

UNMANNED SYSTEMS IN PERSPECTIVE

A Monograph

by

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AY 2014-001

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 22 MAY 2014		2. REPORT TYPE Master's Thesis		3. DATES COVERED (From - To) JUN 2013-MAY 2014	
4. TITLE AND SUBTITLE Unmanned Systems in Perspective				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Major David F. John, United States Air Force				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) School of Advanced Military Studies 201 Reynolds Avenue Ft. Leavenworth, KS 66027				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College ATTN: ATZL-SWD-GD Fort Leavenworth, KS 66027-2301				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT Unmanned systems have become a vital component of US military operations in the twenty-first century. They are here to stay, and their utility will continue to expand. Nevertheless, uninformed beliefs and biases continue to skew the discourse regarding unmanned systems. These systems do not constitute a fundamental change in the nature or character of warfare. Policymakers, strategists, or operators who attempt to use unmanned systems in place of human prudence will be profoundly disappointed with the results. They are not a revolution in military affairs, nor do they provide easy answers to the challenges of war. While all of the Services have developed and fielded unmanned systems, the US Air Force's evolution of unmanned aircraft since 2001 is particularly illuminating for future endeavors. Rather than pursue robotic autonomy, the US military must cultivate professional service members with the skill and discipline to wield unmanned systems adeptly. The Services must fully integrate the tactics and technology of unmanned systems with manned components of the force, as both will be crucial in future endeavors. Leaders should never allow technology to dictate policy or strategy; unmanned systems must always fit into legitimate and comprehensive plans.					
15. SUBJECT TERMS Unmanned Systems, Remotely Piloted Aircraft, Robotic Autonomy, Technology, Professionalism, Planning, Legality					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT (U)	18. NUMBER OF PAGES 94	19a. NAME OF RESPONSIBLE PERSON
a. REPORT (U)	b. ABSTRACT (U)	c. THIS PAGE (U)			19b. TELEPHONE NUMBER (include area code)

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The opinions and conclusions expressed herein are those of the student author, and do not necessarily represent the views of the US Army Command and General Staff College or any other government agency. (References to this study should include the foregoing statement.)

ABSTRACT

UNMANNED SYSTEMS IN PERSPECTIVE, by Major David F. John, United States Air Force, 94 pages.

Unmanned systems have become a vital component of US military operations in the twenty-first century. They are here to stay, and their utility will continue to expand. Nevertheless, uninformed beliefs and biases continue to skew the discourse regarding unmanned systems. These systems do not constitute a fundamental change in the nature or character of warfare. Policymakers, strategists, or operators who attempt to use unmanned systems in place of human prudence will be profoundly disappointed with the results. They are not a revolution in military affairs, nor do they provide easy answers to the challenges of war. While all of the Services have developed and fielded unmanned systems, the US Air Force's evolution of unmanned aircraft since 2001 is particularly illuminating for future endeavors.

Rather than pursue robotic autonomy, the US military must cultivate professional service members with the skill and discipline to wield unmanned systems adeptly. The Services must fully integrate the tactics and technology of unmanned systems with manned components of the force, as both will be crucial in future endeavors. Leaders should never allow technology to dictate policy or strategy; unmanned systems must always fit into legitimate and comprehensive plans.

ACKNOWLEDGEMENTS

I would like to thank Dr. Bob Tomlinson for his flexibility and patience as my monograph director. He allowed me the freedom I needed to explore this subject while still providing sage and timely guidance to keep me on track. I earnestly hope that the final product reflects this mutual trust. I am also indebted to Col Uwe Jansohn for his mentorship. His advice and his example have taught me a great deal about leadership at the field grade level and above.

To the instructors and graduates of the 26th Weapons Squadron, whose research and recommendations invigorated much of my thesis, and to the RPA instructor pilots who reviewed my drafts: I am grateful for your assistance and honored to be a member of your community. What we do and say profoundly affects the future of the Air Force. We have to get this right, and based upon your examples, I know that we will.

Deepest thanks go to my family, whose painstaking reviews helped to make my prose legible to a broader spectrum of readers than folks who wear green pajamas to the office. Chief among these is my wonderful wife. Her tireless efforts as a brand-new mother to our son provided me with the maneuvering space I needed to complete this project despite the (blissful) cacophony of novel sounds and duties.

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ACRONYMS

AOC	Air Operations Center
ATC	Air Traffic Control
CAP	Combat Air Patrol
DARPA	Defense Advanced Research Projects Agency
DOD	Department of Defense
DODD	Department of Defense Directive
FCS	Future Combat System
FMV	Full-motion Video
GPS	Global Positioning System
ICBM	Intercontinental Ballistic Missile
IED	Improvised Explosive Device
ISR	Intelligence, Surveillance, and Reconnaissance
JFACC	Joint Force Air Component Commander
JTAC	Joint Terminal Air Controller
LCS	Littoral Combat Ship
PTSD	Posttraumatic Stress Disorder
ROE	Rules of Engagement
RPA	Remotely Piloted Aircraft
RSO	Remote Split Operations
SA	Situational Awareness
SATCOM	Satellite Communications
SEAL	Sea, Air, Land
SIGINT	Signals Intelligence
SR-UAV	Short-Range Unmanned Aerial Vehicle
TTP	Tactics, Techniques, and Procedures

UAS	Unmanned Aircraft System(s)
UAV	Unmanned Aerial Vehicle
UCAS	Unmanned Combat Air System(s)
UGS	Unmanned Ground System(s)
UGV	Unmanned Ground Vehicle
UMS	Unmanned Maritime System(s)
UN	United Nations
USAF	United States Air Force
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle

INTRODUCTION

Technology alone has never won a war. Genghis Khan's stirrups, Hernán Cortés's firearms, and America's atomic bombs all gave their users critical advantages, but they were pivotal only because they fit into situations and strategies that suited their use. Unmanned systems today fall into the same category. Though many see so-called "drones" as a revolutionary, ominous development in warfare, in fact they are nothing of the sort. Unmanned systems do not constitute a fundamental change in the nature or character of warfare. Policymakers, strategists, or operators who attempt to use unmanned systems in place of human prudence will be profoundly disappointed with the results.

Two explanations exist for the burgeoning interest in military unmanned systems over the past decade. The first is the most obvious: they are multiplying across the globe. Advances in technology, cost considerations, and persistent conflicts waged by modern societies fuel this proliferation. Unmanned systems satisfy numerous requirements for policymakers and combatants. Their utility will continue to expand.

The second explanation for the prevalence of unmanned systems in public discourse is more subjective—they impassion people across a wide spectrum of beliefs and interests. Engineers envision marvelous new creations. Futurists and philosophers contemplate the implications of autonomous robots. The defense industry sees a profitable market. Military budgeters imagine billions of dollars in savings. Commanders clamor for solutions to extend their situational awareness (SA) and control of the battlespace.¹ Soldiers, sailors, airmen, and Marines

¹"Situational Awareness: The perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the future." Department of Defense, *Unmanned Systems Safety Guide for DoD Acquisition*, Version .96 (Washington, DC: Department of Defense, January 2007), http://www.ndia.org/Divisions/Divisions/Robotics/Documents/Content/ContentGroups/Divisions1/Robotics/UMS_SafetyPolicyVer096_Released.pdf (accessed 1 March 2014), 16.

(and their loved ones) envision war without friendly casualties. Meanwhile, pacifists proclaim that drones are slaughtering innocents, and conspiracy theorists think the movie *The Terminator* is now a reality.²

In other words, assertions about unmanned systems often depend more on a speaker's beliefs than on the facts, and these biases distort the collective discussion. The critical thinker must endeavor to minimize these inevitable shades, but one cannot eliminate them. The following analysis just as surely reflects the author's own biases. He is a United States Air Force (USAF) senior pilot of both manned and unmanned aircraft, and holds dual master's degrees in military history and military operational art and science. This background suggests an opportunity for contextual accuracy that many voices in the debate may lack.

This project consists of five parts. Section I examines the evolution of unmanned systems into the types currently employed by the US military. Section II analyzes the ways in which the USAF has integrated unmanned aircraft systems (UAS) into the modern battlefield.³ Section III addresses the false notion that unmanned systems are a revolution in military affairs (RMA), and debunks flawed assumptions regarding the development and employment of this technology. Section IV delves into the realm of policy to demonstrate that unmanned systems change neither the nature nor the rules of armed conflict. Finally, Section V presents three recommendations for the further development and operation of military unmanned systems: professional discipline, comprehensive integration, and prudent strategy.

The lexicon surrounding unmanned systems remains in a state of flux (so it goes with military jargon). This project will adhere to the terminology contained within Joint Publication 1-

²Nick Turse and Tom Engelhardt, *Terminator Planet: The First History of Drone Warfare, 2001-2050* (Lexington, KY: Dispatch Books, 2012), 4.

³The term Unmanned Aerial Vehicle (UAV) refers to an aircraft per se, while Unmanned Aircraft System (UAS) denotes the collection of components that make up a complete package, to include aircraft, control station, launch and recovery equipment, communications relays, etc.

02 and the Department of Defense (DOD) *Unmanned Systems Integrated Roadmap FY2011-2036*, but direct quotes will preserve authors' original phrasing and abbreviations. The expression "unmanned system(s)" will remain unabbreviated throughout this discussion. The inaccurate and pejorative term "drones" will appear only by exception.

I – UNMANNED SYSTEMS PAST AND PRESENT

Humanity has been on a quest to increase standoff distance in warfare ever since an early hominid first thought to hurl a rock instead of bludgeoning his enemy. While the intercontinental ballistic missile (ICBM) and its younger sibling the cruise missile are the ultimate weapons in distance warfare, the military technically does not regard them as unmanned systems. The *Unmanned Systems Safety Guide* defines an unmanned system as such:

An electro-mechanical system that is able to exert its power to perform designed missions and includes the following: (1) there is no human operator aboard and (2) the system is designed to return or be recoverable. The system may be mobile or stationary. [Unmanned Systems] include unmanned ground vehicles [UGVs], unmanned aerial vehicles [UAVs], unmanned underwater vehicles [UUVs], unattended munitions, and unattended ground sensors. Missiles, rockets and their submunitions, and artillery are not considered [unmanned systems].⁴

The development of unmanned systems spanned the twentieth century. In 1898, Nicola Tesla built a radio-controlled boat, which he envisioned as a potential weapon. Western militaries developed remote-controlled aircraft and torpedoes during World War I, but none proved particularly successful.⁵ Further development occurred during the interwar years but reliability and accuracy remained problematic. During World War II, Japan experimented with unmanned air, sea, and ground vehicles, but ultimately it addressed the accuracy problem by resorting to the kamikaze. Germany actually deployed several thousand UGVs called *Goliath*, but their slow

⁴Department of Defense, *Unmanned Systems Safety Guide*, 1.

⁵Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons* (Burlington, VT: Ashgate, 2009), 15-16; Jeremiah Gertler, *U.S. Unmanned Aerial Systems* (Washington, DC: Congressional Research Service, 3 January 2012), <http://fpc.state.gov/documents/organization/180677.pdf> (accessed 1 March 2014), 1.

speed, unwieldy cable link, and lack of a camera (forcing operators to remain within eyesight) made them impractical in combat.⁶ The Allies remained largely disinterested in unmanned systems during the war, notwithstanding the tragic crash of an experimental remotely controlled B-24 bomber that claimed the life of Joseph P. Kennedy Jr., the future president's older brother.⁷

Following World War II, the US military's interest in unmanned systems began to grow. The US Navy used unmanned maritime systems (UMS) to conduct minesweeping operations and to take radioactivity samples after nuclear tests.⁸ In the late 1960s, the USAF first experimented with manned-unmanned teaming by remotely controlling AQM-34 UAVs from an airborne C-130 aircraft.⁹ Most UAVs during the Cold War flew as practice targets, as decoys for enemy radars, or for limited intelligence collection.¹⁰ Concurrently, the US military made great strides with precision-guided weapons and satellite technology, both of which proved crucial to future unmanned endeavors.¹¹

The 1990s heralded the modern age of unmanned systems with the arrival of the General Atomics RQ-1 Predator, which flew reconnaissance missions over the conflicts in the Balkans from 1995 onward.¹² The National Defense Authorization Act of 2001 gave the DOD the goal to

⁶Krishnan, 16-18.

⁷Ibid., 18-19. The crew flew the takeoff and initial navigation of the bomber before setting the autopilot, arming the payload, and preparing to bail out. Unfortunately, the explosives detonated prematurely.

⁸Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036* (Washington, DC: Department of Defense, 2011), <http://www.defenseinnovationmarketplace.mil/resources/UnmannedSystemsIntegratedRoadmapFY2011.pdf> (accessed 1 March 2014), 25.

⁹Ibid., 82.

¹⁰Gertler, 1.

¹¹Krishnan, 19-22.

¹²Christopher Drew, "Drones are Weapons of Choice in Fighting Qaeda," *The New York Times*, 16 March 2009, <http://www.nytimes.com/2009/03/17/business/17uav.html> (accessed 1 March 2014). The coalition did deploy several variants of UAS during the 1991 Gulf War for reconnaissance and gunnery spotting purposes. See Gertler, 2.

convert one third of its deep strike aircraft into unmanned systems within a decade.¹³ In the first half of 2001, the US military began test firing AGM-114 Hellfire missiles from Predator aircraft.¹⁴ The anti-tank Hellfire's lightweight design, laser-guided precision, and modifiable warhead made it a flexible weapon for a wide array of potential targets.

The events of 11 September 2001 (i.e. 9/11) accelerated the weaponization of unmanned systems. On 7 October 2001, the United States first flew an armed Predator over Afghanistan,¹⁵ and on 4 February 2002, a Predator launched the first Hellfire in combat. The alleged target was a tall Saudi expatriate wanted for the recent murder of 3,000 American civilians. The identification proved erroneous, and Osama bin Laden survived for another nine years before his death at the hands of US Navy SEALs.¹⁶ By the end of the first year of Operation Enduring Freedom, Predator crews had launched Hellfires at 115 targets in Afghanistan.¹⁷

In December 2002, the USAF conducted an on-the-job experiment with unmanned air-to-air combat by loading AIM-92 Stinger missiles on its Predators flying over Iraq. One Predator fired a Stinger at an attacking Iraqi MiG-25 fighter, but it missed—the MiG did not.¹⁸

¹³National Defense Authorization Act, Fiscal Year 2001, Appendix. 106th Cong., 30 October 2000. Public Law 106-398, <http://www.gpo.gov/fdsys/pkg/PLAW-106publ398/pdf/PLAW-106publ398.pdf> (accessed 1 March 2014), 1654A-38; Gertler, 2.

¹⁴George Tenet, "Written Statement for the Record of the Director of Central Intelligence before the National Commission on Terrorist Attacks Upon the United States," 24 March 2004, http://www.9-11commission.gov/hearings/hearing8/tenet_statement.pdf (accessed 1 March 2014), 15.

¹⁵*Ibid.*, 16.

¹⁶Thom Shanker and James Risen, "A Nation Challenged: Raid's Aftermath; U.S. Troops Search for Clues to Victims of Missile Strike," *The New York Times*, 11 February 2002, <http://www.nytimes.com/2002/02/11/world/nation-challenged-raid-s-aftermath-us-troops-search-for-clues-victims-missile.html> (accessed 1 March 2014).

¹⁷P. W. Singer, *Wired for War: The Robotics Revolution and Conflict in the Twenty-first Century* (New York, NY: Penguin Press, 2009), 35.

¹⁸Matt J. Martin and Charles W. Sasser, *Predator: The Remote-Control Air War over Iraq and Afghanistan: A Pilot's Story* (Minneapolis, MN: Zenith Press, 2010), 21; David A. Fulghum, "Predator's Progress," *Aviation Week and Space Technology* 158, no. 9 (3 March 2003): 48.

Unmanned Aircraft in the US Military

The Predator is the best-known UAS, but it is only one of many unmanned systems currently flying over conflict zones. The growth of UAS in the past two decades brings to mind the development and proliferation of manned aircraft in the years immediately prior to and during World War II.¹⁹ In the United States, the late 1930s and early 1940s saw the progression of fighter aircraft from outdated monoplanes into the venerable P-51 Mustang and jet prototypes, while twin-engine bombers paved the way for the mighty B-29 Superfortress. Likewise, UAS operated by the US military have burgeoned from simple prototypes into a wide array of sizes and capabilities.

The DOD categorizes its operational UAS into five groups.²⁰ Group 1 consists of short-range unmanned aerial vehicles (SR-UAVs). SR-UAVs in the current DOD inventory are unarmed and communicate via direct line-of-sight (LOS) signals. These platforms, currently flown by all the Services, include hand-launched UAVs like the RQ-11 Raven. The Raven provides “over the hill” situational awareness (SA) to troops in the field. These troops can manually fly the SR-UAV, or program it via Global Positioning System (GPS) waypoints, out to a range of seven to ten miles. Its camera, which sends live video back to the operator, includes both electro-optical (i.e. television) and infrared modes. The WASP III, also known as the Battlefield Air Targeting Micro Air Vehicle (BATMAV), is an even smaller UAV used by Special Operations Command and the US Marines. It has a range of three miles with electro-optical and infrared capabilities similar to the Raven’s sensors.²¹

¹⁹Gertler, 6.

²⁰Each of the Services groups its UAS into tiered systems that do not always correspond to the other Services’ categories; the DOD’s five-group methodology is one attempt to rectify this confusion.

²¹Headquarters, United States Air Force, *United States Air Force Unmanned Aircraft Systems Flight Plan 2009-2047* (Washington, DC: Headquarters, United States Air Force, 18 May 2009), www.govexec.com/pdfs/072309kp1.pdf (accessed 1 March 2014), 25-26.

Group 2 consists of the Scan Eagle, an albatross-sized UAS launched via catapult, to include mounts on US Navy ships. The Scan Eagle can fly via preprogrammed waypoints out to sixty miles for up to twenty hours. The Navy and Marines plan to replace their Scan Eagles with a new Small Tactical Unmanned Aerial System (STUAS), with similar real-time intelligence, surveillance and reconnaissance (ISR) capabilities.²²

Group 3 contains the slightly larger RQ-7 Shadow and the MQ-5 Hunter. These UAS fly higher, faster, longer, and farther than the UAS in Groups 1 and 2, but they remain tethered to a LOS data link.²³ While the RQ-7 is unarmed, the US Army has equipped several of its MQ-5s with small laser-guided bombs (the “M” designates multi-role, i.e. weapon carrying, versus the unarmed “R,” for reconnaissance).²⁴

Group 4 is the domain of the MQ-1 (formerly RQ-1) Predator. It can carry up to two Hellfire missiles and pilots can fly it using LOS signals or via satellite communications (SATCOM). Because SATCOM introduces approximately a two-second roundtrip delay between an operator’s input and the visible aircraft response, USAF crews launch the Predator via LOS. They then transfer control to a geographically separated crew that uses SATCOM to fly missions that can last over twenty-two hours. Remote split operations (RSO) is the term for this collaboration.²⁵ Also included in Group 4 is the US Army’s MQ-1C Gray Eagle, a Predator variant that the Army continues to improve and field in greater numbers, and the MQ-8 Fire Scout unmanned helicopter.²⁶ The latter currently is in testing to carry small laser-guided

²²Gertler, 45-46.

²³Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 21.

²⁴Army Technology, “Hunter RQ-5A / MQ-5B/C UAV, United States of America,” *Army-Technology.com*, n.d., <http://www.army-technology.com/projects/hunter> (accessed 1 March 2014).

²⁵United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 26.

²⁶Tamir Eshel, “Improving the Army’s Gray Eagle,” *Defense Update*, 30 July 2013, http://defense-update.com/20130730_improving-the-armys-gray-eagle-mq-1c.html (accessed 1 March 2014).

rockets.²⁷ The Navy's Unmanned Combat Air System (UCAS), presently in the initial stages of development, will be the subject of further analysis below.²⁸

Group 5 consists of the largest UAS in today's inventory: the MQ-9 Reaper, RQ-4 Global Hawk, and RQ-170 Sentinel. The Reaper is essentially the Predator's big sibling. It can carry up to 3,000 pounds of weapons, currently a combination of Hellfires and 500-pound laser- or GPS-guided bombs. It also can mount payloads like synthetic aperture radar, wide-angle cameras, and other signals intelligence (SIGINT) equipment.²⁹ Reapers eventually will supplant Predators in the USAF inventory, though the timing of this phased replacement remains in flux.³⁰

Dwarfing the Reaper is the RQ-4 Global Hawk, which boasts a 130-foot wingspan. It is significantly larger than the U-2 spy plane of Cold War fame that it was designed to replace (both aircraft remain in service today). The RQ-4 has a 60,000-foot ceiling, 28-hour endurance, a range of 8,700 miles, and cruises at over 300 knots using a turbofan jet engine.³¹ In 2001, one flew nonstop from the United States to Australia.³² The Global Hawk uses RSO similar to the Predator and Reaper, though pilots typically fly it using preplanned autopilot routes rather than manually.³³ The unarmed Global Hawk's missions are ISR and battlefield communication support.³⁴

²⁷Dave Majumdar, "AUVSI: Northrop Close to Completing Firescout Weapon Tests," *Flightglobal*, 14 August 2013, <http://www.flightglobal.com/news/articles/auvsi-northrop-close-to-completing-firescout-weapon-tests-389492> (accessed 1 March 2014)

²⁸Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 21.

²⁹United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 27.

³⁰Stephen Daggett and Pat Towell, *FY2013 Defense Budget Request: Overview and Context* (Washington, DC: Congressional Research Service, 20 April 2012), <http://www.fas.org/sgp/crs/natsec/R42489.pdf> (accessed 1 March 2014), 10.

³¹US Air Force, "RQ-4 Global Hawk," *Air Force Fact Sheets*, 16 October 2008, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104516/rq-4-global-hawk.aspx> (accessed 1 March 2014).

³²James C. Dawkins, Jr., "Unmanned Combat Aerial Vehicles: Examining the Political, Moral, and Social Implications" (monograph, School of Advanced Air and Space Studies, 2005), 15; Gertler, 5.

³³Singer, *Wired for War*, 36; Gertler, 36.

³⁴US Air Force, "RQ-4 Global Hawk"; United States Air Force, *USAF Unmanned Aircraft*

The United States acknowledges the existence of the RQ-170 Sentinel, but details of the program remain mostly classified.³⁵ The RQ-170's "flying-wing" design resembles a B-2 bomber. It has a sixty-five-foot wingspan and a single jet engine. Reports claim an RQ-170 provided ISR and data relay for the US Navy SEAL raid that killed Osama bin Laden in Abbottabad, Pakistan, on 1 May 2011.³⁶ In December 2011, Iran's government claimed that it downed an RQ-170 after the aircraft violated Iranian airspace, but details of the incident remain unclear.³⁷

Although many voices in the UAS community continue to advocate for a future of boundless technological expansion, American UAS growth and development is slowing. As late as 2009, the USAF's *UAS Flight Plan* included a timeline for the development of autonomous aircraft, lethal miniature "swarming" robots, unmanned refueling aircraft, three types of advanced tactical UAS, and next-generation long-endurance ISR platforms.³⁸ Fiscal constriction and the United States' withdrawal from Iraq and drawdown in Afghanistan have forced the DOD to reorient its vision for unmanned systems toward more realistic objectives. In 2009, it cancelled an advanced satellite project to improve military SATCOM bandwidth.³⁹ The Fiscal Year 2013

Systems Flight Plan 2009-2047, 27.

³⁵US Air Force, "RQ-170 Sentinel," *Air Force Fact Sheets*, 10 December 2009, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104547/rq-170-sentinel.aspx> (accessed 1 March 2014).

³⁶Gertler, 41-42.

³⁷Gertler, 42; Spencer Ackerman, "Exclusive Pics: The Navy's Unmanned, Autonomous 'UFO'," *Wired*, 31 July 2012, <http://www.wired.com/dangerroom/2012/07/x47b> (accessed 1 March 2014); Christian Malis, "New Extrapolations: Robotics and Revolution in Military Affairs," in *Robots on the Battlefield: Contemporary Perspectives and Implications for the Future*, eds. Ronan Douaré, Didier Danet, Jean-Paul Hanon, and Gérard de Boisboissel (Fort Leavenworth, Kansas: Combat Studies Institute Press, 2014), <http://usacac.army.mil/CAC2/cgsc/carl/download/csipubs/FrenchRobots.pdf> (accessed 1 March 2014), 36.

³⁸David Deptula and Eric Mathewson, "United States Air Force Unmanned Aircraft Systems (UAS) Flight Plan 2009-2047," (PowerPoint presentation, Washington, DC: Headquarters, United States Air Force, 23 July 2009), <http://www.globalsecurity.org/intell/library/news/2009/intell-090723-dod01.htm> (accessed 1 March 2014), slide 15, slide 20; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 38; Theodore A. Langstroth, "Unmanned Aerial Refueling: Increasing Combat Effectiveness of the Tanker Fleet," *USAF Weapons Review* (Summer 2008): 41; Krishnan, 64-65.

³⁹Gertler, 17.

defense budget halted procurement of new USAF Global Hawks (energetic lobbying is likely to restore funding for the program in the 2015 budget, however).⁴⁰ The DOD has slowed the acquisition of Reapers and delayed the Predator's retirement to cover the shortfall.⁴¹ The USAF has canceled plans for a stealthy "MQ-X" and halted progress on further medium-sized UAS designs.⁴² The Defense Advanced Research Projects Agency (DARPA) continues to promote UAS research and development, but for the time being the true driver of military technology—defense appropriations—is decelerating.⁴³

Unmanned Ground Systems and Mission Command

The US Army had big plans for unmanned ground systems (UGS). In October 1999, the Army began work on a three-decade modernization known as the Future Combat System (FCS). This project envisioned a network of "manned, unmanned, and robotic" vehicles and support equipment designed to enable the Army to prevail on modern and future battlefields.⁴⁴ The unmanned projects in the FCS included several variants of UGV, unattended ground sensors, and two new UAVs: a hovering miniature air vehicle and a Fire Scout variant.⁴⁵ The most novel technology was an armed UGV, operated remotely, which could be equipped with a wide array of

⁴⁰Daggett and Towell, 10; Aaron Mehta, "Global Hawk Wins in 2015 Request, Sources Say," *Defense News*, 26 January 2014, <http://www.defensenews.com/article/20140126/DEFREG02/301260027/Global-Hawk-Wins-2015-Request-Sources-Say> (accessed 1 March 2014).

⁴¹Daggett and Towell, 10. Swarming microbots remain conspicuously absent from the budget.

⁴²Lawrence Spinetta and M. L. Cummings, "Unloved Aerial Vehicles," *Armed Forces Journal* (November 2012), <http://www.armedforcesjournal.com/unloved-aerial-vehicles> (accessed 1 March 2014).

⁴³DARPA-BAA-13-28, *Broad Agency Announcement: Tactically Exploited Reconnaissance Node (TERN) Program* (Arlington, VA: Defense Advanced Research Projects Agency, 13 March 2013), <https://www.fbo.gov/utills/view?id=c7856332d425ee0e7ff54ea0fe061bff> (accessed 1 March 2014).

⁴⁴Andrew Feickert and Nathan Jacob Lewis, RL32888, *Army Future Combat System (FCS) 'Spin-Outs' and Ground Combat Vehicle (GCV): Background and Issues for Congress* (Washington, DC: Congressional Research Service, 30 November 2009), <https://opencrs.com/document/RL32888> (accessed 1 March 2014), 1-2.

⁴⁵Feickert and Lewis, 12-14; Scott Gourley, "Army Establishes Structured Approach to BCT Modernization," *Defense Systems*, 24 July 2012, <http://defensesystems.com/Articles/2012/07/24/Cover-Story-Brigade-Combat-Team-Modernization.aspx> (accessed 1 March 2014).

lethal (and nonlethal) payloads.⁴⁶ While the production model remained in development, in 2007 the Army actually deployed three armed prototypes of the Talon UGV, called SWORDS (Special Weapons Observation Reconnaissance Detection System), to Iraq.⁴⁷ The Army appeared on the verge of a major shift toward reliance on unmanned systems, to include lethal UGS.

A decade of sustained land combat and significant program setbacks led to the demise of the FCS before any of its revolutionary unmanned systems ever hit the field. While Soldiers battled irregular insurgents and improvised explosive devices (IEDs) in Iraq and Afghanistan, the FCS program suffered repeated delays and cost overruns. In April 2009, Defense Secretary Robert Gates began dismantling the FCS program by recommending the cancellation of its manned ground vehicle.⁴⁸ In January 2010, the Army stopped procurement of the larger UAV, followed by the demise of the smaller one in early 2011 (though several dozen prototypes did see service in the field). Then it stopped development of the unattended ground sensors. Finally, it canceled the UGV.⁴⁹ The SWORDS prototypes that deployed to Baghdad never fired a shot, and the Army chose not to purchase more of these systems.⁵⁰

Cost overruns tarnished the FCS, but the program's demise also stemmed from a conscious decision by the US Army and Marines to move away from technological solutions in favor of human ones. These Services have reoriented their focus toward "mission command," the concept of empowering commanders and subordinates to exercise disciplined initiative,

⁴⁶Krishnan, 73.

⁴⁷Krishnan, 28-29; Singer, *Wired for War*, 30.

⁴⁸Robert M Gates, *Duty: Memoirs of a Secretary at War* (New York, NY: Alfred A. Knopf, 2014), 320; Feickert and Lewis, 1.

⁴⁹Kate Brannen, "Army kills off MULE unmanned vehicle," *Army Times*, 15 August 2011, <http://www.armytimes.com/article/20110815/NEWS/108150336/Army-kills-off-MULE-unmanned-vehicle> (accessed 1 March 2014).

⁵⁰Erik Sofge, "Inside Story of the SWORDS Armed Robot 'Pullout' in Iraq: Update," *Popular Mechanics*, 1 October 2009, <http://www.popularmechanics.com/technology/gadgets/4258963> (accessed 1 March 2014).

underpinned by shared understanding and mutual trust.⁵¹ This philosophy is fundamentally about human minds and decision-making, but unmanned systems do still factor into its implementation. FCS-envisioned networking capabilities continue to make progress, improving mission command on the battlefield.⁵² The military also continues to experiment with UGS as an extension of—not a replacement for—human capabilities. Spatial disorientation, task saturation, and frequency congestion in crowded urban environments remain problematic when remotely controlling ground vehicles.⁵³ Nevertheless, numerous UGS prototypes have made their way into the hands of deployed troops, who have developed innovative methods to use them. The initiative of these Soldiers and Marines exemplifies the mission command philosophy.

The Army's most beloved unmanned systems are the UGVs it uses for explosive ordnance disposal. Remote-operated Talons, as well as a smaller vehicle called the PackBot, have saved countless lives—both military and civilian—by defusing IEDs and other explosives that formerly required human technicians to neutralize them.⁵⁴ The US military has used between 5,000 and 6,000 UGVs to defuse tens of thousands of IEDs in Iraq and Afghanistan.⁵⁵

⁵¹Headquarters, Department of the Army, ADP 3-0, *Unified Land Operations* (Washington, DC: Headquarters, Department of the Army, 10 October 2011), 6, 13; Headquarters, United States Marine Corps, Department of the Navy, MCDP 1-0, *Marine Corps Operations* (Washington, DC: Headquarters, United States Marine Corps, Department of the Navy, 9 August 2011), 7-5.

⁵²Gourley.

⁵³Skye L. Pazuchanics, Roger A. Chadwick, Merrill V. Sapp and Douglas G. Gillian, "Robots in Space and Time: The Role of Object, Motion and Spatial Perception in the Control and Monitoring of Uninhabited Ground Vehicles," in *Human-Robot Interactions in Future Military Operations*, eds. Michael Barnes and Florian Jentsch (Burlington, VT: Ashgate, 2010), 88; Tal Oron-Gilad and Yaniv Minkov, "Remotely Operated Vehicles (ROVs) from the Bottom-Up Operational Perspective," in *Human-Robot Interactions in Future Military Operations*, 223; Chris Jansen and Jan B. F. van Erp, "Telepresence Control of Unmanned Systems," in *Human-Robot Interactions in Future Military Operations*, 266; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 61.

⁵⁴Singer, *Wired for War*, 20.

⁵⁵Krishnan, 28; Antonin Tisseron, "Robotic and Future Wars: When Land Forces Face Technological Developments," in *Robots on the Battlefield: Contemporary Perspectives and Implications for the Future*, 3.

The Army is also fielding a 5.5-pound UAV known as the Switchblade, which sports a grenade-sized warhead designed for precision engagement of small targets.⁵⁶ Medea Benjamin of Code Pink calls it a “robotic suicide bomber . . . an unmanned kamikaze.”⁵⁷ She fails to account for the fact that a human remains in control of its maneuvering and lethal employment. In context, the Switchblade sounds far less ominous—and certainly more discriminating—than the ballistic artillery shells responsible for the majority of violent deaths in modern warfare.⁵⁸ The Army and Marines will continue to develop unmanned systems, but they do not appear whatsoever interested in relinquishing lethal discretion to autonomous robots.

Unmanned Maritime Systems

The US Navy’s recent experience with unmanned systems is similar to that of the Army: while a massive modernization program flounders, discreet technologies are finding their way into operational use. In 2002, the Navy began a program to develop and field an advanced warship called the Littoral Combat Ship (LCS). The Navy wanted the LCS for combat operations in coastal regions. Designers promised an affordable, modular solution to difficult problems like minesweeping, detection of stealthy submarines, and defense against small-boat threats.⁵⁹ The Navy planned to use a plethora of unmanned systems to enable a drastic reduction in LCS

⁵⁶UAS Vision, “AeroVironment New US Army Orders for Switchblade Tactical Missile Systems Now Total \$37M,” *UAS Vision*, 12 September 2013, <http://www.uasvision.com/2013/09/12/aerovironment-gets-37m-new-us-army-orders-for-switchblade-tactical-missile-systems> (accessed 1 March 2014).

⁵⁷Medea Benjamin, *Drone Warfare: Killing by Remote Control* (New York, NY: Verso, 2013), 36-37.

⁵⁸Otto Kreisher, “IEDs Replace Artillery as Battlefield’s Biggest Killer, JIEDDO Director Says,” *Breaking Defense*, 17 October 2012, <http://breakingdefense.com/2012/10/ieds-replace-artillery-as-battlefields-biggest-killer-jieddo-g> (accessed 1 March 2014).

⁵⁹Todd Harrison, “Analysis of the FY 2012 Defense Budget,” *Center for Strategic and Budgetary Assessments*, 15 July 2011, <http://www.csbaonline.org/publications/2011/07/analysis-of-the-fy2012-defense-budget> (accessed 1 March 2014), 51; Otto Kreisher, “Littoral Combat Ship (LCS),” *Naval Forces* 30, no. 2 (2009): 28.

crewmembers: just forty Sailors per ship, as opposed to over three hundred on a modern cruiser.⁶⁰

The LCS would deploy unmanned surface vehicles (USVs), unmanned underwater vehicles (UUV), and UAS including the Fire Scout helicopter.⁶¹ The Navy originally asked for seventy LCS hulls, but ultimately settled on fifty-two.⁶² Two competing ship designs, one from Lockheed Martin and the other from General Dynamics/Austal, began concurrent development. As the LCS program got underway, worldwide contingency operations prompted a number of smaller experiments under real-world conditions.

During the 2003 Iraq War, the Navy deployed the Spartan Scout, a remotely operated USV equipped with sensors and communication gear, to inspect civilian boats in the Arabian Gulf.⁶³ Unmanned seaborne operations proved more challenging than airborne ones for many reasons. Ship-mounted antennas limited LOS range for remote surface operations to roughly six nautical miles, although SATCOM capabilities or a relay vehicle could mitigate this shortcoming.⁶⁴ Autonomous USVs might use GPS to maneuver at greater range, but without a link to the ship, their utility would be limited. Roiling seas, adverse weather, and corrosive saltwater wreaked havoc on sensitive technology.⁶⁵ One Navy study determined that USVs were

⁶⁰Michelle Mackin, GAO-13-530, *Navy Shipbuilding: Significant Investments in the Littoral Combat Ship Continue Amid Substantial Unknowns About Capabilities, Use, and Cost*, Report to Congressional Requesters, (Washington, DC: United States Government Accounting Office, July 2013), <http://www.gao.gov/assets/660/656107.pdf> (accessed 1 March 2014), 3; Kreisher, “Littoral Combat Ship (LCS),” 28.

⁶¹Mackin, 31.

⁶²Kreisher, “Littoral Combat Ship (LCS),” 28; Mackin, 1.

⁶³Singer, *Wired for War*, 115. The Spartan Scout in 2003 was unarmed—weapons testing began the following year. The Navy has tested a .50-caliber gun on it, but has not deployed an armed variant in real-world operations to date. See Matthew Richter, “Operational Manning Considerations for Spartan Scout and Sea Fox Unmanned Surface Vehicles (USV),” (master’s thesis, Naval Postgraduate School, 2006), <http://www.dtic.mil/dtic/tr/fulltext/u2/a457242.pdf> (accessed 1 March 2014), 40.

⁶⁴Richter, 38.

⁶⁵Singer, *Wired for War*, 114-115.

more manpower-intensive than manned vessels due to their many intricate systems.⁶⁶ Spartan Scout testing ended in 2006, whereupon further USV research became part of the LCS program.⁶⁷

Another unmanned system that made its military debut in 2003 was the Remote Environmental Monitoring Unit, or REMUS. This torpedo-shaped UUV, adapted from an existing civilian model, conducted minesweeping operations in the Arabian Gulf harbor of Um Qasr.⁶⁸ Its preprogrammed movements and navigation sensors alleviated the need for a cable link to send commands, meaning it truly acted autonomously. Like the Spartan Scout, REMUS was a precursor to equipment that will be integral to the LCS and other naval vessels in the future.

While Sailors and Marines have spent the last decade experimenting with unmanned systems under combat conditions, the LCS program has become a quagmire. Originally promised at \$220 million each, the Fiscal Year 2012 budget listed the per-unit cost of an LCS at over \$1.8 billion.⁶⁹ The first two prototypes arrived two years behind schedule.⁷⁰ Minesweeping modules are four years late, with estimated completion in 2017.⁷¹ The ships will not finish full operational testing until 2019 at the earliest.⁷² Poor management, requirements creep, and real-world developments have hamstrung the LCS program.

⁶⁶Richter, 1-2.

⁶⁷US Navy, "SPARTAN Scout Unmanned Surface Vehicle," US Navy, ODUSD Advanced Systems and Concepts, 2006, <http://www.dtic.mil/dtic/pdf/success/SSUSV20080908.pdf> (accessed 1 March 2014), 1.

⁶⁸Woods Hole Oceanographic Institution, "REMUS," *Woods Hole Oceanographic Institution*, 2013, <http://www.whoi.edu/main/remus> (accessed 1 March 2014); Singer, *Wired for War*, 37-38.

⁶⁹Kreisher, "Littoral Combat Ship (LCS)," 27; Chris Hellman, "Analysis of the Fiscal Year 2012 Pentagon Spending Request," *National Priorities Project*, 14 February 2011, <http://nationalpriorities.org/pressroom/articles/2011/02/14/analysis-of-the-fiscal-year-2012-pentagon-spending> (accessed 1 March 2014).

⁷⁰Mackin, 18.

⁷¹*Ibid.*, 29

⁷²*Ibid.*, 48.

The problems with the LCS point to a broader conclusion: at present, unmanned systems cannot replace most humans at sea. One of the costliest modifications to the LCS has been a twenty-five percent increase in crew size to alleviate workload and fatigue, and this number is likely to increase.⁷³ Space aboard the LCS is tight: if crew requirements grow too large, the viability of both competing ship designs may come into question. Tests on several of the LCS's unmanned systems have revealed unacceptable failure rates and unforeseen complications that corroborate the increased staffing requirements for the Spartan Scout USV.⁷⁴ In July 2013, the Government Accountability Office issued this scathing pronouncement: "Current LCS weapon systems are under-performing and offer little chance of survival in a combat scenario."⁷⁵ Unlike the Army's defunct FCS, the LCS continues to survive on life-support, but the future of the program remains uncertain. In the meantime, the Navy is pursuing one more noteworthy foray into the world of unmanned systems.

The Navy currently operates proven UAS of many shapes and sizes, but it also is developing and testing a potential game-changer: the X-47B UCAS.⁷⁶ The Navy adapted its design from a joint UCAS program that the DOD cancelled in 2006.⁷⁷ The stealthy X-47B has a sixty-two-foot wingspan (comparable to a Reaper or an RQ-170), uses jet propulsion, and includes weapons bays for up to two 2,000-pound bombs.⁷⁸ On 14 May 2013, the X-47B made its first successful catapult launch from the deck of the U.S.S. *George H.W. Bush* (it landed ashore,

⁷³Mackin, 20, 44-45.

⁷⁴Mackin, 32-34; Richter, 1-2.

⁷⁵Mackin, 42.

⁷⁶Once operational, the UCAS will be renamed the Unmanned Carrier Launched Airborne Surveillance and Strike System, or UCLASS. Dave Majumdar, "Navy Restarts X-47B Carrier Testing," *USNI News*, 11 November 2013, <http://news.usni.org/2013/11/11/navy-restarts-x-47b-carrier-testing> (accessed 1 March 2014).

⁷⁷Gertler, 47.

⁷⁸Ackerman.

as planned). Two months later, it made its first carrier landing.⁷⁹ Concurrently, the Navy began testing unmanned aerial refueling from manned tanker aircraft, using a Learjet modified for autonomous flight with human pilots onboard to override any glitches.⁸⁰

The Navy plans to grant unprecedented levels of autonomy to the X-47B. Although current tests involve multiple redundant human controls (pilots, deck officers, and tower personnel all have the ability to wave-off the aircraft from a bad approach), ultimately the Navy envisions a UAS that can fly missions all on its own.⁸¹ However, as Captain Jaime Engdahl, the UCAS program manager, confesses: “We are in the crawl-walk-run stage of autonomous systems.”⁸² The Navy is emphatic that the UCAS is simply a demonstration, and a limited one at that. Originally, it planned to retire the X-47Bs after the July carrier tests. Under pressure from politicians and the defense industry, the Navy conceded to continued experiments. It has allocated a further \$20 to \$25 million to keep the program alive while it determines how to proceed.⁸³ The Navy does not anticipate fielding an operational X-47B before 2019.⁸⁴

Accompanying the Navy’s embryonic experiments with autonomy is the notion that a carrier-based, stealthy UCAS could alleviate host-nation basing requirements for UAS. Elimination of forward bases might reduce the perceived need to gain foreign approval for combat operations.⁸⁵ Then again, USAF B-2 bombers (which fly intercontinental missions from

⁷⁹NAVAIR, “Unmanned X-47B makes historic landing aboard USS George H.W. Bush,” NAVAIR, 10 July 2013, <http://www.navair.navy.mil/index.cfm?fuseaction=home.NAVAIRNewsStory&id=5417> (accessed 1 March 2014).

⁸⁰NAVAIR, “Navy Autonomous Aerial Refueling Tests Underway,” NAVAIR, 11 September 2013, <http://www.navair.navy.mil/index.cfm?fuseaction=home.NAVAIRNewsStory&id=5451> (accessed 1 March 2014).

⁸¹Majumdar, “Navy Restarts X-47B Carrier Testing.”

⁸²Ackerman.

⁸³Majumdar, “Navy Restarts X-47B Carrier Testing.”

⁸⁴Ackerman.

⁸⁵Micah Zenko, *Reforming U.S. Drone Strike Policies*, Council on Foreign Relations, Special

Missouri), carrier-launched manned aircraft, and other ISR assets have conducted military operations without basing rights for decades.

Despite various methods of controlling unmanned systems, a human remains “in-the-loop” and responsible for their safe operation at all times (with the exception of the innocuous REMUS UUV). No autonomous robots are out conducting combat missions unsupervised while their human monitors leave the controls for a lunch break. More importantly, humans remain entirely in charge of every decision to launch lethal munitions, just as they do in manned platforms. While the Army and Marines operate most unmanned systems as an additional duty for conventional troops, the USAF requires rated pilots to fly its Group 4 and 5 platforms.⁸⁶ The next section will discuss how these airmen employ UAS in today’s conflicts. While all of the Services continue to develop tactics, techniques, and procedures (TTP) for unmanned systems, the USAF’s experience over the past twelve years provides the clearest assessment of the realities of unmanned systems in modern warfare.

II – AVIATORS AND INNOVATORS

The USAF calls its unmanned systems Remotely Piloted Aircraft (RPAs) for a reason. The airmen who fly these platforms are no “cubicle warriors”: while they are not physically located inside their airframes, they are connected intimately to the battlefield. Over the past decade, determined RPA crews have toiled to integrate new capabilities into the complex and

Report No. 65 (January 2013), <http://www.cfr.org/wars-and-warfare/reforming-us-drone-strike-policies/p29736> (accessed 1 March 2014), 23.

⁸⁶Gertler, 26; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 26-27; Singer, *Wired for War*, 37. According to AFI 11-401, “A rated aircrew member is a commissioned officer who holds a USAF aeronautical rating. The USAF considers rated officers to be in career aviation status and awards ratings only to pilots, RPA pilot, CSOs [Combat System Operators], ABMs [Air Battle Managers], observers, and flight surgeons.” See AF/A3O-AT, Air Force Instruction 11-402, *Aviation and Parachutist Service, Aeronautical Ratings and Aviation Badges* (13 December 2010, certified current 5 February 2013), <http://www.e-publishing.af.mil> (accessed 1 March 2014), 129.

evolving battle spaces of America's conflicts.⁸⁷ They have managed this feat despite a tempo of constant surge operations, 24 hours a day for 365 days a year. Many RPA crewmembers have deployed to active combat zones to conduct LOS launch and recovery operations.⁸⁸ Their innovations have produced remarkable advances in the way the USAF supports the achievement of strategic objectives, operational successes, and tactical victories.

RPAs have become indispensable assets for US military operations. Stated succinctly, "RPAs benefit from a long loiter time, the ability to provide armed over watch and armed reconnaissance with precision-guided munitions, extensive reach-back capabilities, and the ability to have the [full-motion video] FMV feed exploited real-time."⁸⁹ They are ideal for military missions including ISR, interdiction, close air support, force protection, and maritime patrol. By replacing low-fuel RPAs with fresh ones and swapping out crews multiple times per sortie, squadrons can extend their persistence indefinitely. While pilots and sensor operators handle the immediate tactical tasks, analysts worldwide simultaneously work round-the-clock to convert FMV and sensor reports into actionable intelligence. RPAs also benefit from low acoustic

⁸⁷For the remainder of this discussion, the term "RPA crew" will refer to the rated pilot, enlisted sensor operator, and mission support personnel in direct support of a particular aircraft. They represent only the spearhead of up to 170 people who can be involved in the maintenance and exploitation of a single RPA. See Gertler, 26.

⁸⁸Depending on the scale and intensity of operations, up to one tenth of a typical RPA squadron is deployed for launch and recovery operations at any given time. Major Eric Hendrickson, USAF, e-mail message to author, 8 November 2013.

⁸⁹Timothy W. Ford, "MQ-1/-9 Integration with Ground Control Station for Strike Coordination and Reconnaissance," *USAF Weapons Review* (Winter 2012): 25.

signatures.⁹⁰ Audible concealment is vital for lethal engagements, but it also aids in the building of comprehensive SA that often leads to a decision *not* to use deadly force.⁹¹

These capabilities did not arrive overnight. The rapid deployment of immature UAS technology into dynamic war zones following 9/11 complicated the command, control, and coordination of RPAs with other assets. The operational-level Air Operations Center (AOC) repeatedly clashed with tactical personnel in-theater over RPA allocation and tasking. Many times, manned aircraft and joint terminal air controllers (JTACs) had no idea an RPA even was in their vicinity, much less whether it could assist in an active mission.⁹² As one expert RPA pilot noted, problems arose from “incomplete understanding of MQ-1/-9 capabilities and systemic perception of RPAs as the ‘just-in-case’ tactical employment option.”⁹³ These growing pains reprised the US military’s repeated battles over the use of airpower at large since World War I.

The USAF’s burgeoning RPA community struggled to overcome these deficiencies. The strain of nonstop surge operations initially hampered the development of planning and coordination TTPs to suit remote operations, but these have improved significantly.⁹⁴ Networked computer systems, internet relay chat, e-mail, video teleconferencing, and telephones (both secure and unclassified) enable RPA crews to prepare for the geographically separated missions they

⁹⁰Tamara L. Barlette, “Optimizing the MQ-1/9 in Close Air Support” (student paper, United States Air Force Weapons School, 12 December 2009), 20; Albert F. Scaperotto, “MQ-1 / MQ-9 Remote Split Operations Mission Planning and Execution Cell (MPEC)” (student paper, United States Air Force Weapons School, 11 December 2010), 14; Mike Scorsone, “Fighter-Unmanned Aerial System Integration in Close Air Support Operations,” *USAF Weapons Review* (Winter 2008): 12; Martin and Sasser, 276.

⁹¹Luther S. Turner, Jason Adair and Louis Hammel, “Optimizing Deadly Persistence—Armed UAV Integration in the Joint Tactical Fight,” *USAF Weapons Review* (Summer 2009): 48.

⁹²Brandon E. Baker, “Increasing the Combat Effectiveness of the RQ-4,” *USAF Weapons Review* (Summer 2008): 39-40; Scorsone, 9, 14; Ford, 24; Martin and Sasser, 293-294; Gertler, 16.

⁹³Preston L. Rhymer, “MQ-1/-9 Hellfire IIP Buddy Lase for Fixed Wing” (student paper, United States Air Force Weapons School, 12 December 2009), 1.

⁹⁴Scaperotto, 1-2.

face.⁹⁵ Nothing can replace face-to-face planning and debriefing, but disjunction is not only an issue for unmanned systems: it is a reality for troops deployed across modern, dispersed battlefields. It also represents nothing new. US Navy aviators have conducted dislocated mission planning at sea for decades. They have developed efficient communications and TTPs that enable them to support distant operations.⁹⁶ The RPA community is finally gaining the leeway to free up experienced aviators and intelligence personnel for comprehensive mission planning.⁹⁷ This emphasis is critical to optimizing the capabilities RPAs bring to the fight.

Real-time video may be the most coveted asset on RPAs, but their capabilities as a communications bridge are invaluable as well. RPA crews can leverage multiple voice and data links to contact any echelon, from troops-in-contact all the way to national-level authorities. Rather than waiting to return to base in a manned aircraft, an RPA crew can pass immediate, high fidelity mission reports, battle damage assessments, and other in-flight messages to operations centers and commanders. Likewise, they can pass detailed tactical and administrative data forward to other aircraft and ground troops.⁹⁸ A rated pilot in the driver's seat puts an "airman's perspective" on tactical messages, thus enhancing their utility to warfighters.⁹⁹ Real-time communications are also important for RPA survival: because current models lack onboard threat detectors or countermeasures, crews rely on off-board cues to evade hostile fire.¹⁰⁰

RPA crews can employ their own Hellfires and laser-guided bombs with surgical precision, but they also can pinpoint targets for manned aircraft with heavier firepower. The persistent, stable perspective of an RPA with multifaceted connectivity is a boon to low-flying

⁹⁵Ford, 28.

⁹⁶Scaperotto, 6-7.

⁹⁷Ibid., 8-9, 21.

⁹⁸Barlette, 10-11.

⁹⁹Ibid., 16.

¹⁰⁰Ford, 29.

helicopters or fast-moving jets with limited loiter time.¹⁰¹ An RPA crew may describe visible features in the terrain to guide another aircrew's eyes. The crew also can make use of GPS-derived coordinates, or use the RPA's infrared illuminator or laser designator to cue the sensors of other aircraft, expediting correct target acquisition.¹⁰² The Predator's and the Reaper's lasers are compatible with the targeting pods and laser-guided weapons carried by US (and most allied) aircraft. Use of an RPA to "buddy-lase," in which its laser guides a munition fired from another aircraft or vice-versa, often is the most expeditious and precise method to employ weapons.¹⁰³ Ground personnel likewise can use laser designators and infrared pointers to cue aircraft sensors and weapons. Laser guidance also enables an aircrew to shift weapons in flight away from the intended target if noncombatants enter the impact zone or other extenuating circumstances occur—a rare occurrence, since crews thoroughly scan target surroundings before firing.¹⁰⁴

Tactical data links have become an indispensable component of modern warfare. The RPA community has labored to integrate its aircraft into the primary coalition network, known as Link 16 or the Joint Tactical Information Distribution System (JTIDS). This system communicates position, status, and mission management information regarding friendly assets, detected threats, and potential targets. Link 16 enables diverse platforms to work together across the battle space, increasing SA and enhancing overall effectiveness. These days, an aircraft flying in an active area of operations without Link 16 can be more of a liability than a benefit. Lamentably, RPAs operated in combat zones for years without this essential capability, and this shortcoming hampered their integration with other aircraft.¹⁰⁵ Ultimately, airmen and engineers

¹⁰¹Scorsone, 13.

¹⁰²Barlette, 17.

¹⁰³Rhymer, 4.

¹⁰⁴Zenko, *Reforming U.S. Drone Strike Policies*, 6.

¹⁰⁵Nicholas R. Pederson, "Integrating MSCT to Enhance MQ-1/9 Link 16 Operations" (student paper, United States Air Force Weapons School, 12 June 2010), 5.

devised workarounds to provide basic Link 16 capabilities for Predators and Reapers.¹⁰⁶ USAF RPAs are set to attain full Link 16 capability within a couple years.¹⁰⁷ Future data links must fully include RPAs and other unmanned systems from Day One.

Link 16 connectivity enhances the crucial two-way flow of information needed to maximize the effective integration of RPAs with other assets. When friendly ground troops are nearby, aircrews require clearance from a qualified JTAC or equivalent controller in order to release weapons. Using Link 16, a JTAC can pass digital targeting information to an RPA crew, rather than relying on voice or chat messages (the RPA crew still must visually identify the target and get confirmation from the JTAC before weapons launch).¹⁰⁸ Likewise, a Link 16-equipped RPA with high SA on a target can send detailed information to ground forces and other aircraft instantly and without transmission errors.¹⁰⁹ RPA crewmembers recognize that they are personally responsible for the accuracy and timeliness of target coordinates and information—erroneous or obsolete data could result in fratricide or civilian casualties.¹¹⁰

In situations where friendly ground troops do not physically deploy, such as during Operation Unified Protector over Libya in 2011, RPA crews are ideal controllers for strike coordination and reconnaissance.¹¹¹ The persistence of an RPA allows crews to build detailed SA over extended periods, as compared to intermittent coverage from manned aircraft following a

¹⁰⁶As initially implemented, RPA positional tracks updated less often than the tracks of full link participants. In addition, all of the aircraft in an RPA squadron operated on a single merged server with one identifier, which necessitated clear, standardized communication procedures to avoid confusion. David M. Martinez, “Digitally Aided CAS in the MQ-1/9” (student paper, United States Air Force Weapons School, 10 December 2011), 2-4, 9; Pederson, 4.

¹⁰⁷Pederson, 22-23.

¹⁰⁸Martinez, 5, 14.

¹⁰⁹Pederson, 4.

¹¹⁰Ibid., 17.

¹¹¹Ford, 24. Initial US operations over Libya carried the code name Operation Odyssey Dawn. The North Atlantic Treaty Organization (NATO)’s Operation Unified Protector replaced this moniker after 12 days.

traditional air tasking order. RPAs also can leverage support from myriad coalition assets both inside and outside the theater. An RPA control station can receive cueing information from ISR platforms like the RC-135 Rivet Joint, E-8 JSTARS, E-3 AWACS, U-2, Global Hawk, national-level assets, and tactical aircraft, with scores of analysts in the loop to exploit collected data and intelligence products.¹¹² Persistent RPAs can pass this SA to arriving aircraft while others depart.

In certain scenarios, RPAs may be the only assets available. Although the USAF initially employed them as single aircraft, RPA crews have developed TTPs to fight as teams. This synergy is similar to manned aircraft flying in formation, but instead of close visual formations, RPA crews can use precise timing and coordination to mass sensors and firepower.¹¹³ This capability is not limited to aircraft from the same squadron. By leveraging the multiple communication methods available in their control stations, geographically separated crews can link up, establish a coordinated game plan, and accomplish a tasking without ever meeting face-to-face.¹¹⁴ The key to successful execution is the development of shared understanding, based on rigorous training and common tactical standards across RPA squadrons.¹¹⁵ By practicing and adhering to these innovative TTPs, disciplined crews can transform a few tenuous RPAs into a formidable expression of modern American airpower.

Positive identification of hostile targets in modern combat zones is challenging, but essential.¹¹⁶ Many enemy combatants do not wear uniforms, and even professional militaries employ deception and camouflage to confuse modern sensors, as the Serbs did by using dummy

¹¹²Ford, 30. JSTARS stands for Joint Surveillance Target Attack Radar System and AWACS stands for Airborne Warning and Control System.

¹¹³Kristin A. Wozniak, “MQ-1/9 Multi-ship Operations in OCO” (Student Paper, Nellis Air Force Base, NV: United States Air Force Weapons School, 11 June 2011), 13, 15.

¹¹⁴Ibid., 1-2.

¹¹⁵Ibid., 21.

¹¹⁶Ford, 31.

tanks during the conflict in Kosovo.¹¹⁷ Clear, stable FMV from an RPA can be the most important tool in accurately identifying a suspected enemy target. While crews benefit from a team of professional analysts who aid them in making the right decisions, an RPA pilot employing lethal ordnance bears ultimate responsibility for compliance with the rules of engagement (ROE).

In the event of a friendly aircraft crash, an RPA's persistence may be the decisive factor in successful combat search and rescue. MQ-1 and MQ-9 pilots train to act as on-scene commanders for search and rescue, just like other pilots. They can communicate instantly and comprehensively with rescue coordinators at the operations center.¹¹⁸ Their watchful gaze enables them to direct additional assets to the site—and their precision weapons can target threats to an isolated survivor—without risking additional aircrew.¹¹⁹ The roar of friendly jet engines, though transitory, may be the ultimate emotional comfort for a downed aviator—but 24-hour overhead cover from an armed RPA realistically offers the best chance for a successful rescue.¹²⁰

III – A REVOLUTION IN MILITARY AFFAIRS?

Definitions abound as to what constitutes a revolution in military affairs (RMA), but the notion of discontinuity is common to all. Andrew Marshall argues that an RMA is “a major change in the nature of warfare brought about by the innovative application of new technologies which, combined with dramatic changes in military doctrine and operational and organizational concepts, fundamentally alters the character and conduct of military operations.”¹²¹ An RMA

¹¹⁷Michael Ignatieff, *Virtual War: Kosovo and Beyond* (New York, NY: Metropolitan Books, 2000), 105.

¹¹⁸Scorsone, 14; Michael Lewis, “MQ-1/-9 Role in the Combat Search and Rescue Mission,” *USAF Weapons Review* (Summer 2010): 24.

¹¹⁹Lewis, 24, 30, 32.

¹²⁰Norton Schwartz, “U.S. Drone Program is Fatally Flawed,” *Intelligence Squared Debates*, transcript, 10 September 2013, <http://intelligencesquaredus.org/debates/past-debates/item/905-the-us-drone-program-is-fatally-flawed> (accessed 1 March 2014), 43.

¹²¹Jeffrey McKittrick, et al., “The Revolution in Military Affairs,” in *Battlefield of the Future: 21st*

means more than new gadgets: it represents a fundamental shift that permanently alters the way humans fight. Technology plays a decisive role in nearly all commonly acknowledged RMAs. Specific lists vary, but several episodes tend to feature prominently: the introduction of gunpowder, the Industrial Revolution, the Napoleonic way of war (an exception to the technological impetus), powered flight, blitzkrieg, nuclear weapons, and the Information Revolution of the 1990s.¹²² Many believe the time has come to announce yet another RMA.

The Pitfalls of Believing in RMAs

A number of analysts believe unmanned systems constitute an RMA. As P.W. Singer exclaims, “humans’ 5,000-year-old monopoly over the fighting of war is over . . . the introduction of unmanned systems to the battlefield doesn’t change simply how we fight, but for the first time changes who fights at the most fundamental level.”¹²³ He recalls perusing gadgets in a *Sharper Image* catalog and then reading reports of drone strikes. This juxtaposition convinces him that humanity has arrived at a point of singularity whereupon robots will replace humans on the battlefield.¹²⁴ Other writers decry a coming age of “suicide drones,” evidently unaware of the irony of the phrase.¹²⁵ Admiral Dennis Blair, former US Director of National Intelligence, dismisses the hype. He acknowledges the “novelty factor” of unmanned systems, but believes the

Century Warfare Issues, eds. Barry R. Schneider and Lawrence E. Grinter (Maxwell Air Force Base, AL: Air University Press, 1998), 65. Andrew Marshall has been the director of the Office of Net Assessments in the Office of the Secretary of Defense since 1973.

¹²²Joseph S. Nye, Jr., *The Future of Power* (New York, NY: PublicAffairs, 2011), 36; McKittrick, et al., “The Revolution in Military Affairs,” in *Battlefield of the Future*, 65-68; Thomas C. Graves, “Al-Qaeda, the Revolution in Military Affairs, and the Future of Warfare,” in *Short of General War: Perspectives on the Use of Military Power in the 21st Century*, ed. Harry R. Yarger, 23-38 (Carlisle, PA: Strategic Studies Institute, United States Army War College Press, April 2010), <http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=983> (accessed 1 March 2014), 26-27.

¹²³Singer, *Wired for War*, 194.

¹²⁴Ibid., 10. Singer defines a singularity as “a state in which things become so radically different that the old rules break down and we know virtually nothing.” Ibid., 102.

¹²⁵Turse and Engelhardt, 57; Benjamin, 36-37.

ensuing sense of sinister “overwhelming force” is erroneous.¹²⁶ When discussing an RMA, it is critical to examine reality—not to speculate what could theoretically occur. If militaries ultimately imbue robots with the capability and authority to employ autonomous lethal force, then humanity may indeed experience a discontinuity in history.¹²⁷ However, that day has not arrived.

The entire RMA concept is misleading because it compartmentalizes and distorts the past, equating newfangled innovations with momentous historical developments. P.W. Singer compares unmanned systems to “fire, gunpowder, the steam engine or the computer.”¹²⁸ It took humans thousands of years to tame fire. Gunpowder gradually entered the battlefield in an evolutionary process over hundreds of years. Industrial mechanization may have begun in the eighteenth century, but it continues to evolve to this day. Computer technology has progressed exponentially, but its contribution to warfare has not followed a correspondingly inexorable path. Steven Metz explains: “Even in revolutionary times, continuity outweighs change. . . . War will always involve a dangerous and dynamic relationship among passion, hate, reason, chance and probability.”¹²⁹ True believers in technology would be wise to heed his insight.

RMA proponents of the 1990s focused on new information technologies, like GPS and networking, that helped the United States and its allies defeat Iraq in 1991, but they downplayed the significance of context. Decades beforehand, General William Westmoreland promoted the concept of the “electronic battlefield” in Vietnam. He envisioned a day when “enemy forces [would] be located, tracked and targeted almost instantaneously through the use of data-links,

¹²⁶Dennis Blair, “U.S. Drone Program is Fatally Flawed,” 41-42.

¹²⁷Michael Contratto, “The Decline of the Military Ethos and Profession of Arms: An Argument Against Autonomous Lethal Engagements” (research paper, Air War College, February 2011), 1; Krishnan, 166.

¹²⁸P.W. Singer, foreword to “Game Changers: Disruptive Technology and U.S. Defense Strategy,” by Shawn Brimley, Ben FitzGerald and Kelley Saylor, *Center for a New American Security*, 27 September 2013, <http://www.cnas.org/game-changers> (accessed 1 March 2014), 4.

¹²⁹Steven Metz, *Armed Conflict in the 21st Century: The Information Revolution and Post-Modern Warfare* (Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, 2000), xiv-xv.

computer-assisted intelligence evaluation and automated fire control.”¹³⁰ Technological superiority did not solve Westmoreland’s problems in Southeast Asia. The United States lost in Vietnam and won in Desert Storm because the situations and the strategies were different—not because an RMA occurred in the intervening years. Subsequent American misadventures in Iraq would underscore this fact.

Belief in an RMA can be more than misleading. It can be downright disastrous. America’s military ventures in the 1990s concluded with an air war over Kosovo without a single friendly combat fatality.¹³¹ Meanwhile, al-Qaeda sought ways to merge audacity, low-tech weaponry, and internet connectivity to confound a militarily superior United States.¹³² In 2001, Washington responded to the attacks of 9/11 with military intervention in Afghanistan. Special operations forces backed up by precision ISR and airstrikes (including armed UAS) enabled the Northern Alliance to rout al-Qaeda and the Taliban, seemingly validating the transformational nature of modern technology. As the United States prepared to invade Iraq in 2003, Defense Secretary Donald Rumsfeld fostered the notion that “[w]ith the help of technology . . . a U.S. intervention could be speedy *and* lethal.”¹³³ American confidence in “information superiority” crashed against jagged rocks of poor assumptions and strategic blunders in Iraq, repudiating the purported RMA of the 1990s.¹³⁴ Technology enhanced the warfighting capabilities of the US

¹³⁰William C. Westmoreland, quoted in Krishnan, 19.

¹³¹Ignatieff, 161.

¹³²Graves, 24-25; Michael R. Gordon and Bernard E. Trainor, *Cobra II: The Inside Story of the Invasion and Occupation of Iraq* (New York, NY: Pantheon Books, 2006), 30; Office of the US Air Force Chief Scientist, *Technology Horizons: A Vision for Air Force Science and Technology 2010-2030* (Maxwell AFB, AL: Air Force Research Institute, 2011), http://www.defenseinnovationmarketplace.mil/resources/AF_TechnologyHorizons2010-2030.pdf (accessed 1 March 2014), 39.

¹³³Gordon and Trainor, 53 (emphasis original).

¹³⁴Krishnan, 26; Metz, 39; Singer, *Wired for War*, 184, 188.

military, but it did not bestow victory. As Joseph Nye concluded, “Americans were not mistaken to invest in the revolution in military affairs; they were wrong to think it was sufficient.”¹³⁵

Despite their novelty, unmanned systems in all their present forms do not constitute an RMA. As Section I recounted, their development began before the Wright Brothers’ first flight. They lie upon a continuum, not astride a singularity. As Michael Ignatieff explains, “the battlefield has been emptying for centuries,” transitioning from massed troops to dispersed elements as humans have developed weapons with increased range and precision.¹³⁶ Debate over the morality of distance warfare predates unmanned systems by hundreds of years: medieval knights derided longbow archers as un-chivalric cowards, and Japan’s samurai culture shunned firearms until the 1850s. Unmanned systems’ utility in armed conflict remains entirely dependent on the situation and the strategy chosen. The author is not alone in the opinion that unmanned systems are not an RMA. Medea Benjamin, no fan of unmanned systems, instead argues that they represent a “progressive evolution” in surveillance and killing, not a revolutionizing force.¹³⁷

The USAF’s greatest achievements with UAS have come through iterative, collaborative approaches and adaptations—not via technological wizardry. This is not a new story. By the end of World War I, military airplanes already were flying every type of mission that they do today, with the exception of nuclear bombing. In the interwar period, premier airpower advocates such as Giulio Douhet and William “Billy” Mitchell were themselves aviators. These days, the most strident voices on unmanned systems hail from academia or industry.¹³⁸ P.W. Singer is one of the leading authorities on unmanned systems, but he tips his hand when he uses catchy terms like

¹³⁵Nye, 35.

¹³⁶Ignatieff, 169.

¹³⁷Benjamin, 219. Instead, she fears that they represent a slippery slope to rampant murder.

¹³⁸P. W. Singer, “What Churchill Can Teach Us About the Coming Era of Lasers, Cyborgs and Killer Drones,” *Foreign Policy*, 22 October 2013, http://www.foreignpolicy.com/articles/2013/10/22/winston_churchill_military_technology_lasers_cyborgs_drones (accessed 1 March 2014); Singer, *Wired for War*, 138.

“killer application” to describe them.¹³⁹ Robotic independence would constitute a significant leap, perhaps akin to the advent of nuclear weapons (the only plausible RMA to date, in this author’s opinion), but the US military is not moving inexorably toward this fate.

There is no “Red Button of Death”

One of the most prevalent misconceptions distorting the discourse on unmanned systems is the illusion of an instantaneous kill-chain: a “red button” of death that allows national leaders to kill capriciously.¹⁴⁰ Micah Zenko, another respected authority on unmanned systems, claims that they provide “a near-instantaneous ‘find-fix-finish’ loop.”¹⁴¹ He contrasts this responsiveness with the time required to plan and execute the 1998 cruise missile strikes that targeted Osama bin Laden. The problem with this argument is that it compares the prompt fly-out of a Hellfire to the extended flight of a Tomahawk cruise missile, without acknowledging the unseen mountains of deductive effort behind the decision to launch either. The FMV recording from a Predator that one might glimpse on *WikiLeaks* is but a fraction of the intelligence collection, analysis, and exploitation that goes into operations involving unmanned systems.¹⁴²

To some degree, the US military has been its own worst enemy in this regard. Top commanders with access to FMV have tended to become overly involved in tactical operations.¹⁴³ Micromanagement undermines the mutual trust that is vital to the military chain of command. It also leads to unnecessary delays, as commanders overloaded with information endeavor to make all of the decisions, rather than letting their subordinates exercise the initiative inherent in mission

¹³⁹Singer, foreword to “Game Changers,” 4.

¹⁴⁰Benoit Royal, “Military Robots and Ethics: Ethical Problems for European Industrial, Political, and Military Leaders,” in *Robots on the Battlefield*, 126.

¹⁴¹Zenko, *Reforming U.S. Drone Strike Policies*, 6.

¹⁴²Medea Benjamin notes that, as of 2010, the USAF processed almost 1,500 hours of FMV and 1,500 images daily, requiring approximately nineteen analysts per UAS. See Benjamin, 21.

¹⁴³Singer, *Wired for War*, 349-350.

command.¹⁴⁴ This problem is not new. In May 1975, President Gerald Ford himself intervened in an ongoing operation to recover the crew of the *Mayaguez*, a US ship hijacked by the Khmer Rouge. He and his advisors repeatedly questioned tactical decisions and prohibited Navy planes from disabling a hostage-laden enemy ship at sea, resulting in a disastrous island assault during which forty US Marines died.¹⁴⁵ Real-time intelligence from unmanned systems only increases a commander's temptation to meddle, but instant responsiveness, in most cases, is an illusion.

The exception to the myth of the "instant kill" further strengthens the case for decentralized execution with regard to unmanned systems. RPAs providing direct support to friendly ground units can enable rapid decisions regarding lethal force within the constraints of strict ROE.¹⁴⁶ In Iraq and Afghanistan, a common insurgent tactic has been to emplace mortar tubes or IEDs and then activate them remotely, while the combatants disappear into the civilian landscape. When empowered by their commanders, UAS crews can detect, confirm, and engage these hostile targets more effectively than calling in a manned airstrike or artillery barrage.¹⁴⁷ This responsiveness exists only because multiple individuals have done their homework. The process of identifying patterns of life, tracking enemy movements, identifying likely ambush spots, detecting hostile activity, confirming target coordinates, avoiding noncombatants, and then guiding weapons all the way to impact, is a team effort. Moreover, the team is legally (and morally) responsible if something ever goes wrong.¹⁴⁸

¹⁴⁴Singer, *Wired for War*, 354-355.

¹⁴⁵Dawkins, 22-24.

¹⁴⁶Martin and Sasser, 238.

¹⁴⁷Martin and Sasser, 131-132; Ralph Peters, *Fighting for the Future: Will America Triumph?* (Mechanicsburg, PA: Stackpole Books, 1999), 107; Dawkins, 28.

¹⁴⁸Christopher Drew, "Study Cites Drone Crew in Attack on Afghans," *New York Times*, 10 September 2010, <http://www.nytimes.com/2010/09/11/world/asia/11drone.html> (accessed 1 March 2014); Martin and Sasser, 131, 269.

Total Situational Awareness is an Illusion

The myth of instant responsiveness couples with the notion that unmanned systems finally offer a path to “battlespace awareness,” which is another term for *total* SA. The US military’s experiences in Iraq and Afghanistan should have taught its commanders and strategists that these phrases represent metaphors, not tangible goals. Nevertheless, the belief persists that technology can clear away the fog of war, despite decades of contradictory evidence.¹⁴⁹

During the Kosovo conflict, state-of-the-art NATO aircraft expended tons of ordnance on dummy tanks and other decoys that appeared real from fifteen thousand feet.¹⁵⁰ Modern UAS might have been better at discerning fact from fiction, but this simply would have prompted the Serbs to devise alternate countermeasures (increased use of human shields, perhaps). Moreover, Serbian air defenses would have taken a significant toll on exposed UAS. In the decade preceding the 2003 Iraq War, the USAF flew numerous U-2 missions over Iraq that transmitted plentiful SIGINT and imagery to analysts, but decision-makers still lacked accurate information regarding Saddam Hussein’s weapons programs.¹⁵¹ Furthermore, technical data could not answer the subjective questions about Iraqi society that led to insurgency there once the regime collapsed. If the United States had possessed a fleet of UAS at the time, they would have collected more information than U-2s and orbiting satellites provided. Would it have made a difference? Perhaps, but information and intelligence are two different things.

The data links that have proven so vital to operations in Iraq and Afghanistan also tend to convince commanders that their SA is higher than it actually is. Modern US ground forces deploy

¹⁴⁹Singer, *Wired for War*, 184-5. The metaphors of the “fog” and “friction” of war originally derive from Carl von Clausewitz, *On War*, ed. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 119, 140.

¹⁵⁰Ignatieff, 105.

¹⁵¹Micah Zenko, *Between Threats and War: U.S. Discrete Military Operations in the Post-Cold War World* (Stanford, CA: Stanford University Press, 2010), 41-42.

with “blue force trackers” to communicate friendly positions and movements. These reports aid in command and control, but they say nothing about enemy intentions. Blue force trackers, Link 16, and other networks can transmit detected enemy activity, but no amount of collected data equates to a true “red force tracker.”¹⁵² Irregular adversaries also tend to emit fewer of the SIGINT transmissions that advanced ISR technology can detect and exploit.

Persistent, real-time FMV and SIGINT from UAS mitigate some of these intelligence holes, but they also increase “fog” in two ways: they limit contextual awareness while simultaneously overloading data collection resources. A common analogy equates monitoring an FMV feed to looking through a “soda straw”: focused clarity of a small space with zero peripheral vision. One study equated remote operation to driving at night, as contextual information normally available to a daytime driver (i.e. a manned system) is missing.¹⁵³ If individual Predator feeds actually represented the sum of intelligence on their targets, then such discomfort would be appropriate. Fortunately, this almost never is the case.

UAS cameras and sensors continue to improve from the grainy black-and-white footage of a decade ago, but even high-definition pictures can be enigmatic without proper context. Many pundits argue that a truck full of fruit looks the same as a truck full of weapons.¹⁵⁴ This would be true if the observer viewed the truck in isolation—unaware of its origin, destination, or additional contributing factors. Persistent UAS can address these gaps in SA, if crews receive the time and corroboration needed for accurate characterization. This attention to detail helps explain why only one incident of fratricide has occurred in over a decade of armed UAS operations. On 6 April 2011, a Predator strike killed a Marine and a Navy specialist during a firefight in which the

¹⁵²Singer, *Wired for War*, 189-190.

¹⁵³Laurel Allender, “A Cognitive Systems Engineering Approach for Human-Robot Interaction: Lessons from an Examination of Temporal Latency,” in *Human-Robot Interactions*, 321.

¹⁵⁴Benjamin, 27; Singer, *Wired for War*, 223.

ground commander mistook them for the enemy.¹⁵⁵ One fratricide still is too many. Compared to historical friendly fire rates, however, this is a remarkable record.

In the quest to build persistent SA across a dynamic battlefield, military forces most often demand improved technology and ever more unmanned systems. What they really need is an improved concept of operations. UAS units in support of American campaigns have had to juggle competing demands from multiple parties. Because its data can go to any facility that has approved access and connectivity, one UAV may simultaneously be supporting several teams of analysts.¹⁵⁶ This system works when all are examining the same target, but it creates conflict when disparate parties each want a single aircraft to observe different things.¹⁵⁷ One proposed technological solution to the “soda straw” conundrum was a multiple-camera pod for the MQ-9 Reaper called Gorgon Stare. Despite a “do not field” recommendation from RPA test pilots who found it impractical, several Gorgon Stare pods made it to operational units. Subsequently, in the spring of 2013, the USAF cut funding for the program.¹⁵⁸

Failed enterprises like Gorgon Stare indicate that the problem is not the capability to collect FMV and SIGINT, but rather the ability to process and interpret all of the information. Under current procedures, while RPA crews conduct real-time missions, distributed analysts require hours or even days to review reams of data.¹⁵⁹ DARPA and other agencies continue to pursue automated collection and processing capabilities, hoping to use technology to distill

¹⁵⁵Benjamin, 28.

¹⁵⁶United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 66.

¹⁵⁷Martin and Sasser, 254, 293-294; Baker, 40.

¹⁵⁸Major Landon Quan, USAF, e-mail message to author, 20 February 2014; Maggie Ybarra, “Air Force Pulls Plug on Gorgon Stare Funds, May Freeze Increment 2 Pods,” *Inside The Air Force*, 9 May 2013, <http://insidedefense.com/Inside-the-Air-Force/Inside-the-Air-Force-05/10/2013/air-force-pulls-plug-on-gorgon-stare-funds-may-freeze-increment-2-pods/menu-id-151.html> (accessed 1 March 2014).

¹⁵⁹Major Landon Quan, USAF, e-mail message to author, 20 February 2014.

needles of clarity from haystacks of data.¹⁶⁰ Their initiatives obscure the true problem: human interpretation is required to convert information into actionable intelligence. More UAS are not the answer to information overload, especially not swarms of miniature robots that many writers portend.¹⁶¹ The solution is the development of a strategy that utilizes focused, persistent ISR—not a quest for omnipresent battlespace awareness. Joint planners and operators must know how to ask the right questions, prioritize limited assets, and adapt to changing and unexpected circumstances. Section V addresses this integrated approach.

Proliferation is not Exponential

The exponential growth of unmanned systems in recent years leads many to claim that future development will follow a similar trend. P.W. Singer invokes Moore's Law (which postulates that semiconductor technology doubles roughly biennially) across a broad spectrum of military-related technology including microchips, data storage, wireless networks, and internet bandwidth. He associates this process with the progressive emptying of battlefields due to increasingly precise and lethal modern weapons, but military developments do not follow his logic.¹⁶² Battlefields may be emptying, but unmanned systems have neither alleviated the need for deployed forces nor eliminated the deadly risks of combat. For example, note the number of American ground troops in Kosovo in 1999 (zero) versus the number that invaded Iraq in 2003 (150,000).¹⁶³ Destructive potential is not ever increasing, either: the Soviet Union tested the world's most powerful nuclear bomb in 1961, but nuclear weapon yields and arsenals since have

¹⁶⁰Singer, *Wired for War*, 291; US Air Force Chief Scientist, *Technology Horizons*, xxi; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 62.

¹⁶¹Brimley, FitzGerald and Sayler, "Game Changers," 20.

¹⁶²Singer, *Wired for War*, 98-100.

¹⁶³Gordon and Trainor, 555. NATO troops did occupy portions of Kosovo and Serbia following the ceasefire, and several thousand remain there to this day.

shrunk drastically. Context matters—warfare does not follow mathematical projections.

Nevertheless, the DOD's statistics on UAS growth are startling indeed.

The increase in the number of hours flown by UAS followed an exponential curve until 2011. Between 1995 and May 2007, UAS crews logged approximately 250,000 hours. They flew another 250,000 hours in the subsequent eighteen months, between May 2007 and November 2008.¹⁶⁴ In 2009 alone, UAS logged nearly 500,000 hours, and by mid-2010, they had surpassed 1,000,000 total flight hours.¹⁶⁵ Between 2001 and 2008, ISR flight time rose by 1,431 percent.¹⁶⁶ In 2004, the USAF could maintain five simultaneous 24-hour Predator combat air patrols (CAPs).¹⁶⁷ In 2009, the Secretary of Defense gave the USAF the objective of supporting fifty Predator and Reaper CAPs, and by July of that year, the USAF had thirty-four CAPs in operation.¹⁶⁸ Washington subsequently raised the target to sixty-five CAPs by mid-2014. The USAF was up to sixty-one simultaneous CAPs by 2013, just four short of the ultimate goal.¹⁶⁹

In order to accomplish this unprecedented growth, the USAF had to strain its rated pilot force. The USAF's cadre of approximately fifty RPA pilots in the late 1990s had to multiply in response to worldwide commitments post-9/11, and shortages were inevitable.¹⁷⁰ By mid-2007, the USAF had begun to extend the length of pilots' assignments in RPA squadrons. It augmented their ranks with a round of involuntary transfers, forcing many young pilots to transition from

¹⁶⁴Deptula and Mathewson, slide 43.

¹⁶⁵Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 22.

¹⁶⁶Deptula and Mathewson, slide 34.

¹⁶⁷Turse and Engelhardt, 36.

¹⁶⁸United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 76; Deptula and Mathewson, briefing transcript.

¹⁶⁹Bradley T. Hoagland, *Manning the Next Unmanned Air Force: Developing RPA Pilots of the Future* (Washington, DC: The Brookings Institution, Federal Executive Fellows Policy Paper 17, 6 August 2013), <http://www.brookings.edu/research/papers/2013/08/06-air-force-drone-pilot-development-hoagland> (accessed 1 March 2014), iv.

¹⁷⁰*Ibid.*, 2.

manned aircraft to unmanned squadrons before their previous tours were up. Then it further extended assignments, lengthened mobilization periods for Air National Guard and Air Force Reserve RPA pilots, curtailed RPA flight testing, and delayed the opening of the new RPA Weapons School squadron to fulfill operational demands.¹⁷¹ In 2010, the USAF initiated RPA-only pilot training for officers without prior flying experience, speeding up the pipeline and reducing training costs.¹⁷² As of 2013, the USAF had approximately 1,300 RPA-qualified pilots (8.5 percent of total USAF pilots), projected to increase to 1,650 pilots by 2017.¹⁷³

Something interesting has happened in the last three years: the numbers have leveled off. Since 2010, the US military's UAS flight hours have begun to normalize at roughly 500,000 to 600,000 a year—still an astounding number, but no longer a runaway statistic.¹⁷⁴ USAF pilot shortfalls likewise are stabilizing. Over the past three years, UAS have been busy in the Middle East, Asia, and Africa, but the US military also has departed from Iraq. Future UAS operations in Afghanistan will depend on the ultimate security agreement between the American-led coalition and the Afghan government, but America's footprint there will certainly diminish. According to one analyst, "drawdown is all but inevitable; the USAF simply does not need to maintain 65 combat air patrols unless there are major ground combat operations underway."¹⁷⁵

¹⁷¹Deptula and Mathewson, slide 35.

¹⁷²Lawrence Spinetta, "The Glass Ceiling for Remotely Piloted Aircraft," *Air & Space Power Journal* (July-August 2013), <http://www.airpower.maxwell.af.mil/article.asp?id=155> (accessed 1 March 2014), 102.

¹⁷³Hoagland, 3.

¹⁷⁴General Atomics, "Predator Family UAVs Pass 2 Million Flight Hours," *Defence Talk*, 26 September 2012, <http://www.defencetalk.com/predator-family-uavs-pass-2-million-flight-hours-44758/> (accessed 1 March 2014). This statistic includes Predator, Reaper, and Gray Eagle hours, which represent the overwhelming majority of statistically tracked UAS flight hours.

¹⁷⁵Dave Majumdar, "USAF: Current Unmanned Aircraft Irrelevant in the Pacific," *Flightglobal*, 6 December 2012, <http://www.flightglobal.com/news/articles/usaf-current-unmanned-aircraft-irrelevant-in-the-pacific-379839> (accessed 1 March 2014).

Hence the answer to every security problem is not always “more unmanned systems.” When alarmists lament that growth to date “undoubtedly means . . . more countries with drones flying over them, more drone bases, more crashes, more mistakes,” they are begging the question.¹⁷⁶ Continued escalation is not a certainty; there is no perpetual motion machine inexorably replicating “drones.” The future growth—or retrenchment—of unmanned systems depends on a host of factors, chiefly policymakers’ decisions concerning the use of force and the composition of the military. As discussed in Section I, DOD-wide belt-tightening already is revising future UAS plans. Sections IV and V examine policy dynamics in detail.

Are Unmanned Systems Really “More Bang for the Buck?”

In times of constrained budgets, unmanned systems appeal to governments and militaries because they seem cheaper than manned alternatives. The DOD has acknowledged this belief in writing—its *Unmanned Systems Integrated Roadmap FY2011-2036* states: “affordability [will] be treated . . . like a Key Performance Parameter (KPP) such as speed, power, or data rate.”¹⁷⁷

Predators and Reapers certainly are cheaper than F-22 Raptors and F-35 Joint Strike Fighters.

However, as with the issue of escalation, past performance is not a guarantee of future returns.

The cost equation of unmanned systems is more complex than it seems.

The US military rushed the development and deployment of many unmanned systems to satisfy urgent requests from commanders in the field. This nontraditional approach concealed many of these systems’ expenses and shortcomings. Funding for many unmanned systems came from wartime contingency appropriations, as opposed to the traditional budget process.¹⁷⁸

Initially, commercial off-the-shelf technology like the Predator or the Talon UGV provided rapid

¹⁷⁶Turse and Engelhardt, 156

¹⁷⁷Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, v.

¹⁷⁸United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 63.

solutions at remarkably low cost. However, as operations continued and the need grew for these systems to integrate with other combat capabilities, problems surfaced. As the *Unmanned Systems Integrated Roadmap* explains, “each unmanned system was procured as a vertically integrated, vendor-proprietary solution . . . this resulted in an inhibition to innovation; increased vulnerability to threats . . . increased complexity . . . [and] increased costs.”¹⁷⁹ The DOD is revising the acquisition process for unmanned systems to match traditional practices, and demanding interoperability and open architecture in future designs.¹⁸⁰

UAS may be cheaper than manned fighters and bombers, but many still cost tens of millions of dollars each, particularly when the cost of ground control stations and communications equipment is included.¹⁸¹ In 2012 dollars, a Reaper system of four aircraft, ground control station, and satellite uplink costs \$30.9 million. A Gray Eagle platoon of four aircraft and all support equipment costs \$153.1 million, and a single Global Hawk costs \$222.7 million.¹⁸² “They are not expendable, they are very expensive,” states General Mike Hostage, commander of Air Combat Command.¹⁸³ The Congressional Budget Office agrees: “Although a pilot may not be on board, the advanced sensors carried by unmanned aircraft systems are very expensive and cannot be viewed as expendable.”¹⁸⁴ Each crash reduces combat capability.

Regrettably, many such crashes have occurred—but raw numbers are misleading. In 2007, the USAF determined that it had lost 50 percent of its Predators.¹⁸⁵ By 2010, thirty-eight

¹⁷⁹Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 33.

¹⁸⁰*Ibid.*, 15, 34.

¹⁸¹Gertler, 13.

¹⁸²Michael J. Sullivan, *Defense Acquisitions: Assessments of Selected Weapon Programs*, report to Congressional Committees, GAO-13-294SP (Washington, DC: United States Government Accounting Office, March 2013), <http://www.gao.gov/assets/660/653379.pdf> (accessed 1 March 2014), 101, 105, 113.

¹⁸³Majumdar, “USAF: Current Unmanned Aircraft Irrelevant in the Pacific.”

¹⁸⁴Gertler, 4.

¹⁸⁵Krishnan, 127.

Predators and Reapers had crashed in Iraq and Afghanistan, at a cost of \$3.7 to \$5 million each. Nine others had crashed stateside. Ostensibly, the USAF's RPAs were crashing themselves out of existence.¹⁸⁶

Mishap rates have decreased significantly over the past several years. The 2009 accident rate for the Predator was comparable to that of the F-16 fighter at that aircraft's same stage of development, and better than that of single-engine private planes in the United States. Crash rates for aircraft in general tend to be highest during development and initial operations. The US military accepted the risks associated with deploying untested unmanned systems because the capabilities they provided were worth the cost. Mishap rates for manned aircraft have declined markedly over the past fifty years due to improvements in designs and training, and today unmanned systems are aligning with this trend.¹⁸⁷

Developers identify modularity as a key affordability factor for future unmanned systems, envisioning a "standardized, low-cost, small- to medium-sized, remotely piloted airframe able to carry mission-specific payloads."¹⁸⁸ This concept (aside from the remote pilot) sounds remarkably like the DOD's original vision for the F-35 Joint Strike Fighter. The Pentagon wanted the F-35 to be an affordable aircraft whose three variants would answer the respective needs of the USAF, Navy, and Marines for decades to come. After years of requirements creep, cost overruns, and broken deadlines, the price tag for each F-35 now stands at \$135 million.¹⁸⁹

The F-35's skyrocketing price tag is no surprise to USAF Lieutenant Colonel Lawrence Spinetta, an experienced pilot and former RPA squadron commander. He notes, "[w]ithout

¹⁸⁶Gertler, 17-18.

¹⁸⁷*Ibid.*, 18-19.

¹⁸⁸US Air Force Chief Scientist, *Technology Horizons*, 83.

¹⁸⁹Harrison, 43. This number comes from the 2012 Defense Budget. In the 2013 Budget, the DOD cut the production rate of the F-35 to reduce total program cost. This move further increases per-unit price, as research and development costs are shared across a smaller fleet. Daggett and Towell, 10.

exception, every generation of bomber and fighter aircraft since the Wright Flyer has been an order of magnitude more expensive than its predecessor.”¹⁹⁰ However, his claim that “[u]nmanned aircraft . . . offer so much capability for so little money that they represent a way out of the service’s force structure death spiral” is either prescience—or fallacy.¹⁹¹ The exorbitant Global Hawk and the Navy’s UCAS certainly challenge such an assertion.

General Hostage’s assertion that unmanned systems are nonexpendable is not universal. The *Unmanned Systems Integrated Roadmap* envisions a future in which commanders habitually make decisions to expend (i.e. destroy) robotic vehicles in order to accomplish their missions.¹⁹² It notes, “[i]n order to be expendable, which is often the intent of building an unmanned system, the vehicle must be low-cost.”¹⁹³ The *Roadmap* does not mention an associated requirement: in order to be expendable, commanders must have enough units that sacrificing them does not exhaust available reserves. Cost equals price-per-unit times the total number of systems purchased. Future designs may be expendable, but this does not mean the total bill will be low. The *Roadmap* is correct to regard affordability as important, but when the same document highlights the need to “protect the defense industrial base,” one begins to surmise the intended audience.¹⁹⁴ Unmanned systems can be cost effective only if the US military resists the siren song of cheap, quick fixes perpetually emanating from the purveyors of armaments.

More Machines, Fewer Humans: the Wrong Answer

Personnel costs are a significant component of military budgets. If technology could decrease the ratio of crews-to-vehicles, then unmanned systems might reduce this expense

¹⁹⁰Spinetta and Cummings, “Unloved Aerial Vehicles.”

¹⁹¹Ibid.

¹⁹²Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 7.

¹⁹³Ibid., 14.

¹⁹⁴Ibid., 64.

without sacrificing combat effectiveness. The USAF presently uses one pilot and one sensor operator to control each RPA. This two-to-one ratio does not include the scores of additional personnel involved in the support and intelligence exploitation of each aircraft.

In the mid-2000s, the USAF tested a system called Multi-Aircraft Control (MAC), which allowed one ground control station to manage up to four airborne RPAs during benign operations like transit or holding patterns. The *United States Air Force Unmanned Aircraft Systems Flight Plan 2009-2047* set a goal to implement MAC on a wider scale by late 2010, envisioning 56 percent in manpower savings across the RPA fleet.¹⁹⁵ Such developments prompted drone alarmists to forecast omnipotent puppet masters singlehandedly directing squadrons of lethal drones to incinerate clusters of (presumably innocent) people in distant lands.¹⁹⁶ In actuality, such marionette-like manipulation turned out to be more difficult than expected.

At first glance, MAC may appear analogous to air traffic control (ATC), in which each controller can manage multiple airborne aircraft. However, human factors experts call this analogy “fallacious for projecting the safe human-robot ratio because it ignores the Pilot-in-Command role. . . . If a manned air vehicle encounters difficulties, the ATC does not assume control of the aircraft; the Pilot on board remains in charge of each individual aircraft.”¹⁹⁷ The interplay between controllers and pilots is what makes ATC function, particularly when the unexpected occurs. The author’s personal experience as a flight leader, instructor pilot, and mission commander in the F-15C Eagle, F-22 Raptor, MQ-1 Predator, and MQ-9 Reaper corroborates this finding. In dynamic situations, flying one’s own aircraft while simultaneously directing a formation of four or more fighters is extremely demanding. Proficiency requires years

¹⁹⁵United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 18, 55; Deptula and Mathewson, slide 11.

¹⁹⁶Turse and Engelhardt, 43.

¹⁹⁷Robin R. Murphy and Jennifer L. Burke, “The Safe Human-Robot Ratio,” in *Human-Robot Interactions*, 47.

of training and constant practice. It relies on rigorous tactical standards and prudent delegation to the qualified human aviators operating each additional aircraft.

Studies of multitasking have consistently shown that human performance deteriorates when a person attempts to do several things at once (text messaging while driving, for example). Experiments with unmanned systems have demonstrated that simultaneously controlling multiple vehicles engenders significant risks of lost SA, cognitive overload, and incorrect task prioritization.¹⁹⁸ P.W. Singer notes, “[j]ust having a human operator control two rather than one UAV at a time reduces their performance by an average of 50 percent.”¹⁹⁹ One experiment with UGVs found that single operators controlling two vehicles detected less than 25 percent of their targets, but *adding* an additional operator to each system improved detections up to 170 percent—in other words, more humans were the answer, not fewer.²⁰⁰ Technological solutions that simplify inputs or make displays more intuitive may streamline a remote operator’s changeover between the controls of multiple vehicles, but ergonomics cannot eradicate the pitfalls of multitasking.²⁰¹

The USAF’s MAC trial ended in 2011-2012 because aircrews found it infeasible and unreliable. One veteran RPA pilot lamented the “inability to build SA as you push into the target area” when flying multiple aircraft.²⁰² Another explained that MAC control did not suffice when there were “two targets to prosecute or two malfunctioning airplanes. That was more than one

¹⁹⁸Michael J. Barnes and A. William Evans III, “Soldier-Robot Teams in Future Battlefields: An Overview,” in *Human-Robot Interactions*, 12, 21-22; Keryl Cosenzo, Raja Parasuraman, and Ewart de Visser, “Automation Strategies for Facilitating Human Interaction with Military Unmanned Vehicles,” in *Human-Robot Interactions*, 104.

¹⁹⁹Singer, *Wired for War*, 126.

²⁰⁰Florian Jenstch, A. William Evans III, and Scott Ososky, “Model World: Military HRI Research Conducted Using a Scale MOUT Facility,” in *Human-Robot Interactions*, 422.

²⁰¹Barnes and Evans, “Soldier-Robot Teams,” in *Human-Robot Interactions*, 22; Jennifer M. Riley, et al., “Situation Awareness in Human-Robot Interaction: Challenges and User Interface Requirements,” in *Human-Robot Interactions*, 178-179; Gloria Calhoun and Mark Draper, “Unmanned Aerial Vehicles: Enhancing Video Display Utility with Synthetic Vision Technology,” in *Human-Robot Interactions*, 242.

²⁰²Major Landon Quan, USAF, e-mail message to author, 4 December 2013.

pilot could handle.”²⁰³ These “targets” include not just lethal strikes, but any dynamic surveillance task, such as following a vehicle through crowded urban streets or tracking individuals in rugged terrain. A human-flown RPA with real-time FMV is the ideal platform for such volatile situations, but they require singular focus to be successful. The fog and friction of ground combat is even greater than that of airborne operations.²⁰⁴ One Pentagon report determined, “[e]ven if the tactical commander is aware of the location of all his units, the combat is so fluid and fast-paced that it is very difficult to control them.”²⁰⁵ The Navy’s plan to synchronize multiple types of unmanned systems from an LCS in hostile waters portends a multitasking nightmare.²⁰⁶

Multi-aircraft control may still be useful for scripted flight plans like those of the Global Hawk (although even its pilots frequently have to intervene manually), but for demanding, unpredictable situations, unmanned systems require one crew per vehicle.²⁰⁷ Even if MAC could reduce personnel requirements during transit, the ratio of aircraft en route versus those on target would depend on the tactical scenario. A squadron would still need a full roster of pilots standing by to assume aircraft control during intense situations.²⁰⁸ Only one factor might alter the equation. It is the most controversial subject in the debate over unmanned systems: what if technology could eliminate the need for human control altogether?

²⁰³Martin and Sasser, 301.

²⁰⁴von Clausewitz, 119, 140.

²⁰⁵Singer, *Wired for War*, 126.

²⁰⁶Riley, et al., “Situation Awareness in Human-Robot Interaction,” in *Human-Robot Interactions*, 176.

²⁰⁷Gertler, 36.

²⁰⁸Michael Lewis and Jijun Wang, “Coordination and Automation for Controlling Robot Teams,” in *Human-Robot Interactions*, 415. Moreover, the MAC required a sensor operator to monitor each vehicle during transit, so there was no improvement to enlisted personnel requirements. See Michael Hoffman, “Are Enlisted Airmen Next to Pilot UAVs?” *Air Force Times*, 21 December 2008, <http://www.airforcetimes.com/article/20081221/NEWS/812210319/Are-enlisted-airmen-next-to-pilot-UAVs> (accessed 1 March 2014).

Robotic Autonomy

If militaries develop and deploy fully autonomous lethal systems, the character of warfare will change in significant but unpredictable ways. As discussed above, fully autonomous systems to date exist only as experimental prototypes.²⁰⁹ While academia, industry, and certain DOD entities continue to advocate for increased robotic autonomy, uniformed personnel at all levels remain opposed to relinquishing the human decision over the employment of deadly force.

Full autonomy is distinct from automation or semi-autonomy. An autonomous robot consists of several components: “sensors” to obtain information, “processors” to interpret it, and “effectors” to implement its decisions.²¹⁰ Autonomous systems are “self-directed toward a goal in that they do not require outside control, but rather are governed by laws and strategies that direct their behavior . . . [even in] unpredictable situations.”²¹¹ They must be capable of “complex decision making, including autonomous mission planning, and [have] the ability to self-adapt to the environment.”²¹² In contrast, an *automatic* system (an aircraft flying on autopilot with a human monitor, for example) “is not able to define the path . . . or to choose the goal.”²¹³ Semi-autonomous systems implement even more automation, but still do not make decisions. “Fire and forget” missiles, radar-guided air defenses, and mines are semi-autonomous systems.²¹⁴

Department of Defense Directive (DODD) 3000.09, *Autonomy in Weapon Systems*, dated 21 November 2012, spells out the US military’s current stance on the subject:

²⁰⁹Krishnan, 44.

²¹⁰Singer, *Wired for War*, 67.

²¹¹Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 43.

²¹²US Air Force Chief Scientist, *Technology Horizons*, 53.

²¹³Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 43.

²¹⁴Department of Defense, Directive 3000.09, *Autonomy in Weapon Systems* (Washington, DC: Department of Defense, 21 November 2012), <http://www.dtic.mil/whs/directives/corres/pdf/300009p.pdf> (accessed 1 March 2014), 14; Krishnan, 45. While a human does not select the specific target for a mine, one does select its (static) location and fusing function. The device only reacts to a direct stimulus—it does not make a “decision” to explode.

Commanders and operators [shall] exercise appropriate levels of human judgment over the use of force . . . in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement (ROE). . . . Human-supervised autonomous weapon systems may be used . . . for local defense to intercept attempted time-critical or saturation attacks. . . . Autonomous weapon systems may be used to apply non-lethal, non-kinetic force such as some forms of electronic attack.²¹⁵

The regulation permits the military to use semi-autonomous lethal weapon systems under human control, as it has for decades. Ancillary studies may make many assertions about the need for autonomy in future designs, but DODD 3000.09 is plain in its restrictions.²¹⁶ Speculation aside, “for the foreseeable future, decisions over the use of force . . . will be retained under human control in unmanned systems.”²¹⁷

DODD 3000.09 does not present novel concepts; the US military learned its lessons regarding human-supervised autonomy long ago. In 1960, the United States deployed a radar system designed to detect Soviet ICBM launches and trigger a rapid nuclear response sequence. Shortly after activation, the system lit up with warnings of an incoming attack. Its radar had picked up a large object rising above the horizon: the moon. The system worked as programmed—its designers simply had not taught it to distinguish a missile from a celestial object. An astute commander quickly spotted the error and ended the crisis.²¹⁸

Forays into autonomy have not always ended bloodlessly. On 3 July 1988, a US Navy Aegis cruiser in the Arabian Gulf detected an unknown aircraft. The newly installed air defense system aboard the *Vincennes* misidentified a civilian airliner as an Iranian F-14 fighter. Despite situational evidence to the contrary, the crew trusted the computer and shot down the airliner,

²¹⁵Department of Defense, Directive 3000.09, 2-3.

²¹⁶United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 33; Deptula and Mathewson, slide 21; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, vi, 27, 45-46.

²¹⁷Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 17.

²¹⁸“Moon Stirs Scare of Missile Attack,” *New York Times*, 8 December 1960.

killing all 290 passengers and crew.²¹⁹ The human-supervised autonomy of the *Vincennes* would have fit the defensive stipulations of DODD 3000.09, but the crew's actions would have violated the requirement always to exercise human judgment and apply ROE. Today, Phalanx ship-defense guns and the equivalent land-based C-RAM (Counter Rocket, Artillery, and Mortar) can operate under human-supervised autonomy, but only under strict, short-range constraints.²²⁰

The US military has built up a healthy mistrust of autonomous weapon systems. Nevertheless, academics, think tanks, and industry advocates continue to publish studies proclaiming that autonomy is not just desirable, but necessary and inevitable.²²¹ In 2011, the Office of the USAF Chief Scientist's *Technology Horizons* asserted, "[i]ncreasing levels of flexible autonomy will be needed for a wider range of Air Force functions."²²² A recent study from the Center for a New American Security concluded: "To realize their full game-changing potential, militaries may need to use more contentious concepts of operation including fully autonomous ISR or even combat missions."²²³ Armin Krishnan believes that if Western armed forces "wish to retain their current military advantage in the long run they will need to increasingly substitute soldiers with technology, i.e. robots."²²⁴ These statements all use the word "need" to characterize the importance of autonomy, but all come from sources outside the military chain of command.²²⁵

²¹⁹Mark Hagerott, "Robots, Cyber, History, and War," in *Robots on the Battlefield*, 25; Singer, *Wired for War*, 124-125.

²²⁰Singer, *Wired for War*, 38; 34. The C-RAM only targets incoming projectiles, not live adversaries. Hagerott, "Robots, Cyber, History, and War," in *Robots on the Battlefield*, 27.

²²¹Krishnan, 34.

²²²US Air Force Chief Scientist, *Technology Horizons*, 53.

²²³Brimley, FitzGerald and Sayler, "Game Changers," 15.

²²⁴Krishnan, 2.

²²⁵US Air Force Chief Scientist, *Technology Horizons*, 166-169. The authors of *Technology Horizons* are all civilians except for two USAF colonels, both of whom have spent their careers in research and development, not operations.

Vignettes that advocate for autonomous systems tend to sound contrived. The *Unmanned Systems Integrated Roadmap* presents a hypothetical scenario wherein friendly autonomous systems neutralize a rogue UUV and destroy a futuristic enemy UAV.²²⁶ In both engagements, friendly actions promptly defeat a non-adaptive foe. Other studies further strain credulity. One proposal from 2006 addresses ROE concerns by suggesting that autonomous robots should “shoot to destroy hostile weapons systems, but not suspected combatants,” as if aiming a missile at a vehicle rather than the driver inside changes the outcome.²²⁷ Ronald Arkin, a leading advocate for robotic autonomy, envisions autonomous aircraft programmed to hold fire or select a smaller weapon if a hostile target passes near a hospital. He and his colleagues believe future autonomous systems could even wait to determine whether a person “seems ready to attack” before they shoot at him.²²⁸ These appeals for autonomy casually disregard the reality of warfare in myriad ways. Guileful adversaries habitually leverage protected symbols and structures (i.e. hospitals and religious buildings) in far more complex and nefarious ways than simply driving past them. Determining a human’s actual intentions remains squarely in the realm of science fiction.

Empirical evidence does not support lofty aspirations for autonomous weapons systems. To assess whether autonomous systems could replace human soldiers, scientists must develop scenarios that replicate the unpredictability of combat against a live, adaptive foe. As *Technology Horizons* explains, “it is the lack of suitable V&V [verification and validation] methods that prevents all but relatively low levels of autonomy from being certified for use.”²²⁹ Robotics

²²⁶Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 9-10.

²²⁷Singer, *Wired for War*, 128.

²²⁸Tara McKelvey, “Could We Trust Killer Robots?” *Wall Street Journal*, 19 May 2012, <http://online.wsj.com/article/SB10001424052702303448404577410032825529656.html> (accessed 1 March 2014).

²²⁹US Air Force Chief Scientist, *Technology Horizons*, xx.

experts have determined that “[a]rtificial intelligence required for vehicle autonomy remains a disappointing technology despite exponential improvements in computing cost and density.”²³⁰

Artificial intelligence can exceed human capacity in certain endeavors. For example, the computer *Deep Blue* beat human chess champion Gary Kasparov in 1997. Chess has relatively simple rules that an adroitly programmed machine can use to generate nearly infinite combinations.²³¹ Computers excel at chess because all possible moves take place within a “well-defined problem space.”²³² Chess is a *complicated* game, with vast possible permutations that nevertheless operate in patterned and finite ways. War, on the other hand, is *complex*: it adapts based on diverse interactions and emergent properties that make it impossible to predict with certainty.²³³ In war, a wise adversary hardly ever plays by the “rules.” Instead, a deft combatant seeks victory through asymmetric and adaptive methods.

Computers falter when problems do not have clear boundaries. For example, it is difficult for a computer to tell the difference between an apple and a tomato without detailed analysis, as nearly all measures of comparison overlap in some regard (size, shape, color, etc.). Most humans can distinguish between an apple and a tomato—or between a Soviet ICBM and the moon—intuitively.²³⁴ Experiments with teams of autonomous vehicles have found that robotic self-coordination quickly becomes “computationally intractable” because every decision spawns an ever-expanding set of possibilities.²³⁵ Swarms of robots that resemble phenomena in nature are

²³⁰Nancy J. Cooke and Roger A. Chadwick, “Lessons Learned from Human-Robotic Interactions on the Ground and in the Air,” in *Human-Robot Interactions*, 361.

²³¹Krishnan, 47; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 41.

²³²Chris Jansen and Jan B. F. van Erp, “Telepresence Control of Unmanned Systems,” in *Human-Robot Interactions*, 251.

²³³Gökçe Sargut and Rita Gunther McGrath, “Learning to Live with Complexity,” *Harvard Business Review* 89, no. 9 (September 2011): 70-71.

²³⁴Singer, *Wired for War*, 76; “Moon Stirs Scare of Missile Attack.”

²³⁵Lewis and Wang, “Coordination and Automation for Controlling Robot Teams,” in *Human-*

intriguing but impractical in unscripted scenarios.²³⁶ Human intellect is imperfect, but it has evolved the ability to distill coherency from complex uncertainty without requiring a preprogrammed solution. This explains how pilots can wield formations of aircraft in unfamiliar situations where the research indicates that autonomous robots would quickly run out of ideas.

Autonomy at any level of the decision-making process affects the application of lethal force, even if a human ultimately pulls the trigger. Military operations demand trust and shared understanding, from tactical engagements all the way to strategic direction and planning. A program that could evaluate “up to 3,000 friendly COAs [courses of action] per minute” would be counterproductive because commanders and staffs never would learn why certain options did not make the cut.²³⁷ Commanders and staffs develop courses of action and conduct wargames to focus their planning, not to arrive at perfect solutions (which do not exist).

Any autonomous ISR system designed to cull unnecessary data before sending it to human analysts would have to be pristine, as erroneous omissions could be disastrous.²³⁸ Unfortunately, when autonomous systems are assigned tasks such as “making a prediction of enemy activity . . . the data upon which the diagnosis is based are fuzzy and uncertain. Hence a substantial error rate in diagnostic accuracy is anticipated.”²³⁹ Skepticism is critical in order to avoid “automation bias—an overreliance in which people treat information from the robot as fact

Robot Interactions, 402.

²³⁶Tisseron, “Robotic and Future Wars,” in *Robots on the Battlefield*, 13; Hagerott, “Robots, Cyber, History, and War,” in *Robots on the Battlefield*, 30; George R. Lucas, Jr., “The Ethical Challenges of Unmanned Systems,” in *Robots on the Battlefield*, 139-140.

²³⁷Krishnan, 54.

²³⁸ Michel Yakovleff, “Battlefield Robotization: Toward a New Combat Ecosystem,” in *Robots on the Battlefield*, 254; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 49.

²³⁹Christopher D. Wickens, Brian Levinthal and Stephen Rice, “Imperfect Reliability in Unmanned Air Vehicle Supervision and Control,” in *Human-Robot Interactions*, 194.

without seeking additional information.”²⁴⁰ The crew of the *Vincennes* demonstrated automation bias in 1988 with tragic consequences.

Professional military members accept the personal responsibility inherent in the state sanction of lethal operations. Autonomy threatens to fracture this paradigm, which has legal and ethical implications, but advocates for autonomy are not depraved. Instead, they believe the military needs autonomous robots because future conflicts will demand split-second timing that exceeds human capabilities. The *Unmanned Systems Integrated Roadmap* envisions systems that can “adapt and learn . . . fast enough to provide benefits within the adversary’s decision loop.”²⁴¹ Aerial dogfights, cyber-attacks, and nuclear missile launches do demand near-instantaneous responsiveness, but it is irresponsible to invoke a metaphorical feedback loop to justify imbuing robots with decision-making authority.²⁴² Military operations as a rule require not reflexive action but rather prudent deliberation and an acceptance of responsibility for both intended effects and unintended consequences.²⁴³ The following section will examine these challenges as they pertain to current policies and strategies involving unmanned systems.

IV – ARE UNMANNED SYSTEMS MAKING MORE TERRORISTS?

The preceding sections analyzed the development of unmanned systems into their present forms, and dissected persistent misconceptions regarding their character and promise. Unmanned

²⁴⁰Lori Fister Thompson and Douglas J. Gillan, “Social Factors in Human-Robot Interaction,” in *Human-Robot Interactions*, 70.

²⁴¹Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 48. This concept derives from the Observe-Orient-Decide-Act loop developed by USAF Colonel John Boyd, a fighter pilot and theorist, in the 1970s. RMA proponents of the 1990s and early 2000s borrowed this concept in their pursuit of technological solutions to the fog and friction of war. See Frans Osinga, *Science, Strategy, and War: The Strategic Theory of John Boyd* (New York, NY: Routledge, 2007), 1-3.

²⁴²United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 16.

²⁴³Hagerott, “Robots, Cyber, History, and War,” in *Robots on the Battlefield*, 28; Dominique Lambert, “Autonomous Robots: The Irreducible and Complementary Place of Officer’s Ethics,” in *Robots on the Battlefield*, 132.

systems provide remarkable proven—and potential—capabilities, but they are an amalgamated component of war’s evolution, not a divergent path. Like any inanimate tool, unmanned systems themselves are neither legal nor illegal; neither moral nor immoral; neither right nor wrong. When wielded by professionals, they operate well within the accepted rules of warfare.²⁴⁴ Conversely, if used carelessly or with ill intent, unmanned systems have the potential to explode the notion that warfare—though always regrettable—can be a legitimate, noble endeavor. Unmanned systems must not lower the threshold for when to employ force. The consequences of a cavalier attitude toward violence will be severe.

Too Seductive for Policymakers?

Some analysts believe that the apparent risk-free nature of unmanned systems facilitates the decision to resort to force, making violence a first resort rather than a last one.²⁴⁵ The nature of risk is among the most complex subjects in warfare, particularly as technology has enabled greater distance and detachment between combatants. With regard to tactical risk, unmanned systems do increase the safety and security of their operators as compared to manned equivalents. In terms of their ability to produce mission success, or their potential to transfer danger to other friendly forces or civilians, unmanned systems are not a riskless proposition.²⁴⁶

Since the dawn of aviation, many airpower advocates claimed that aircraft could shatter existing paradigms of protracted warfare on land and at sea, providing shortcuts to victory by striking enemy leadership and economies directly. Their predictions always failed: against

²⁴⁴Christof Heyns, “Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions,” Report A/68/382, submitted to the United Nations General Assembly, 13 September 2013, <http://justsecurity.org/wp-content/uploads/2013/10/UN-Special-Rapporteur-Extrajudicial-Christof-Heyns-Report-Drones.pdf> (accessed 1 March 2014), 4.

²⁴⁵Zenko, *Reforming U.S. Drone Strike Policies*, 8; Schwartz, “U.S. Drone Program is Fatally Flawed,” 45.

²⁴⁶Benjamin, 212-213; Zenko, *Reforming U.S. Drone Strike Policies*, 8.

Germany, Japan, North Korea, Vietnam, Iraq, and Serbia, US air attacks alone never broke enemy resistance.²⁴⁷ Instead, they served as critical enablers for comprehensive approaches (with varying levels of success). Even the atomic bombing of Japan did not produce victory singlehandedly: it represented the final act of years of grueling combat on land, at sea, and in the air, including a strangling naval blockade and the entry of the Soviet Union into the Pacific theater.

Nevertheless, despite the dearth of evidence, each technological advance in air combat spawned new pundits who insisted airpower finally could make warfare systematically winnable.²⁴⁸

Following the Gulf War and an ill-fated troop deployment to Somalia in 1993, the United States and its allies relied almost exclusively on airpower for a number of military operations. Policymakers chose this option because they did not want to risk ground forces, and because they believed aircraft could accomplish the desired missions. The two no-fly zones over Iraq minimized friendly casualties and contained Iraq at a cost of \$1 billion per year, but they did not achieve the ultimate goal of eliminating the regime of Saddam Hussein.²⁴⁹

Military options that avoided placing personnel in harm's way altogether were even more attractive to policymakers, as demonstrated by the 1998 cruise missile strikes that (unsuccessfully) targeted Osama bin Laden and his associates. In this instance, the United States unleashed deadly force into Afghanistan and Sudan—nations with which it was not at war.²⁵⁰ Cruise missile attacks alleviated the need for forward bases and involved zero risk of friendly casualties or prisoners-of-war. Unfortunately, they also failed to achieve their objectives. The United States' international prestige slipped, and the legend of bin Laden grew. The persistence

²⁴⁷Turse and Engelhardt, 25. These are examples of American air campaigns, but other nations have tried similar approaches. The Luftwaffe's failure to subdue Britain during the *blitz* campaign is a prime example of resilience in the face of air attack.

²⁴⁸John A. Warden III, "Air Theory for the Twenty-First Century," in *Battlefield of the Future*, 121-122.

²⁴⁹Zenko, *Between Threats and War*, 29, 38, 49.

²⁵⁰*Ibid.*, 52.

and accuracy of modern unmanned systems may offer a higher probability of effective targeting than standoff weapons like cruise missiles, but precision does not equate to mission success.²⁵¹

Contemporary American military leaders have been more reluctant to employ force than their civilian counterparts have, and the former tend to eschew simple martial solutions to difficult problems.²⁵² Sometimes the civilian leadership heeds their advice, and sometimes it rejects it. The no-fly zones over Iraq “were generally supported by senior civilian officials and opposed by senior military officials” (the latter viewed them as ineffective).²⁵³ In the run-up to the 2003 invasion of Iraq, senior civilian leaders spurned top generals’ recommendations for a larger force to mitigate risk, instead opting for an RMA-inspired invasion plan.²⁵⁴ Conversely, in July 2013, Chairman of the Joint Chiefs of Staff Martin Dempsey’s astute articulation of the risks of American intervention in Syria’s civil war succeeded in mollifying hawkish political leaders.²⁵⁵

Unmanned systems appeal to casualty-averse politicians because they reduce the risk of friendly losses, but this factor does not make the decision to employ force an easy one. Every time a commander uses state-sanctioned violence to achieve an end, he or she injects a stimulus into a system that will create multiple-order effects, and the payoff had better be worth the potential cost. Nonetheless, once leaders make the decision to employ force, they are obliged to select tools that minimize risk to friendly forces and reduce collateral damage.²⁵⁶ Unmanned systems—at times—may be the right answer. General Norton Schwartz, former Air Force Chief of Staff, cannot believe any responsible citizen “would prefer for the American military to absorb

²⁵¹Dawkins, 17-18, 21; Heyns, 4-5.

²⁵²Zenko, *Between Threats and War*, 26, 67-68.

²⁵³*Ibid.*, 48-49.

²⁵⁴Gordon and Trainor, 101-103.

²⁵⁵Martin Dempsey, “Gen. Dempsey Responds to Levin's Request for Assessment of Options for Use of U.S. Military Force in Syria,” 19 July 2013, <http://www.levin.senate.gov/download/?id=f3dce1d1-a4ba-4ad1-a8d2-c47d943b1db6> (accessed 1 March 2014).

²⁵⁶Lucas, “The Ethical Challenges of Unmanned Systems,” in *Robots on the Battlefield*, 136.

casualties just for the purpose of making war less numbing to the political leadership.”²⁵⁷

Unmanned systems may seem particularly seductive for spying because they alleviate prisoner-of-war concerns in the case of a crash, but this precedent already exists. American satellites have been peering into other nations for more than half a century.

The words and phrases policymakers use to describe strategy directly influence the way nations conceive and fight wars. Use of the term “Global War on Terror” to define American military operations against al-Qaeda and its affiliates after 9/11 gave the impression that the nation was at war with an extensive, incorporated adversary. Consequently, the United States mobilized massive worldwide military and intelligence efforts, including the rapid proliferation of unmanned systems, in a conflict whose very title implied limitless commitment. In reality, those responsible for 9/11 numbered in the hundreds, and most other extremists worldwide had little or no connection with them; grievances tend to be local, not global. The notion that the United States had embarked on a so-called “long war” thus became a self-fulfilling prophecy.²⁵⁸

The Administration of President Barack Obama retired the Global War on Terror moniker, but it maintained the assertion that America is committed to a long-term conflict against persistent adversaries.²⁵⁹ Many worry that the increased use of unmanned systems under the current administration “may lower social barriers in society against the deployment of lethal force,” leading to an era of eternal conflict.²⁶⁰ Speculation aside, this concern highlights the danger of seeking violent solutions to complex problems: absent a comprehensive approach to

²⁵⁷Schwartz, “U.S. Drone Program is Fatally Flawed,” 12.

²⁵⁸Benjamin, 97.

²⁵⁹White House, *The National Security Strategy of the United States of America* (Washington, DC: US Government Printing Office, May 2010), 19-21; Amnesty International, *Will I Be Next? US Drone Strikes in Pakistan* (London, UK: Amnesty International Publications, October 2013), <http://www.amnestyusa.org/research/reports/will-i-be-next-us-drone-strikes-in-pakistan> (accessed 1 March 2014), 48.

²⁶⁰Heyns, 5.

solving the root causes of strife, lethal attacks tend to spread discontent and transfer risk. This metastasizing effect explains why new “al-Qaeda” offshoots seem to emerge daily.

Unmanned systems are tools that do not apply equally to all strategic, operational, and tactical problems. If, based on rigorous analysis and debate, the United States’ government elects to target a legal combatant with lethal force, then the stealth, persistence, and precision of a UAS may be the appropriate solution. Still, experience to date demonstrates that simply eliminating one or a handful of individuals does not ensure victory. The 2011 *National Military Strategy of the United States* explains: “While such operations disrupt in the short-term, they cannot be decisive and do not constitute a viable long-term strategy for combating extremism.”²⁶¹

Policymakers must analyze every contingency specifically to determine how to proceed, rather than grouping distinct crises into a unitary, Cold War-like model. Fortunately, the available evidence indicates that this is what they at least endeavor to do. The latest *National Security Strategy of the United States* repeatedly emphasizes that lethal force is only one component of a comprehensive, interdependent approach to securing the safety and interests of the nation.²⁶² Technology has increased the global interconnectedness of America’s allies and its adversaries alike, but leaders must always tailor decisions involving lethal force to fit specific situations.

Legality

Unmanned systems do not permit a nation to deviate from international laws and norms. During declared armed conflicts between states or between a state and a non-state actor, international humanitarian law applies. Under this framework, lethal attacks must be *proportional* (devastation must not outweigh the intended gain) and *discriminating* (they must target lawful

²⁶¹Joint Chiefs of Staff, *The National Military Strategy of the United States* (Washington, DC: US Government Printing Office, 2011), 6.

²⁶²White House, *National Security Strategy of the United States*, 3-4, 8, 18, 20-22.

combatants and not civilians, also called *distinction*).²⁶³ Violence must reach a defined minimum level of intensity, and participants must be governmental authorities or organized armed groups.²⁶⁴ Modern terrorists strain these guidelines by intentionally embedding their activities among civilian populaces, maintaining fluid organizational structures, and frequently switching between violent action and peaceful existence, but their flaunting of legal characterization does not make them immune from attack.

International humanitarian law presumes an individual is a noncombatant until proven otherwise. One can lose this protected status based upon “insignia or conduct.”²⁶⁵ Conduct such as propaganda, recruitment, finance, and logistical support to the enemy do not make an individual a targetable combatant.²⁶⁶ Activities must indicate a “continuous combat function,” meaning a person is a member of an armed group and actively participates by planning, commanding, or executing “operations amounting to direct participation in hostilities.”²⁶⁷ A lethal strike from an unmanned system can exemplify proportionality and distinction, or else it can be murder—as the United Nations (UN) Special Rapporteur explains, “[t]he legal test remains whether there is sufficient evidence.”²⁶⁸

The United States asserts that it uses unmanned systems in a declared armed conflict that began the week after 9/11. On 18 September 2001, the US Congress passed the Authorization for the Use of Military Force. This act legitimated military action against “nations, organizations, or

²⁶³Dawkins, 26, 30; Amnesty International, 27; Heyns, 14-16.

²⁶⁴Amnesty International, 45-47; Heyns, 12-14.

²⁶⁵Heyns, 14-15.

²⁶⁶Ben Emmerson, “Report of the Special Rapporteur on the Promotion and Protection of Human Rights and Fundamental Freedoms While Countering Terrorism,” Report A/68/389, submitted to the United Nations General Assembly, 18 September 2013, http://msnbcmedia.msn.com/i/msnbc/sections/news/UN_Drones_Report.pdf (accessed 1 March 2014), 21; Benjamin, 133.

²⁶⁷Emmerson, 20.

²⁶⁸Heyns, 15.

persons [that] planned, authorized, committed, or aided the terrorist attacks that occurred on September 11, 2001, or harbored such organizations or persons, in order to prevent any future acts of international terrorism against the United States by such nations, organizations or persons.”²⁶⁹ Concurrently, UN Security Council Resolutions 1368 and 1373 provided international justification for state self-defense against transnational threats like al-Qaeda.²⁷⁰ The United States has carried out UAS strikes in Afghanistan, Pakistan, Yemen, and Somalia under these sanctions, while those in Iraq and Libya fell under other UN authorizations.²⁷¹

Outside of armed conflict, international human rights law regulates violent action. This body of law is stricter: deadly force may only be a last resort to prevent immediate loss of life.²⁷² In addition, if an armed conflict diminishes below the aforementioned coherence and intensity, human rights law replaces humanitarian law as the accepted standard.²⁷³ Some believe human rights law should apply during armed conflict as well, but this notion is naïve—deadly force is the defining feature of war, not a fallback option.²⁷⁴ Due to the restrictive nature of human rights law, armed unmanned systems rarely, if ever, belong outside the realm of armed conflict.

²⁶⁹Joint Resolution, S.J. Res. 23, 107th Cong., 18 September 2001. Public Law 107-40, <http://www.gpo.gov/fdsys/pkg/PLAW-107publ40/pdf/PLAW-107publ40.pdf> (accessed 1 March 2014), 115 STAT. 224; Zenko, *Reforming U.S. Drone Strike Policies*, 16.

²⁷⁰Emmerson, 16; United Nations Security Council, Resolution 1368 (2001), 12 September 2001, S/RES/1368, <http://www.un.org/docs/scres/2001/sc2001.htm> (accessed 1 March 2014); United Nations Security Council, Resolution 1373 (2001), 28 September 2001, S/RES/1373, <http://www.un.org/docs/scres/2001/sc2001.htm> (accessed 1 March 2014).

²⁷¹Benjamin, 129-130; Amnesty International, 48; Emmerson, 7-10; Zenko, *Reforming U.S. Drone Strike Policies*, 9.

²⁷²Emmerson, 17; Eric Pomes, “A Comparison of Drones and Military Unmanned Ground Vehicles (UGVs) in International Law,” in *Robots on the Battlefield*, 93-94.

²⁷³Heyns, 14; Zenko, *Reforming U.S. Drone Strike Policies*, 16.

²⁷⁴Amnesty International, 23, 44; Heyns, 9.

Civilian Casualties

War is deplorable even when it is justified, and the deaths of innocent civilians rank high among its horrors. In the past three centuries, wars have claimed the lives of approximately equal numbers of civilians and soldiers.²⁷⁵ The deaths of noncombatants are tragic but they are legal as long as belligerents adhere to the laws of armed conflict and do not intentionally target or wilfully harm them.²⁷⁶ Incidental civilian casualties may technically be permissible, but in an age of instant global connectivity, every innocent death risks derailing a nation's strategy and empowering its adversaries.

Civilians have died because of American UAS strikes.²⁷⁷ In Afghanistan, The UN notes that unmanned systems have accounted for fewer civilian deaths than manned aircraft.²⁷⁸ General Schwartz asserts that the ratio of civilians to combatants killed by UAS strikes in the Afghan theater is roughly one to seven, far below historical proportions.²⁷⁹

The remote, hostile nature of the regions where many UAS strikes take place obfuscates the debate over civilian casualties. In these areas, interloping militants intentionally embed themselves among civilian populations in defiance of humanitarian law.²⁸⁰ Civilians live in constant fear of becoming collateral damage from an airstrike. The intruders terrorize the locals, murdering anyone suspected of spying.²⁸¹ Civilians seldom speak candidly with outsiders for fear

²⁷⁵William Eckhardt, cited in Alexander B. Downes, "Desperate Times, Desperate Measures: The Causes of Civilian Victimization in War," *International Security* 30, no. 4 (Spring 2006): 152.

²⁷⁶Heyns, 16; Krishnan, 93.

²⁷⁷Amnesty International, 52.

²⁷⁸Emmerson, 7-8.

²⁷⁹Schwartz, "U.S. Drone Program is Fatally Flawed," 18.

²⁸⁰Amnesty International, 47; Krishnan, 94.

²⁸¹Amnesty International, 14-15, 32-33.

of retribution.²⁸² Owen Bennett-Jones, a British journalist who has spent extensive time in these treacherous regions, belies common perceptions with his assessment:

The closer you get to the places where the drones are actually landing, the more support for them there is . . . the reason is that these Taliban commanders and fighters are causing absolute havoc in the tribal areas. They are going around killing people, beheading them. They are cutting people's limbs off, writing graffiti in blood from severed limbs . . . people are terrified of them. And these drones come along and kill them.²⁸³

Marauding terrorists cause far more devastation than American unmanned systems, but this disproportion does not mitigate the costs of civilian deaths due to UAS strikes. The precision of a UAS makes it a far more discriminating weapons system than artillery or other unguided munitions, and its persistence enables crews to wait for shot opportunities that avoid collateral damage.²⁸⁴ Nevertheless, mistakes have occurred and likely will occur in the future.

Some observers, including Amnesty International and UN Special Rapporteur Christof Heyns, imply that not all civilian deaths are unintentional. They recount follow-up UAS strikes that appeared to target first responders and medical personnel trying to aid victims of an initial attack. If true, these strikes would constitute war crimes.²⁸⁵ In the author's experience with missions in Afghanistan, as soon as first responders showed up, the shooting was over. The US military does not practice such illegal and deplorable tactics.

Even if unmanned systems shrink the number of civilian casualties to a pittance, the psychological impact on those living underneath protracted air campaigns is severe. Despite their precision in targeting the wrongdoers that Bennett-Jones mentions above, UAS strikes also are alien and unexpected. Civilians fear that any stranger in their midst may be the target of the next

²⁸²Amnesty International, 10, 34.

²⁸³Owen Bennett-Jones, "Tensions Continue To Rise Between US And Pakistan," interviewed by Robin Young, *Here & Now*, transcript, 5 November 2013, <http://hereandnow.wbur.org/2013/11/05/tensions-us-pakistan> (accessed 1 March 2014).

²⁸⁴Emmerson, 7; Blair, "U.S. Drone Program is Fatally Flawed," 19; Amnesty International, 16.

²⁸⁵Heyns, 15; Amnesty International, 27, 29-30.

missile impact.²⁸⁶ One RPA sensor operator empathized that it must be “horrible” to live under such an omnipresent threat.²⁸⁷ Defense analyst Eliot Cohen believes this constant menace will demoralize America’s enemies, but his argument is ahistorical.²⁸⁸ Humans tend not to accept a feeling of powerlessness, and the notion that enemy militants will succumb to the psychological pressure is nonsense. If they cannot fight their foes on the battlefield, they will find new—often unexpected—ways of striking back elsewhere.²⁸⁹ Attempting to subdue populations by deploying swarms of UGS to patrol streets and neighborhoods would engender even worse results.

The psychological impact of civilian casualties resulting from protracted campaigns counteracts the benefits of eliminating lawful enemy combatants. In other words, it is bad strategy. The senior commander’s guidance in Afghanistan is unequivocal: “If we kill civilians or damage their property in the course of our operations, we will create more enemies than our operations eliminate.”²⁹⁰ Prolonged campaigns in remote areas generate opportunities for enemy propaganda that enrages millions, even if the facts on the ground contradict false claims that UAS strikes are indiscriminate and wanton.²⁹¹ When armed unmanned systems act as a component of a comprehensive strategy (comprising more than purely military means), a surgical strike on a high-value target may be a decisive achievement that contributes directly to strategic aims. The

²⁸⁶Benjamin, 118; Turse and Engelhardt, 65.

²⁸⁷Matthew Power, “Confessions of a Drone Warrior,” *GQ*, 23 October 2013, <http://www.gq.com/news-politics/big-issues/201311/drone-uav-pilot-assassination> (accessed 1 March 2014).

²⁸⁸Singer, *Wired for War*, 297-298.

²⁸⁹Singer, *Wired for War*, 312-313; Ahmed Rashid, “U.S. Drone Program is Fatally Flawed,” 15.

²⁹⁰Letta Tayler, *Between a Drone and Al-Qaeda: The Civilian Cost of US Targeted Killings in Yemen*, eds. Andrea Prasow, Joe Stork, and Joseph Saunders (Human Rights Watch, October 2013), <http://www.hrw.org/reports/2013/10/22/between-drone-and-al-qaeda-0> (accessed 1 March 2014), 27.

²⁹¹John Donvan and John Kael Weston, “U.S. Drone Program is Fatally Flawed,” 31-32, 48; Scott Shane, “C.I.A. Is Disputed on Civilian Toll in Drone Strikes,” *International New York Times*, 11 August 2011, <http://www.nytimes.com/2011/08/12/world/asia/12drones.html> (accessed 1 March 2014); Royal, “Military Robots and Ethics,” in *Robots on the Battlefield*, 122.

alternative, which Admiral Blair has called a global game of “Whac-A-Mole” that costs approximately \$20 million per terrorist each year, is not a viable approach to national security.²⁹²

Proliferation and Asymmetric Warfare

The policies governing unmanned systems remain controversial, but these systems’ effectiveness in America’s twenty-first-century conflicts to date is indisputable. Nonetheless, anyone who assumes that they provide an insurmountable advantage under any circumstances is mistaken. GPS signals, satellite links, and the various nodes that support remote operations all have vulnerabilities.²⁹³ Individuals who participate directly in the employment of these systems—including civilian contractors—are lawful combatants regardless of their physical location.²⁹⁴ On their own, contemporary UAS and other unmanned systems do not stand a chance against advanced militaries. Iran’s questionable claim that it crashed an RQ-170 by hacking its control signal suggests that nations are working to develop non-kinetic options to defeat unmanned systems.²⁹⁵ Increasing autonomy might allay vulnerabilities in communication links, but the costs of erroneous decisions and unintended consequences from autonomous vehicles operating in uncertain situations would far outweigh any gains.

Adversaries have found low-tech ways to confound or exploit vulnerabilities in unmanned systems. Militants in Iraq and Afghanistan used commercial software to intercept Predator video feeds, providing them with counterintelligence and early warning, before coalition forces discovered the breach and encrypted the signals. Pentagon officials knew this vulnerability existed but assumed adversaries would not know how to exploit it, and they did not want to spend

²⁹²Admiral Blair reached this figure by dividing the annual US intelligence budget of \$80 billion by an estimated 4,000 al-Qaeda members worldwide. Benjamin, 209.

²⁹³Dawkins, 54-55; Singer, *Wired for War*, 199.

²⁹⁴Dawkins, 58.

²⁹⁵Gertler, 41-42; Ackerman.

time and money to upgrade the systems.²⁹⁶ In an al-Qaeda safe house in Timbuktu, Mali, investigators found a document detailing ways to counter or confuse unmanned systems. Much of its advice was farfetched but certain tactics were remarkably prudent.²⁹⁷ Taliban fighters supposedly foiled some UGVs simply by tipping them over.²⁹⁸ Future systems likewise will be susceptible to asymmetric methods: a simple mosquito net would be a significant impediment for a swarm of insect-sized microbots. Nature also gets a vote. Severe weather can keep an entire fleet of UAS grounded regardless of operational needs.²⁹⁹ Military personnel learn always to have a backup plan, and unmanned systems do not alter this wisdom.

The United States has been the most prolific user of unmanned systems in combat to date, and some critics wish the nation could rewind the clock and reverse what they perceive as an inexorable slide toward robotic war.³⁰⁰ The belief that the spread of unmanned systems is America's fault, or that the nation singlehandedly could prevent their proliferation, is specious. At last count, eighty-seven countries have unmanned systems, and more than forty are developing robotic weapons.³⁰¹ Cultures perceive concepts like autonomy in different ways: P.W. Singer finds that some Asian nations have little antipathy toward autonomous weapons.³⁰² Much of the technology underpinning unmanned systems is inexpensive and available on the commercial

²⁹⁶Siobhan Gorman, Yochi J. Dreazen and August Cole, "Insurgents Hack U.S. Drones," *Wall Street Journal*, 17 December 2009, <http://online.wsj.com/news/articles/SB126102247889095011> (accessed 1 March 2014).

²⁹⁷Abdullah bin Mohammed, "The Al-Qaida Papers – Drones," *AP*, 17 June 2011, http://hosted.ap.org/specials/interactives/_international/_pdfs/al-qaida-papers-drones.pdf (accessed 1 March 2014).

²⁹⁸Tisseron, "Robotic and Future Wars," in *Robots on the Battlefield*, 4.

²⁹⁹Martin and Sasser, 125.

³⁰⁰Turse and Engelhardt, 30-31.

³⁰¹Singer, "What Churchill Can Teach Us"; Krishnan, 11.

³⁰²Singer, *Wired for War*, 168.

market.³⁰³ Nevertheless, advanced unmanned systems are not simple to develop and field. Micah Zenko notes that many countries have missed multiple deadlines in their unmanned projects.³⁰⁴

Precedents do have consequences, and the ways in which the United States uses its unmanned systems influence developments worldwide. The UN has emphasized that there is nothing illegal or immoral about unmanned systems per se—used properly, they are more discriminating and proportional than many other weapons.³⁰⁵ To set the example, and to retain the authority to condemn others' transgressions, the United States must employ unmanned systems within internationally recognized laws and norms of armed conflict.³⁰⁶ Collaborative consensus, not gadgetry or expedience, must be the catalyst for any changes to existing frameworks.³⁰⁷ As Central Intelligence Agency Director John Brennan says, “[i]f we want other nations to use these technologies responsibly, we must use them responsibly.”³⁰⁸ Countries will continue to develop some weapons in secret, as they always have, but international sales demand transparency and regulation.³⁰⁹ These measures will enable the United States and its allies to use unmanned systems effectively while retaining the license to dissuade violations by less scrupulous actors.³¹⁰

International frameworks do not change the fact that asymmetry is a fundamental component of warfare: no military wants a “fair fight.”³¹¹ Combatants always work to maximize

³⁰³US Air Force Chief Scientist, *Technology Horizons*, xvii.

³⁰⁴Zenko, *Reforming U.S. Drone Strike Policies*, 18, 20.

³⁰⁵Heyns, 4-5; Emmerson, 7, 23.

³⁰⁶Zenko, *Reforming U.S. Drone Strike Policies*, 4, 24-25.

³⁰⁷Emmerson, 5.

³⁰⁸John Brennan, quoted in Zenko, *Reforming U.S. Drone Strike Policies*, 5.

³⁰⁹Amnesty International, 55; Krishnan, 158; Zenko, *Reforming U.S. Drone Strike Policies*, 19; Heyns, 23; Eric Germain, “Stakeholders and Issues: Outlook for Change in the International Legal Framework for the Use of Military Robotics,” in *Robots in the Battlefield*, 69.

³¹⁰Rashid, “U.S. Drone Program is Fatally Flawed,” 14, 49; Benjamin, 145-146; Turse and Engelhardt, 165.

³¹¹Dawkins, 35-36.

their advantages while confounding those of their enemies.³¹² Technology can provide a temporary edge but overconfidence is perilous, for opponents always devise ways to counterbalance one-sided advantages.³¹³ America must not assume that its enemies' answer to unmanned systems will be corresponding machines of their own. For example, terrorists to date have not been particularly interested in unmanned systems as weapons of choice.³¹⁴ Likewise, the notion that superior unmanned systems are the only way to defeat hostile unmanned vehicles is myopic. The US military must employ tactics, technologies, and strategies that can adapt to evolving and unexpected situations.³¹⁵ The final section of this project will discuss three ways the United States can enhance the utility of unmanned systems as instruments of national security.

V – WHERE TO GO FROM HERE

Unmanned systems do not fundamentally alter the nature or character of warfare. They are tools whose effectiveness depends on the ways a nation chooses to perceive and utilize them. The US military must select, educate, and equip professionals who can wield unmanned systems with the skill and discipline that the profession of arms demands. The Services must fully integrate the tactics and technology of unmanned systems with manned components of the force, as both will be crucial in future endeavors. Leaders should never allow technology to dictate policy or strategy; unmanned systems must always fit into legitimate and comprehensive plans.

³¹²Metz, 22; Tisseron, “Robotic and Future Wars,” in *Robots on the Battlefield*, 14.

³¹³Singer, *Wired for War*, 240, 321.

³¹⁴Krishnan, 147; Zenko, *Reforming U.S. Drone Strike Policies*, 21.

³¹⁵Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 4; Richard Szafranski, “Parallel War and Hyperwar: Is Every Want a Weakness?” in *Battlefield of the Future*, 135; Singer, *Wired for War*, 201.

Professionalism

Just as unmanned systems do not alter the nature of warfare, they do not change what it means to serve as a member of the profession of arms. The fact that one is not at mortal risk while controlling an unmanned system does not mean that one will never face danger in the course of a career. Thousands of service members who originally performed support roles have deployed to Iraq and Afghanistan since 9/11, and many have experienced battle firsthand. Like other forward-positioned personnel, deployed RPA operators routinely endure mortar and rocket attacks within yards of their duty stations.³¹⁶ In the author's experience, RPA pilots and sensor operators are every bit as committed to military service as fighter pilots or infantrymen. In today's military, some "will close with the enemy while others will not. Regardless of the nature of the weapons system, the end result is still the same."³¹⁷ Volunteers for military service must understand that this vocation entails participation in organized violence, regardless of one's current job description. One who is "never prepared to take a life" should not enlist in the first place.³¹⁸

All of the Services identify a "warrior ethos" as essential to military service, but what they actually demand is a "professional military ethos."³¹⁹ Americans want a military culture that espouses not belligerence but rather traits like "sacrifice, courage, bravery, aggressiveness and discipline."³²⁰ Critics claim that unmanned systems eliminate the need for valor.³²¹ Colonel Eric Matthewson, a highly experienced USAF RPA pilot, retorts that valor need not always involve physical danger: "Valor is doing what is right. Valor is about your motivations and the ends that

³¹⁶For example, Major Eric Hendrickson recalled "around five mortars and one rocket land within 100 yards of me, while performing my duties as an RPA pilot." Major Eric Hendrickson, USAF, e-mail message to author, 15 February 2014.

³¹⁷Dawkins, 60.

³¹⁸Power, "Confessions of a Drone Warrior."

³¹⁹Dawkins, 44.

³²⁰Ibid., 40.

³²¹Benjamin, 87, 174; Weston and Schwartz, "U.S. Drone Program is Fatally Flawed," 21.

you seek. It is doing what is right for the right reasons.”³²² Unmanned systems operators who understand that they are integral to national security—and who receive recognition for their deeds—will be poised to exercise the restraint and judgment that their profession requires.³²³

The profession of arms also entails accountability for one’s actions, and unmanned systems do not change this fact. The legal and ethical implications of killing do not vary based on one’s proximity to the violence.³²⁴ In February 2010, misleading communication from a Predator crew led to an airstrike that killed twenty-three Afghan civilians. An investigation of the incident led to disciplinary sanctions for the USAF RPA operators and several US Army officers who were also involved in the event.³²⁵ Section III explained why robotic autonomy is infeasible from a pragmatic standpoint. The legal and ethical demands of military service further condemn the concept of robot warfare: if no human were accountable for lethal force, then the links between intent, action, and consequence that characterize state-sanctioned violence would be broken.³²⁶

Military service members understand that their profession involves killing, but this knowledge does not eliminate the traumatic nature of violence, even violence experienced remotely. A December 2011 study of six hundred USAF RPA pilots found 42 percent reporting “moderate to high operational stress,” with 20 percent reporting “burnout.”³²⁷ Instances of posttraumatic stress disorder (PTSD) among unmanned systems operators are unfortunate but unsurprising. The intimate view provided by unmanned systems gives their operators a visceral

³²²Turse and Engelhardt, 50.

³²³Hoagland, 14; Singer, *Wired for War*, 394.

³²⁴Singer, *Wired for War*, 407.

³²⁵Dexter Filkins, “Operators of Drones are Faulted in Afghan Deaths,” *New York Times*, 29 May 2010, <http://www.nytimes.com/2010/05/30/world/asia/30drone.html> (accessed 1 March 2014); Drew, “Study Cites Drone Crew in Attack on Afghans”; Emerson, 8.

³²⁶Contratto, 2, 15-16, 19; Singer, *Wired for War*, 432; Krishnan, 87; Ronan Doaré, “The Legal Aspects of Military Ground Robots,” in *Robots on the Battlefield*, 74-75.

³²⁷Power, “Confessions of a Drone Warrior.”

link with the enemy that a fighter pilot, sailor, or artillery crewmember may never experience.³²⁸ The author can attest that the seconds between pulling the trigger and a Hellfire missile's impact seem to last an eternity, even when the target is definitely hostile. The sounds and sights of distant comrades under fire provoke equally gut-wrenching emotions.³²⁹ PTSD is a predictable reaction to the horror of war. Unmanned systems do not remove it—nor should they. The US military has a sworn duty to care for traumatized service members, but it must not imagine that it can eliminate the fundamental causes of PTSD. Anyone who believes technology can make war painless has no business in its commission.

To maintain the professionalism and readiness that leads to success in war, units that operate unmanned systems require capable leadership, vibrant esprit, and robust training—not gadgetry. It is past time to retire the insulting label of “cubicle warriors” that totally misrepresents the way forces employ unmanned systems today.³³⁰ America needs talented, experienced, prudent individuals in control of its military unmanned systems. The Services must cultivate and appoint commanders who can focus their units on mission success without neglecting the strains of remote combat on personnel and their families. Amid the challenges of nonstop operations, units must nourish the camaraderie and shared identity that sustain all successful military forces.

As troops redeploy from Afghanistan, the operating tempo should slacken for many units that operate unmanned systems.³³¹ Units must utilize this leeway to implement continuous training programs that emphasize the tactical proficiency and practical expertise needed in unfamiliar situations. These programs also groom future instructors and leaders.³³² In 2009, the

³²⁸Martin and Sasser, 52; Benjamin, 90; Power, “Confessions of a Drone Warrior.”

³²⁹Drew, “Drones are Weapons of Choice in Fighting Qaeda”; Power, “Confessions of a Drone Warrior”; Singer, *Wired for War*, 332.

³³⁰Singer, *Wired for War*, 329; Turse and Engelhardt, 54-55.

³³¹Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 29, 74.

³³²Ryan Cross, “MQT to IP: A Roadmap for MQ-1/-9 Pilots,” (student paper, United States Air

USAF Weapons School, which develops elite tacticians for all major USAF weapons systems, inaugurated a squadron for RPA pilots.³³³ The other Services would benefit from similar programs. Simulator-based training is useful, but it does not replace hands-on instruction and mentorship.³³⁴ The skills needed to wield unmanned systems may differ from those that are ideal for manned platforms, but the obligation to train and promote talented individuals is the same.³³⁵

The current environment supports the normalization of assignments and careers involving unmanned systems. America's massive military endeavors following 9/11 obliged the DOD to generate combat power in various caustic ways. Involuntary assignments to unmanned systems ostensibly represented punishment tours and career-enders.³³⁶ This era is concluding. As unmanned systems gain legitimacy, assignment to them no longer equates to a hardship tour. Enlisted Army UAS operators currently promote at higher-than-average rates.³³⁷ Conversely, promotion and command opportunities for USAF RPA pilots lag behind those of other career tracks. Besides involuntary assignments, constant surge operations prevented many of these individuals from attending professional military education or other career broadening opportunities, leading to a lower promotion rate for RPA pilots as compared to their peers.³³⁸ This inequity must improve commensurate to the emerging balance between manned and unmanned

Force Weapons School, 1 June 2013), 1, 4, 5, 12.

³³³Daniel Turner, "USAF Weapons School Activates the 26th Weapons Squadron MQ-1/-9 Weapons Instructor Course," *USAF Weapons Review* (Winter 2008): 7-8. The USAF Weapons School is equivalent to the Navy's "Top Gun" program.

³³⁴Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 75; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 82.

³³⁵Hoaglund, 5-6; Singer, *Wired for War*, 370; Schwartz, "U.S. Drone Program is Fatally Flawed," 6; E.W. Powers, "Developing and Integrating Unmanned Systems for Military Operations," in *Robots on the Battlefield*, 197.

³³⁶Spinetta, "Glass Ceiling for Remotely Piloted Aircraft," 103; Dawkins, 42-43; Krishnan, 37.

³³⁷Hoffman.

³³⁸Spinetta, "Glass Ceiling for Remotely Piloted Aircraft," 102; Hoaglund, 11-12.

platforms.³³⁹ The Services should cultivate service members with distinct aptitude for remote operations, but they also must develop individuals with broader experience.³⁴⁰ Leaders with expertise in both manned and unmanned operations will be vital to future force development and integration.

Unmanned systems designed for pure troop support in benign skies do not require rated pilots, but platforms capable of participating in complex air campaigns will continue to demand officer aviators with the requisite qualifications and authority.³⁴¹ UAS operations since 2001 have occurred under an umbrella of friendly air supremacy. This condition masks the challenges of joint operations in the event an adversary does not cede total control of the airspace and frequency spectrum. Contested air operations will remain the domain of specialized, rated aviators for the foreseeable future.

Integrated Technology and Tactics

In order to prevail in future conflicts, the US military must fully integrate the technology and tactics of unmanned systems with the other components of national defense. This is not an “either-or” dilemma: manned and unmanned systems both have important roles to play. The nation’s wartime experiences since 1991 have furthered a misleading sense of American dominance in conventional military operations, prompting some to presume this lead is so

³³⁹For a comprehensive discussion of the need to update the USAF’s command and promotion system to account for unmanned systems, see Spinetta, “Glass Ceiling for Remotely Piloted Aircraft” and Hoaglund.

³⁴⁰Hoaglund, v, 4, 7, 19; Cooke and Chadwick, “Lessons Learned from Human-Robotic Interactions on the Ground and in the Air,” in *Human-Robot Interactions* 366; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 49, 59, 81.

³⁴¹David R. Buchanan, “Joint Doctrine for Unmanned Aircraft Systems: The Air Force and the Army Hold the Key to Success” (student paper, Naval War College, 3 May 2010), <http://www.dtic.mil/dtic/tr/fulltext/u2/a525266.pdf> (accessed 1 March 2014), 14-15; Hoffman; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 28-30; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 72.

insurmountable that advanced weapons are simply boondoggles.³⁴² This assumption is myopic. America cannot assume air supremacy in future wars, nor can it expect unfettered access to the electromagnetic spectrum, and both are critical elements for unmanned operations.³⁴³ Modern air defenses would annihilate most existing UAS platforms that entered their engagement zones without additional support.³⁴⁴ Kinetic weapons are not the only threats: future adversaries will use electronic warfare and cyber-attacks to blunt US military endeavors.³⁴⁵ Simple malfunctions and unintentional radio jamming by friendly forces already have spoiled many UAS missions.³⁴⁶

Technology can help address these challenges without resorting to autonomous killing robots. The USAF's use of Link 16 and laser weapon guidance to integrate RPAs with manned platforms is archetypal. Against advanced foes, technological solutions that enable seamless integration among disparate platforms ensure adaptability and resilience.³⁴⁷ Compression and encryption techniques can reduce the ever-increasing strain on frequency bandwidth.³⁴⁸ The US military should equip unmanned systems with defensive countermeasures and a wider array of weapons, including air-to-air capable UAS. Unmanned systems may still falter against advanced defenses and severe electronic jamming, but this does not mean they are irrelevant in these

³⁴²Turse and Engelhardt, 61; Peters, 21.

³⁴³Paul Madsen, "Network Centric Warfare," *USAF Weapons Review* (Winter 2009): 31-32; Majumdar, "USAF: Current Unmanned Aircraft Irrelevant in the Pacific."

³⁴⁴Majumdar, "USAF: Current Unmanned Aircraft Irrelevant in the Pacific"; Turse and Engelhardt, 150.

³⁴⁵Singer, *Wired for War*, 201.

³⁴⁶Martin and Sasser, 44; Power, "Confessions of a Drone Warrior."

³⁴⁷Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 3, 30-31; US Air Force Chief Scientist, *Technology Horizons*, 43. Unmanned systems are not the only platforms that have struggled with integration. The F-22's original designers assumed the advanced Raptor would not want to risk electronic detection in order to collaborate with other platforms, so they did not include the ability to transmit via Link 16. The author spent two years testing multimillion-dollar workarounds to provide this critical (and still unfinished) capability.

³⁴⁸Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 28, 67-68.

arenas.³⁴⁹ Remote vehicles that lose communications can be configured to loiter or transit through contested zones, rather than automatically returning to base, until friendly forces regain the airwaves.³⁵⁰ Unmanned systems must be able to communicate via multiple links.³⁵¹ In order to prevail against a fully integrated US military, an enemy would need to defeat every component simultaneously, not just block a single network or frequency band.

Technology is effective only when optimally employed. The US military has made great strides integrating unmanned systems under combat conditions. It must build upon these successes with rigorous joint training. As historical precedents reveal, innovative thinking, comprehensive evaluation, and constant practice are more important than technology alone. In the 1930s, traditionalists in Britain and America resisted the integration of tanks into their armies, while Germany developed the combined tactics that became blitzkrieg.³⁵² The Allies learned to integrate mechanized ground forces, bombers, and fighters only after bloody experiences on the battlefields of Europe and the Pacific.³⁵³ In order to set the conditions for optimal integration of manned and unmanned systems, the nation must maintain robust military training facilities. It also must open national airspace to UAS flights that adhere to strict safety regulations.³⁵⁴ The Services must practice realistic scenarios that replicate advanced adversaries, and they always must train to fight as a joint team—just as they have on the battlefield for more than a decade.³⁵⁵

³⁴⁹Madsen, 35-36; Majumdar, “USAF: Current Unmanned Aircraft Irrelevant in the Pacific.”

³⁵⁰Krishnan, 39.

³⁵¹United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 43-44; Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 66, 69.

³⁵²Singer, “What Churchill Can Teach Us”; Singer, *Wired for War*, 252.

³⁵³Thomas A. Hughes, *Overlord: General Pete Quesada and the Triumph of Tactical Air Power in World War II* (New York, NY: The Free Press, 1995), 186-191.

³⁵⁴Department of Defense, *Unmanned Systems Integrated Roadmap FY2011-2036*, 53-55, 57-58.

³⁵⁵Madsen, 36; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 14, 46.

The final piece of the integration puzzle is the establishment of adaptable joint doctrine to govern the command and control of unmanned systems. America must prepare for multiple contingencies with varying levels of intensity and simultaneity. UGS, UMS, and small UAS will remain under the direct control of their respective ground units or ships, but larger, highly capable unmanned systems need more flexibility to shift rapidly between missions. Army UAS operators deploy with ground forces to preserve continuity and esprit, but this setup is far less effective than the USAF's satellite-enabled remote split operations (RSO). One study found that, assuming a baseline of 132 UAVs, USAF RSO could maintain thirty-four 24-hour CAPs while the Army's model could sustain only twelve.³⁵⁶ The Army should consider adopting the RSO model, and trust its capable troops to build camaraderie and unity of effort despite the distance.³⁵⁷

UAS that fly above five hundred feet need to be included in the Joint Force Air Component Commander's (JFACC's) purview.³⁵⁸ In exchange for this overarching authority, the JFACC and his AOC must be willing to delegate varying levels of tactical control to forward-deployed echelons commensurate with a given situation. Accordingly, the Services have begun to utilize the Air Component Coordination Element, a forward-positioned air liaison that represents the JFACC, to address prior frustrations regarding over-centralization of air assets.³⁵⁹ An intense air campaign versus a robust adversary will require different command and control than

³⁵⁶Deptula and Mathewson, slide 28; Singer, *Wired for War*, 217; "Air Force vs. Army Concepts for UAV Employment," Arlington, VA: Air Force Association, n.d., http://secure.afa.org/grl/UAV_CONOPS.pdf (accessed 1 March 2014); Buchanan, 1, 5, 10-11, 13.

³⁵⁷Buchanan, 19.

³⁵⁸Deptula and Mathewson, slide 40.

³⁵⁹Mike Hostage, "A Seat at the Table," *Air & Space Power Journal* (Winter 2010), http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/win10/2010_4_05_hostage.pdf (accessed 1 March 2014), 18-20; United States Air Force, *USAF Unmanned Aircraft Systems Flight Plan 2009-2047*, 53-54; Buchanan, 18-19.

counterinsurgency operations.³⁶⁰ Joint doctrine must evolve to address both effectively. Mutual trust among the Services is the linchpin.

Manned and unmanned aircraft recently demonstrated the value of integration. In March 2013, a flight of Iranian F-4 Phantoms attempted to intercept an MQ-1 Predator in the Arabian Gulf. The Iranian pilots quickly changed their minds when an F-22 Raptor suddenly appeared in their formation and radioed them that they “really ought to go home.”³⁶¹ Unmanned systems may be on the rise, but advanced manned weapons systems remain vital for deterrence and domain superiority.

Prudent Policy and Comprehensive Strategy

If policies that include unmanned systems are defective, professional human control and effective force integration will not be enough to produce favorable results. The US government must never compromise its reputation as a law-abiding, responsible global actor for the sake of expedience or opportunity.³⁶² Policies driven by fear lead to dark places—they lead to waterboarding, Abu Ghraib, and errant UAS strikes. Diligent analysis and multinational collaboration are the real catalysts of US national security. It is time to dismiss all notions of a global conflict against monolithic terrorism and properly articulate ongoing American efforts for what they truly are: discrete operations against specific adversaries.³⁶³ In order to reinforce

³⁶⁰Buchanan, 4, 6, 8, 15.

³⁶¹General Mark D. Welsh, quoted in Matthew Cox, “Welsh: F-22 Flew to Drone’s Rescue off Iran Coast,” *Military.com*, 17 September 2013, <http://www.military.com/daily-news/2013/09/17/welsh-f22-flew-to-drones-rescue-off-iran-coast.html> (accessed 1 March 2014).

³⁶²Benjamin, 198-199; Turse and Engelhardt, 117.

³⁶³White House, Office of the Press Secretary, “Fact Sheet: U.S. Policy Standards and Procedures for the Use of Force in Counterterrorism Operations outside the United States and Areas of Active Hostilities,” 23 May 2013, <http://www.whitehouse.gov/the-press-office/2013/05/23/fact-sheet-us-policy-standards-and-procedures-use-force-counterterrorism> (accessed 1 March 2014); Emmerson, 18-19; Heyns, 14; Turse and Engelhardt, 92-93.

America's commitments to justice and human rights worldwide, Washington should make good on its promises to increase transparency and accountability regarding unmanned systems.³⁶⁴

Unmanned systems exist within conceivable approaches to warfare—they are not iconoclastic. They are tools to support strategy, which Colin Gray defines as “the bridge that relates military power to political purpose.”³⁶⁵ Knowledge of tactical options is important for the strategist, but a comprehensive approach to national challenges never depends upon a single tactic or technology.³⁶⁶ For instance, nuclear weapons may have underpinned the Cold War strategy of containment, but they were just one of many amalgamated approaches to oppose communism.

While strategy is a never-ending quest for enduring relative advantage, actual military operations must have achievable end states and not endure perpetually. Like airpower to date, unmanned systems alone will not be decisive in warfare.³⁶⁷ Furthermore, they do not appear to deter prospective enemies.³⁶⁸ Unmanned systems do not make prolonged, continuous armed conflict desirable; warfare is too complex and adversaries are too adaptable. Neither do unmanned systems offer an instantaneous riposte to unexpected threats. At the strategic level, prudent analysis trumps reflexive reaction every time.

Good strategy advantageously influences the mind and will of both opponents and allies. The ultimate purpose of armed unmanned systems, like other weapons, is to kill people and break things. They are not tools to build nations or prevent state collapse. At best, a lethal UAS strike

³⁶⁴Kimberly Dozier, “Brennan Defends Drone Strikes, Even on Americans,” *Yahoo News*, 7 February 2013, <http://news.yahoo.com/brennan-defends-drone-strikes-even-americans-224334056--politics.html> (accessed 1 March 2014); Shane; Steve Inskeep and Carrie Johnson, “DOJ Paper: When it’s OK to Kill Americans in Al-Qaida,” *NPR.org*, 5 February 2013, <http://www.npr.org/2013/02/05/171138329/doj-paper-when-its-ok-to-kill-americans-in-al-qaida> (accessed 1 March 2014); Amnesty International, 9, 35, 49; Heyns, 20-21, 23; Emmerson, 11-13.

³⁶⁵Colin Gray, *Modern Strategy* (Oxford, UK: University Press, 1999), 17.

³⁶⁶Rashid, Weston, and Donovan, “U.S. Drone Program is Fatally Flawed,” 13, 34.

³⁶⁷Metz, 16.

³⁶⁸Zenko, *Between Threats and War*, 88-89.

can create maneuvering space for comprehensive efforts to achieve strategic goals—at worst, an errant or ill-timed attack could ruin years of collaboration.³⁶⁹ Likewise, nonlethal ISR from unmanned systems can inform and influence prudent decisions, or else it can deceive its users while enraging others by invading their privacy. US strategy must meld precision targeting with “*psychological* precision . . . shaping a military operation so as to attain the desired attitudes, beliefs, and perceptions on the part of both the enemy and other observers.”³⁷⁰

A final vignette from recent operations in Afghanistan offers a microcosm of the way in which unmanned systems can support strategic objectives. In 2008, UAS participated in combined US-Canadian operations in the Kandahar region. Precision strikes from UAS

represented the culminating point of a rigorous, multidisciplined (intelligence, operations, information operations) process and cumulative understanding of our environment that evolved throughout the deployment. They reduced risk to friendly forces, minimized collateral damage and dislocated the enemy, reducing his freedom of action while marginalizing his strength in the eyes of the population—the key terrain.³⁷¹

The tactical advantages that persistent, precise unmanned systems supplied to joint, multinational forces directly contributed to long-term strategic goals of destabilizing insurgents and securing friendly populations.³⁷² Disciplined professionals worked tirelessly to integrate unmanned systems into a well-conceived and carefully orchestrated plan. Afghanistan remains a nation in peril, but this example reveals the right way to use unmanned systems within a broader strategy.

Conclusion

Unmanned systems have become instrumental to the national security of the United States. They will continue to evolve as innovators across the planet develop novel ways to

³⁶⁹Bennett-Jones; Blair, Schwartz, Weston and Donovan, “U.S. Drone Program is Fatally Flawed,” 16-17, 33, 44; Martin and Sasser, 81; Zenko, *Between Threats and War*, 117.

³⁷⁰Metz, 77-78 (emphasis original).

³⁷¹Turner, Adair and Hammel, “Optimizing Deadly Persistence,” 43.

³⁷²*Ibid.*, 44, 46, 49.

employ them. Unmanned systems are here to stay—the issue remains how best to use them. Autonomous killing robots, despite marginal showings to date, are possible. Human ingenuity, especially when stimulated by the contest of warfare, makes many things possible. However, just because something is possible does not mean it is desirable. History is replete with ideas that seemed foolproof in concept but resulted in catastrophe when attempted. Autonomy is a mistake.

Technological improvements should make future unmanned systems easier to operate and incorporate with other military assets. The skillsets required to wield them will evolve. Nevertheless, technology will never replace human perception and judgment in warfare. War is a chimera that transforms before one's eyes. Successful militaries cultivate professional soldiers and leaders with the prudence to comprehend uncertainty and adapt accordingly. Optimal strategy clearly defines its approach and ultimate goals before choosing its means, and it continuously adjusts to suit the environment and the adversary. Wise policy upholds legitimacy and discretion in order to engender support from likeminded allies and marginalize malefactors. Unmanned systems, properly regarded and employed, are integral to all of these concepts.

In 1999, when the author was a cadet at the United States Air Force Academy, then-Brigadier General Mark D. Welsh (now General Welsh, USAF Chief of Staff) gave his first address as Cadet Wing Commandant. He concluded with these words: “War is a horrible, horrible, horrible thing. There is nothing good about it. But it is sometimes necessary. And so somebody better be good at it.”³⁷³ No technology—manned or unmanned—will ever alter this timeless wisdom.

³⁷³Mark D. Welsh, “Commandant’s Address to the Cadet Wing” (United States Air Force Academy, CO, 26 August 1999), <http://www.usna.org/bgwelshspeech.html> (accessed 1 March 2014).

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