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TAKING PEOPLE OUT

Drones, Media/Weapons, and the Coming Humanectomy

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The future may or may not bear out my present convictions, but I can not refrain from saying that it is difficult for me to see at present how, with such a principle brought to great perfection, as it undoubtedly will be in the course of time, guns can maintain themselves as weapons. We shall be able, by availing ourselves of this advance, to send a projectile at much greater distance, it will not be limited in any way by weight or amount of explosive charge, we shall be able to submerge it at command, to arrest it in its flight, and call it back, and send it out again and explode it at will, and, more than this, it will never make a miss, since all chance in this regard, if hitting the object of attack were at all required, is eliminated. But the chief feature of such a weapon is still to be told; namely, *it may be made to respond only to a certain note or tune, it may be endowed with selective power.* Directly such an arm is produced, it becomes almost impossible to meet it with a corresponding development. It is this feature, perhaps more than in its power of destruction, that its tendency to arrest the development of arms and to stop warfare will reside.

—Nikola Tesla, "Plans to Dispense with Artillery of the Present Type" (emphasis added)

NIKOLA TESLA, REMEMBERED for his farsighted vision into the realms of electrical production and dissemination, was anything but a Luddite. Yet in 1898 he saw that advances in the scientific application of technical media to ballistics—specifically the use of media to produce knowledge about the trajectory and guidance of weaponry—would ultimately lead to weapons that could determine for themselves which target to select. Autonomous artillery would thus be birthed through its capacity to take *note* of and *attune* itself to its surroundings. Artillery's ability to selectively capture and process information—to become media—should, according to Tesla, make obvious the need to avoid such a technological path. In point of fact, by the

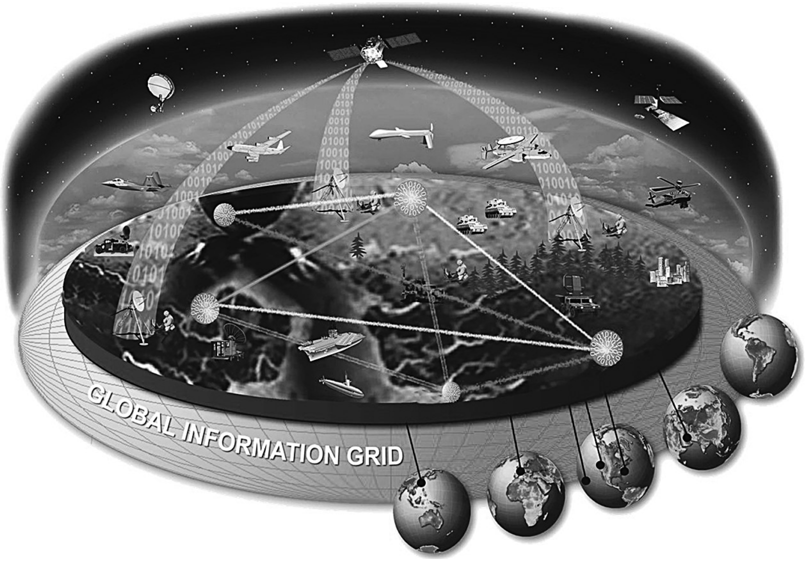

Figure 11.1. U.S. military's global information grid. [National Security Agency, "Global Information Grid"]

1890s new forms of technical media, notably photography, were already being used scientifically to fine-tune the capacities of artillery and create "smarter" weapons.[1] Against such weaponry, no capable human response would be possible. Abolishing warfare altogether was the only logical response to such inevitability.

Rather than taking note of Tesla's warning to "dispense with Artillery of this type," the U.S. military is making plans to dispense instead with humans. Particularly since the Cold War, when the Americans were faced with Soviet numerical superiority, the U.S. military has resigned itself to maintaining *technological* superiority.[2] In particular, that superiority was oriented around what, during the Cold War, was called "electronic warfare."[3] Thus, while the Soviet strategy was oriented around recruiting and developing the human soldier, the American strategy was devoted to sacrificing the human in favor of technological innovation, especially innovation in communication and information technologies. According to this logic, it is hardly surprising that current U.S. defense policy now shows itself so willing to dispense with the human altogether.

In the present chapter, we describe this development of "humanectomy" through the stereoscopic lenses of media and communications theory. Our media-centric analysis draws upon three key operative understandings. First, following Friedrich Kittler, media are understood in terms of the selection, storage, processing, and transmitting of information.[4] Drones are thus increasingly prominent "earth-observing" media.[5] The production of military knowledge is foremost a media problem, and the world's militaries have been at the developmental front of media technologies for thousands of years.[6] More broadly, warfare is conducted according to communicative capacities. Even the size of singular permanent military formations, not to be composed of more than three thousand prior to the French Revolution, was dictated by the limits imposed by the soldier's perceptive capacity to see visual signaling technologies—flags.[7] In this and in related ways, command and *capacities* in war depend on the media created to collect data on self and enemy, use that information to develop strategy, transmit that strategy through the chain of command, and guide tactics in real time via perceptual engagements. Since its expansive reconfiguration during World War II, one valence of military strategy is represented by "the art or science of employing the economic, military, psychological, and technological forces of a nation to afford maximum support of national policies."[8] Military strategy at such a scale is produced via a form of electronic warfare or "Infowar" in which the world is informationalized in such a fashion that all realms of human, technological, and ecological activity might legitimately necessitate electronic/digital surveillance.[9] Accordingly, the U.S. military has been engaged in creating the global information grid (GIG), which entails a "globally interconnected, end-to-end set of information capabilities for collecting, processing, storing, disseminating, and managing information on demand to warfighters, policy makers, and support personnel" (see figure 11.1).[10]

Second, following Claude Shannon and Warren Weaver's classic theory, communications systems achieve optimal results through the creation of extensive feedback loops that work to reduce noise to enable greater amounts of information to be accurately transferred. Swarmed drones are being created with multipath cybernetic feedback loops.[11] Thus, the frontier of advancement in drone technologies is not so much ballistic superiority but rather *software* superiority. Insofar as military strategic goals must answer to the capacities of media and the conventions of communications theory, the U.S. military is experimenting with taking humans out of as many links in the chain of command as possible. Autonomatonization results. As with so many other systems-based approaches, humans can be counted on to insert noise into the system. They may introduce noise as an attack or hack,

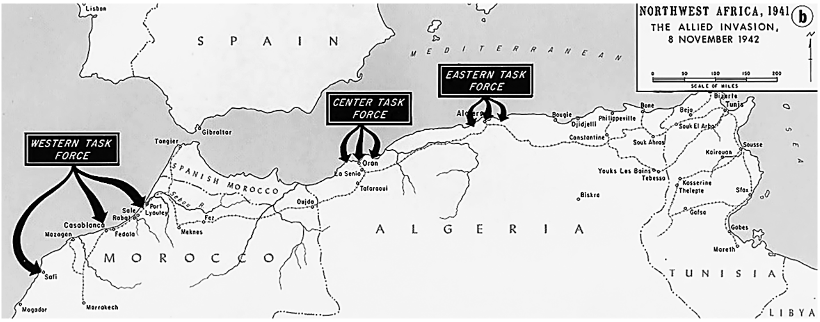

Figure 11.2. Allied Invasion of French North Africa, including Oran, 1942. [Wikimedia.org]

or they may do so because humans are inherently undependable when it comes to mediation—they have highly unreliable data collection, storage, and processing capacities. At any one of these points, even under benign circumstances, counting on humans to successfully operate as transformers or relays is doomed to inefficiencies and failure. Conversely, drones and other infoweapons instantiate emergent forms of military strategy that are largely responding to the conditions of Shannon and Weaver's classic consideration of communications as a mathematical problem whose solutions demand noise reduction.[12] Humans, as the noisiest of communicators, can be a lethal liability in the Infowar.

The third and related point also comes from Kittler, who has noted that, because war is noisy, "command in war must be digital."[13] This suggests that the answer to these problems of military command and communication is the application of digital certainty. As Gerfried Stocker points out, "There is no sphere of civilian life in which the saying 'war is the father of all things' has such unchallenged validity as in the field of digital information technology."[14] While the standard historical treatment of such sentiment relies on a narrative stemming from two World War II objectives, cryptography and ballistics prediction, it has been suggested that such a "digital telos" presents itself at least as early as the U.S. Civil War, when attempts to "digitize" semaphore telegraphy for the purposes of semiotic certainty and greater autonomous mobility were developed by the United States Army Signal Corps.[15] Regardless of its provenance, a digital telos still reigns in U.S. strategic thinking, and autonomy has been always been one of its perceived benefits.

These three considerations have continually set the stage for military strategic thinking. However, they do not guarantee that one military logic will prevail. Rather, military media capacities have been mustered to support two competing visions. Military centralization is founded on a hierarchical organization in which expert-trained generals depend on media to serve their needs—to give them perfect information and produce seamless chains of command.[16] The competing logic relies on autonomous tactical agents or regiments—for example, the "detachment" that can "think for itself" and act accordingly. At the forefront of such military-media machines is the drone. Drones have placed in bold relief a struggle between an old logic of "command and control" and an emergent vision of detachment or autonomy. Such internal military conflict had its electronics-induced birth during the Crimean War, when, in 1854, "commanders in the field were for the first time interfered with (they felt) by constant questions and suggestions (and sometimes orders) from distant military headquarters in London and Paris."[17]

What follows is an analysis of key historical moments in which military doctrine and objectives have been reoriented by media breakdowns and breakthroughs. That is, there has been a recurrent and recursive relationship between media and military strategy. To illustrate this tortured relationship, we begin by examining how hierarchical logics of military command have been fueled by evolving capacities for media to relay battlefield data and open up communications between soldiers and their commanding officers. To a great degree, military command has been vexed by Carl von Clausewitz's sentiment that the "great uncertainty of all data in War is a peculiar difficulty, because all action must, to a certain extent, be planned in a mere twilight, which in addition not unfrequently—like the effect of a fog or moonshine—gives to things exaggerated dimensions and an unnatural appearance."[18] The last 150 years have seen attempts to create media systems capable of piercing the fog of war to produce transcendent military intelligence that, by extension, should lead to unassailable strategy. Yet next-generation drone media are obliterating this commonsense impulse toward a hierarchical military command structure. Because innovations in digital media have unveiled the fallible, bumbling human as the true "fog of war," drones are now being designed with explicitly nonhuman forms of intelligence, cooperation, and communication. The demands of precise military command and organization, therefore, present us with a situation in which the human *must* be excised. The only way to solve the logical contradictions of seminal military doctrines like centralized control/decentralized execution, as well as the medial weaknesses of the soldiering human subject, is to perform a preventive humanectomy.

Centralized Control, Decentralized Execution

Visions of the heroic and autonomous World War I fighter pilot—which were widely and wildly documented in news and fictional accounts—were anachronistic before they truly took flight. One of the first technological breakthroughs the Americans brought to the Western Front in 1917 was airborne radio, "which transformed the airplane from a weapon of individual opportunity to a weapon capable of centrally commanded operation. The airborne radiotelephone made possible the application of the military principle of concentration of mass to aerial combat."[19] Long before Hitler's Panzer divisions were coordinated by very high frequency (VHF) radio, of which Kittler makes much ado,[20] American media transformed the airplane from a lone wolf into a pack. As Paul Clark notes, George Owen Squier, the same figure who invented the photo-chronograph for measuring the velocity of ballistics, pushed for the first successful application of radio use in airplanes when he was the Chief Signal Officer of the Signal Corps. Squier called for "combatant units to multiply their military strength" through the application of "weapons and agencies provided by scientists and engineers."[21] The pack is not merely a set measured according to addition. It is a "force multiplier."

It would be several decades, however, before U.S. Army doctrine caught up to the reality of these new technical capacities. In November 1942, as the German Sixth Army was beginning to freeze in Stalingrad, the Allies launched an invasion of French North Africa. In the early stages of Operation Torch (see figure 11.2), American forces stormed the Algerian beaches near Casablanca, Oran, and Algiers, striving to impose air superiority over this strategic sliver of Axis control. Calculating that French troops would not resist the American invasion, the Allies launched an amphibious assault with thirty-nine C-47 aircraft and 18,500 troops. As the Americans stormed the beaches at Oran, they used loudspeakers to woo French forces: "Ne tirez pas!" (Don't shoot!). When the French replied with machine-gun fire, the Allies had to suddenly shift their invasion strategy from Option Peace to Option War.

The airborne C-47s, however, never got the message. Although the nearby anti-aircraft ship, the HMS *Alynbank*, tried to transmit this last-minute change of plans, the *Alynbank*'s operators reportedly used the wrong radio frequency. The result was a strategic disaster for the unseasoned American forces. Despite the fact that the French troops were ill equipped and outmanned, only fourteen of the Americans' thirty-nine C-47s landed unscathed. Although the Allies eventually took control of Oran and the rest of Algeria's strategic coastline, air forces would only play an auxiliary role.[22]

The Americans, however, learned from this notorious blunder in command and control. Just a few months after the invasion of Oran, the United States issued *War Department Field Manual FM 100-20: Command and Employment of Air Power*, which established its new doctrine of aerial warfare. This field manual, released on July 21, 1943, argued for a monumental shift in the U.S. military's relationship of forces. While theretofore airpower had been organized as supplementary and subordinate to ground forces, the new field manual's first lines emphasized: "Land power and air power are co-equal and interdependent forces; neither is an auxiliary of the other."[23] After asserting the necessary independence of airpower, the manual continues: "The inherent flexibility of air power is its greatest asset. This flexibility makes it possible to employ the whole weight of the available air power against selected areas in turn; such concentrated use of the air striking force is a battle winning factor of the first importance. Control of available air power must be centralized and command must be exercised through the air force commander if this inherent flexibility and ability to deliver a decisive blow are to be fully exploited."[24] In light of the communication failures at Oran, this plea for "centrality" established the need for an air force under the independent control of a specialized air command.[25] Yet, in an interesting tension with this emphasis on centrality, the manual also made the case for a "flexible" air force: "In order to obtain flexibility, the operations of the constituent units of a large air force must be closely coordinated. Flexibility enables air power to be switched quickly from one objective to another in the theater of operations."[26] While the authors sought an independent, centralized command, they also recognized that the unique nature of aerial warfare demanded a resilient flexibility from its units and pilots. This flexibility—as well as its apparent tension with "centralized" control—became a core mission of the U.S. Air Force when it was founded in 1947. In fact, "centralized control, decentralized execution" remained the essential doctrine of the air force for decades, and only now in the face of digital warfare has it been seriously called into question.

On the cusp of this monumental shift, air force official doctrine in 1997 emphasized, “Centralized control and decentralized execution of air forces are critical to force effectiveness. Air forces must be controlled by an airman who maintains a broad perspective in prioritizing the limited assets across the range of operations.”[27] In 2011 doctrine expressed similar concerns: “Because of airpower’s unique potential to directly affect the strategic and operational levels of war, it should be controlled by a single Airman who maintains the broad, strategic perspective necessary to balance and prioritize the use of a powerful, highly desired yet limited force.”[28] This continued emphasis on a single “airman,” of course, places the central responsibility on a seasoned, specially trained fighter who has honed his or her knowledge in a wide range of battlefield experiences. This wise leader then programs certain orders and strategies into the heads of pilots, who carry out their missions under the supervision of their leaders. While this basic hierarchical command-and-control strategy ensures the autonomy of air forces, it limits the reactive “flexibility” increasingly desired by air command.

Beginning in the 1990s, U.S. Air Force doctrine—under the weight of centuries of hierarchical military theory—sought to maximize this flexibility by developing a special brand of networked warfare.[29] Yet, because commands were still being filtered through a centralized node (or “controller”), advanced networking technologies simply reinscribed the military’s traditional structures of centralized command and control. For example, the *Department of Defense Dictionary of Military and Associated Terms* defines “centralized control” the following way: “In joint air operations, placing within one commander the responsibility and authority for planning, directing, and coordinating a military operation or group/category of operations.”[30] Decentralized execution, likewise, is defined as “the delegation of execution authority to subordinate commanders.” In emphasizing the centrality of “one commander” who delegates tasks to subordinates, this doctrine essentially sacrifices the adaptability and operational autonomy sought—though left unfulfilled—by current forms of decentralized warfare.

For a new generation of military strategists, this centralization is proving to be one of the military’s key obstacles. For example, Milan N. Vego, a strategist who teaches at the Naval War College, argues that the “most serious current problem in the Armed Forces is the trend toward over-centralized decisionmaking on the operational and strategic levels.”[31] Yet, as Vego points out, attempts to decentralize command through networking have always fallen short of their promise: "Networking supposedly promises decentralization, affording greater initiative to subordinates. Evidence suggests the opposite: theater commanders increasingly use information technology to make decisions that would normally be the province of tactical commanders."[32] As Vego argues, "Advances in communications allow senior leaders to observe events in near real time from thousands of miles away. This promotes a false impression that remote headquarters can perceive the situation better than tactical commanders on the scene."[33] Technological advances that "clear the fog" for senior commanders, therefore, allow them to micromanage the battlefield from afar. For Vego, overcentralized command and control "encourages an unwillingness or inability on the part of subordinates to act independently and take responsibility for their actions."[34] This, of course, defeats the underlying purpose of networked decentralization. Advanced media of surveillance and communication, therefore, have actually worked against efforts to decentralize the work of war because they implicate senior commanders more deeply into the scene of battle, thereby remediating traditional structures of hierarchical command.

Vulnerable Media, Vulnerable Command

In a similar fashion, media that were designed to minimize battlefield noise have led to increased communications vulnerability. Reflecting on the radio communications systems of World War I, Kittler once remarked: "Technical media don't arise out of human needs, as their current interpretation in terms of bodily prostheses has it, they follow each other in a rhythm of escalating strategic answers."[35] Because telegraph cables were so vulnerable to enemy interception, Italian engineer Guglielmo Marconi developed a media solution based on wireless systems of radio communications. "But alas," as Kittler points out, "the new wireless medium of radio introduced even greater risks of interception than telegraphic cables."[36] Although radio was celebrated as a solution to the inherent limitations of cable telegraphy, opening up new possibilities for transatlantic communication, the new technology simply introduced new vulnerabilities that would have to be solved by new media.

This trend has been borne out in the bumpy development of postcentralized military command and control. As we have already seen, while new communications and surveillance technologies allowed for greater operational flexibility among pilot networks, they also exacerbated the problem of centralized command. To comprehensively tackle the prospect of decentralization, therefore, the U.S. military has begun to radically reconceptualize the ways in which battlefield data can be captured, stored, and processed. Technologies like autonomous vehicles, electromagnetic rail guns, and multi-phenomenology sensors are giving rise to what Robert Work and Shawn Brimley, scholars at the Center for a New American Security, call a "military technical revolution"[37]—that is, a disruptive technological convergence that promises to upturn the ways in which warfare is waged. One of the key teloi of this revolution is the development of technological solutions to the centralization problem. And as Kittler could have foreseen, these decentralizing technologies are creating new problems that are gradually leading to a singular technical solution—the elimination of the human from the chain of command and control.

Unmanned aerial vehicles, of course, are on the frontier of these efforts. Simply taking humans out of aircraft radically increases their flexibility on the battlefield. While a pilot can only stay in the air for twelve to fourteen hours, unmanned craft, with aerial refueling, can stay in the air for forty to fifty hours at a time.[38] The weight savings are also remarkable, allowing for a stealthier craft with higher endurance. And perhaps most of all, drones can partake in high-altitude and high-speed missions that are impossible for human pilots to safely endure.[39] Establishing air dominance in the age of drone warfare, therefore, requires activities in which humans simply cannot participate.

Faced with this shifting technological landscape, in 2010 then Secretary of Defense Robert Gates ordered the army and the air force to develop new multi-aircraft piloting technologies. In response, the army—which deploys its drone pilots to overseas bases—has developed a system by which pilots can oversee two vehicles at once. In 2015, therefore, the army began to field multi-aircraft control for their cutting-edge drone, the MQ-1C Gray Eagle.[40] This advance in unmanned warfare has been made possible only because the drones have a remarkable degree of autonomy, having the capacity to take off and land on their own, for example.[41] Yet this step forward in the autonomous operation of aerial vehicles creates a deluge of additional vulnerabilities. The Gray Eagle's present data transmission systems, for example, are highly sensitive to enemy hacking. Just as telegraph cables and then wireless radio transmissions enhanced the potential for message interception, drones' complex systems of satellite-based communications are highly vulnerable to penetration and sabotage. In fact, in order for drones to operate in the air, unmanned systems require constant, assured communications to remote pilots.[42] This communication link, therefore, is an Achilles's heel of unmanned craft: as Work and Brimley point out in *Preparing for War in the Robotic Age*, "an actor who dominates in cyber conflict can infiltrate command-and-control networks, generate misinformation and confusion, and potentially even shut down or usurp control over physical platforms. This will be especially true for unmanned systems."[43] To better secure these channels, the Department of Defense (DoD) is experimenting with high-bandwidth, protected communications like high-frequency satellites and laser and free-space optical communications.

Ultimately, however, new transmission media are not radical enough to solve this problem in all its complexity. In summer 2014 the Defense Advanced Research Projects Agency (DARPA), the principal research and development wing of the DoD, awarded a contract to Northrop Grumman for a post–satellite navigation system. Designed to allow navigation in "GPS-challenged" environments, DARPA's Chip-Scale Combinatorial Atomic Navigator (C-SCAN) program will be integrated with a microelectromechanical system (MEMS) and atomic inertial guidance technologies to form a single inertial measurement unit. In the words of Northrop Grumman vice president Charles Volk, "This microsystem has the potential to significantly reduce the size, weight, power requirement, and cost of precision navigation systems. . . . Additionally, the system will reduce dependence on GPS and other external signals, ensuring uncompromised navigation and guidance for warfighters."[44] Note the emphasis on reducing crafts' reliance on external navigation systems: by eliminating the vulnerabilities of external communications—even fully automated communications between crafts' navigational systems and their guiding satellites—craft autonomy can be significantly increased.

A number of recent innovations have energized this shift away from satellite communications (SATCOM), as researchers have demonstrated how simple it is to hack military satellite systems. According to a security consultant who produced a controversial white paper on the vulnerability of current-generation military SATCOM, "Multiple high risk vulnerabilities were uncovered in all SATCOM device firmware. . . . These vulnerabilities have the potential to allow a malicious actor to intercept, manipulate, or block communications, and in some cases, to remotely take control of the physical device."[45] Military SATCOM devices like the Cobham Aviator 700D, which have long served as secure communications and navigations systems for diverse military functions, are quickly becoming as hackable as telegraph lines were in the early twentieth century. The C-SCAN and kindred technological programs, therefore, are striving to develop navigation systems that are fully internal and thus process all locational data onboard.

Data security, however, is not the only communications challenge facing unmanned craft. According to the Department of Defense's 2013 "Unmanned Systems Integrated Roadmap," manpower and bandwidth are two of the costliest elements of their unmanned systems programs.[46] These costs, of course, are complementary: because unmanned systems cannot adequately process all the data they capture, they are required to use significant bandwidth to transmit these data back to humans on the ground.[47] In fact, the principal personnel burden for unmanned vehicles is the processing of all the surveillance data they generate.[48] Emphasizing that "one of the largest cost drivers in the budget of DoD is manpower," the Department of Defense "Roadmap" argues that "of utmost importance for DoD is increased system, sensor, and analytical automation that can not only capture significant information and events, but can also develop, record, playback, project, and parse out those data and then actually deliver 'actionable' intelligence instead of just raw information."[49] Remotely "piloting" drone aircraft requires remarkably little bandwidth; the vast majority of unmanned systems' bandwidth needs are devoted to transmitting their surveillance data to humans on the ground. Therefore, according to DoD, automated onboard data processing "can help minimize critical bandwidth necessary to transmit ISR data to the warfighter and may also be suitable for reducing the intelligence officer workload and decreasing the time in the kill chain."[50] According to DARPA estimates, automated image-processing technologies could reduce the personnel burden for wide-area drone sensors—which provide surveillance coverage for an entire city—from two thousand personnel to about seventy-five.[51] These onboard processing systems would scan the drones' surveillance data for anomalies and would only pass along to humans those items of potential interest. In the words of a Department of Defense report, "automated target recognition enables target discrimination, i.e., reporting contacts of interest instead of sending entire images for human interpretation."[52] Onboard computers, therefore, would autonomously determine which data should be shared with humans and which should be simply filtered out.

The Gathering Swarm

In other words, select war machines are now entrusted with the capacity to decide which battlefield data their controllers access. While at this time only humans are entrusted with "kill" decisions based on these data, this official DoD policy is being contradicted by autonomous media/weapons like Raytheon's new Close-In Weapon System, the Phalanx.[53] To compensate for the data vulnerability and financial cost of keeping humans in the command chain, these new military technologies are surrendering to automated computing systems the capacity to determine who is friend and who is enemy. Thus, in tracing the history of how new surveillance and communications technologies have been used to massage the tensions between centralized command, decentralized execution, and data security, we have been telling a story that has been built more or less logically on the computerized automation of enemy epistemology (and hence, eventually, the automation of kill decisions). This long drive toward decentralization, therefore, has serious epistemological and political implications.

In one of the cutting-edge developments of this military technical revolution, the figure of the "network" has receded into the figure of the *swarm*. While swarm warfare has important precedents in military history—such as in Alexander the Great's Central Asian campaigns, the Mongol invasions of Asia and Eastern Europe, Native American attacks on the western frontier, and postcolonial guerilla resistance in Asia and Africa[54]—logics of robotic autonomy have revolutionized the potential of the swarm. Many military strategists, faced with the failure of networks to solve the problem of overcentralization, have begun to realize that traditional models of intelligence and command—based, that is, on human cognition and human communication—are inadequate to the challenges of twenty-first-century warfare. While for now the Department of Defense is trying to keep humans in the kill chain of unmanned operations, a human-dominated control and command structure simply cannot fulfill the objectives of decentralized twenty-first-century warfare. The next step in the military technical revolution, therefore, relies on the development of nonhuman models of knowledge and communication. Observing this transition to animal intelligences, military strategist Paul Scharre has remarked that forces will shift "from fighting as a *network* to fighting as a *swarm*, with large numbers of highly autonomous uninhabited systems coordinating their actions on the battlefield. This will enable greater mass, coordination, intelligence, and speed than would be possible with networks of human-inhabited or even remotely controlled uninhabited systems."[55] While humans could retain a degree of supervisory contact with the swarm, "the leading edge of the battlefront across all domains would be unmanned, networked, intelligent, and autonomous."[56]

To many who work in military research and development, it is becoming increasingly clear that the only solution to the fog of war is the abandonment of human models of communication and command. The human—with its limited vision, its juvenile data-processing capacities, and its highly vulnerable communications processes—is the ultimate source of the fog of war. The human, however, was never intelligible as the source of this fog until it was possible to replace the human with digital media. Thus, with the development of extremely sophisticated systems for processing battlefield data, the human has suddenly emerged as an epistemological hindrance. This development helps us think more fully through the implications of Kittler's statement that "command in war must be digital precisely because war is noisy."[57] Of course, Kittler is not simply pinpointing the necessity of digitality in human-based communications and command. Noise elimination has its ultimate fulfillment in the elimination of humans' innate weaknesses in data selection, storage, and processing. For command to be truly digital, fully automated machine-to-machine command, control, and coordination must be developed.

With its extraordinary capacities for intercraft cooperation, the swarm is the ideal technological system for dispersing the fog of war. Upending the metaphorical connotations of "fog," swarms operate through a "combat *cloud*" that is driven by collective interoperability.[58] Traditional military networks, of course, had to safeguard their principal nodes of intelligence against enemy attack. But with swarms, this epistemological center of gravity is a thing of the past. In a radical departure from human-centered control and command, which requires communication between psychically isolated cooperating subjects, the swarm cloud possesses a continuously refined, emergent collective intelligence that is far beyond the grasp of humans' physiological capacity. These swarms continuously reorient their collective intelligence—they are even "self-healing" in the event of companion loss, which they compensate for by readjusting the epistemological topology of the swarm.[59] These decisions for topological restructuring can be accomplished by the use of "voting" mechanisms, which could allow swarms to achieve a decentralized epistemology that is inconceivable among networked human combatants.[60]

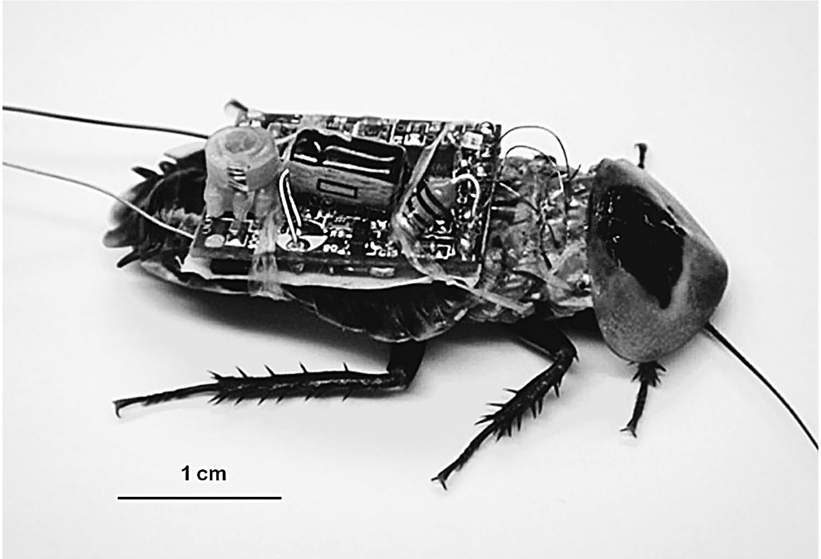

Figure 11.3. Specimen from DARPA's Hybrid Insect Micro-Electro-Mechanical System (HI-MEMS).

This emergent intelligence is made possible by what military strategists call "implicit communication," which is modeled on the cooperative epistemologies of flock and school animals like birds, ants, and fish.[61] New digital manufacturing technologies, such as 3-D printing, are providing the impetus for DoD affiliates to develop these sophisticated swarms that take the physical form of dragonflies, "robobees," houseflies, and other insects (see figure 11.3).[62] As 3-D printing has given rise to the mass production of these swarming minidrones,[63] and as computing and navigational systems continue to shrink and become more mobile, this development could allow DoD to deploy thousands or even billions of tiny, cheaply produced, cooperative drones that could be released into the field of combat in order to carry out reconnaissance and locate enemy combatants.[64]

Unlike schools of fish and flocks of birds, however, stigmergent robotic swarms are not necessarily composed of homogeneous parts. Of course, schools and flocks operate as collectives of whole organic units—each schooling fish has its own eyes, a lateral line sensory system, fins, teeth, bowels, and so forth. Yet military strategists have begun to imagine the emergence of a "swarmanoid," which is a heterogeneous assemblage of bots that each perform unique epistemological and kinetic functions. According to specifications developed by researchers at the University of Brussels, the swarmanoid could comprise three different components: "foot-bots," which specialize in moving through uneven and challenging terrains; "hand-bots," which climb vertical surfaces and manipulate objects; and flying "eye-bots," which collectively gather and process information that is then shared with the foot-bots and hand-bots.[65] Many swarms of the future will consist not of homogeneous swarming components but rather heterogeneous bots that collectively delegate tasks based on individual units' strengths in various kinetic or epistemological tasks.

Drawing on some of these emergent capacities, in the 2013 edition of its "Unmanned Systems Integrated Roadmap," the Department of Defense laid out its plans for unmanned systems during the next generation. In this document, the DoD foresees "smart teams of unmanned systems operating autonomously" and in concert.[66] Constructing a collective enemy epistemology, these swarms assess and classify their surroundings while carrying out nontraditional means of warfare, synchronizing electronic and kinetic attacks.[67] These swarms, in fact, are already being deployed on the battlefield in the form of advanced cruise missile systems, some of which are equipped with the capacity to autonomously determine and engage enemy targets. Outfitted with sophisticated onboard sensors, these swarms can perform battle damage assessments before they strike, thus enabling them to collectively refine their knowledge of the enemy and coordinate their attacks accordingly.[68] This process of enemy determination/incapacitation has reached an impressive degree of autonomy in naval warfare, where the craft in Lockheed Martin's Low-Cost Autonomous Attack System (LOCAAS) line collectively "vote" on which tactics and weapons to use against a determined target.[69] The cutting edge of these autonomous naval warfare technologies is currently the Control Architecture for Robotic Agent Command and Sensing system (CARACaS).[70]

The DoD's "Roadmap" also envisions a near future in which the air force will develop weaponized unmanned aerial systems that are designed to carry out autonomous swarm attacks. Calling these craft "loitering weapons," DoD envisions aerial swarms outfitted with imaging sensors that serve as "intelligent munitions."[71] Using data-processing systems like the LOCAAS, these swarming media/weapons are designed to "autonomously search and destroy critical mobile targets while aiming over a wide combat area."[72] While these swarming munitions are currently "man in the loop"—that is, in use while soldiers on the ground make decisions about lethal engagements—DoD suggests developing a data-processing "mothership" that could guide these

"Surveilling Miniature Attack Cruise Missiles." This artificially intelligent mothership, which will support four individual missiles, will aid the swarm in movement coordination, enemy determination, and attack protocols.[73] The DoD, therefore, foresees that the center of gravity for autonomous missions will be continuously deferred onto different machinic assemblages, as intelligent munitions are programmed to follow kill commands devised by machines, based on coordinates formulated by machines, and ultimately targeted at the enemies determined by machines.

Conclusion

As we have tried to make clear, the U.S. military has developed dueling compulsions and capacities that fluctuate according to the rise of new media technologies. On the one hand is the drive for fully centralized command and control, and on the other is the desire to have fully capable "on the ground" soldiers able to execute strategy based on their assessment of any given situation. One concern regarding autonomy is the rogue soldier or rogue platoon. Any *detachment* has the real potential to go rogue. The further and longer detached from central command and *oversight*, the more likely it becomes for the rogue to develop. Command in war necessitates clear lines of communication but also clear means of surveillance—you need to see both your enemy and yourself. Losing contact with your soldiers, no longer being able to track their whereabouts, can have negative consequences not just in terms of failed missions but for the development of counterinitiatives. This, of course, is an essential problem with drones: if they carry out their media logic to its full extent, they would remove human oversight to "close the loop."

These competing capacities, breakdowns, and reversals are organized through continuous innovations in communications technologies. Self-destructing orders move the chain of command into the realm of conjecture. Secret orders can be hidden from the externally known enemy as well as the potentially internal enemy. However, the existence of "secrets" means rogue orders can be invented and hidden behind the veil of secrecy that has long cast "deciphered" messages into question. An autonomous drone will be much like the detachment of old. Once sent on its mission, how it carries it out and how it interprets "the mission" remain open to a systemic feedback loop that is ideally hidden from human perception, let alone human decipherment. As with any sign that depends on intelligence to be given meaning, drone detachments must at some point give life to goals, to missions.

This bringing into being can only be accomplished through robotic autonomy. The drone must be able to freely choose how best to carry out the mission. Human communicative fallibility (with its narrow bandwidth, faulty memory, slow and irrational processing, weak signaling) must be systematically and surgically removed from military communications—extensively and intensively—for the drone to truly be free to carry out its mission. Any trace of the human is an insidious infection, a threat to the security and intelligence—to the very life—of the autonomous system. While a postoperative surgeon may check "the margins" in a search for remaining malignant tissue, humans may not be able to properly sense the ripple effects of their own presence in the system, however diminished. In that sense, humans cannot be counted on to remove all that is "human" from the drone. Only the drone can do that. The U.S. military's prognosis, alas, is clear: only a humanectomy can truly save us.

Notes

1. Paul Virilio (*War and Cinema*), Friedrich Kittler (*Gramophone, Film, Typewriter*), and Manuel DeLanda (*War in the Age of Intelligent Machines*) have all in their own way described the overlapping development of modern media technologies with those of guided artillery systems. What Tesla would likely have been well aware of was the expansive use in the 1890s of the scientific study of ballistics and artillery enabled by new forms of data collection—that is, of new media devices used to collect information about ballistics in increasingly specific and detailed fashion. Albert Cushing Crehore and George Owen Squier conducted groundbreaking research using photography and electromagnetism to measure the speed of ballistics. Their 1897 book, *The Polarizing Photo-Chronograph*, collected research previously published in the *Journal of the United States Artillery* that the U.S. military developed in 1892 for the scientific advancement of weaponry. Kittler (*Gramophone, Film, Typewriter*) noted that related research was also taking place in Europe.
2. Barton, *The Politics of Peace*, 165.
3. D. Gordon, *Electronic Warfare*.
4. Kittler, *Gramophone, Film, Typewriter*, 369.
5. See Packer and Reeves, "Romancing the Drone," which appeared in a special issue of the *Canadian Journal of Communication* devoted to "earth-observing media."
6. Kittler, *Gramophone, Film, Typewriter*; Sterling, *Military Communications*; Van Creveld, *Command in War*.
7. Van Creveld, *Command in War*, 24.
8. D. Gordon, *Electronic Warfare*, 10.

9. D. Gordon, *Electronic Warfare*; Stocker and Schopf, *INFOWAR: Information. Macht. Krieg*. Climate security is now considered one of the key considerations for U.S. military strategy. CNA Military Advisory Board, "National Security and the Accelerating Risks."
10. National Security Agency, "Global Information Grid."
11. Shannon and Weaver, *The Mathematical Theory of Communication*.
12. See Asaro, "Determinism, Machine Agency, and Responsibility," 271–74.
13. Kittler, "Media Wars," 119.
14. Stocker, "InfoWar."
15. Maddalena and Packer, "The Digital Body."
16. See Wall and Monahan, "Surveillance and Violence from Afar," 246–50.
17. Sterling, *Military Communications*, xxvii.
18. Von Clausewitz, *On War*, 106.
19. Clark, "Early Impacts of Communications," 1408.
20. While Kittler mentions the necessity of wireless communication for planes and submarines in World War I, it is the tank that receives the greatest attention. Kittler describes tanks as having suffered most from poor communication in World War I and having achieved the greatest force multiplier effect in World War II. See Kittler, *Gramophone, Film, Typewriter*, 95–105.
21. Clark, "Early Impacts of Communications," 1408.
22. Romero, "The Origins of Centralized Control," 8–10.
23. United States War Department, *War Department Field Manual*, 4.
24. United States War Department, *War Department Field Manual*, 4.
25. For more on the development of the early American discourse of airpower, see Kaplan, *Aerial Aftermaths*.
26. United States War Department, *War Department Field Manual*, 7.
27. See Romero, "The Origins of Centralized Control," 100.
28. United States Air Force, "Air Force Basic Doctrine," 38.
29. See Arquilla and Ronfeldt, *The Advent of Netwar*.
30. *Department of Defense Dictionary*, 33.
31. Vego, "Operational Command and Control," 101.
32. Vego, "Operational Command and Control," 102.
33. Vego, "Operational Command and Control," 101.
34. Vego, "Operational Command and Control," 101.
35. Kittler, "Media Wars," 121.
36. Kittler, "Media Wars," 121.
37. Work and Brimley, *Preparing for War*, 7.
38. Scharre, "Robotics on the Battlefield: The Coming Swarm"; cf. Crandall, "Ecologies of the Wayward Drone," 269.
39. Scharre, *Robotics on the Battlefield*, pt. I, *Range, Persistence, and Daring*, 10–11, 24.
40. Scharre, *Robotics on the Battlefield*, pt. I, 17.
41. Scharre, "Robotics on the Battlefield," video.
42. Scharre, *Robotics on the Battlefield*, pt. I, 31.

43. Work and Brimley, *Preparing for War*, 23.
44. Northrop Grumman Corporation, "Northrop Grumman Awarded Contract."
45. Santamarta, "A Wake-up Call for SATCOM Security," 1.
46. Department of Defense, "Unmanned Systems Integrated Roadmap FY2013–2038," 25, 49.
47. See Parks, "Zeroing In."
48. Scharre, *Robotics on the Battlefield*, pt. I, 17.
49. Department of Defense, "Unmanned Systems Integrated Roadmap," 29.
50. Department of Defense, "Unmanned Systems Integrated Roadmap," 85.
51. Scharre, *Robotics on the Battlefield*, pt. I, 17.
52. Department of Defense, "Unmanned Systems Integrated Roadmap," 89.
53. Stimson Center, "Recommendations and Report of the Task Force," 71. Although the DoD officially prohibits autonomous UAVs from launching weapons without human command, the 2014 task force on drone policy admitted that "current directives raise the possibility of permitting the use of such autonomous weapons in the future, with the approval of high-ranking military and civilian officials" (Stimson Center, "Recommendations and Report of the Task Force," 26). Indeed, DoD directive 3000.09, the notorious 2012 Autonomy in Weapon Systems policy document, establishes a legal loophole by which DoD officials can use their discretion to bypass all restrictions on lethal autonomous weapons (Department of Defense, "Directive Number 3000.09," 3). Further, as competing drone systems are developed in Russia, China, and elsewhere, it is hard to imagine that the U.S. military will fail to enhance their drone programs to the highest levels of sophistication.
54. See Arquilla and Ronfeldt, *Swarming and the Future of Conflict*; and S. Edwards, *Swarming and the Future of Warfare*.
55. Scharre, *Robotics on the Battlefield*, pt. I, 8.
56. Work and Brimley, *Preparing for War*, 29.
57. Kittler, "Media Wars," 119.
58. Stimson Center, "Recommendations and Report of the Task Force," 26.
59. Rubinstein and Shen, "A Scalable and Distributed Model"; Scharre, *Robotics on the Battlefield*, pt. I, 32.
60. Scharre, *Robotics on the Battlefield*, pt. II, *The Coming Swarm*, 26; see also *Defense Update*, "Low Cost Autonomous Attack System."
61. See Sharkey and Sharkey, "The Application of Swarm Intelligence"; Sarker and Dahl, "Bio-Inspired Communication."
62. Piore, "Rise of the Insect Drones."
63. Golson, "A Military-Grade Drone."
64. Scharre, *Robotics on the Battlefield*, pt. II, 20; see also Perry, "A Self-Organizing Thousand-Robot Swarm."
65. Dorigo et al., "Swarmanoid."
66. Department of Defense, "Unmanned Systems Integrated Roadmap," 72.
67. Center for a New American Security, "Robotics on the Battlefield."
68. Scharre, *Robotics on the Battlefield*, pts. I and II; Scharre, "Robotics on the Battlefield," video.

69. *Defense Update*, "Low Cost Autonomous Attack System."
70. See Smalley, "The Future Is Now."
71. Department of Defense, "Unmanned Systems Integrated Roadmap," 78.
72. Department of Defense, "Unmanned Systems Integrated Roadmap," 78.
73. Department of Defense, "Unmanned Systems Integrated Roadmap," 78.