Tightening the Strategic-Technological OODA Loop

Evolving America's force-in-readiness to America's adaptable force

by Maj Kelly Haycock

The Strategic-Technological OODA Loop

It is almost cliché regarding how central Boyd's observation, orientation, decision, action (OODA) loop is to Marine Corps maneuver warfare. In simplest terms, a tactical OODA loop provides the decision-making framework to defeat an opponent within a discrete battlespace. An operational OODA loop operates in the time-space of a campaign. Strategic OODA loops are the domain of the military-industrial enterprise to man, train, and equip a force for a particular war. In strategic OODA loops, we—the Marine Corps—posture ourselves to reduce the time to respond to war by maintaining an adaptable, customizable, task organized force-in-readiness: our current hallmark characteristic. Our military-industrial enterprise provides the best-trained, best-equipped, best-maintained force the Nation can afford. We depend greatly on strategic measures like Marine Corps Recruiting Command, Training and Education Command, Combat Development Command, and Systems Command to ensure the U.S. response to an emerging adversary will be bigger, better, and faster than any enemy. This infrastructure exists to eliminate steps in our strategic OODA loop to secure the inside track for strategic tempo and initiative in war.

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Strategic-Sustainability and Strategic-Adaptability Infrastructure

However effective our technological superiority, an adversary's strategic OODA loop can easily out-pace our own. For a case study on strategic-technological OODA loops faster than our own, one only has to read how American maneuver warfare was crippled by exceptionally adaptable IED warfare in Iraq. As we go into an era of robotic weaponry and support equipment, we must proceed with sustainability and adaptability in mind. This is done through cross-organizational integration in terms of requirements development and material solution development processes migration to strategic-sustainability and strategic-adaptability infrastructure.

A Manned and Un-manned Teaming Raid Force

As 0311 Sgt Jason Edwards of A Company, 1/5, leads his sixteen-Marine raid force squad through pre-combat checks aboard the big deck amphibious launch platform, USS *A.M. Gray*, his weaponeer, 0391 Sgt Fred "Fitz" Fitzpatrick, chooses the loadout for each of the Marines' manpack quadcopter drone. The warning order indicates their mission is to capture or kill a criminal cell operating 30 miles east of Sana'a, Yemen, which our theater cyber operations cell has identified as the source of major destabilizing cyber and political terror efforts. The intelligence preparation of the battlefield indicates the cell is well funded and will rely on a mix of high-tech and low-tech means of defending themselves. In this theater, there has been a rash of handheld electro-magnetic pulse (EMP) grenade attacks against our robotic assets and localized broad-spectrum radio and GPS jamming. Each drone will still need to communicate; identify friend, foe, and civilian; and provide both non-lethal and lethal fires.

In addition to the ubiquitous program of record quadcopter airframe each Marine will carry stowed in his pack, Sgt Fitz chooses a mixture of quadcopter modules to support the mission concept of operations. For the security element fire team, Sgt Fitz chooses visible and infra-red spectrum optics, smoke grenade, riot control grenade, and micro-drone swarm modules

Quadcopters had been tested during pre-deployment training and were now being loaded out to support the squad's mission. *(Photo by LCpl Scott Jenkins.)*

as well as picket-line flight algorithms. For the assault and support element fire teams, Sgt Fitz chooses two Marines to carry drones outfitted with visible and infra-red optics; flash-bang, smoke, and frag grenade modules; and room-clearing flight algorithms. The other two Marines' drones are outfitted with infra-red and X-ray spectrum optics and three micro-drone swarm modules with building search and human stunning algorithms.

For Sgt Fitz's own battle management team, two drones will be outfitted with prime communications modules to establish wideband data-links with the low-earth orbit netted data satellite constellation, a multi-spectral optics module to have additional eyes in the sky, and a chaff, flare, and electronic counter measures module to support a high-altitude, high-persistence flight algorithm. One drone will be designated as the wrecker drone with snap-on augmented capacity motors and batteries to support the rapid recovery of downed drones back to the battle management team's location. The final drone will be the medical drone outfitted with an automated anti-pathogen synthesis module, traumatic wound repair module, and taser self-defense and smoke obscuration modules with default casualty homing and evasive flight algorithms. All drones will use laser communications modules and flight algorithms to ensure full mesh netted communications and blue force tracking in a high-radio-jamming-risk environment. All drones will use their optional low-capacity, high EMP resistance power sources. This will limit the air-time of each drone to about one hour per charge, but one Marine from each team will carry a double capacity rapid recharge station instead of the standard issue single. Finally, the support mule will carry two double capacity rapid recharge stations, one rapid battery swap station, the prime communications base station and battle manager common operational picture system, solar and slave power converter, spare quadcopter modules, and one extra day supply of chow, water, batteries, and ammunition.

> ***... two drones will be outfitted with prime communications modules ...***

In the pre-dawn hours, as the Marines board their tilt-roter assault support capable gun ship, Sgt Edwards receives the squad's final orders. Aboard the aircraft, each Marines' planning tablet provides them with open source neighborhood maps, photos, and building schematics, the mission, basic concept of operations, and intelligence preparation of the battlefield. Throughout the hour-long flight, they complete an abbreviated course of action (COA) development, COA wargame, COA decision, and rehearsal of concepts walk-through of the developed concept of operations. The 0392 battle manager, Sgt Anthony Sladek, leads comm checks with the squad's multi-spectrum head-set mounted radios and backup helmet mounted laser radios. Sgt Edwards submits a request for tactical offensive cyber operations to his battalion S-3 fires coordination cell to shut down all Internet and phone services in the buildings and associated cell towers surrounding the objective area for the duration of the raid. Thus, nobody can tip off potential sources of reinforcement provided by social media, cellular, and soft phone capabilities. Everything else is well established unit SOP.

Five minutes before the dismount point, the tilt-rotor gunship deploys its own sentry drones: six smaller fixed-wing drones with multi-spectral optics; combined anti-aircraft, anti-armor, and assault-breaching missiles; and set with default close air support and self-sacrificing/gunship defense flying algorithms. All communications systems include the laser communication capability to digitally interoperate and share situational awareness with the Marines on the ground while mitigating risk to radio frequency jamming.

The dismount point is a park located three blocks away from the objective area. A Marine from each team deploys his drone out the back ramp to join the gunship's sentry drones in a scouting patrol of the LZ. After a multispectral scan of the park and potential threat zones around it, the drones indicate a low risk of threat agents to the battle manager. Sgt Sladek gives Sgt Edwards the all clear. The squad dismounts while the aircraft departs for a support pattern. With a drone each taking the point, over-watch, and tail-end, Char-

lie positions in the patrol formation, multi-spectral imagery fed to various helmet displays shows a quiet morning in an urban residential district with a few early morning commuters and indications of sleeping bodies in the upper story apartments.

The drone in overwatch, positioned a few stories overhead, provides an alarm signal to its operator that—as expected—its main radio communication network is no longer able to communicate anywhere in the radio spectrum. There must be a local broad spectrum jammer near the objective area. The entire network defaults to laser communications and flight algorithms now require there to be a line-of-sight chain between all drones and operators.

In the last few hundred paces to the objective area, the Marines identify the buildings designated to house the battle management team and the support element, respectively. The support team deploys its micro-drone swarms to scout its gray, seven-story building adjacent to the objective by entering the open windows and gaps in the door frames to map out the interior rooms. The picture of the accessed rooms is analyzed by the battle manager common operational picture system and a 3D model of the building, and its organic and inorganic contents are sent near-realtime to the fire team leader's hand-held view screen. Upon concurrence from the squad leader, they enter and clear the main hallway and an unoccupied room on the fourth story facing their objective building before taking their support positions accordingly.

The battle management team, consisting of the weaponeer, the battle manager, two other riflemen, and the support mule, opts to occupy the partially low-walled yard across the street from the back of the objective building because it has good line-of-sight to the objective area and surrounding airspace. The security element deploys in buddy pairs to the northeast and southwest street corners to cordon the objective area with their drones flying a picket-line algorithm around the building.

With all elements checked in and showing "green" for readiness, Sgt Sladek gives the signal back to the squad leader. The command of the support element's micro-drone swarm is handed over to the assault element for re-hiving. The combined micro-drone swarm then deploys to analyze the interior of the objective building. As hundreds of micro drones probe the building for entry points, many find open windows and door gaps through which to infiltrate. Within moments, a synthesis of the drones' mapping efforts starts materializing into a point-cloud model of the building while simultaneously administering sedatives via micro syringe to all of its inhabitants. With two thirds of the building mapped and its inhabitants put into a renewed sleep, a sudden silence consumes the building as the few air conditioners and outdoor lights shut off. A few heartbeats later, a concussion tears through the otherwise quiet night and the micro-drones stop reporting. Upon entering some space in the building, the micro-drones must have tripped a booby trap triggering a tactical EMP device.

With the EMP hardened systems still intact, and multi-spectrum radio communications now re-enabled, the squad leader signals to initiate the attack while the power is still out. The assault element breaches through the bottom floor back door and makes their way up the stairs with two drones in the lead. When they reach the partially mapped fourth floor, the drones are the first to turn the corner into the main corridor. A deafening rifle burst rips down the hallway from the opposite end. The drone pair—set to obscure, cordon, and surveil—buzzes down the hall along the bullet trajectories toward the calculated source of the rifle fire. One drone lobs a flash-bang and smoke-grenade down the hall to obscure the corridor, while the other takes position with bayonet-like needles deployed to the drone's front, blocking the enemy's escape route.

As the fire team stacks on the wall preceding the corridor, the first drone operator views on her helmet display an infra-red feed of the disoriented shooter's body crouched in the corner and the warm glow of an automatic weapon in his grasp. The operator toggles the taser arming selector mounted on her rifle's trigger guard, observes through her helmet display a red circular highlight centered on the targets back, and pulls the accompanying drone munitions trigger. With a click, a tiny snap, a disconcerting jolting sound, and a very loud yelp of pain, the enemy shooter is subdued. A quick take down, cuffing, and gagging renders this enemy fighter incapacitated. After two turns down the hallway, the target apartment is identified. The remaining micro-probes were

Sgt Jones received the squad's final orders, and during the flight, the squad would go through COA and a rehearsal of concepts. *(Photo by LCpl Juan Ayala.)*

After landing in a park near the objective, Marines released the drone swarm to analyze the interior of the objective building. *(Photo by LCpl Samuel Lyden.)*

not able to infiltrate the apartment's rooms, but the X-ray optics on one of the drones provides a rudimentary view of several armed individuals in covered positions in the main room. With a coordinating signal to the battle manager and squad leader, the support element across the street sends a barrage of gunfire blasting open the windows and allowing their drones to lob in flash bangs and smoke grenades, causing an incapacitating tumult of noise and blinding light followed by darkness in the main room of the apartment. With a crack, the assault element breaks in the door and sends in its drones to map the room with its multi-spectral optics while leaving one drone in the hallway in a sentry pattern. The room imagery data is sent back to the battle manager for processing. As the members of the assault element step into the room, they toggle their helmet displays into virtual reality mode so they can see a digital rendering of the room in the complete smoky darkness, courtesy of the model built by the battle management common operational picture system.

Within moments of stepping into the room, the drones and their operators are able to identify, target, and tase two of the culprits. The third fighter rips off a burst of rifle fire into the doorway before a third drone is able to close in on him. Though the modern body armor easily protected the Marine's vital organs, a serious flesh wound erupted from the back of his shoulder, right under his collar-bone. With his bio alarm going off at the battle management common operational picture system, the medical drone rapidly dispatches itself to the downed Marine's location. As the remaining team members put lethal rounds through the dark into the enemy figure, amidst the Marine's blood curdling screams of pain, the medical drone buzzed into the room through the wafting smoke, centered over a nerve ending near the mangled shoulder, and dropped a tiny syringe to administer local anesthetics and mute the pain. The drone then plants a small six-legged insect shaped, cat-sized robot on the floor next to him. This traumatic wound repair drone has the ability to rapidly 3D print and stitch together biological material for the reconstruction of some of the Marine's flesh. As the corpsman arrives a few minutes later, the Marine's gear and clothes are cut away, and antiseptic is applied. The robot then climbs onto his shoulder and begins to work.

With all enemy threats eliminated and the room starting to clear of smoke, a cursory intelligence evaluation of the room shows several thin client computers and other documents of likely intelligence value. After a total of fifteen minutes in the objective area, with one stable casualty, one target eliminated, and three others captured, the retrograde signal was given.

Science Fiction to Science Pending

The technologies envisaged here may seem decades away, but this is not science fiction. This is science pending. Concepts for manned and un-manned teaming are maturing at a rate exceeding our Joint Capabilities Integration and Development System's ability to incorporate. In an address at the 2016 Modern Day Marine expo, then-Commandant of the Marine Corps, Gen Robert B. Neller, announced, "At the end of next year, my goal is every deployed Marine infantry squad has got their own quad copter." This is the archetypal example of technology accelerations that, if not synchronized with a complete logistics concept, can result in a series of cascading support problems in the current model.

Regarding the use implementation of quad copters, Gen Neller went on to say,

> They're like iPhones; every six months there's another one. So it would be silly to field the whole Marine Corps at one time, because in six months, there will be something better to buy; hopefully cheaper.

This procurement concept presents a problematic paradigm shift that should make any project team, contract officer, schoolhouse trainer, maintainer, supply-chain manager, and good steward of government funds very uncomfortable. Yes, we need our Marines and our institutions to be adaptable. However, we should strive to make the adaptation to rapid technology transition models as painless as possible.

If the Marine Corps bought a new version of the squad copter every year and fielded it to one quarter of squads every year, assuming laws about competitive contracting remain intact, it is reasonable to assume that four different squad copter models would be fielded to the fleet. That is four sets of capabilities and limitations, operator and maintainer periods of instruction,

Testing and training with drones and their capabilities will evolve over time. *(Photo by LCpl Samuel Lyden.)*

national stock numbers, sets of spares, contracts, and program office teams, in addition to economy of scale buying power advantages missed when failing to buy prime equipment, support equipment, and spare parts in bulk. A decade of contractor-maintained rapidly fielded urgent universal needs statement systems in Iraq and Afghanistan showed that it is not cost effective for the enterprise to sustain systems in this way.

The method of sustaining a fleet of squad copters depicted in the above narrative supports the current Joint Capabilities Integration and Development System implementation while allowing industry to continue to innovate and rapidly spiral in new capabilities, but not necessarily new platforms. With strategic-sustainability infrastructure, Marine Corps Combat Development Command and Marine Corps Systems Command determine a common, ubiquitous drone base that can be bought in bulk and provisioned like any other full program of record. All system interfaces are based on open Institute of Electrical and Electronics Engineers standards and module inputs and outputs are made available to contractors who want to spiral in a new capability. This way, an early drone model may have no EMP shielding and three hours of battery life. A competing industrial partner would propose a new module to provide 3.5 hours of battery life and some EMP shielding. The cultural and requirements-contracting-sustainment process evolution associated with this is an example of strategic-adaptability infrastructure aligned with strategic-sustainability infrastructure. As a condition of bidding on the contract, technical data would be offered to the government and options to buy new power modules would be exercised as the government saw fit to meet requirements.

Using strategic-adaptability infrastructure, capability upgrades can be similarly spiraled in from payload modules, to propeller configurations, and communications modules. When emerging radio jamming threats prohibit normal equipment operation, the program office can spiral in auto-tracking, high-bandwidth, multi-spectral radio modules. When enemy tactics, techniques, and procedures start defeating our $1,000 drones with $1 bags of confetti or $5 nets, the program office can spiral in confetti-resistant propellers or net-cutter attachments. As the requirements evolve over time, an accumulated library of plug-and-play modules can enable custom configurations of drones according to the specific needs of the mission. It would be the function of the Marine Gunner or weaponeer to determine the mix of weapons and modules appropriate for the mission. This is employing the strategic-adaptability infrastructure in the tactical sphere, at least as fast as the enemy in that particular battlespace.

Gen Neller concluded,

> And if we get successful additive manufacturing and 3-D printing, maybe we can just buy the design and 3-D print our own. We won't buy a parts block. We'll buy the tech package and print our own parts. It's going to disrupt everything we know about supply.

It is unknown at what part of the 21st century 3D printers will be able to print integrated circuit cards that are rugged and survivable. It is very probable, however, that a second or third echelon maintainer (or fabricator) will produce any necessary component while forward deployed. This is the epitome of strategic-sustainability and strategic-adaptability infrastructure optimized for the tightest possible strategic-technological OODA loop, aligned with the operational and tactical OODA loops.

The journey from the urgent universal needs statement rapid fielding model of "a drone in every squad by the end of year," to a logistically supportable ubiquitous family of systems model that has digital interoperability built in from the ground up, to an additive manufacturing model where national stock numbers are made irrelevant through the aggregation of tech-data libraries and 3D printers will require significant cultural and process evolution; in terms of both strategic-sustainability and strategic-adaptability infrastructure, this adaptability and sustainability will overcome "force-in-readiness" as the hallmark characteristics of a force that iterates through tactical, operational, and now strategic-technological OODA loops faster than any adversary.