

U.S. Army RDECOM



DARPA's Warrior Web project. Technological advancements could fundamentally alter the equation of women in combat.

# Women Warriors

## Why the Robotics Revolution Changes the Combat Equation<sup>1</sup>

BY LINELL A. LETENDRE

*[This] should not be about women's rights, equal opportunity, career assignments for enhancement purposes for selection to higher rank. It is about, most assuredly is about...combat effectiveness, combat readiness, winning the next conflict....*

— General Robert H. Barrow (retired), 27<sup>th</sup> Commandant of the U.S. Marine Corps

So began the testimony of General Barrow before the Senate Armed Services Committee in June 1991 regarding his opinion on women in combat during which he gave his ultimate conclusion: “women can’t do it...and there is no military need to put women into combat.”<sup>2</sup> That is about to change. In the wake of women successfully integrating into submarines and graduating from Army Ranger School, an additional—and heretofore underappreciated—factor is poised to alter the women in combat debate: the revolution in robotics and autonomous systems. The technology leap afforded by robotics will shift the debate from whether women are able to meet combat standards to how gender diversity in combat will improve the U.S. military’s fighting capability. Over the next decade, the U.S. military will reap huge benefits from robotic and autonomous systems that will fundamentally change both the tools used on the battlefield and the approach taken to combat. Not only will robotic technology undermine the standard arguments against women in combat, but full gender integration across all combat roles will maximize American employment of autonomous systems and corresponding combat effectiveness.

To understand how robotics will change the equation of women in combat, this article first examines the current law and policy regarding women in combat positions, taking a close look at how the services are approaching the current Department of Defense (DOD) guidance to

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establish gender-neutral standards for all occupational specialties. While present policy and direction favors opening all combat career fields across genders, full integration is still more notional ideas than reality. To understand why, this article examines the arguments surrounding women in combat, both for and against. Next, the article highlights how robotics technology in development today will change the future battlefield by augmenting the physical capabilities of soldiers and lightening the loads carried by combat troops. Finally, this article assesses how robotic advancements will not only counter the naysayers of women in combat, but should also compel senior leaders to integrate women into

combat roles faster than currently planned. In sum, diverse combat teams will improve U.S. future combat effectiveness in a robotic and autonomous systems fight.

### Women in Combat: Current Status of Law and Policy

Though women have served in the Armed Forces in every conflict our nation has faced since its founding, the numbers of women and types of roles or occupational specialties they have assumed have grown dramatically since World War II. This expansion of female participation in the military was driven in part by necessity following the implementation of the All-Volunteer Force in 1973 and in part by the



U.S. Air Force

Frances Green, Margaret Kirchner, Ann Waldner, and Blanche Osborn. Members of the Women Airforce Service Pilots who trained to ferry the B-17 Flying Fortresses during WWII.

equal rights movement. Despite these drivers, combat participation was specifically forbidden by statute until 1993. Following the recommendations put forth by the Presidential Commission on the Assignment of Women in the Armed Forces in 1992, Congress lifted the statutory restrictions surrounding women in combat and instead left decisions regarding appropriate occupational roles for genders to the Department of Defense. While these changes allowed women to serve in combat aviation roles, DOD excluded women from assignment to any unit below the brigade level whose primary role was to engage in direct ground combat.<sup>3</sup>

Following a number of Congressionally-mandated reports and the expanding role of women in combat roles in the War on Terror, DOD replaced the ground combat exclusion with a requirement for gender neutral standards in 2013. In a joint memorandum by Secretary of Defense Leon Panetta and the Chairman of the Joint Chiefs of Staff, General Martin Dempsey, DOD committed to removing “as many barriers as possible to joining, advancing, and succeeding in the U.S. Armed Forces.”<sup>4</sup> DOD called upon the military services to integrate women into combat units as “expeditiously as possible,” but no later than January 1, 2016. Prior to that date, services could recommend to the Secretary of Defense that a particular occupational specialty or unit remain closed to women if the service is able to justify with “rigorous analysis of factual data” that women lack the abilities and skills necessary for the combat role.<sup>5</sup>

Since this proclamation of full integration, services—particularly the Army and Marine Corps—have been working to integrate women into various combat preparatory courses such as the Army’s Ranger course and

the Marine Corps’ Infantry Officers Course. Services are also struggling to define the standards for combat readiness in terms of physical fitness expectations and warfighting skills. The Marine Corps, for example, established a Ground Combat Element Integrated Task Force in October 2014 to develop a standards-based assessment for ground combat arms tasks.<sup>6</sup> In September 2015, the Marine Corps requested a waiver from Secretary of Defense Ashton Carter that would exclude women from infantry and armor positions. On December 3, 2015, Secretary Carter denied that request and directed the services to open all combat jobs to women.<sup>7</sup> This announcement, however, has not quelled the debate over women entering combat roles.

### **Women in Combat: Arguments For and Against**

While General Dempsey justified the policy change as an attempt to “strengthen the joint force,” critics of the integration of women in combat remain vocal.<sup>8</sup> Since serious discussions of lifting the combat exclusion began in the early 1990s, the main arguments surrounding women in combat have focused on women’s physical capabilities and the impact of gender integration on a unit’s ability to fight effectively. Opponents point to clear differences between men and women’s physical abilities: men typically have 30 percent more muscle strength and 15-30 percent more aerobic capacity than women.<sup>9</sup> These differences can have meaningful consequences when considering that an infantry soldier may carry packs of 100 pounds or more into combat. Women and men also carry loads differently, with women shortening their gait or stride when under heavy loads. While a 1996 Army study showed that a 24-week physical training

course for civilian women enabled 78 percent of the group to carry and lift objects over 100 pounds and improved the women's ability to run with a 75-pound pack, the fact remains that most men can out-lift, out-carry, and outrun the average woman.<sup>10</sup>

Outspoken critics, like Elaine Donnelly of the Center for Military Readiness, assert that such physical differences "detract from mission accomplishment" by impacting the cohesion and effectiveness of combat units.<sup>11</sup> Social scientists who study group behavior have found that male groups thrive on competition, hierarchy, and conflict while female groups flourish on equality and cooperation. Men are more likely to be risk takers and be physically aggressive, while many women are culturally raised to be more nurturing and empathetic.<sup>12</sup> Opponents of women in combat view such differences in group behavior negatively and infer that dissimilarities in group dynamics combined with physical capability deltas will result in a decline in unit cohesion and, subsequently, degraded combat effectiveness.<sup>13</sup> They cite concerns that male soldiers will seek to "protect" women and that sexual tensions in a mixed combat unit will destroy morale and trust.<sup>14</sup> The sum of such disruptions, proclaim antagonists, will destroy U.S. combat capability.

Proponents of gender integration in combat units reject such claims of a loss of combat effectiveness. Though recognizing physical difference between genders, proponents ask that DOD simply adopt a consistent combat standard and allow women who meet the standard to join the combat ranks. Other women-in-combat champions view the physical prowess debate as a superficial excuse to cover deep-rooted resistance to women in the military generally. Supporters note that women have

fought in combat historically (e.g., the Soviet army in World War II and the "Long-haired Warriors" in Vietnam) and are successfully fighting in ground combat today.<sup>15</sup> While not disputing differences of women's aerobic and anaerobic capabilities when compared to men, advocates reference that most soldiers in a 2008 Army Research Institute (ARI) study concluded that women *do* possess the physical strength, stamina, and mental capabilities to succeed in combat.<sup>16</sup>

Protagonists also dismiss claims that unit cohesion would suffer if women were integrated into ground combat units. Social science literature demonstrates that unit cohesion is comprised of two parts: task cohesion and social cohesion. When opponents trumpet potential degradation of unit cohesion based on differences between the sexes, they normally refer to aspects of social cohesion or the emotional bonds of trust between group members. Studies have shown, however, that task cohesion—or the unifying force of a team focused on a combined mission—is the overwhelming contributor to overall unit cohesion, not social cohesion.<sup>17</sup>

Similar arguments about risk to unit cohesion have been raised and disproven numerous times in our military's history to include racial integration of ground forces, females joining combat aviation units, and most recently the service of openly gay and lesbian service members. Each integration experience has demonstrated that well-led teams derive their cohesion from a focus on the mission itself not on the differences or similarities of social makeup or backgrounds. Additionally, women-in-combat advocates dismiss concerns of sexual assault and decreased discipline in integrated units as problems appropriately handled through leadership and professionalism.<sup>18</sup>



Opening up more military jobs to women, proponents contend, will promote greater equity in promotions and positively affect the overarching military culture.<sup>19</sup>

While both proponents and opponents of women in combat have evidence and rhetoric to support their positions, the debate has principally centered on whether or not women can accomplish the job. Indeed, most advocates of gender-integrated combat units simply seek the opportunity of equality—allow women who can meet combat requirements to participate equally in the defense of their nation. To date there has been little discussion about how advances in technology—specifically robotics and autonomous systems and the corresponding changes in concepts of operation—will alter the debate. To begin to understand this effect, this article will now highlight

a range of developing robotic and autonomous systems and their potential impact on the future of combat.

### Revolution in Robotics: A Changing Battlefield<sup>20</sup>

The battlefield of the future will look exceedingly different from today's combat fight due in large part to advances in robotics and autonomous systems. Not only is robotics changing how soldiers are able to individually perform and interact on the battlefield, but autonomous systems are changing the very nature of combat. The Defense Science Board recognized in 2012 that robotic systems were significantly impacting warfare worldwide by enabling persistent capabilities over the battlefield and expanding warfighter combat abilities.<sup>21</sup> With over 50 countries estimated to



John F. Williams, U.S. Navy

CHIMP, or the Carnegie Mellon University Highly Intelligent Mobile Platform, approaches the door during the DARPA's 2015 Robotics Challenge.

have built or purchased unmanned aerial vehicles (UAVs) for military purposes and a handful of countries (namely the United States and Israel) having demonstrated devastating kinetic capabilities using unmanned systems, the robotics and autonomous revolution possesses the potential to change the time, space, and nature of warfare.<sup>22</sup> The U.S. Department of Defense has committed to maintaining technical dominance in the area of autonomy across all warfare domains.<sup>23</sup> The most applicable domain for the current women-in-combat debate, however, involves robotic technology affecting land warfare.

From exoskeletons to robotic mules, technology is reducing the weight of combat gear and improving soldiers' physical abilities and load-carrying capabilities. The Defense Advanced Research Projects Agency (DARPA) kick-started innovation in this area in 2001 by funding labs, industry, and universities under the Exoskeletons for Human Performance Augmentation (EHPA) program. The goal of that five-year program was to increase soldiers' strength and speed, provide greater protection from enemy fire, and improve soldiers' stamina while carrying loads. Some of the innovation DARPA funded under EHPA has transferred into demonstration projects in the services and fledgling programs of record. The Human Load Carrier (HULC), for example, is a hydraulic-powered exoskeleton made of titanium that allows soldiers to carry a sustained load of 200 pounds over a variety of terrain and to run at 10 miles per hour. While Lockheed Martin continues to upgrade HULC's battery power, the system currently allows eight hours of continuous field exercise or lasts several days for less exertive tasks like standing guard.<sup>24</sup>

Another DARPA initiative, called Warrior Web, began in 2011 and is funding projects to explore how to prevent musculoskeletal injuries developed from carrying heavy combat loads. Final designs are expected to allow a soldier to carry 100 pounds with 25 percent less effort and enable soldiers to run a 4 minute mile. Under this program, Harvard is developing a soft exoskeleton comprised of soft webbing woven into wearable fabric that assists joint movements in a soldier's legs. Weighing just 13 pounds, the Soft Exosuit does 15-20 percent of the work associated with walking under heavy loads, thus enabling soldiers to walk farther.<sup>26</sup> Another research institute has developed a system that serves as a robotic exomuscle near a soldier's calf. The system activates as a soldier walks and provides enough metabolic gain to make a 100-pound pack feel like it weighs 50 pounds. Future system developments will allow the robot to learn and self-adapt the rate of firing based on whether the soldier is walking or running. The final versions of these Warrior Web prototypes will be ready by 2016.<sup>27</sup>

Other exoskeletons are designed to augment a soldier's physical capabilities. Raytheon Sarcos developed an exoskeleton, the XOS 2, which uses hydraulic energy and allows users to punch through three inches of wood and lift 200 pounds hundreds of times without tiring.<sup>28</sup> A tethered version for military logistics is being fielded this year and an untethered version is due out in 2020. A DOD-funded research lab is developing an electrostatic forces gripper that will improve a soldier's ability to climb walls. Meanwhile, U.S. Special Operations Command (SOCOM) began the Tactical Assault Light Operator Suit (TALOS) program in 2013 to bring the warfighter an array of special capabilities from full-body

advanced armor and enhanced situational awareness to thermal management and command and control. The exoskeleton suit will include wearable computers and health monitoring systems capable of stabilizing wounds until care arrives. SOCOM aims to field TALOS by 2018 and is capturing innovations from 56 companies, 16 government agencies, 13 universities, and 10 national laboratories.<sup>29</sup>

Technological advances are also making equipment lighter for combat troops. The Massachusetts Institute of Technology (MIT), for example, is researching a liquid body armor that converts to a solid in milliseconds after a magnetic field or electrical current is applied.<sup>30</sup> To cut down on the weight of battery packs carried by combat operators, the Office of Naval Research (ONR) is developing

a flexible solar panel to charge flat-form batteries with incredible efficiency. These batteries, called Marine Austere Patrolling System (MAPS), will weigh only six pounds and should be fielded in the next five years.<sup>31</sup> Another DARPA-funded research center is developing an autonomously guided kite that generates tens of kilowatts of power simply through flight. Such a system would enable a combat squad to regenerate power autonomously and dramatically reduce the overall weight in batteries the unit must transport.

While such innovations will certainly help reduce the overall weight required to be carried by the individual soldier over the coming years, heavy loads will not be completely eliminated from a combat unit. Robotics, however, may change *how* the unit carries those loads.



Lance Cpl. M. L. Meier, U.S. Marine Corps

Military robotics, such as “Big Dog,” may level the playing field for women in combat.



DARPA's Legged Squad Support System (LS3) program created a robotic mule capable of carrying loads of over 400 pounds over a wide variety of terrain. Affectionately known as "Big Dog," the robot is able to traverse terrain in one of three modes: leader-follower (where the robot follows close behind the human leader), semi-autonomously (where the soldier selects the destination but the robot selects the path), or a leader-follower corridor (where the robot follows the human leader but has wider latitude to select its preferred path). Though continued work is underway to develop a quiet electric motor to power the system (vice the currently loud diesel engine), the LS3 could be operational in the decade.<sup>32</sup>

Future combat units will also utilize unmanned ground vehicles (UGVs) for carrying loads and battlefield resupply and logistics. Such UGV reliance is operational today in the State of Israel, which is currently operating over 200 UGVs in the field. Israeli UGVs range from the small, battery-powered, tele-operated UGVs, like RoboTeam's ProBot that can carry a payload of 550 pounds, to large UGV trucks and armored personnel carriers.<sup>33</sup> Some Israeli robotics companies have been building UGVs for over eight years and have over 70,000 hours of operational field experience. G-Nius provides an applique to the customer's preferred platform to convert it to an unmanned system. The UGV can then be tele-operated, drive semi-autonomously (where the system will stop when it sees an obstacle and rely on a human to resolve the obstacle before starting again), or operate fully autonomously, with the ability to recognize and resolve obstacles and make the best route planning decisions.<sup>34</sup> The United States has explored UGV technology (to include some Israeli UGV technology)

and laid out a roadmap for joint acquisition of UGVs in 2011.<sup>35</sup>

Full integration and reliance on robotic and autonomous systems by U.S. ground combat units is far from a "next generation or so" idea. Former Army Chief of Staff, General Raymond Odierno, recognizes that robotics will be an integral part of the force of 2025 and included robotics development as one of just eight lines of effort essential to achieving the Army's ten-year strategy.<sup>36</sup> To that end, DARPA is investing in Squad X, a program that promotes man-unmanned teaming within a dismounted infantry squadron. Squad X capitalizes on the interface between robotic technology and soldiers to improve precision engagement, command and control, detection of threats, and overall squad situational awareness. Whether improving an individual soldier's personal performance, carrying equipment to the battlefield, or enhancing a squad's combat lethality, robots are poised to change the nature of ground combat.

### Impact of Robotics Revolution on Women in Combat Debate

The most apparent consequence of this changing battlefield and growing reliance on robotics systems is the impact on the physical requirements necessary for ground combat forces. The combination of robotic-enabled enhancements of a soldier's physical capabilities with lighter combat gear and robotic mules will quickly level the physical capability gap between men and women. For example, the exoskeletons being developed today result in a 25 percent improvement of physical strength and endurance—enough to close the aerobic and anaerobic delta between the average man and the average woman. With the ability to run faster, lift more weight, and carry

weight for longer periods of time without physical injury, the average woman will meet or exceed combat capability standards—and that is before receiving targeted physical training and conditioning proven to improve women’s physical prowess.

Skeptics might argue that robotic and autonomous systems will simply make male soldiers able to run faster and lift more, thus eliminating any derived benefit for women. While in the initial implementation stages of robotic exoskeletons such argument may have merit, it would be myopic to think that technology will not one day eliminate all such distinctions. Indeed, the essential attributes of future warriors will almost certainly derive less from physical strength and more from technical abilities.<sup>38</sup> Furthermore, such skeptical thinking neglects the affirmative arguments for capitalizing on gender diversity in the future robotic battlespace.

The U.S. military needs gender diverse combat units to better implement robotic and autonomous systems technology on the future battlefield. Autonomy will not just change what tools soldiers use to fight but *how* the fight will be conducted. While advances like the Squad X system or TALOS may sound otherworldly, technological progress is not the major driver of combat capabilities. As one roboticist explained, “[h]istorically when one looks at major changes in combat, it hasn’t been due to the gadget itself; it is the gadget that enabled the CONOPS to change.”<sup>39</sup> To date, much of the U.S. military’s implementation of robotic and autonomous systems has simply been to replace an existing function performed by a human with a robot, especially when such a task is dull, dirty, or dangerous. Unfortunately, the potential of robotics will not be reached with such linear thinking.

The U.S. military must begin to field combat teams and grow combat leaders who are willing and able to think and implement autonomous systems in new and creative ways. To do this most effectively, combat teams need a diverse mix of individuals—including men and women. Diverse teams have been shown to think more creatively, accept change more readily, and solve problems more effectively.<sup>40</sup> The same has proven true in the technology field. As one commentator explained, “[w]omen bring unique talents and perspectives to the table in any field, but they are particularly vital to a world of invention and innovation shaped by technology.”<sup>41</sup> A leading engineer in the defense industrial base remarked that she seeks out diverse teams especially in the area of robotics because such teams approach issues differently and find more effective and creative solutions to problems.<sup>42</sup> It is this same creativity and problem-solving that the U.S. military needs in its future robotic-propelled combat forces.

Israel has already discovered the importance of utilizing women in the employment of robotic and autonomous systems. During the latest ground campaign, the Israeli Defense Forces (IDF) discovered that the best controllers of their UGVs were women. The IDF determined that their female soldiers possessed better focus and attention to detail—attributes necessary when viewing a multitude of sensors and employing robotic systems in ground combat. Additionally, IDF leadership found women displayed more self-restraint and deliberation before employment of weapons from the UGV, a skill set much in demand during a conflict where collateral damage or killing of non-combatants was heavily scrutinized. The benefits of woman-unmanned teaming were so great the IDF placed all UGV

operations in the hands of woman soldiers.<sup>43</sup> While (in this author's opinion) all-female employment of robotic and autonomous combat technology tips the balance too far, the United States can learn from the Israeli experience and recognize the potential benefits of integrating women into all combat units.

### A Question of When...Not If

Given that robotic technology has the potential to minimize the physical distinctions between genders on the battlefield, and positive benefits exist for diverse employment of autonomous systems in combat, the question remains as to when to integrate ground units fully. Should the services proactively integrate women into ground combat roles in anticipation of a changing robotics battlefield, or should they wait for the technology to mature? In implementing the Secretary of Defense's

2013 guidance to set gender-neutral standards for ground combat units, the services have consistently stressed that physical standards and training will not change, while simultaneously trying to study and justify why those standards exist in the first place.<sup>44</sup> Simply put, the services are focused on determining what standards (physical and mental) need to be met for today's fight...not what qualities ground combat forces will need in the future. Such an approach will not position the force to maximize the potential of autonomous systems.

To best utilize robotic and autonomous systems, a diverse set of warriors needs to be both on the battlefield implementing the technology and in positions of leadership to develop CONOPs and policy. Men *and* women need to be in the room when deciding ethical questions surrounding autonomous weapons



Cpl. Zeev Marmorstein, IDF Spokesperson's Unit

Israeli soldier with UGV.

employment, when developing requirements for future technological advances in robotic systems, and when formulating creative ways to employ the nascent technology.<sup>45</sup> Women will not appear in the decision room overnight as the military grows its future leaders from the ground up. Every year the U.S. military delays full and proactive integration of women into ground combat is another delay in the pipeline of developing female military leaders with the ground combat experience necessary to positively impact the application of robots in the battlespace. Thus, the question for today's senior leaders should not be whether women can pass today's current combat course, but how soon the military can integrate women into ground combat squads in order to best employ robotic and autonomous systems against the enemy. **PRISM**

## Notes

<sup>1</sup> As a student at the National Defense University's Dwight D. Eisenhower School for National Security and Resource Strategy (distinguished graduate), Colonel Letendre received the 2015 NDU Women, Peace, and Security writing award for this article. The views expressed herein are those of the author and do not necessarily reflect the official policy or position of the United States Air Force Academy, the U.S. Air Force, the Department of Defense, or the U.S. Government.

<sup>2</sup> "SASC Testimony," YouTube video, General Robert H. Barrow, 27th Commandant of the Marine Corps testimony before the SASC on Women in Combat, June 1991, posted by Robert Barrow. <<https://www.youtube.com/watch?v=fy--whDNNKk>>.

<sup>3</sup> David F. Burrelli, "Women in Combat: Issues for Congress," Congressional Research Service, (May 9, 2013): 4-5.

<sup>4</sup> Secretary Leon Panetta and General Martin Dempsey, U.S. Department of Defense, "Elimination of the 1994 Direct Ground Combat Definition and Assignment Rule," (January 24, 2013). <<http://www.defense.gov/news/WISRJointMemo.pdf>>.

<sup>5</sup> Ibid.

<sup>6</sup> U.S. Marine Corps, "Ground Combat Element Integrated Task Force," <<http://www.gceitf.marines.mil/>>.

<sup>7</sup> Matthew Rosenberg and Dave Phillips, "All Combat Roles Now Open to Women, Defense Secretary Says," *New York Times*, December 3, 2015. <[http://www.nytimes.com/2015/12/04/us/politics/combat-military-women-ash-carter.html?\\_r=0](http://www.nytimes.com/2015/12/04/us/politics/combat-military-women-ash-carter.html?_r=0)>.

<sup>8</sup> Cheryl Pellerin, "Dempsey: Allowing Women in Combat Strengthens Joint Force," Armed Forces Press Service, January 24, 2013. <<http://www.defense.gov/news/newsarticle.aspx?id=119100>>.

<sup>9</sup> Lisa Grossman, "The Right to Fight: Women at War," *New Scientist*, (February 2, 2013): 6.

<sup>10</sup> Robert L. Maginnas, *Deadly Consequences: How Cowards Are Pushing Women into Combat* (Washington, D.C.: Regnery Publishing Inc., 2013): 79 and 82.

<sup>11</sup> Rosemarie Skaine, *Women in Combat: A Reference Handbook* (Santa Barbara: ABC-CLIO, 2011): 57.

<sup>12</sup> Kingsley Browne, Co-Ed *Combat: The New Evidence that Women Shouldn't Fight the Nation's Wars* (New York: Sentinel, 2007): 28-29.

<sup>13</sup> Ibid, 130-146; Maginnas, 138-140.

<sup>14</sup> Skaine, 62.

<sup>15</sup> Ibid, 57 and 59. Even critics recognize the contributions of women warriors throughout history. Maginnas, 12-18. The “Long-haired Warriors” denote the upwards of one million Vietnamese women who fought the French in the early 20<sup>th</sup> Century and later the Americans in the Vietnam Conflict. David E. Jones, *Women Warriors: A History*, (Washington, D.C.: Potomac Books Inc., 2005): 33-36.

<sup>16</sup> Skaine, 61.

<sup>17</sup> Department of Defense, “Report of the Comprehensive Review of the Issues Associated with a Repeal of ‘Don’t Ask, Don’t Tell,’” (November 30, 2010): 98-99.

<sup>18</sup> Skaine, 38-39 and 64.

<sup>19</sup> Grossman.

<sup>20</sup> Unless otherwise noted, the research for this section was derived from numerous interviews with robotics industry engineers, academic research labs, and military personnel during the author’s study (2014-2015) at the Dwight D. Eisenhower School for National Security and Resource Strategy.

<sup>21</sup> U.S. Department of Defense, Defense Science Board, “Task Force Report: The Role of Autonomy in DoD Systems,” (July 2012): 62 and 1. <<http://www.acq.osd.mil/dsb/reports/AutonomyReport.pdf>>.

<sup>22</sup> Hugh Gusterson, “Toward an Anthropology of Drones: Remaking Space, Time, and Valor in Combat,” in *The American Way of Bombing: Changing Ethical and Legal Norms, From Flying Fortresses to Drones*, Matthew Evangelista and Henry Shue, eds., (Ithaca, NY: Cornell University Press, 2014): 191, 193, and 196.

<sup>23</sup> Paul Scharre, “Robotics on the Battlefield Part II: The Coming Swarm,” Center for New American Security, (October 2014): 5.

<sup>24</sup> Jeremiah Cushman, “Rise of Men Inside the Machines,” *Military Periscope Special Reports*, December 18, 2014.

<sup>25</sup> Ibid.

<sup>26</sup> American Society for Engineering Education: PRISM, “Wearable Technology: Power Suit,” November 2014, <<http://www.asee-prism.org/first-look-nov-2/>>; “U.S. Military Funds Soft Exoskeleton for Enhanced Soldiers,” *The Engineer*, September 18, 2014. “U.S. Military Funds Soft Exoskeleton for Enhanced Soldiers,” *The Engineer*, September 18, 2014.

<sup>27</sup> Jeremy Hsu, “The Weight of War: Modern Technology Tackles the Ancient Issue of Combat Loads,” *Popular Science*, (November 2014): D61.

<sup>28</sup> Cushman.

<sup>29</sup> John Keller, “Special Operations Needs Battle Suit with Cooling, Embedded Computers, and Sensors,” *Military & Aerospace Electronics*, October 2013; Cushman.

<sup>30</sup> Cushman.

<sup>31</sup> Hsu.

<sup>32</sup> Ibid.

<sup>33</sup> Roboteam, “Probot,” accessed March 19, 2015. <<http://www.robo-team.com/products/Systems/probot>>.

<sup>34</sup> G-Nius Unmanned Ground Systems, “Products,” accessed March 19, 2015. <<http://g-nius.co.il/unmanned-ground-systems/index.php>>.

<sup>35</sup> Department of Defense, Robotics Systems Joint Program Office, “Unmanned Ground Systems Roadmap,” (July 2011). <[http://www.dtic.mil/ndia/2011MCSC/Thompson\\_UGSRoadmap.pdf](http://www.dtic.mil/ndia/2011MCSC/Thompson_UGSRoadmap.pdf)>.

<sup>36</sup> Secretary John M. McHugh and General Raymond T. Odierno, Department of the Army, “*FORCE 2025 and Beyond - SETTING THE COURSE*,” (July 22, 2014). <[http://www.arcic.army.mil/app\\_Documents/TRADOC\\_Memo\\_Force-2025-and-Beyond-Setting-the-Course\\_06AUG2014.pdf](http://www.arcic.army.mil/app_Documents/TRADOC_Memo_Force-2025-and-Beyond-Setting-the-Course_06AUG2014.pdf)>; Department of the Army, “Training and Doctrine Command’s (TRADOC) Technology and Capability Objectives for Force 2025 and Beyond,” (August 4, 2014). <[http://www.arcic.army.mil/app\\_Documents/ARCIC\\_InformationPaper\\_TRADOC-Technology-and-Capability-Objectives-for-Force-2025-and-Beyond\\_18AUG14.pdf](http://www.arcic.army.mil/app_Documents/ARCIC_InformationPaper_TRADOC-Technology-and-Capability-Objectives-for-Force-2025-and-Beyond_18AUG14.pdf)>.

<sup>37</sup> DARPA, “Squad X Core Technologies Seeks to Bring Technological Advances to the Infantry Squad,” (February 9, 2015). <<http://www.darpa.mil/NewsEvents/Releases/2015/02/09a.aspx>>.

<sup>38</sup> Caroline Kennedy-Pipe, “Women and the Military,” *Journal of Strategic Studies* 23, no. 4 (2000): 32 abd 45.

<sup>39</sup> Defense contractor, interview with the author (January 30, 2015).

<sup>40</sup> Howard J. Ross, *ReInventing Diversity: Transforming Organizational Community to Strengthen People, Purpose, and Performance* (Lanham, MD: Rowman & Littlefield, 2011): 24-25.

<sup>41</sup> Whitney Johnson, “Women are the Great Disruptors,” in *Innovating Women: The Changing Face of Technology*, eds. Vivek Wadhwa and Farai Chideya, (Diversion Books, 2014): chap. 1, Kindle. The STEM-gap between genders means that women with technical background and experience are in high demand. If the military hopes to compete successfully for such women, equality of opportunity across all occupational specialties must be real.



<sup>42</sup> Katherine Lemos, interview with the author (March 8, 2015).

<sup>43</sup> The author learned about Israeli experiences through a variety of interviews of Israeli Defense Forces (IDF) officials and contractors during her field studies while a student of National Defense University's Dwight D. Eisenhower School for National Security and Resource Strategy (March 6-11, 2015).

<sup>44</sup> David Martin, "A Few Good Women," *Sixty Minutes*, aired March 15, 2015 on CBS, <<http://www.cbsnews.com/news/female-marines-women-in-combat-60-minutes/>>. The Marine Corps hired the Neuromuscular Research Lab at the University of Pittsburgh to conduct a "thorough scientific approach to testing and analysis of tactical requirements and musculoskeletal and physiological profiles of Marines."; Neuromuscular Research Lab, "USMC Initiative Launched." <<http://www.nmrl.pitt.edu/news-story/usmc-initiative-launched>>.

<sup>45</sup> For commentary on why a feminist approach to ethics in employing autonomous systems is essential from an international relations perspective, see Eric M. Blanchard, "The Technoscience Question in Feminist International Relations: Unmanning the U.S. War on Terror," in *Feminism and International Relations*, eds. J. Ann Tickner and Laura Sjoberg, (London: Routledge, 2011): 146 and 162.

## Photos

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