and logistics combat element structures. This will enable flexible, “more horizontal” MAGTFs, facilitate

lateral communications, and structure them for anticipated future missions. There need to be more MEU-level baseline organizations that can quickly scale up or down via flexible sourcing options to meet requirements. They should be more permanent to facilitate creating and maintaining habitual relationships with external organizations. Every unit must pursue better integration within, between, and among organizations at home stations via training and other means to support rapid task organization and overall readiness. Finally, to best train and prepare units to meet these new challenges, it is time to create a Marine Corps Red Team that focuses internally to "disrupt ourselves" as well as externally to scan the future.

Enhancements will come in the form of smaller, lighter, and more capable technologies that meet requirements of all elements of the MAGTF. These technologies will include robotic and autonomous systems in support of enhanced lethal and nonlethal functions. Specific challenges and potential solutions include manpower (robots), thinking (AI), training (augmented reality), and logistics (3D printing). Marines need innovative materiel and nonmateriel solutions to make individuals, units, and equipment lighter and faster, while concurrently increasing their capabilities and lethality across the physical and cognitive domains.

The Marine Corps has always insisted on forces completely reliant on organic capability. Some attendees believe that the aviation combat element (ACE) is what makes the MAGTF and the Marine Corps unique. To better leverage technology, they advocate pushing organic aviation and other capabilities down to lower organizational echelons, which in the case of the ACE increasingly will be unmanned rotary-wing and fixed-wing platforms. The MAGTF must be a "fifth Generation force" as opposed to being a third generation MAGTF with fifth generation aircraft in a fifth generation ACE. The Marine Corps is predominantly and culturally an infantry-centric organization with a wide range of organic support. The ground combat element (GCE) must be enabled by technology ranging from physical support (such as an exoskeleton), to nonmaterial support, to the data-information-knowledge-understanding continuum via AI.

Special operations forces, of which Marine Corps Forces, Special Operations Command (MARSOC) is a part, have absorbed some Marine Corps missions, and the Army has its sights set on other "expeditionary" tasks that historically have been the purview of the Marine Corps. In a resource-constrained environment, it will be necessary to sort out how to become 10 times better by utilizing others' assets. Outsourcing in this context primarily means relying on joint, interagency, and combined resources. Leveraging external assets for the Marine Corps means taking advantage of joint and coalition forces, industry, and academia.

MATERIEL. Big data seems to be the major obstacle to becoming an ExO. More data exists than can be efficiently analyzed and the Marine Corps' current data-analysis processes are scatterbrained and cumbersome. Marines must learn how to use new communications

technology and manage big data faster for better collaboration and coordination. This includes embracing technological changes at exponential rates that result in increased situational awareness and greater ability to gain and maintain tempo. Communications in support of decision-making should be streamlined and automated to become more focused and to "lose the noise" that can cause confusion. As an example, streamlining situational awareness on heads-up displays or using iPhone-like devices instead of PRC-117G-like devices would foster tempo gains through increased awareness and rapid decision-making. Another example is to operate swarms of unmanned air systems to provide communications instead of relying on deniable GPS systems. The Marine Corps must incorporate emerging commercial off-the-shelf (COTS) solutions, when available, and work with other organizations, particularly the Department of the Navy and Department of Defense (DoD), to change budgetary process restrictions. Other areas of consideration include manned-unmanned or human-machine teaming, robotic and autonomous systems, and sensors to "cut out the middle man" and reduce the time from identification of shortfalls to delivery of assets.

One of the plenary speakers identified "nano, bio, info, neuro, and quantum" as the five primary technology trends that will shape the future, likely through synergistic "exponential convergence." One group considered that info, quantum, and nano were the most likely contributors to a future ExO-like Marine Corps. They felt that the following quote from *Exponential Organizations* (Chapter 8: ExOs for Large Organizations) was germane to the Marine Corps. Alluding to large and established companies, it states, *"Already dinosaurs, they've been hit by a comet of information and are at increased risk of extinction. Nowhere is this more the case than among insular organizations, regardless of the industry, that rely heavily on manpower or are asset-based. All are subject to the extreme threat of disruption."*[11]

LEADERSHIP AND EDUCATION. The use of lessons learned needs to be improved. Specific lessons should be easily accessible by function in order to assist in collaboration rather than be part of a report stuffed away on some government-controlled repository.

The Marine Corps must assess mission capability in a more realistic manner. Marines should train more in force-on-force exercises against a thinking enemy. Schools must have the freedom to innovate beyond rote memorization and open up more paid opportunities for higher education to bring more outside-the-box thinking into the Marine Corps. The professional military education (PME) continuum should support a culture of training "early and often," to include "buy in from the top" for fostering and developing disruptive and critical thinkers. Transitioning to an ExO will require funding for live, virtual, and constructive training.

[11] Ismail, et al, op cit, 202.

PERSONNEL. DoD program policy and the added requirement to change key personnel through permanent change of station guidelines are a hindrance to executing current processes, and seem contrary to effecting the changes needed to become an ExO.

The Marine Corps must accelerate fielding innovations and harness the great ideas of individual Marines who can quickly vet and implement change to increase the velocity from ideas to fielding. The Marine Corps should assign a Marine's MOS based on experience and proclivity to excel at certain skills. Innovative thinkers require training and education that go beyond annual baseline training requirements and standard PME offerings. Leaders need to identify and nurture long-range and deep thinkers as well as "pain-in-the-ass guys." From a talent management perspective, the Marine Corps might consider an innovation occupational field with appropriate incentives.

Staffing-on-demand actions equate to task organization of assigned assets and to command relationships (OPCON, TACON, ADCON) with non-assigned external assets. New manpower management practices will be required that disrupt linear career tracks and the top-down bureaucracy, foster and reward alternative viewpoints, and incentivize promotions accordingly. If a Marine veers from the accepted path of operational tours and commands, that Marine is usually "punished" by failing promotion or not screening and slating for command or resident PME. The Marine Corps must find a way to keep and promote its innovators.

The Marine Corps should provide its innovative thinkers with a flatter organizational architecture, tailored training and education, and assignments to organizations like MCWL's Rapid Capabilities Office. It should also create a group "on the edge of the organization" that would look beyond the "second horizon," seeking ways to disrupt the institution, and ultimately feed the combat development process from an alternative perspective.

Finally, the Marine Corps must fix the deployment to dwell problem so operational units can adequately plan and adjust deployments as necessary.

2017 Innovation Challenge Winners

The Commandant of the Marine Corps, General Robert Neller, personally presented the awards to each of the challenge winners. General Neller emphasized the importance of these innovation efforts and encouraged all the attendees to foster new ideas and to support others who do. He also reconfirmed his commitment to changing the Marine Corps for future operations and reemphasized the importance of being prepared for a type of warfare we may have never experienced.

Marine Corps Warfighting Laboratory Innovation Challenge

Maj Thomas Waldron	Autonomous Hydrographical Coastal Survey
Sgt Aaron Urbanski	Autonomous Hydrographical Coastal Survey
Capt Christopher Luger	Follow-me UAS for Troop Overwatch
Capt Warren Choi	Follow-me UAS for Troop Overwatch
LtCol Kenneth Goedecke	Alternative Antenna Platform
Capt Matthew Morse	Automated Convoy Load Planning

Marine Corps Training and Education Command Innovation Challenge

Major Dennis Katolin	An MCDP on Ethics
1stLt Michael Adkins	Making Infantry Quarterbacks
Capt Milad Afkhami	Use Games to Supplement PME
Maj Sasha Huhlow	Use Games to Supplement PME
CWO3 Sean Flores	Use Games to Supplement PME
SSgt Paul Middaugh	Decision Forcing Cases
Civ Benjamin Jensen	Wargaming 2025 Building Decision Games

Day Two Plenary Session

To set the stage for the second session of breakout group work, speakers briefed participants on the Campaign of Learning (CoL) and the relationship between the FDSP and the CBA processes. The presentation aimed to equip members of the breakout groups with a basic understanding of the combat development process, which would then enable them to address the symposium's second research question.

The presentation was not a "sales pitch" but rather an overview of the current process—a basis for "exponential innovation." The term "capability development" describes the Marine Corps' approach to conceptualizing and developing the future force, including methods for training and educating Marines and Sailors. It is "a disciplined approach to conceptualizing, testing, and developing the future force," and it integrates conceptual and tangible aspects while balancing the natural tension between supporting the current force and developing the future force.

Much of this tension is fiscal, as the current force and future force effectively compete for a share of the Marine Corps budget.

The FDSP is a tool that is central to this approach. It helps to define and refine the processes by which the Marine Corps executes capability development. Moreover, it better links the efforts of MCWL/FD, Capabilities Development Directorate, Operational Analysis Directorate, and Training and Education Command to support the development of current and future Marine Corps capabilities, while also supporting ongoing Marine Corps roles and missions. The FDSP also connects outputs from HQMC's Combat Development and Integration (CD&I) Department to efforts by the Programs and Resources (P&R) Department to develop the Program Objective Memorandum (POM) [12].

The Deputy Commandant for Combat Development and Integration (DC, CD&I) intent for combat development is to:

> *Develop and lead a deliberate, collaborative, innovative, and resource-informed Marine Corps force development enterprise that is in line with DOD analytic guidance, drives change, and guarantees the Marine Corps always succeeds in meeting its Title 10 responsibilities.*

To accomplish this, MCWL/FD executes the CoL to inform the capability development process. Incorporating both top-down guidance and bottom-up input, the CoL is *"a disciplined and deliberate collection, learning, and analysis plan that seeks to address [the Marine Corps'] most vexing warfighting challenges in order to enhance MAGTF capability in the near, mid, and far term."* It involves the recurring incorporation of lessons learned in the development of concepts and capabilities; wargaming, experimentation, and analysis of these concepts and capabilities; and insertion of promising science and technology throughout. Quarterly Integration Forums and Quarterly Futures Reviews serve as mechanisms to integrate, manage, and control the campaign.

[12] Program Objective Memorandum (POM) is a central component of the Programming phase of the PPBE, when planning decisions, programming guidance, and congressional guidance is converted into a detailed allocation of resources. The Program Objective Memorandum (POM) is used to submit programming proposals. https://dap.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=79420a26-7a89-4e94-aad2-6d5d61bb7511 downloaded 15 June 2017.

The CoL represents Phase I of combat development and feeds into the Marine Corps' CBA process, which comprises the four remaining phases of combat development. Phase II, Capabilities Analysis, is a multistep process designed to produce a comprehensive set of required Marine Corps capabilities. Phase III, Gap Analysis, involves the rigorous comparison of required capabilities to capabilities already planned or possessed, and it yields a list of gaps and overlaps. Phase IV, Solutions Analysis, orients on identified gaps and identifies potential solutions to close those gaps based on the DOTMLPF-P[13] construct. Finally, Phase V, Risk Analysis, involves a structured assessment of risks to the force and/or mission, based on the solutions selected and unfilled gaps, if any.

DC/CD&I intent for combat development: Develop and lead a deliberate, collaborative, innovative, and resource-informed Marine Corps force development enterprise that is in line with DoD analytic guidance, drives change, and guarantees the Marine Corps always succeeds in meeting its Title 10 responsibilities.

Having outlined the various phases of combat development and covered Phase I, Campaign of Learning, in some detail, the next speaker offered specific insights on the remaining four phases. Phases II through V encompass a set of deliberate processes in which the Marine Forces, advocates, and deputy commandants fulfill precise roles. The process follows specific procedures for identifying tasks, conditions, and standards associated with a required capability; assessing whether a capability gap exists; and developing a solution based on the DOTMLPF-P construct. Realistically, the analysis of potential solutions is routinely constrained by "what we can afford."

The Marine Corps' CBA process is cyclical because it plays a significant role in the execution of the Planning, Programming, Budgeting and Execution (PPBE) process and in justification of the POM.

The speaker presented a timeline/synchronization matrix (Figure 2) that depicts the PPBE system and ended by urging the breakout groups to generate ideas for improving, streamlining, and accelerating the PPBE system.

[13] DOTMLPF-P is the DoD acronym for doctrine, organization, training, matériel, leadership and education, personnel, facilities, and policy analysis. It pertains to the eight elements involved in solving warfighting capability gaps. These solutions may result from a Capabilities-Based Assessment (CBA) or any study that investigates DoD warfighting capabilities and identifies capability gaps. DOTMLPF-P is cited in CJCSI 3170.01, Joint Capabilities Integration and Development System (JCIDS), and described in detail in the JCIDS Manual.

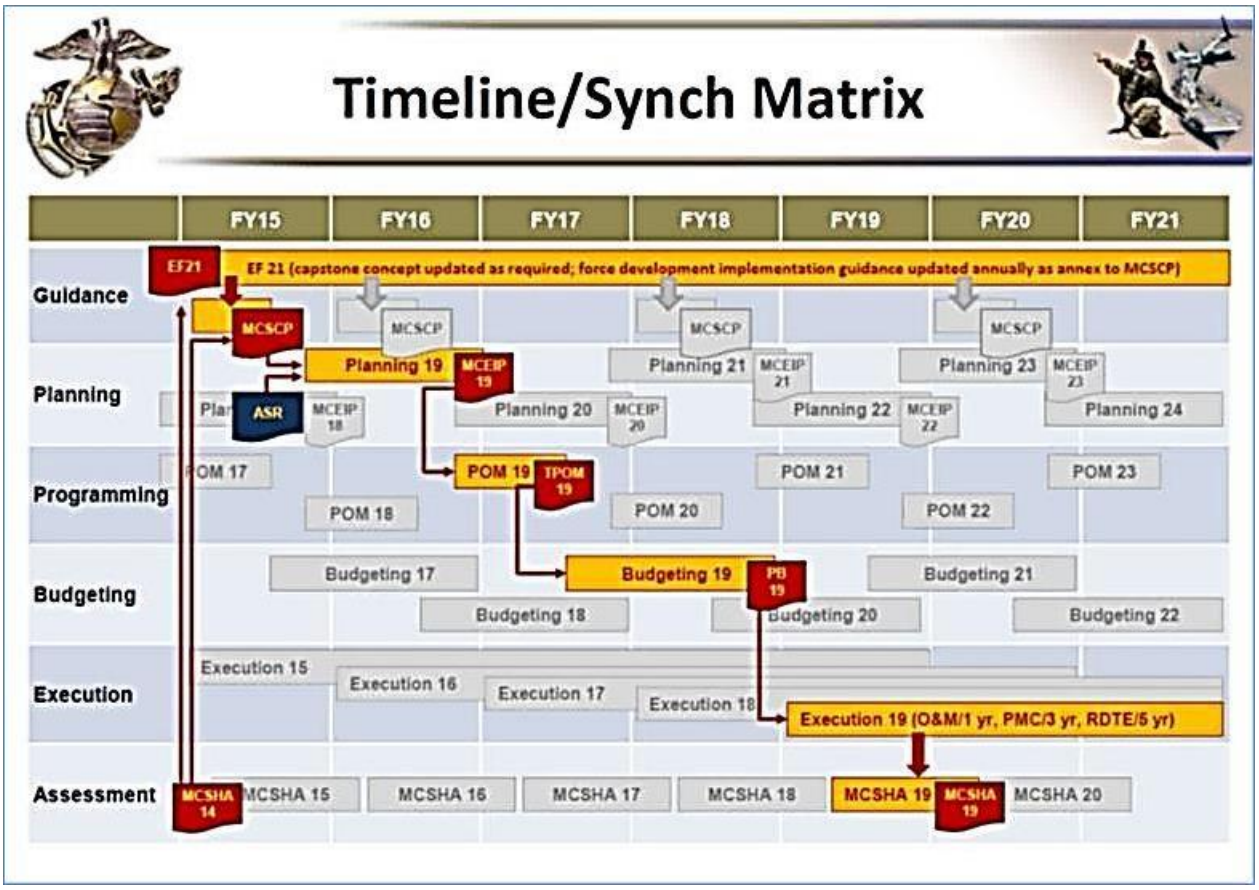

Figure 2: Timeline/Synchronization Matrix

Support of the POM process cannot be effective if it does not have the resources to execute the plan. The ensuing discussion raised several important points:

- Both external and internal parameters influence the CBA and PPBE processes; therefore, any effort to improve the combat development enterprise must consider both.
- Laws, regulations, and policies outside the Marine Corps' control play significant roles in shaping the CBA process.
- The effects of simple bureaucratic inertia should not be underestimated; the bureaucracy should therefore be an object of any innovation efforts.

Problem II Workshops

Through the lens of the Force Development Strategic Plan (FDSP) and Capabilities-based Assessment (CBA) process, what does the combat development enterprise look like under the construct of the ExO?

An exponential-like combat development process must communicate transparently, increase the tempo of the process, and alter some of the traditional methods of executing the process. Budget constraints hinder rapid change while the establishment pushes back and resists change.

DOCTRINE (or, the way it is). There are two major impediments to Marine Corps combat development: the lack of at least a two-year budget cycle and lagging IT policies and procedures. The cumbersome PPBE system inhibits innovation and execution at a rate that outpaces the adversary's tempo of change. The process requires simplification to gain speed and tempo in a changing landscape.

A two-year budget cycle, as illustrated in Figure 3, might improve Marine Corps procurement decisions because it would allow the service to align procurement decisions to emerging technology half-lives.

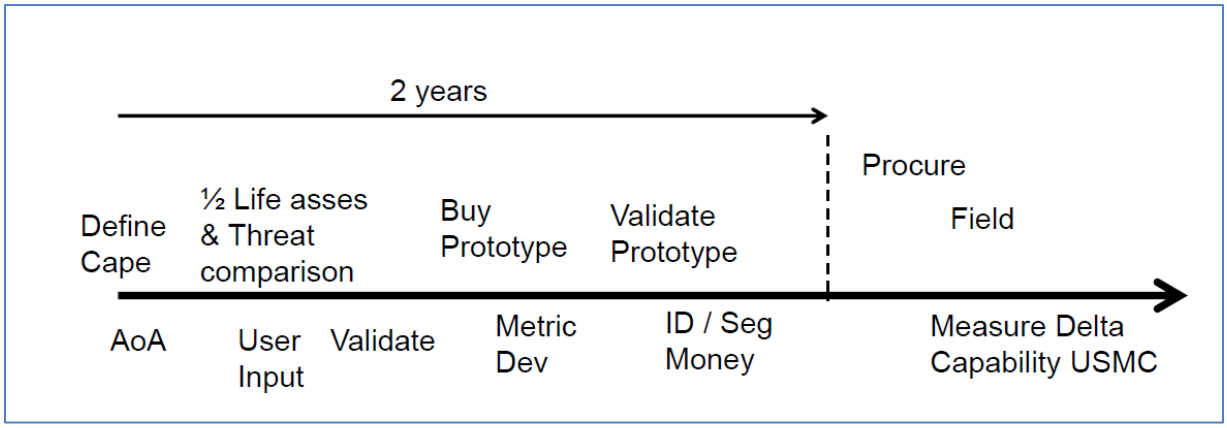

Figure 3: Two Year Procurement

The Marine Corps could incentivize units to reallocate funds without penalty through crowd-funding platforms. In the current combat development process, Marines burn through budgets in the fourth quarter of the fiscal year for following year budget survival. If the money is not spent by the end of the fiscal year, units risk having the next year's budget decreased to current expenditures, resulting in the annual "fourth quarter burn."

The attendees believe that Marines are not aware of the resources available to them to solve problems. The details of the process are neither shared nor transparent, and it does not encourage, welcome, or allow time for ideas beyond its own walls. If something is not shared, it is not reality. As an example, attendees had no knowledge of action taken on, or rejection of, the recommendations from last year's innovation symposium. There is a lack of awareness

across the enterprise of current innovation. Innovation exists in stovepiped, closed units that solve problems unilaterally even though they have equities across stovepipes.

Current capability development and acquisition processes do not consider program implications across the MAGTF. In fact, the current system makes it nearly impossible to identify interoperability shortfalls until very late in the development process. For example, specific – stovepiped – operational advisory groups (OAGs) and advisory boards are myopic in their outlook, and do not consider the MAGTF holistically. Any change to one element of the MAGTF affects every other element of the MAGTF; the MAGTF must be viewed as a system.

The CBA process is slow and cumbersome; it may be possible to address a POM 19 gap in POM 20, but the reality is, "less analysis, more politics." Capability and gap analyses are linear, deliberate, and inflexible. There should be a way to address "off-schedule," pop-up capabilities or gaps via a responsive, timely, and flexible process. The goal would be to enable changes within the CBA process rapidly and continuously. If successful, similar changes might follow in the DoD and national-level PPBE.

During the CBA process, combat developers often identify capabilities before identifying what gaps they are filling. Fiscal resources will continue to be limited, so it is important to consider modernizing or repurposing current systems before building something new to meet capability gaps.

The combat development enterprise needs to be more flexible and responsive. A "reserve fund" of some kind, possibly resourced by rolling over unspent funds at the end of the fiscal year, could contribute to this end. Many of these changes to appropriations rules would require Congressional action.

ORGANIZATION. The MEF is capable of determining, validating, and approving tactical warfighting requirements. Some of the combat development responsibilities and personnel could be realigned to augmented MEF staffs with the ultimate goal of streamlining the acquisition process.

TRAINING. The Marine Corps should experiment and train with realistic, viable future capabilities that are tied to future warfighting requirements. Where there are no prototypes to test, virtual systems can be utilized. Only those capabilities that fill currently validated gaps should be procured. A truly responsive "just in time" procurement system would allow capabilities to be quickly produced as needed, rapidly fielded, and easily employed and maintained. It also should result in lower costs and assurance that we procure "the latest version."

MATERIEL. The Marine Corps should abandon initially purchasing in bulk. Instead, the Marine Corps should purchase existing prototypes, allowing the service to procure the latest model when it is ready for wholesale buying.

Attendees believe that the Marine Corps often pursues, and in some cases procures, a system before knowing if or how it will fit into the organizational force structure. Procurement and production timelines vary, with large and complex systems such as ships and aircraft taking longer than smaller, simpler capabilities. The system should be more responsive to rapidly changing technologies and MAGTF Commanders should be given more discretionary funding to address emergent problems.

Transparency in communications would speed up and improve the force development and procurement process. Receiving "on demand" tailored information, from across all levels within the Marine Corps, could serve as an internal crowd sourcing input for requirements officers. A related challenge is that of over-classification, which one group member described as "the enemy of communications, transparency, and true understanding."

LEADERSHIP AND EDUCATION. The enterprise must comfortably include external voices participating in the capability development process and must have increased flexibility and freedom in funding.

The Marine Corps needs an innovation ecosystem. This would entail battalion-level innovation cells and regimental innovation labs to enable virtual and effective collaboration in an innovation community of interest. The divisions, wings, and logistics groups could serve as innovation incubators for developing ideas. This would empower and facilitate innovation at the user level. Establishing a virtually constructed innovation community of interest would help to develop situational awareness across the Marine Corps. Where practicable, the Marine Corps should emulate and apply proven, effective industry practices to its processes. Crowdsourcing can help with prioritization once virtual situational awareness is established. Transforming the Marine Corps into an ExO requires better communication and coordination among the departments and divisions of HQMC, particularly CD&I, P&R, and the other advocates.

Wargaming should be emphasized in Marine Corps schools as part of professional development and to feed the capability process. Wargaming results can also be used to accelerate continuous updates to training and readiness standards.

Senior leadership should routinely provide clear, transparent guidance to the capability development process. This could be a regular output of the quarterly executive off site (EOS) forums and be used as the basis for identifying capability development themes and priorities. The EOS guidance, when combined with Marine Corps mission and tasks, a future security

environment assessment, and the current force structure (manpower and equipment) would inform a future automated CBA process.

PERSONNEL. Bureaucratic processes must change to better execute combat development as well as put the right people in the right positions with promotions available from non-standard career tracks. More tours of duty in the commercial business world for officers selected to the Marine Corps Fellows program could aid innovation after observing how civilian organizations encourage or implement innovations. Within the Marine Corps, moving development and decisions to lower levels could catalyze innovation.

Closing Remarks

At the 2016 Innovation Symposium, the Commandant stated that the Marine Corps must get to a place where the process is easier, things are procured faster and done smarter, and where whatever is acquired is cheaper. Money alone will not solve all the challenges facing the Marine Corps. The future is more about changing the rules and having a process to acquire needed equipment that is easier to use and increases combat effectiveness. It seems clear that the answer is not just about getting more money, but is more about changing our processes. Adapting to the ever-changing security environment will require that the Marine Corps take risks and embrace new and unproven ideas while providing pathways for innovators to be successful. Innovators do not necessarily fit well into the traditional view or career trajectory of a successful Marine.

Effecting change means the Marine Corps must fundamentally alter the way it does business. That means Marines will have to speak truth to power and break some rice bowls. It also means taking risks, because if business continues in the same old way, or if nothing is done, “we lose.”

Events like this are vitally important to the Marine Corps as they challenge Marines to question how the Marine Corps organizes, trains, equips, and plans for the future. The Commandant has stated that the Marine Corps is at an inflection point relative to the future threat. The Marine Corps must innovate if it is to remain relevant. It is not easy to get the future right; we need a cadre of experts as we move forward remembering our strategic advantage is our freethinking people.

It is vital to take time occasionally for deeper thought while emphasizing how important events like the Innovation Symposium are to the Corps. The Marine Corps’ “freethinking people [are an] advantage,” and the Marine Corps has a long history of being “an armed service of mavericks.” This is a key attribute that can help enable innovation. Youth is also a resource, and participants should leverage the freethinking minds of the younger Marines in their organizations, “harnessing” them to “pull us along.” Finally, attendees should return to their

organizations and share what they learned during the symposium and be "positive enablers, positive disrupters" for change. Given the emerging operational environment, it is important to innovate, but to innovate in a positive way.

Recommendations

The symposium yielded several recommendations. Foremost among them was an overarching recommendation to create a Massive Transformative Purpose (MTP), the higher, aspirational purpose of the organization. An MTP is not a mission statement; it should be forward-looking and inspirational to every Marine. Aligning the organization via a Massive Transformative Purpose (MTP) is a worthy goal. However, such an effort needs to start with identifying what have been unique strengths and "sacred cows" and then examining which of them should be considered for transformation. According to *Exponential Organizations*, finding an MTP is a novel and interesting way of asking two questions: (1) what do I really care about? and (2) what am I meant to do? How the Marine Corps answers these questions will determine whether it becomes an ExO.

Below is a summary of remaining recommendations organized by research question.

Research Question One: *What would the Marine Corps look like as an Exponential Organization (ExO)? What is required to enable this?*

- Provide evaluation criteria to identify the innovators among our Marines and possibly make it an evaluation category on the Marine Corps fitness report.
- Provide new career and/or MOS road maps. Enhance personal strengths that benefit the organization and reward those who take the less-travelled road if it contributes to the success of the Marine Corps. This will require creating measures of competence beyond current fitness reports and possibly employ a 360-degree evaluation of each Marine by his or her peers, juniors, and seniors.
- Encourage innovation at lower unit levels, at least down to battalions and squadrons, and perhaps down to the company level. These units could function as "incubators" for new ideas that could then be shared with higher headquarters and the Marine Corps. Some examples might include information technology innovations, 3D printing, robotic and autonomous systems, and "hobby shops" for these capabilities so that Marines who have an interest in new technologies can informally acquire the knowledge, skills, and abilities to work with and employ these technologies.
- Review the commercial world and accelerate the process for acquiring COTS technology and equipment, especially to solve the problem of "Big Data." Marines must be able to utilize

available data to make informed decisions and to understand the operating environment and planning processes.

- Establish a standing opposing force that is rapidly reconfigurable and provides a realistic, thinking, enemy perspective. Force-on-force training with a thinking enemy has long been a shortcoming. Red cells and red teams are routinely used for wargames, but the Marine Corps has not routinely taken advantage of the myriad benefits provided by force-on-force training.
- Transform the Marine Corps system of global sourcing and outsource specific capabilities, such as cyber operations (both defense and offense), some logistics (such as transportation), and other capabilities. Strategies include using short-term contractors, activating select Reserves, or employing a strategy such as that of the Bulgarian "Minutemen" where subject matter experts are identified in advance and then activated for a specific task or tasks where their expertise is vital to success.

Research Question Two: *Through the lens of the Force Development Strategic Plan (FDSP) and Capabilities-based Assessment (CBA) process, what does the combat development enterprise look like under the construct of the ExO?*

- Fundamentally change the Manpower Management system. Reexamine incentives for accession, reenlistment, promotion, pay, etc. to ensure the right people are in the right jobs to ensure success. Many will say this has been tried before; now may be the time to completely revamp the entire process and create it (not redesign it) from scratch so it functions in the way it needs to function as an ExO. It may be advisable to mature the force to confront the challenges of new warfighting domains and the increase in complexity and speed required for technologically advanced operations. Eliminate the current up-or-out policy. In many of today's jobs it is more important to be competent in one's specific billet rather than being the traditional, well-rounded, operational Marine.
- Establish an annual CD&I Roadshow similar to the manpower roadshow to explain the combat development process in a way that everyone can understand it and potentially contribute to its success. A possible adjunct could be a MCWL roadshow to inform the force regarding future technology, potential concepts, and planned wargames and experiments. Information sessions like these could lead to crowd sourcing ideas that contribute to the knowledge and planning of headquarters entities and improve communication throughout the Marine Corps.
- Incentivize or allow units to reallocate excess funds without cutting funding from year to year due to an inability to totally commit funds for any given fiscal year. This would avoid the annual spending spree that occurs during the last quarter of every fiscal year. One solution might be to establish a platform for identifying requirements and priorities from units to reallocate funds as needed; this would probably require legislation from Congress.

- Appoint a Chief Data Officer of the Marine Corps. As the amount of data continually increases, solutions are needed for on-demand data retrieval so that the right information goes to the right individual at the right time.
- Decentralize more decisions and capabilities to lower levels. This issue receives lip service but is only practiced in combat and even then is thoroughly reviewed, post-action. Allow "middle managers" to provide recommendations and comments, but only the final approval authority can give an issue a final up or down.
- Allow MEF commanders to approve and validate tactical requirements after which HQMC supports the requirement by providing a solution. This would be similar to the urgent universal needs statement process and might accelerate the current slow acquisition.
- Encourage innovative software development at the lowest level. Often, users are able to improve the performance of provided software but are prohibited from using it due to proprietary issues or verification and validation (V&V) requirements. Create a methodology for more rapidly conducting the V&V process and approving upgrades for widespread use.

Final Thoughts

Innovation has become a strategic necessity, but it is hard to define and it means different things to different people. Innovation exists along a continuum, from materiel improvements, to existing products or processes, all the way to the rare disruptive innovation. Innovative thinking, like critical thinking, does not come naturally to most people. That is one reason innovation is so hard. Yale University Information Technology Services defines innovation as the process of implementing new ideas to create value for an organization. This may mean creating a new service, system, or process, or enhancing existing ones. Innovation can also take the form of discontinuing an inefficient or out-of-date service, system, or process.[14]

Innovation cannot be manufactured, but it can be institutionally encouraged and the practitioners protected. To protect innovators they have to be identified and sorting out who are the disruptors with good ideas and which ones are just disruptive for disruptions' sake is the leader's greatest challenge. Similarly, not all ideas are good, practical, or executable and determining who gets to arbitrate the good from the bad will be another contentious issue. Ultimately, it must be the purview of leaders to create the environment for innovators to excel.[15]

In the February 2017 issue of the Marine Corps Gazette, Captain Joshua Waddel takes Marine Corps leadership to task for what he terms its self-delusion regarding the "organizational energy and innovative agility of our Marines and the depressive stagnation found within the

[14] Yale Information Technology Services, op cit.
[15] 2016 United States Marine Corps Force Development 25 Innovation Symposium final report, p. 50

Supporting Establishment."[16] Many of the issues he addressed in his article were topics of discussion at this year's symposium. This report includes many recommendations that offer potential solutions to some of the Marine Corps' most pressing future problems; however, the ability to institute many of them remains subject to the vagaries of other institutions and limit the ability to enact these changes. The challenge, then, is to act on those recommendations that are within control. Marines must be prepared to take risks regarding the future course of the Marine Corps. If Marines are unable or unwilling to act, there is a real possibility of defeat, failure, or irrelevance as a military institution. In the end, a failure to innovate might be simply a failure of imagination. Rather than try to institutionalize innovation, the best path to success may be simply finding a way to tap into the "innovators."

[16] Waddell, op cit.