Disruptive Commercial Technologies

2008 Naval Research Advisory Committee Study

"…Irregular warfare and all aspects of it will be with us…for the next couple of decades…so we need to invest in that and we need to make sure we get that right"

—Admiral Michael Mullen

Chairman, JCS

12 June 2008

National Press Club

26 June 2008

The study panel members wish to dedicate this report to the memory of their late colleague, Jack Bachkosky, who passed away in the spring of 2008. He was a long-serving NRAC member whose wisdom, collegiality, unfailing good nature and true patriotism are sorely missed.

Executive Summary

- Advanced commercial technologies are widely distributed throughout the world and are generally accessible through the internet.

- Credible threats to Marine capabilities and gaps can be developed from imaginative combinations of commercial products. These products can be acquired via the Web and distributed by the global supply network. Commercial technologies are readily adaptable into systems or devices that can threaten Marine forces. The internet functions effectively as both an R&D resource and supply chain for irregular forces throughout the world. Commercial technologies pose a real and enduring threat to Marine forces.

- The Marine Corps has no effective methods for anticipating these unconventional threats, nor does it have access to a proactive and rapid research, development, test, and evaluation (RDT&E) system for countering threats without identifiable solutions.

- The Department of the Navy should create an accelerated S&T approach to address threats with no technologically mature solutions for Urgent Universal Needs Statement (UUNS) requirements, and the Commanding General, Marine Corps Combat Development Command, should be given authority to create Urgent Universal Needs Statements.

- The Marine Corps should establish a continuous, adaptive process that can anticipate use of commercial technology by irregular adversaries, and that can develop ways of countering such threats before Marines are actually attacked with them—that capability is Commercial Hunter.

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Introduction and Terms of Reference

The Naval Research Advisory Committee (NRAC) was tasked to consider the implications of disruptive commercial technologies for United States Marine Corps operations, because irregular adversaries increasingly employ globally-available commercial technologies against Marine Corps forces deployed worldwide. Specifically, NRAC was tasked to:

− Study potentially disruptive technologies.

− Establish potential threats and timelines for those threats.

− Identify technologies and indicators.

− Propose countermeasures.

− Propose an investment strategy for meeting the potential threats it identified.

The panel was instructed to focus on technologies likely to emerge within the next three to seven years.

The study sponsor, the Commanding General, Marine Corps Combat Development Command (MCCDC), offered some amplifying guidance: the panel would make a real contribution if it recommended a process to anticipate, identify, and counter commercial technologies disruptive to Marine Corps tactical operations. This guidance shaped the panel's approach to the problem—indeed, it drove the panel to focus on process as opposed to technology identification.

The panel consulted several studies that concentrated on predicting potential unconventional threats (see Figure 1).

Study	Organization	Year
Capabilities Surprise	Defense Science Board	2008 (ongoing)
Future Warfare Technologies	Central Intelligence Agency	2008
Ahead of the Curve	Monitor Group	2007
Global Strategic Trends Programme	DCDC	2006
Global Technology Advances	National Research Council	2005
Global Technology Revolution	RAND	2001
Technology Acquisition by Terrorist Groups	RAND	2001

Figure 1 Other studies of disruptive commercial technologies

These studies, however, and the lists they evolved, have not appeared to have had a substantive impact on the development of countermeasures. The panel concluded that this is due largely to two factors. First, the expression "disruptive commercial technologies" is ambiguous. Commercially, a disruptive technology is typically understood to be an innovation, normally a lower-cost product or service that displaces an established family of products or services. Such a technology disrupts a marketplace by forcing out the formerly dominant technology. This, however, is not the sense of *disruptive* actually contemplated in the terms of reference. From the Marine Corps perspective, technologies are disruptive if they threaten Marine Corps tactical operations. A disruptive technology in this interpretation is roughly equivalent to a technology or commercial product that poses a threat, and this is the meaning that the panel used in its study.

Second, the focus of most other studies has been on technologies that are genuinely new. But the panel found that the most significant unexpected threats Marines have faced have not been from new technologies, but rather from existing technologies or products used or exploited in unexpected ways.

The panel therefore directed its study toward answering how we can best position the Marine Corps to face the continuing challenge of disruptive technologies embodied in commercial products. In its fact-finding it received the briefings listed in Figure 2, below.

Fact-Finding
Marine Corps/Navy
Center for Emerging Threats and Opportunities
Combat Development and Integration, Capabilities Based Assessment Branch
Commanding General, Marine Corps Combat Development Command (MCCDC)—study sponsor
Intelligence Activity
Office of Naval Research (ONR) Code 30
ONR Global
Strategic Vision Group
Defense University/National Lab
National Defense University
Naval Postgraduate School
Sandia National Laboratories
Other DOD and Agencies
Central Intelligence Agency (CIA)
CIA, Weapons, Intelligence, Nonproliferation, and Arms Control Center (WINPAC)
Defense Intelligence Agency, Defense Warning Office
Former Defense Advanced Research Projects Agency (DARPA) Information Technology Office Director
Former Director, National Intelligence for Science & Technology
Office of the Director, Defense Research & Engineering (ODDR&E)
Others
CISCO
Global Fairness Initiative
In-Q-Tel
NRC Report
Opportunity International
Strategic News Service
Synthesis Partners, Inc.

Figure 2 Fact-finding

Some further clarification of terms within the terms of reference is also in order. Conventional adversaries are nation states with conventional forces roughly similar in kind to United States conventional forces. These adversaries are, for the most part, observable and fairly well understood. They are therefore reasonably predictable and utilize weapons development processes that are well understood by U.S. intelligence agencies. While they generally have significant resources and are able to apply these resources to research, development, and acquisition programs over extended periods, their development process also has relatively long cycle times.

Conventional adversaries are often the focus of disruptive technology and "surprise" studies, but they are not the focus of this study, which focuses instead on irregular adversaries. These generally stateless and often transnational groups are

difficult to penetrate, observe, and predict. The thinking of irregular adversaries is nonlinear, and their methods culturally uninhibited. They have adequate resources they apply to immediate tasks with extremely short cycle times. They tend to depend upon the rapid acquisition and integration of commercially available products. Conventional adversaries figure in this threat to the extent that they produce products they make available in the global market or provide irregular adversaries directly with more conventional weaponry.

The irregular adversary is motivated, intelligent, culturally-savvy, and flexible. Members of irregular adversary groups and cells are often relatively young. They are comfortable with today's commercial technology tools, and their problem-solving and creative methods are tightly coupled to those tools. This means the threats they develop are fundamentally different from the outcomes we have come to expect from conventional adversaries, as they are formed without the constraints our mores, laws, standards, and moral values would impose.

Current communications technology, in particular, enables the irregular adversary to operate against Marine forces. Effectively, this technology gives the adversary access to a globalized information grid and supply chain. The worldwide web permits anyone to propagandize, recruit, and teach disruptive skills and techniques. Anyone can use the web to find, acquire, assemble, and attack, while remaining anonymous.

> **The panel learned early that:**
> - **It's about anything that attacks key capabilities or gaps; it's not limited to "disruptive technologies."**
> - **It's about the power of unconventional and unconstrained imagination, not about "technology surprise."**
> - **It's about anticipating threats, not about merely reacting.**
> - **It's about operating in a much wider orbit outside the domain of intelligence; it's not about functioning within it.**
> - **It's about how <u>they</u> see the world and process information, not about how <u>we</u> do.**

The incredible growth in the use of cell phones likewise provides the irregular adversary with a powerful new tool because cell phones' capability is such that they have become a cheap, basic C4ISR system. Eighty-seven percent of the world's population is covered by a cellular phone network: individuals either own a cell phone or have access to someone who does. There are more than three billion cell phones in use globally today.

With the introduction of this global communication and supply technology, it no longer takes a state to create a technologically relevant threat. While it is still unlikely that a small group could neutralize a key Marine Corps core competency, it is increasingly likely that such a group could assemble the means to diminish the Corps' effectiveness by using disruptive commercial products to inflict casualties in unexpected numbers in unanticipated ways.

Accordingly, we need to understand that we have enemies that are newly empowered. Globalized information and supply are like the repeating rifles of the old West—equalizers that make an otherwise small, weak enemy worth worrying about.

The threat the Panel focuses on can be usefully visualized as shown in Figure 3 below. Globalization is the great enabler of the lower-left quadrant. Before the web and the globalization of manufacturing and distribution, only nations could put together weapons that could reasonably be said to constitute threats. Our present adversaries range
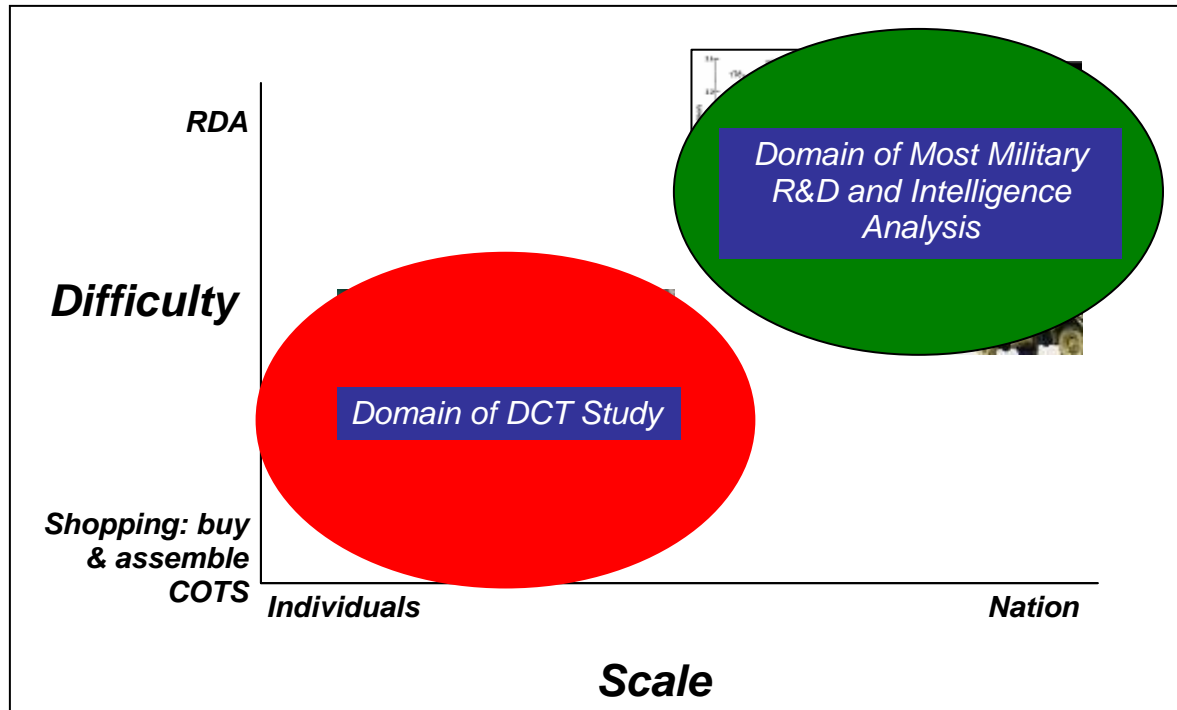
Figure 3 Diversity of the threat

from individuals to nation states. They employ methods that range from COTS used unconventionally to national military investment in applied research. To understand the perspective of this Panel, it is helpful to understand how the domain of our study differs from the work of traditional military analysis. Historically, military intelligence deals with understanding the invention and development of military technologies and systems by nation states.

The illustrations in the upper right hand quadrant are examples of threats identified and analyzed using conventional intelligence methods. The examples illustrated (from left to right counterclockwise) are Isomeric Weapons, Anti-Satellite Weapons, and Military Drones. Isomeric weapons are being researched by conventional competitors and have explosive potential between conventional and nuclear weapons. The Anti-satellite illustration is of the recent, successful test conducted by China. The drone is manufactured by the Israelis and sold to other nations.

The domain of our study lies in the lower left hand quadrant: innovative use of easy to find, easy-to-buy, easy-to-use and simple-to-integrate technologies and products against US lives and interests. The examples shown (from left to right counterclockwise) are cyber attack, IEDs, radio controlled hobbyist aircraft, and suicide bombers.

Predicting specific developments in this domain is inherently difficult. When a commercial technology will "take off" is frequently sudden and surprising. Consider GPS, the personal computer, the Internet, the fax, and the cell phone. Each of these technologies exploded rapidly many years after it was initially developed. And the uses to which they were eventually put were often surprising. The Internet was initially proposed as a means to provide wider access to the Iliac 4 and other (D)ARPA-funded computers, and not as a tool of global commerce and information exchange. The cell phone was initially perceived as something people would use to call for help when their car broke down. In our opinion, however, we don't have to predict tipping points and novel uses of technology. We need only project innovative uses of existing technology, already on the market, and plan accordingly.

Still, projecting innovative users is also difficult because one of the greatest challenges to effective projection is overcoming confirmation bias. In psychology and cognitive science, confirmation bias (or confirmatory bias) is a tendency to search for or interpret information in a way that confirms one's preconceptions. Decision makers have been shown to actively seek out and assign more weight to evidence that confirms their hypothesis, and to ignore or underweight evidence that could disconfirm their hypothesis.

Because the new problem is so different from the traditional challenge, we have to find ways to get out of our traditional thought patterns. The panel could have just made a list of worrisome products, but because the number of potential combinations to worry about is vast and because new combinations constantly emerge, the panel concluded there would be little, if any, value in just producing another list. Instead, the panel concluded that what the Marine Corps needs is not another list but a restructuring of education, intelligence, and acquisition processes so that we can adequately track activity in the lower-left quadrant of the threat space. Minor adjustments to current processes are insufficient to deal with an adequately resourced, innovative, adaptable, and difficult-to-identify enemy.

We suggest that we need a new, two-pronged approach. First, we need mechanisms that enable us to get out of our way of thinking and into the enemy's way of thinking. Second, we need to bring our processes in line with the rapid adaptability of the threat.

Commercial Red Cell Demonstration

The NRAC Disruptive Commercial Technologies Study Panel undertook an unusual side excursion and conducted a Commercial Red Cell Demonstration to investigate the potential of creative people with World Wide Web access to produce new ideas, anecdotally determining what capacity a Red Cell might have to defeat key USMC capabilities or gaps. This experiment tested our hypothesis concerning the potential of small, Internet-enabled groups to interfere with key USMC capabilities. We reached out to the Hollywood creative community for two reasons:

− One of our panel members had previous experience with Hollywood concept-development efforts, and was confident that the results would be positive.

− As a shared value, people in the Hollywood community are accustomed to the idea of *ad hoc* groups tackling novel tasks in highly focused efforts.

An NRAC study panel member identified and recruited the Red Cell participants, developed the experiment's format, and ran the session. In recruiting our Red Cell, the panel sought young-adult, tech-savvy professionals with neither military backgrounds nor expertise. They were given a USMC Expeditionary Warfare School Tactical Decision Game scenario and a specially-crafted mission brief. The experiment itself was straightforward:

− 20 minute orientation

− 3 hours Red Cell research, concept development and Internet searches ("shopping") to support and validate their concepts.

− 1 hour concepts outbrief

- *Players drawn from two groups in entertainment industry:*
  - *New media content creators*
  - *New media technology enablers*
  - *Groups shuffled into two teams*
- *Observer/Controller SMEs*
  - *Director of DIA Defense Warning Office, Red-Team specialist*
  - *USMC officer, recent NPS graduate*
  - *University physics professor*
- *One session, nominally four hours*
  - *Red cell researched targeted USMC capabilities*
  - *Concept development concurrent with "shopping"*
  - *Web sites visited documented*

Figure 4 Commercial Technology Red Cell Experiment

Entertainment industry participants came from two areas: "new media" content creators and "new media" technology enablers. "New media" practitioners are generally focused on non-traditional distribution technologies, favoring the Internet over more traditional technologies like broadcast and cable or satellite television, DVDs, and theatrical feature exhibition. They tend to be, in traditional Hollywood terms, "subversives." As there are typically significant technological challenges in their work, they are generally much more technologically inclined than their counterparts from previous generations of filmmakers and storytellers. The technology enablers in our experiment had a particular focus on innovative user interfaces (most commonly for Internet applications) and media "set-top" boxes. When the two groups arrived, they were re-shuffled into two teams that worked independently, but re-assembled for the final outbrief.

There were three Subject Matter Experts (SME's) available for guidance and arbitration: the Director of the DIA Office of Defense Warning, a Marine Corps officer with an advanced degree from the Naval Postgraduate School, and a physics professor from the Stevens Institute of Technology. It is fair to say that all SMEs were skeptical: the professor expected the ideas to lack a sound scientific basis, the DIA representative expected the exercise to be a waste of time, and the USMC officer expected a disheveled, unfocused, and undisciplined group.

We suggested four hours for a total demonstration length, but freely allowed overtime. The outbriefing ran longer than expected; the experiment ran to five hours.

The Red Cell had to demonstrate that everything they conceived could be enabled by means of technology and resources—whether commercial off-the-shelf (COTS) products, non-developmental items (NDI), or products built by hobbyists—that were available on the Internet. All the websites the Red Cell visited were recorded.

We used a Tactical Decision Game format based on an Expeditionary Warfare School scenario customized for an asymmetric Red Cell. The scenario postulated a Marine Expeditionary Unit (MEU) supporting a UN peace-keeping force in Somalia. The Marines have driven an insurgent force into complex terrain and the insurgents have sustained heavy losses. Much of the Marines' success is keyed to their ability to conduct night and helicopter operations. Thus the Red Cell teams were asked to neutralize or degrade those two key operational capabilities. The scenario focused on political upheaval in Somalia and the growing influence of external Sunni radical elements. The Transitional Somali government reached out to Ethiopia for help containing the growing influence of the Islamic Courts Union. The Union agreed to support the deployment of a UN Peacekeeping Force, provided it included US forces and provided that Ethiopian units already in-country withdrew. The US sent a Marine Expeditionary Unit.

Al-Islamiya, an urban guerrilla force of 155 with Al-Qaeda support, has grown to dominate communities in the Beledweyne region. The Marines successfully drove Al-Islamiya out of the towns and villages of Beledweyne so they could effectively pursue the insurgents in complex terrain. Al-Islamiya sustained 50% casualties, but has fought on vigorously. The Marines' effectiveness is directly related to their ability to conduct night and helicopter operations. Al-Qaeda has come to the aid of Al-Islamiya by engaging a technical sleeper cell in Italy. The cell is smart and creative and has been granted unlimited financial support. Their only limitation is that all materiel solutions must come from the Internet.

The Red Cells were asked to play the role of a supporting cell based in Italy tasked with creating countermeasures to the Marines' capabilities and with establishing comparable night capabilities. As in the scenario, they had essentially unlimited funding, and were to purchase all the materials they needed from the internet.

Any technology or capability they used to realize their concept had to actually exist, but beyond that it could be any commercial item, hobbyist's product, or non-developmental article they could purchase on the internet. They were then to integrate what they found into a threat to Marine Corps capabilities.

- *Marine Expeditionary Unit (MEU) supporting a UN Peace-keeping force in Somalia*

- *USMC drives insurgent force into complex terrain*

- *Insurgents sustain heavy losses--Marines' success keyed to <u>ability to conduct night and helicopter operations</u>*

- *Italy-based red cell tasked with*

  - *Creating countermeasures*

  - *Establishing comparable night capabilities*

- *Unlimited funding; all material from Internet*

Figure 5 Commercial Technology Red Cell Scenario

The process began with an orientation and a mission, after which the Red Cells researched USMC night vision and helicopter systems. They developed concepts concurrent with their "shopping." In slightly more than four hours, the Red Cells developed three families of concepts that appeared to have some plausibility. The Red Cell was instructed to focus on USMC night operations, particularly on night vision devices and night helicopter operations. They were encouraged to devise countermeasures as well as to consider approaches that would give Al-Islamiya capabilities equivalent to the Marine Corps.

The first concept employed unmanned aerial vehicles to serve as loitering aerial mines and sensors. An open-source application, "Autopilot," was found to work with several COTS model rotary aircraft. These Unmanned Aerial Vehicles (UAVs) could be dispatched in swarms to tactically significant areas and detonate by proximity sensors or, when equipped with wireless sensor payloads, increase situational awareness of Blue Force maneuver for Red Forces on the ground.
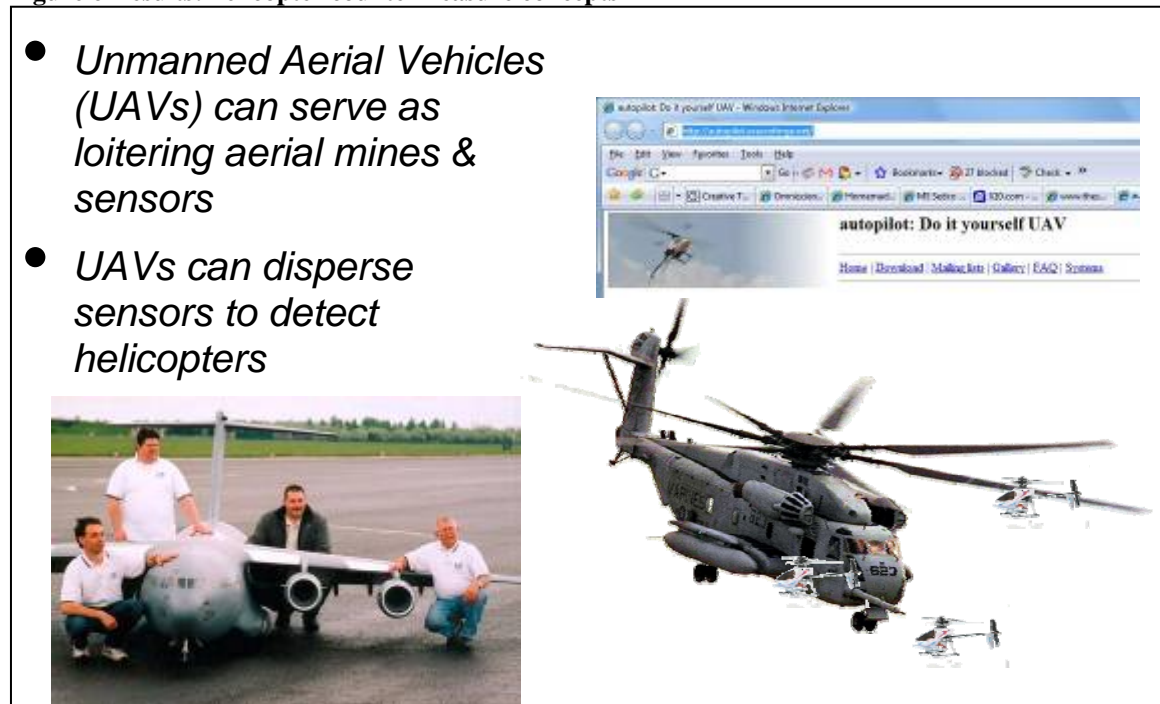
There was also the suggestion that UAVs could be used to dispense Unattended Ground Sensors. It was believed that large hobbyists' UAVs could be used to deploy a significant number of sensors. A video posted by hobbyists to YouTube showed this model in operation. Its four Jetcat P-120 turbines collectively produce 112 pounds of thrust at 123,000 rpm. The ramp can be deployed by remote control, and in one reported demonstration, a model HMMWV was driven off the ramp and safely parachuted to earth. In a different video, an inexpensive, lightweight hobbyist UAV, the Magpie AP, drops ten ounce water balloons from a COTS bomb release retrofit. Both systems, it was felt, could be retrofitted to disperse wireless sensors (internet available) to track Blue Forces. It was further believed that balloons could be used to carry countermeasure payloads. (See Figure 6.)

Additional concepts suggested Night Vision Device countermeasures. Some, like pre-planned magnesium firebreaks and smoke bombs, could be used to fortify Red Force defensive positions. They could be rigged both as active (i.e. triggered by sensors with no human-in-the-loop) and passive (i.e. triggered by operators equipped with wireless pyrotechnic control consoles). High-output infrared illuminators coupled with rotating mirrored "disco" balls could be used to blind and confuse Marine forces while masking Red positions. COTS polycarbonate first-responder shields with infrared coatings could conceal individual Red Force dismounts. Finally, the Red Cell believed that PirateEye, a COTS industrial product intended to foil video piracy in theatrical feature distribution, could be employed or modified to compromise Blue Force NVDs. PirateEye scans for optical systems up to 800 yards from its location and disrupts their operation by transmitting infrared energy at suspected pirates.

The Red Cells were impressed with the number and variety of COTS wireless sensors. There is a robust capability to create a sensor field including IP-based network cameras (with both electro-optical and infrared capability), seismic, acoustic, and motion sensors. The Cells believed that they could establish an inexpensive C4ISR capacity that would improve Red Force effectiveness against the USMC. The Cells found a microwave sensor rated to a range of sixty feet that can discriminate between approaching and retreating traffic. The day of the experiment coincided with Apple's announcement of the revised iPhone. The group was impressed with the product's light

Figure 6 Results: helicopter countermeasure concepts

- *Unmanned Aerial Vehicles (UAVs) can serve as loitering aerial mines & sensors*

- *UAVs can disperse sensors to detect helicopters*

sensor, video camera, microphone, accelerometers, GPS receiver, Wi-Fi, and Bluetooth connectivity, packaged with a robust Operating System (stripped down Apple OS-X) and a seven-day standby power rating. Cellular phone service, they believed, was potentially inconsequential relative to the other capabilities in the package.

The Red Cell also considered the development of an inexpensive reconnaissance capability through the utilization of COTS and hobbyist-grade model rocketry video. Using different sized engines, a COTS Estes product is capable of capturing 16 seconds of video, but must be retrieved to be viewed. Other rocket video systems, utilizing Advanced Television (ATV) digital transmission had been employed using open source software to counter the rotation of the rocket in the video feed.

Several interesting points emerged from this demonstration. First, creative people + web access + global supply = a creditable threat (e.g. aerial loitering mines). Second, two independent groups produced similar results and looked at many of the same web sites, which suggest both that convergence is worth looking for and therefore useful to

Figure 7 Results: cheap C4ISR concepts

have multiple groups producing concepts. Finally, we were struck by how both groups were heavily influenced by the same-day announcement of the new iPhone—we probably would have seen much different results if the exercise had been held a day earlier. This strongly suggests that such any effort should be a continuing, sustained process.

The demonstration showed us that tech-savvy people lacking military domain knowledge could generate provocative and potentially useful ideas about ways in which key USMC capabilities or gaps could be compromised using COTS materiel employed in new ways. That they came from the entertainment industry and from the "new media" sector in particular, suggests to us the need to employ people in an activity of this kind who are of a certain mindset. New media people, along with the technical people who support them, typically share a vision of upsetting the status quo in entertainment

distribution (i.e. traditional film, television, cable, satellite, DVD's and audio CD's) and replacing it with the decentralized, direct-audience connection of the Internet. They are, in traditional "Hollywood" terms, subversives. This subversive attitude played a very significant role, we believe, in their effectiveness.

- *Active/passive*
  - *Magnesium firebreak*
  - *Smoke bombs*
  - *2M candlepower IR illuminators aimed at disco balls*
  - *IR strobes to spoof Blue Forces*
- *Polycarbonate police shields that block IR info*
- *PirateEye modified to work with an IR laser*

"We specialize in small orders"

United Nuclear

Chemicals & Metals

Figure 8 Night vision device countermeasures concepts

The Internet was, in fact, a key enabler in the demonstration. Generally, all the USMC system specifications they needed for their analysis were available in open source on the World Wide Web. Specific knowledge about the underlying technologies in these systems was also available on the web (e.g. both the characteristics and underlying science of current generation night vision goggles). Thus equipped, the Red Cells' collective imagination informed their deliberations.

Furthermore, reflecting the near-ubiquitous availability of an immense range of technological components of all kinds, Red Cell's job became one more of product integration than development. They did not, for example, need to develop small COTS UAVs to deploy loitering aerial mines or build a brassboard to create a microwave proximity sensor capability. These, along with all manner of integrated circuits, chemicals, compounds, hardware and other equipment were available nearly everywhere with a credit card. The challenges were to imagine the capability and pay for it.

In a certain sense, the exercise eerily reflected a comment attributed to Albert Einstein: "Imagination is more important than knowledge." Our Red Cell not only found the materials and components that it needed on the Web, it also understood how to learn…and learn rapidly…from the Web. In this respect, its imagination was more valuable than prior knowledge of the subject.

A proposed approach to identifying disruptive commercial threats

The experiment the panel conducted suggests a way forward. Consider the analogy of the Marine Corps Combat Hunter program: Combat Hunter reached outside the Corps to bring in unconventional expertise (professional big-game hunters, trackers, and big-city police officers) to help Marines adopt a new attack mindset in their approach to defeating irregular forces. Notably, it changed the orientation of Marines on patrols from a reactive position to offense and has had other implications:

> "Combat Hunter started as a Marine Corps Warfighting Laboratory (MCWL) project initiated at the request of the Commanding General, I Marine Expeditionary Force (I MEF)… The project's goal is to improve combat efficiency, while reducing combat casualties, through the application of skills used by hunters as they pursue their quarry... Using a carefully selected combination of world renowned big game hunters, dangerous game guides, man trackers, experienced urban police detectives, seasoned infantry trainers from Marine ranks, and human performance engineers, the Warfighting Lab, Training and Education Command (TECOM), and the Office of Naval Research collaborated to produce a training and equipment package that was put through its paces during the three LOE's… Combat Hunter teaches the use of observation skills combined with an innate understanding of the enemy and the environment in which they fight."
>
> − Brian.E.Nance.ctr@usmc.mil Release # MCWL-07 -0205 MARINE CORPS BASE QUANTICO, VA - *"Always the hunter, never the hunted."*

A similar approach would address the threat of disruptive commercial technologies—we will call this approach "Commercial Hunter." Commercial Hunter would use unconventional outside experts to identify, prioritize, and demonstrate the feasibility of threats that could emerge from an adversary's innovative use of commercial technologies and products. As the process anticipated and defined credible threats, the Marine Corps would have an opportunity to neutralize them well before they materialized. A combination of operational demonstrations and assessments would provoke action through pro-active Urgent Universal Needs Statements (UUNS) or new indications and warnings (I&Ws). Commercial Hunter, like Combat Hunter, is intended to help the Marine Corps move from reactive or defensive posture to an anticipatory and offensive one. This approach also provides access to an internal talent pool that can increase awareness of commercial technologies generally through education and training, and mobilizes an innovative source for red teaming challenges in wargames and field exercises. Notionally, Commercial Hunter would be comprised of:

− **People:** A small standing core group with creative leadership, lean administrative support, and a small staff of engineers and technicians. Teams of creative countercultural outsiders would be recruited for short periods of times to serve on Red Cells.

− **Facilities:** A lean facility with meeting space, appropriate rapid prototyping capability and access to equipment as needed should be located where it would be

easily accessible to the creative outsiders who would staff the Red Cells. This facility should probably be located off base, but close to Marine Corps Base Quantico.

− **Time & Money:** Commercial Hunter should have a budget and both contracting and purchasing authority. It should be able to test an idea for technical feasibility in days or weeks, not months or years.

The creative leadership of Commercial Hunter should have the right "Rolodex," authorities, and traits (appropriate charisma, a renegade spirit, and the demonstrated ability to guide eclectic groups effectively) to identify and recruit the talent necessary to staff the Red Cells. Red Cell participants are envisaged as young creative outsiders representing a diverse, multidisciplinary group—engineering, social science, finance, computer, international development, entertainment, new media, etc.—who would be able to interact as needed with uniformed operators and the prototyping team. ***They should include a strong counter-cultural tone.*** Commercial Hunter would look for technologically proficient renegades and china-breakers. Such individuals are unlikely to be motivated by money, but rather by a belief that participation in the group is a badge of honor (because they are among an elite set of peers) and because they have been offered an unusual opportunity to use their distinctive talents in the Nation's service.

A minimal standing core group of administrative and multidisciplinary engineers and technicians provides the infrastructure needed to execute on tasks quickly. The effort would have a minimal facility equipped with a rapid prototyping capability appropriate to the threats it would investigate— it is not envisaged that this would be a large laboratory, but Commercial Hunter should have the ability to equip it with the required level of sophistication and decision speed. Imagine the facility as including high-end hobbyists' shops—the sort of technical facilities irregular adversaries would be likely to have access to. Locating Commercial Hunter off base would enable it to create an environment suitable to the talent pool sought and provide them with convenient access.

Figure 9 describes the Commercial Hunter model. The Marine Corps would provide the basic core capabilities and gaps, guidance, and in some cases, scenarios, against which the Red Cells would develop commercial technology threat concepts. These concepts would then be screened to establish their priority. Commercial Hunter would establish its priority screening criteria in cooperation with Marine Corps leaders— the criteria would be a living set evolved and refined over time. The highest priority concepts would be vetted for consideration in operational demonstrations by establishing technical feasibility through purchases on the internet, integration, and rapid prototyping within Commercial Hunter. Some iteration and experimentation would often be necessary at this stage. Medium priority threats, or threats with high uncertainty, would be candidates for development of indications and warnings (I&W) passed on to the operating forces. Threats judged to be low priority would be archived either permanently or for future review.

High priority threats with demonstrated technical feasibility would become candidates for operational field demonstrations led by the Marine Corps Warfighting Laboratory through exercise, simulation, gaming, operational test and evaluation, or other appropriate means. The goal of such assessment would be to establish the operational impact of the threat. If an irregular commercial technology threat succeeded in the

operational demonstration, an Urgent Universal Needs Statement (UUNS) would be issued. This UUNS would be generated by the Commanding General, Marine Corps Combat Development Command (CG, MCCDC), rather than by an operational commander. (This would, of course, require that UUNS authority be delegated to CG, MCCDC—a departure from current practice.) The UUNS would catalyze a DOTMLPF response well ahead of the appearance of the threat in active operations.
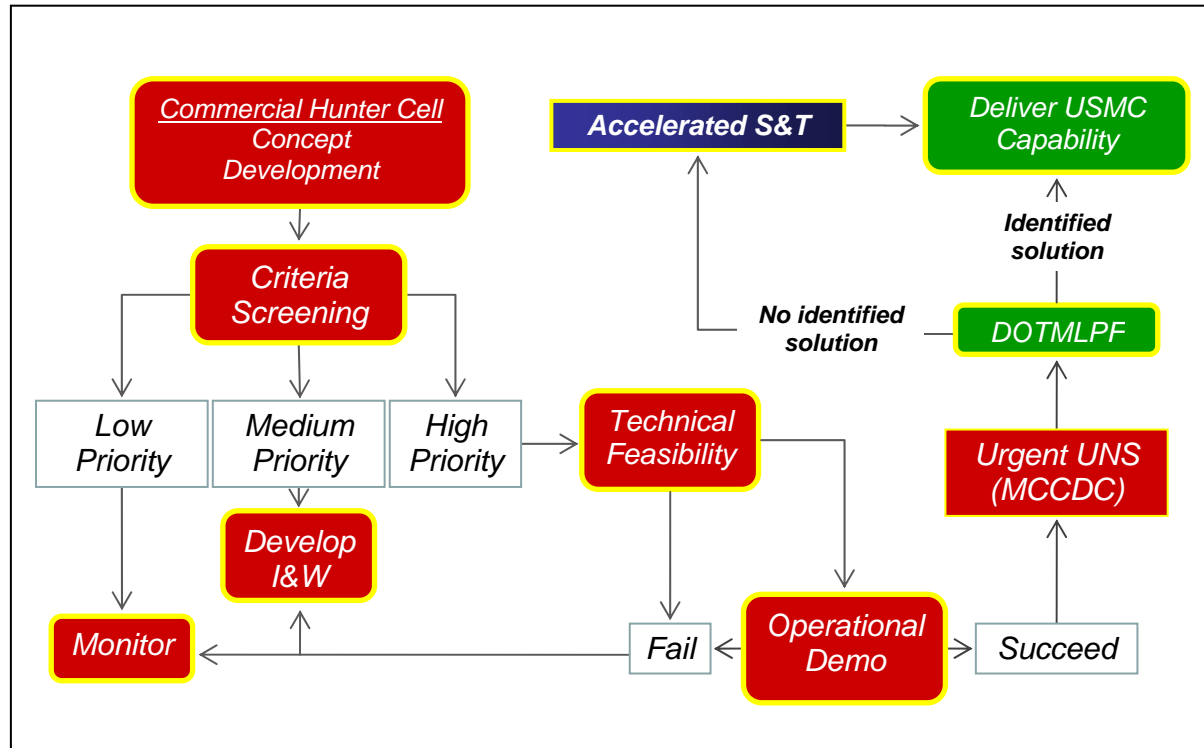
Figure 9 Commercial Hunter model

The Marine Corps has sufficient existing mechanisms for rapid implementation of solutions that address UUNS when such solutions require changes or modifications to tactics, techniques, and procedures (TTPs) or other non-materiel solutions. Threats with identified and mature countermeasure materiel solutions (at TRL 6 or above) may also be appropriately handled through established, existing acquisition processes. The panel identified a potential response gap, however, for those threats with unidentified solutions that require an accelerated science and technology (S&T) response.

As such, all elements shown in Figure 9 in red or blue require creation. They are designed, in the spirit of Combat Hunter, to provide the Marine Corps with the ability to preemptively attack threats based on an adversary's innovative use of commercially available technologies and products. They leverage existing capabilities within the Department of the Navy and the Marine Corps in response. These latter capabilities are shown in green.

Commercial Hunter has obvious implications for education and training. The idea that commercial products in general can be used effectively against our capabilities is a relatively new one. Commercial products can in fact become the primary technological resource for unconventional forces. Their availability will continue to expand into the remotest and least developed parts of the world—indeed, these technologies are already

very widely dispersed. Our education and training relative to combat operations against unconventional forces must include this new element technological capability. As we have done to high degrees of fidelity with conventional forces replicated to oppose us in both field and virtual exercises, we must also equip our irregular OPFOR with the tools they would be likely to acquire and apply against us in creative new ways. Whether in force-on-force field exercises or wargames conducted at our schools and universities, a realistic element of commercial technology play should be introduced. With the existence and expertise of Commercial Hunter within the Marine Corps Combat Development Command, the technical means to generate the educational and training information will exist. Providing such information should become an additional duty of Commercial Hunter.

Findings

Advanced commercial products and their associated technologies are widely distributed throughout the world and are generally accessible through the internet. Credible threats to Marine capabilities can be developed from imaginative combinations of such commercial products. These products can be acquired via the Web and distributed by the existing global supply network. Commercial technologies are readily adaptable into systems or devices that can threaten Marine forces. The internet functions effectively as both an R&D resource and supply chain for irregular forces throughout the world. Commercial technologies pose a real and enduring threat to Marine forces.

The Marine Corps has no effective methods for anticipating these unconventional threats, nor does it have access to a proactive and rapid system for countering threats without identifiable solutions.

Recommendations

The Department of the Navy should create an accelerated S&T approach to address potential solutions below TRL 6 for Urgent Universal Needs Statement (UUNS) requirements, and the Commanding General, Marine Corps Combat Development Command, should be given authority to create Urgent Universal Needs Statements.

The Marine Corps should establish an on-going, adaptive process that can anticipate use of commercial technology by irregular adversaries, and that can develop ways of countering such threats before Marines are actually attacked with them—Commercial Hunter.

Actions

The panel recommends the following actions:

1. **Assistant Secretary of the Navy (Research, Development, and Acquisition):** direct the Chief of Naval Research to develop an accelerated S&T approach for UUNS that have no mature solution. This S&T process should bring solutions to a level of maturity sufficient to permit prototyping.

2. **Commandant of the Marine Corps:** delegate authority to create Urgent Universal Needs Statements to the Commanding General, Marine Corps Combat Development Command.

3. **Commanding General, Marine Corps Combat Development Command:** establish Commercial Hunter (as outlined in this report) and establish training and education programs for irregular commercial technology threats.

Appendix 1—Study Panel Members

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  - NRAC Associate
- **Dr. A. Michael Andrews II – Co-Chair**
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- **Dr. Regina E. Dugan**
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  - Creative Technologies Inc.
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Executive Secretariat

- **Mr. Robert McKinney – Executive Secretary**
  - MCWL (OSTI)
- **Mr. B. Greg Kesselring – Asst. Executive Sec.**
  - MCWL (OSTI)
- **Mr. E. William Powers – Asst. Executive Sec.**
  - MCWL (CETO)

In memoriam

- **Mr. Jack Bachkosky**
  - Study panel member, long-serving NRAC member

Appendix 2—Terms of Reference

Disruptive Commercial Technologies (DCT)

Terms of Reference

US Marine Corps Expeditionary Forces face constant threats known and unknown. Merging threats can include commercially available global technologies and products that may be "weaponized" and used against Marine expeditionary forces in the near and foreseeable future. The enemies' intent would be to:

- Neutralize or reduce essential Marine Corps tactical capabilities and key technological advantages

- Attack critical vulnerabilities or gaps in future operational capabilities, and

- Generally reduce an unconventional adversary's reliance upon conventional weapons supplied by outside supporters.

These are the critical elements of the terms of reference in order to address the threats these disruptive commercial technologies may impose on expeditionary forces:

- Study the potentially disruptive nature of current and near future technologies

- Identify technologies and products that pose immediate asymmetrical counter to Marine Forces

- Establish timelines for the identified threats

- Identify indicators that would aid Marine Forces in recognizing deployed DCTs

- Propose countermeasures to DCTs

- Propose a coherent, integrated investment strategy to counter DCTs

- Focus the study on the period 5-15 years from now

Follow-on Guidance: The study sponsor, **Lieutenant General James F. Amos**, CG Marine Corps Combat Development Command, directed the Committee to explore relevant research, technologies and capabilities, by which the Marine Corps can anticipate these potential developments, and to counter or neutralize their effect prior to application in future military operations.

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Appendix 4—Glossary

ASN. Assistant Secretary of the Navy.

C4ISR. Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance.

CAB. Capabilities Based Assessment Branch.

CD&I. Combat Development and Integration.

CDD. Combat Development Directorate.

CETO. Center for Emerging Threats and Opportunities.

CG. Commanding General.

CIA. Central Intelligence Agency

CMC. Commandant of the Marine Corps.

CNR. Chief of Naval Research.

COTS. Commercial-off-the-shelf.

DARPA. Defense Advanced Research Projects Agency.

DCT. Disruptive Commercial Technologies.

DDR&E. Director, Defense Research & Engineering.

DIA. Defense Intelligence Agency.

DoD. Department of Defense.

DoN. Department of Navy.

DOTMLPF. Doctrine, Operations, Training, Materiel, Leadership & Education, Personnel and Facilities.

DSB. Defense Science Board.

Indications and warning. Those intelligence activities intended to detect and report time-sensitive intelligence information on foreign developments that could involve a threat to the United States or allied and/or coalition military, political, or economic interests or to US citizens abroad. It includes forewarning of hostile actions or intentions against the United States, its activities, overseas forces, or allied and/or coalition nations. Also called I&W.

Irregular forces. Armed individuals or groups who are not members of the regular armed forces, police, or other internal security forces.

Irregular warfare. A violent struggle among state and non-state actors for legitimacy and influence over the relevant population(s). Irregular warfare favors indirect and asymmetric approaches, though it may employ the full range of military and other capacities, in order to erode an adversary's power, influence, and will.

I&W. Indications and warning.

JCS. Joint Chiefs of Staff

MCCDC. Marine Corps Combat Development Command.

MCSC. Marine Corps Systems Command.

MCWL. Marine Corps Warfighting Lab.

NRAC. Naval Research Advisory Committee.

NRC. National Research Council.

ONR. Office of Naval Research.

R&D. Research and Development.

RDA. Research Development and Acquisition.

S&T. Science and Technology.

SVG. Strategic Vision Group

Technology Readiness Level. A measure of the maturity of an evolving technology.
There are nine Technology Readiness Levels:

Technology Readiness Level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Example might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. The application is speculative and there is no proof or detailed analysis to support the assumption. Examples are still limited to paper studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so that the technology can be tested in a simulated environment. Examples include 'high fidelity' laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond the breadboard tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high fidelity laboratory environment or in simulated operational environment.
7. System prototype	Prototype near or at planned operational system. Represents a

demonstration in an operational environment	major step up from TRL 6, requiring the demonstration of an actual system prototype in an operational environment, such as in an aircraft, vehicle or space. Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and 'flight qualified' through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system 'flight proven' through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under operational mission conditions.

TOR. Terms of Reference.

TRL. Technology Readiness Level.

TTP. Tactics, Techniques, and Procedures.

UAV. Unmanned Aerial Vehicle.

Unconventional warfare. A broad spectrum of military and paramilitary operations, normally of long duration, predominantly conducted through, with, or by indigenous or surrogate forces who are organized, trained, equipped, supported, and directed in varying degrees by an external source. It includes, but is not limited to, guerrilla warfare, subversion, sabotage, intelligence activities, and unconventional assisted recovery.

Universal Needs Statement. A Universal Needs Statement identifies operational enhancement opportunities and deficiencies in capabilities. Opportunities include new capabilities, improvements to existing capabilities, and elimination of redundant or unneeded capabilities.

UNS. Universal Needs Statement.

Urgent Universal Needs Statement. An Urgent Universal Needs Statement (UUNS) addresses a critical capability gap that places the accomplishment of a unit's mission in jeopardy or unduly increases the risk of casualties. A UUNS is submitted by operational commanders and must be addressed within 120 days.

UUNS. Urgent Universal Needs Statement.

WINPAC. Weapons, Intelligence, Nonproliferation, and Arms Control Center.