**This paper is a good example of a Pathfinder. I have included it here with the student's consent to give you an idea of the final project.**

# Intelligent Systems: The Future of Global Combat

*“It is well that war is so terrible. We should grow too fond of it.”* Robert E. Lee

Introduction

The nature of global warfare is changing. Advancements in military technology now make it possible to remove human combatants from the battlefield, instead using “smart technology”, artificial intelligence, and robots to move supplies and munitions, conduct reconnaissance, and identify targets and deploy munitions. Some of these technologies are so advanced that humans play only a “veto” role in the targeting and deployment of lethal force. The U.S. alone currently deploys more than 12,000 unmanned systems in Iraq.

The U.S. Army is leading the development of future systems to augment or replace human resources in many areas of combat. The August 2007 “Fact Sheet on the Army’s Future Combat Systems” presented by the Center for Defense Information lists plans for eighteen new systems to be deployed by multiple branches of the armed services, ranging from personal equipment and weaponry for the individual soldier to autonomous unmanned vehicles of various types. Future development plans include intelligent systems capable of searching out and destroying targets with little or no human involvement.

What are the benefits and risks associated with using non-human resources in warfare? Technological advances are changing the complexion of conflicts around the world, and the outcomes and future effects are yet unknown. Can artificial intelligence distinguish between combatants and civilians? Will the diminishing human cost of warfare ultimately lower the resistance of governments and peoples to engaging in conflict? These questions are topics of debate for military researchers and developers, philosophers, and public policy think tanks around the world.

**Topic Analysis**

#### **Academic Disciplines**

· Military science

· Ethics

· Politics

· Sociology

· Economics

· Law

**Library of Congress Subject Headings**

Military science. U21.22.3 War. Philosophy. Military sociology

Political science. JZ6385-6405 The armed conflict. War and order

JZ6530 Humanitarian aspects of war

Technology. TJ210-2-211.47 Mechanical devices and figures. Automata. Ingenious mechanisms. Robots.

#### **Key Word Terms**

· Artificial intelligence

· Intelligent systems

· Autonomous systems

· Robotics or robots

· War or warfare or combat or military

· Ethics or ethical or moral or morality

· DARPA

**Search strategy examples:**

(artificial intelligence AND (military OR war\*) AND (ethic\* OR moral\*))

((artificial intelligence OR robot\*) AND (military OR war\*) AND (ethic\* OR moral\*))

((robotics OR “artificial intelligence”) AND (military OR combat))

**Databases and Periodical Indexes**

· ProQuest

· Academic Search Complete

· EBSCO

**Experience Identifying Subject Headings and Key Words**

I began my search of databases and periodical indexes using fairly broad, open-ended keywords – robot\*, war\*, ethic\*. I found that my searches were returning too many resources and that the sources were too general for my topic. I did find additional terminology in some of the relevant articles – “intelligent systems” and “autonomous systems”. I narrowed my search results by using the advanced search parameters and entering more specific terms – “artificial intelligence” and broadening some of the terms with synonyms – military OR combat. I identified the best key words through finding an article that was on topic and using terms from the article in subsequent searches. The subject index in ProQuest was also helpful.

## Reference Sources

#### **Organization**

Brookings <[http://www.brookings.edu](http://www.brookings.edu/)>

1775 Massachusetts Avenue, NW

Washington, DC 20036

202.797.6000

Singer, Peter W. “Military Robots and the Laws of War.” *Brookings.* The

Brookings Institution. 2009. Web. 23 Feb. 2009.

*Brookings* is the Internet publication of The Brookings Institution, a non-profit public policy organization that conducts research in social sciences and government policy. The Institution’s research programs are conducted and published by a group of more than 200 content experts and research fellows. Articles are generally scholarly and research opinions are well supported. The site can be navigated by keyword, research program, or expert (author) name. There is a list of Top Topics than can be expanded to review all topics. The site also has options for a weekly e-mail of its latest research. Of particular interest to my research topic is the 21st Century Defense Initiative, part of the Institution’s Foreign Policy research program.

#### **Statistical**

*Statistical Resources on the Web: Military and Defense*. The University of Michigan Documents

Center. University of Michigan. 2008 Web. 5 Nov. 2008.

Marte, Anna and Elise Szabo. “Fact Sheet on the Army’s Future Combat Systems.” *Straus*

*Military Reform Project.* Center for Defense Information. 2007. Web. 08 March 2009.

The Center for Defense Information, founded in 1972, is an organization of the World Security Institute. The CDI conducts research and provides analysis of U.S. and international security issues and defense policies. Experts and staff members include high-ranking retired military officials, academics, and research fellows at global affairs organizations. Statistical information on the U.S. military’s Future Combat Systems programs from the Straus Military Reform Project was particularly useful to my topic.

#### **Encyclopedias**

Moseley, Alexander. “Just War Theory.” *The Internet Encyclopedia of Philosophy*. n.p. 2006.

Web. 23 Feb 2009.

The Internet Encyclopedia of Philosophy is a specialized subject encyclopedia that provides scholarly articles on a wide variety of philosophical topics. All articles are peer-reviewed and many are regularly updated. Dr. Alexander Moseley is an educator and author who has contributed several articles to the encyclopedia. “Just War Theory” discusses philosophical aspects of how and why wars are fought and the implicit or explicit limits of warfare. Of particular interest to my topic is his discussion of the principles of *Jus In Bello*, just conduct within war. The two ethical principles of *jus in bello* are who may be considered legitimate targets in warfare and what level of force is morally acceptable. The article also contains an extensive list of references and bibliography.

Dennis, Michael Aaron. “Defense Advanced Research Projects Agency”. *Encyclopedia Britannica*

*Online.* Encyclopaedia Brittanica. 2009. Web. 08 March 2009.

Michael Dennis is an academic and author who has contributed more than two dozen articles to the Encyclopedia Britannica Online. The Defense Advanced Research Projects Agency (DARPA), founded in 1958, is an agency of the U.S. government whose role is to facilitate research and development of potential future military weapons and technology. DARPA awards contracts to scientists and researchers to direct projects for potential military development. The article provides a compact outline and timeline of the agency’s activities. It also includes a section listing additional readings. This article was important to my research because DARPA is one of the primary agencies directing the investigation and development of artificial intelligence and autonomous systems for military use.

## Books

P.W. Singer. *Wired for War: The Robotics Revolution and Conflict in the 21st Century.* New

York: The Penguin Press, 2009. Print.

P.W. Singer is a senior fellow at the Brookings Institution and director of the institute’s 21st Century Defense Initiative. His book combines references from popular science fiction and research in military technology to discuss the present and future uses of intelligent systems and robots in combat. He addresses the unintended consequences and moral questions associated with autonomous systems in warfare. This book provided the most detailed information for my research on current military intelligent systems and the future direction of combat worldwide. The book was just published in January 2009 and not yet in any of the library collections I searched. I heard an interview with the author that spurred my interest in intelligent systems as my research topic, so I purchased the book.

De Landa, Manuel. *War in the Age of Intelligent Machines*. New York: Swerve Editions, 1991.

Print.

Dr. De Landa is a philosopher and professor who lectures at several universities in the United States and Europe. In his book, he provides a history of information and weapons development from the Renaissance to the first Gulf War. He also provides a philosophical background for the interaction of humans and the evolution of technology in warfare. While this book was published several years ago, De Landa’s observations on the moral issues associated with using non-human combatants in warfare and society’s possible attitudes towards those developments are still quite relevant. I found De Landa’s book during a visit to the reference library at Spokane Falls Community College. I chose the book for my research because it provided an excellent

## Periodical Articles

Lin, Patrick, George Bekey and Keith Abney. *Autonomous Military Robotics: Risk, Ethics, and*

*Design*. United States Department of Navy, Office of Naval Research. 20 Dec. 2008. Web.

18 Feb. 2009.

The writers are researchers in the Ethics & Emerging Technologies Group at California State Polytechnic University, San Luis Obispo. Because the report was produced for the US Navy, there is an extensive and detailed discussion of current and future autonomous military systems. The discussion of ethics centers on established guidelines of the Laws of War and Rules of Engagement outlined in the Geneva Conventions and raises questions about how intelligent systems might behave in future military conflicts. The article is very focused on the military development and programming of the systems and is probably too detailed for general audiences. It does, however, contain an appendix of definitions that is very helpful.

Sharkey, Noel. “Cassandra or False Prophet of Doom: AI Robots and War”. *IEEE Intelligent*

*Systems*. 23.4. (2008): 14-17. *Sciences Module.* ProQuest. Web. 17 Feb. 2009.

Dr. Sharkey, Professor of Artificial Intelligence and Robotics at the University of Sheffield in the U.K., focuses this article on the development of unmanned vehicles for warfare by the U.S. The article cites numerous systems under development and their budgets as published by the Department of Defense. He quotes several DOD and Pentagon sources regarding plans for deployment of these systems. He raises questions that, because autonomous systems decrease the risk for human soldiers, there might be fewer disincentives to start future wars. Dr. Sharkey supported his ethical arguments with references to the Geneva Convention and the Hague convention. The article is primarily directed to the Artificial Intelligence research community, but the language is accessible to a broad audience.

Sparrow, Robert. "Killer Robots." *Journal of Applied Philosophy.* 24.1 (2007): 62-77.

*Humanities Module*. ProQuest. Web. 17 Feb. 2009.

Dr. Sparrow, a Senior Lecturer at Monash University in Australia, has conducted research on ethical issues related to military robotics and just war theory. This article explores the military application of artificial intelligence in warfare and addresses questions of who should be held responsible for intelligent systems in instances of war crimes – the designer or programmer, the commanding officer, or the robot itself. Dr. Sparrow asserts that it is necessary under the principle of just war, that someone can be held responsible for deaths that occur. He argues that, because no responsibility can be reliably assigned in this case, it is unethical to use intelligent systems in warfare. The article provides factual information about military systems in a language that appeals to a broad audience. Dr. Sparrow’s discussion of war and ethics is thought provoking and he provides the philosophical background to support his arguments.

## Internet Sources

*Ethics + Emerging Technologies Group.* 2007-2009. California State Polytechnic University.

Web. 18 Feb. 2009.

The Ethics + Emerging Technologies Group at CalPoly was established in 2007 as a non-partisan group “focused on risk, ethical, and social concerns related to new and emerging technologies.” Members are educators and researchers engaged in teaching, publishing, lecturing and conducting research on the ethical issues of technology in science and society. The Web site contains several relevant news articles on artificial intelligence, robots and warfare. There is also a list of research publications. From their lecture series page, I found the names of additional authors and researchers on my topic. The site is well organized and easy to navigate and provided a link to contact the director of the organization.

*21st Century Defense Initiative.* 2009. The Brookings Institution. Web. 15 Feb. 2009.

The 21st Century Defense Initiative was begun by The Brookings Institution in 2006 to research and analyze topics focused on international defense and security. The Initiative’s primary issues are 1) The Future of War, 2) The Future of U.S. Defense Needs and Priorities, and 3) The Future of the U.S. Defense System. The topic of “The Future of War”, which includes analysis of new technologies and their impact on global conflicts, is the one most closely related to my research topic. The site provides links to related government and policy websites and provides biographies for its research fellows.

## Non-print Sources

Dean, Cornelia and Ronald Arkin. Interview with John Hockenberry. “Lethal Autonomous

Systems: The Ethics of Programming Robots for War.” *The Takeaway.* Public Radio Intl.

25 Nov. 2008. Web. 2 March 2009.

Cornelia Dean, an author and science reporter for The New York Times and Dr. Ronald Arkin, an Associate Dean for Research in the College of Computing at the Georgia Institute of Technology, were interviewed for the PRI radio program “The Takeaway”. The interview explores questions about whether society is ready to accept the use of military robots in combat. The audio interview also contains links to written guest’s notes and commentaries. The interview with Cornelia Dean is valuable for my research topic because it provides a perspective by a researcher other than a computer scientist regarding the ethical issues of military combat robots.

Singer, P.W. Interview with Terry Gross. “’Wired for War’ Explores Robots On the Battlefield”.

*Fresh Air.* National Public Radio. 22 Jan. 2009. Web. 2 March 2009.

P.W. Singer is a senior fellow at the Brookings Institution and director of the institute’s 21st Century Defense Initiative. He discussed his research and his new book “Wired for War” in a 38-minute audio interview on “Fresh Air”, a Peabody Award-winning program covering contemporary issues. Singer has conducted extensive research with the military regarding artificial intelligence and autonomous systems for use in current and future combat applications. The Web site also contains links to related NPR stories. The interview is valuable to my research because Singer’s book was the inspiration for my topic.

## Review of My Research Process

I chose my topic after hearing an interview with P.W. Singer, a senior research fellow at the Brookings Institution and the author of a new book “Wired for War”, on National Public Radio. I was fascinated by the discussion of the use of robots and artificial intelligence in combat, and searched the library catalogs for the book, but it had been published very recently and the libraries had not yet acquired it. I ordered the book from my local bookstore and began my research process before it arrived. I had made a few notes while listening to the interview and started my research with key words from my notes.

I was particularly interested in the ethical issues involved in the use of intelligent or autonomous systems in warfare and began my search with the philosophical aspects of war. I had never used subject encyclopedias before, but found two excellent articles – one at my local college library and the other on the Internet. Beyond the broad topic of ethics and warfare, I soon found that my topic was too current to find a sufficient number of relevant resources in books and reference materials.

My search for more current information lead me to the database and periodical indexes at Seattle Central Community College and Spokane Falls Community College. While both colleges had access to much the same resources, the search process itself was slightly different on each. I began my search with rather broad terms and gradually using phrases and synonyms narrowed my subjects and key words to find resources that were both timely and relevant.

My biggest challenge was in identifying the best resources for my topic. I evaluated the quality of my sources and the credentials of the authors carefully before selecting a resource. I identified a number of excellent sources by using Google U.S. Government Search and narrowing the results to scholarly articles. I also found that some of the best resources contained only abstracts, not full articles. However, I used the bibliographic information from the abstracts to search the Internet and was able to locate several of the full articles and research papers on other Web sites.

Because my topic is a current and evolving one, the periodical databases and the Internet proved to be my best resources. However, I found more detailed information in the few books that I did locate. The books also pointed me to new subjects and search terms to use in my Internet research.