

Disruptive Innovations to Help Protect against Future Threats

Ernest Y. Wong and Nicholas M. Sambaluk

Abstract—Innovation is back in vogue within the U.S. military. In the face of defense spending cuts and reductions in military manpower after prolonged campaigns in Iraq and Afghanistan, the U.S. is turning once again to developing key technologies to offset its quantitative inferiority in conventional forces. The U.S. has pursued this offset strategy twice before—the first time was in the 1950s with nuclear deterrence countering the numerically superior armament and fighting forces of the Warsaw Pact, and the second time was in the 1970s with DARPA-led efforts to gain technological superiority from enhanced intelligence, surveillance, and reconnaissance, precision-guided weapons, stealth technology, and space-based communications and navigation. The current Third Offset Strategy targets many promising innovations including robotics and autonomous systems, miniaturization, big data, and advanced manufacturing. The U.S. military has even created a number of new organizations such as the Army Cyber Institute to explore high-tech innovation and the Defense Innovation Unit Experimental to expedite the transfer of cutting-edge technology to warfighters. Nonetheless, some critics believe the U.S. military is such an unwieldy bureaucracy that it lacks the nimbleness to transform into a force that can win tomorrow’s wars—particularly in cyberspace. These critics also note that most of the innovation the U.S. currently seeks come from groundbreaking research—the type of innovation that is expensive to develop. This paper proposes that by adding disruptive innovations—the type of innovation that tends to be cheaper and less technologically complex—into its R&D portfolio mix, the U.S. military will not only strengthen its offset strategy, it will also better protect itself from future threats by reducing the likelihood of strategic surprise. In this paper, we review Christensen and Bower’s disruptive technologies framework, illuminate successful disruptive innovations in military history, and provide insights into how the U.S. can foster disruptive innovation.

Index Terms—breakthrough innovations, disruptive innovations, U.S. Third Offset Strategy

I. INTRODUCTION: ENHANCING THE U.S. THIRD OFFSET STRATEGY

IN 2014, then Secretary of the U.S. Department of Defense (DoD), Chuck Hagel, introduced the Defense Innovation Initiative which emphasized how the United States would focus on promoting innovation and developing key technologies as a way stay ahead and maintain a decisive edge over any potential military adversary even in a fiscally

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constrained environment [1]. This offset strategy would allow the U.S. to preserve its technological military edge by investing in new technologies which, in turn, serve to offset a reduction in resources, cuts to military manpower, and an erosion of current military overmatch capabilities to adversaries and threats that have been “modernizing their militaries, [and] developing and proliferating disruptive capabilities across the spectrum of conflict” [2].

The Third Offset Strategy focuses heavily on breakthrough innovations and remains consistent with the first two offset strategies that the U.S. had implemented. The first took place after World War II in the 1950s, during which time the U.S. took the lead on ground-breaking research into physics, atomic energy, and fissile materials to come up with nuclear deterrence to offset against the numerically superior conventional military forces of the Soviet Union and the Warsaw Pact. The second took place after the Vietnam War in the 1970s, when DARPA helped lead efforts to gain technological superiority from cutting-edge research that led to the development of enhanced ISR platforms, precision-guided weapons, stealth technology, and space-based communications and navigation to offset against the Soviet Union’s larger nuclear arsenal and the Warsaw Pact’s continually growing conventional military capabilities.

By targeting a number of state-of-the-art technologies including robotics and autonomous systems, miniaturization, big data, and advanced manufacturing [3], the current Third Offset Strategy invests heavily once again into breakthrough innovation—the type of innovation that is typically expensive to research, requires sophisticated technology, and is difficult to successfully materialize. Whereas the U.S. has demonstrated that it can succeed at turning groundbreaking research into operational practice and has shown that it can maintain a competitive advantage in such endeavors, this paper advocates that the U.S. should also pursue and include disruptive innovations into its research and development (R&D) portfolio mix. Doing so will help to not only reinforce the U.S. offset strategy, it will also help better protect the nation against what N. Taleb describes as black swan events—those unforeseen outliers that cause significant impact which only after the fact become rationalized as being completely explainable [4]—by reducing the likelihood of strategic surprise.

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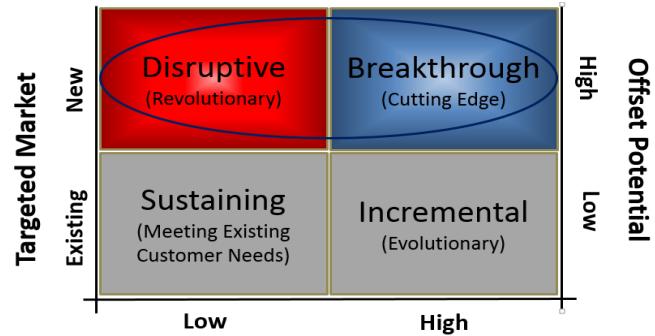
II. DRAWING DISTINCTIONS IN INNOVATION TO BECOME MORE INNOVATIVE IN THE RIGHT WAYS

The dictionary defines “innovation” as simply “a new idea, device, or method”, or “the act or process of introducing new ideas, devices, or methods” [5]. A recent article promoting the importance of U.S. military cyberspace operations elaborates on this definition by specifying that it is “the implementation and integration of new concepts, processes, and material that enhance mission capability” [6]. In spite of making the terminology more precise and signifying that true innovations do not just promote new ideas but lead to actual improvements, arguably scant research, however, has been conducted to help make it easier to become more innovative. The business community has embraced “innovation” as a watchword that can help land an individual or company’s unique experiences and practices with innovation on to the New York Times Best Seller List. But more often than not, readers are left wondering just how they can systemically apply these insights into their own particular situations. This paper attempts to address these shortcomings by introducing a more methodical understanding of what is meant by “innovation”. Through a clear realization that there is not just one type of innovation, the hope is that this paper will encourage the U.S. DoD to become more systematic in leveraging, managing, and nurturing the right types of innovation so that a reduced number of U.S. military forces can successfully achieve the Third Offset Strategy.

There are four types of innovation: sustaining, incremental, disruptive, and breakthrough innovations. Each type of innovation is defined by two key factors. The first factor is the innovation’s target market, whether it be an existing one that appeals directly to existing customers and current needs, or a new market where there may not be a clearly identifiable customer or well-defined requirement at that point in time. The second factor that helps to draw distinctions between the different types of innovations is the level of technological complexity or sophistication required to bring the innovation to fruition. Fig. 1 provides a graphical representation of how to distinguish between the four types of innovations based on these two factors.

From a military perspective, sustaining and incremental innovations tend to be more reactive in nature. These innovations primarily serve existing markets and typically produce improvements based on easily identifiable needs. Sustaining innovations typically occur when an organization is partial to a product or process, and it simply wants to improve upon a good thing usually to advance efficiencies. An example of a sustaining innovation in the U.S. military is the M16 assault rifle which over the course of 50 years progressed to the M16A2, M16A3, and M16A4 models. Incremental innovations typically happen when an organization’s product or process are challenged by an adversary and the organization must evolve in order to preserve its effectiveness. An example of an incremental innovation in the U.S. military is the development of chaff countermeasures, initially developed to obscure aircraft from enemy radars during World War II, and later to prevent radar-guided missiles from target acquisition. Sustaining and incremental innovations, whereas key to generating improvements within existing systems, do not, however, have considerable potential to supplement an offset strategy.

Because both these innovations stem mostly from environmental changes that prompt the improvements rather than being an innovation designed to proactively alter the market itself, sustaining and incremental innovations usually come about as a reactive measure. Most innovations that become widely adopted and considered successes are sustaining and incremental innovation primarily because they have been developed and designed with a much greater knowledge of what is needed for the market and environment.



Technological Complexity or Sophistication

Fig. 1. The four distinct innovation types. It is important to note that even though disruptive and breakthrough innovations are ideal for an offset strategy, there will be a considerable percentage of failures associated with these types of innovation. Sustaining and incremental innovations, however, have a greater chance of success, but offer much more limited offset potential.

Disruptive and breakthrough innovations, on the other hand, possess greater appeal for an offset strategy because both target new markets in their design, and when adopted and implemented, have a greater likelihood of reshaping the environment. These types of innovation tend to be more proactive in nature and seek to shift the balance of power in favor of those who possess the innovation. However, it is critical to understand that both disruptive and breakthrough innovations are difficult to achieve and are very risky undertakings because of the fact that they target markets that usually do not even exist. Therefore, to increase the chance that U.S. research endeavors do actually materialize into operational efforts that generate new and significant advantages to its military and enhance mission capability, the U.S. DoD needs to consider not only breakthrough innovations, but disruptive ones as well.

Despite being associated with more failures than successes, disruptive innovations succeed most often within organizations that foster successful experimentation. Examples throughout U.S. history showcase groups that have demonstrated such a speculative knack include: the first American colonists who had to make do with all resources at their disposal in order to survive; this nation’s founding fathers who fought against the British Regulars with unconventional tactics; and early American explorers and pioneers who journeyed into uncharted territories with very few comforts and possessions. In order to increase the chances of success in experimentation, strategy and organization experts S. L. Brown and K. M. Eisenhardt advocate conducting a portfolio of experiments that are small, fast, and cheap, initiating experiments that create a more complex and dynamic strategy for the future, and designing

experiments that enable the gaining of insights into the future that may unfold without losing operational flexibility [7]. By instituting such types of systematic experimentation, the U.S. DoD can increase its likelihood of creating successful disruptions.

III. CHAMPIONING THE CASE FOR DISRUPTIVE INNOVATIONS

While breakthrough innovations typically originate from complex ideas and depend heavily upon cutting-edge technologies, disruptive innovations according to J. Bower and C. Christensen “are usually not radically new or difficult from a technological point of view” [8]. As such, disruptive innovations generally are cheaper to produce and do not require the level of sophisticated R&D that breakthrough innovations need as illustrated in Fig. 2. Within an environment of constrained resources, it logically follows that disruptive innovations ought to play a key role in U.S. DoD research efforts.

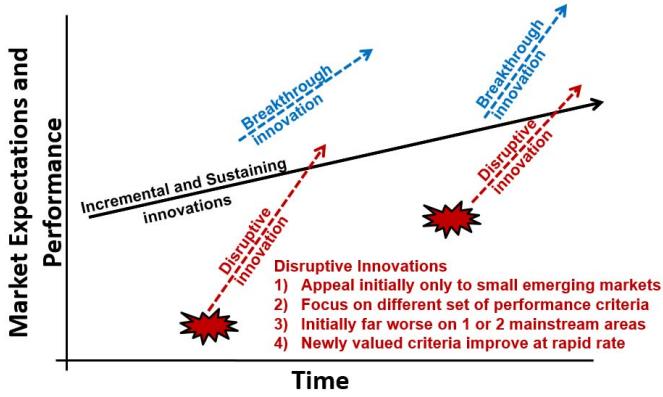


Fig. 2. Successful disruptive innovations shown in relationship to the other types of innovation (breakthrough, sustaining, and incremental). Although disruptive innovations initially appeal only to a small group of individuals, the new performance criteria that attract these individuals to the innovation are so appealing that a whole new market begins to quickly develop around it. And despite being initially far worse in a few performance criteria from the existing market leader (who typically focuses on incremental and sustaining innovations), the disruptive innovation rapidly improves as the new market grows into adopting the innovation.

It is important to note that even though a disruptive innovation initially appeals only to a much smaller base consisting of a new and emerging market, a successful disruption occurs when a much larger portion of the market finds value in the innovation. The performance attributes of the disruptive innovation which the new market finds attractive and appealing quickly catches the attention of a larger market that had not originally been serviced by the existing dominant product or process. This new market does not particularly care that the disruptive innovation fares much worse on one or two mainstream areas and performance attributes; instead, the emerging market values the disruptive innovation based on a particular set of new performance attributes, with pricing and cost typically being the most important criteria [9]. Because demand for such an affordable product or process grows rapidly, the disruptive innovation is able to quickly improve in

nearly all performance attributes, even the ones in which it initially was considerably inferior.

Examples of successful disruptive innovations in the U.S. commercial sector include the following: Ford Motor Company’s use of assembly-line manufacturing which disrupted a sizable number of companies building cars manually at a time; Apple Computer’s foray into the personal computing space which disrupted IBM’s hold over mainframe computers; and Hewlett Packard’s inkjet printers that were substantially inferior to laser printers but met the needs of home-based businesses at a considerably superior price point.

Disruptive innovations have also played a prominent role in U.S. military history with highlights depicted in Fig. 3. In the American Revolutionary War, the outnumbered and ill-equipped American irregulars repelled the British Regulars with constant skirmishes and hit-and-run tactics. After World War I, battleships which had served the U.S. Navy’s leading capital ship lost their role to the disruptive innovation of carriers and the extended reach that their on-board aircraft provided. During World War II, operational research scientists were able to determine that the survivability of transport ships increased significantly when travelling in convoys; the use of statistical analysis helped to disrupt the Nazi U-boats’ control of the sea lines of communications. In the 1980s, the U.S. Army and Air Force came up with the AirLand Battle concept which focused on the attrition and destruction of enemy forces and helped to disrupt the military’s preoccupation with concentrating all available resources on to a single terrain-oriented objective. Even today, the U.S. military is rapidly fielding and deploying unmanned aerial vehicles and systems so that tactical surveillance is readily available to the lowest command-level possible and so that information can be actioned as quickly as possible. Although most people tend to think of disruptive innovations as clever gadgets and smart technology, these examples show that they can also be techniques, tactics, and procedures that help drive organizational change. These examples also help to bolster this paper’s claim that the U.S. military does have a proven track record with experimentation and the development of successful disruptive innovations.

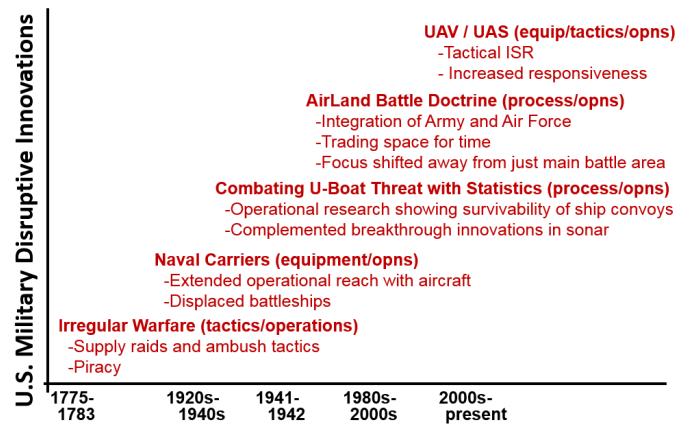


Fig 3. Examples of successful military disruptive innovations in U.S. history.

Throughout the course of its relatively short history, the U.S. has shown that not only can it produce breakthrough innovations with cutting-edge technology, but that its military

can also come up with disruptive innovations that help to offset its lack of a large standing force. In fact, one can argue that there exist strong disruptive tendencies which prevail in the American spirit—making do with what is available and using them in novel ways to overcome impediments towards success. Furthermore, the ongoing disruptive changes still in place today, from naval carriers to UAVs, goes to show that the U.S. military, though oftentimes and rightly considered an unwieldy bureaucracy, can come up with novel disruptive innovations that can help transform itself into a more nimble force that can win in information-age warfare.

IV. EXPERIMENTATION TO REDUCE STRATEGIC SURPRISE

In spite of the fact that the U.S. military has oftentimes mastered what it means to be a disruptive force, the victories and military successes garnered through its disruptive innovations have oftentimes paradoxically diminished the need for it to keep up with its successful innovations. The argument can be made that the U.S. has entered into one of these periods again, where its military forces are not correctly postured to fight and succeed in cyber warfare. Fortunately, the U.S. Defense Innovation Initiative encourages the entire U.S. Department of Defense to promote and leverage innovation in substantive ways to offset declining resources yet still sustain and advance its military superiority [10].

The U.S. military has invested in and developed a number of new organizations to help champion these efforts. It created the Army Cyber Institute at the United States Military Academy to explore high-tech innovation and develop intellectual capital to enable the nation to outmaneuver adversaries in cyberspace [11]. It also established outposts in Silicon Valley and Boston with the Defense Innovation Unit Experimental to help expedite the transfer of cutting-edge technology to warfighters through the rapid identification, contracting, and prototyping of novel innovations [12]. The U.S. military is beginning to realize that warfare in the digital age will center on cyber capabilities that target system vulnerabilities that go beyond DoD networks. Critical infrastructure and services that U.S. citizens depend upon on a daily basis are threatened as well. Consequently, an understanding that the wars of tomorrow will require not just a whole-of-government response but also a whole-of-nation effort will help to reinforce the critical role that all its citizens can and will play in whether or not the U.S. can win in cyber warfare.

The mere inclusion of disruptive innovations into discussions on breakthrough innovations that the U.S. military already envisions for the Third Offset Strategy will help to significantly reduce strategic surprise. A brief retrospective look into how U.S. adversaries have initiated disruptive changes to offset superior U.S. military advantages will help to emphasize this point. In the ongoing conflicts in Iraq and Afghanistan, the lesser armed insurgents have employed improvised explosive devices (IEDs) to strike fear into the substantially better equipped U.S. military forces. During the Vietnam War, the U.S. Air Force's attainment of air superiority and massive bombing campaigns of the Ho Chi Minh trail failed to achieve their objectives principally because the Viet Kong and North Vietnamese Army's logistics network was not initially

dependent upon key infrastructure such as rail lines and vehicular roads, and the supply lines could reconstitute without considerable effort. In the Korean War, General MacArthur consistently and severely underestimated the strength of the Chinese military forces that fought on behalf of North Korea because they had conducted major movements exclusively at night or periods of limited visibility, thereby countering the advanced aerial photography and surveillance afforded to the U.S. and U.N. forces. Each of these instances of disruptive change initiated by technologically inferior adversaries highlight that in spite of how advanced U.S. military forces become and how many breakthrough technologies and innovations it employs, a smart and thinking enemy will attempt to develop ways to counter the U.S. military advantages. Accordingly, it behooves U.S. military planners to consciously think of disruptive measures that have the capacity to thwart potential breakthrough innovations that the U.S. plans to pursue as part of its deliberate wargaming process. Doing so will help to make the U.S. offset strategy more robust and lessen the chances of potentially calamitous black swan events [13]. The U.S. is embarking upon its Third Offset Strategy which brings innovation into the forefront of planning for the future of the U.S. military. There is, however, no guarantee the U.S. will succeed. But by leveraging the success it has achieved in the past and combining both disruptive and breakthrough innovations into its R&D portfolio mix, the U.S. increases its chances for success while simultaneously reduces strategic surprise.

V. CONCLUSION

From America's struggle for independence to its bloody civil war, from the nation's emergence on to the global stage during the world wars to its lackluster results during the Korean and Vietnam wars, and from its triumphant Cold War victory to its ongoing military entanglements in the Middle East, the U.S. has operated on both sides of the disruptive innovation paradigm and has, oftentimes, mastered what it means to be a disruptive force—able to leverage innovation, ingenuity, and creativity into out-thinking, out-lasting, and out-maneuvering its adversaries using relatively unsophisticated and rudimentary methods. Over the past century, the U.S. has become enamored with breakthrough innovations, especially as each offset strategy has provided resounding success in allowing its smaller conventional forces to match, and even surpass, its adversaries' larger conventional military forces with cutting-edge technology and ground-breaking research. However, breakthrough innovations are expensive to research, are technologically sophisticated, and are very difficult to achieve. While the likelihood of achieving immediate success and widespread adoption of disruptive innovations are also low, the fact that they attempt to offset an adversary's strength with systems already in place make them generally more economical and less technologically daunting propositions. This paper does not attempt to rank which type of innovation is better—the fact that successful disruptive and breakthrough innovations are hard to come by ought to signal that both need to be in the R&D portfolio mix of any U.S. offset strategy. Furthermore, to

reduce the likelihood of dire black swan events in this challenging endeavor, it is important for the U.S. to leverage disruptive ideas as part of wargaming efforts to test and validate promising breakthrough innovations currently in development.

Not only is it important for the U.S. to continue to innovate against the threats of tomorrow, it must equip, train, and prepare its military to fight against them. Smart adversaries study the strengths and weaknesses of the U.S. military—they will exploit this to their maximal advantage. The U.S. would prefer to fight the dumb enemy who attacks its strengths and is ignorant of its weaknesses, but the reality is the U.S. will likely not have the luxury of getting to choose whom it fights after it is attacked. There is constant talk of a “cyber Pearl Harbor” or a “cyber 9/11” taking place—the U.S. must leverage all of its innovative genius to prevent such a calamity. And regardless of how much overmatch the U.S. military thinks it has over its adversaries, it must also be aware of the disruptive innovations its enemies can develop as their own offset their disadvantages.

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