Military Robotics & Technological Determinism,

A brief literature review & the beginning of a larger paper

David A. Edgell

Texas Tech University

Abstract

This paper examines the ways new advances in military robotics can potentially replace soldiers in combat, the ethical problems involved with that replacement, and how this serves as another example of technological determinism with extraordinary consequences. First, a brief history of technology and warfare will be followed by a history of artificial intelligence and robotics research to serve as a foundation for an explanation of current and future military robotics technology. The ethical implications of these developments will be examined in light of Asimov's Laws of Robotics, Jean Baudrillard's commentary on the media representation of the first Gulf War, and the ease of killing at a distance and lowered risk that robotics technology can facilitate. Finally, aspects of technological determinism will be examined through these new developments of replacing the dueling of war with machines.

Keywords: military robotics, technological determinism, risk, warfare, ethics.

"*War is nothing but a duel on an extensive scale."*
Carl von Calusewitz, On War

Humans' primary struggles have been demonstrated by two or more people facing each other and either negotiating a solution or fighting. Technology changed this struggle when one of the combatants picked up a rock. As humanity's struggles have grown from personal conflict to world scale warfare, so has our use of technology. "Every part of war is touched by technology." (van Creveld, 1989) As we make advances in technology, we use those advances in our perpetual duel and as we gain resources through war, we build better technology. Our new technological developments in artificial intelligence (AI), computer capabilities, sensors, and robotics may finally replace the combat soldier or warfighter with a machine.(Singer, 2009) There are many technologies that branches of the military are researching and developing; however, this paper will focus specifically on the duel between autonomous ground robotics armed with offensive weaponry and their use against other humans. This paper will examine previous uses of technology in warfare to give a perspective on autonomous robotic warfighters, which could be misinterpreted as just another military technology. A history of artificial intelligence and robotic design will frame a new computer simulation of the human cortex that could lead to significant developments in the next decade. An examination of the significant epistemological concerns with autonomous robotics will precede a discussion of the ethical implications and how this technology may indicate a new form of technological determinism.

Introduction

Almost every paper on the subject of robotics begins with a statement of Isaac Asimov's Three Laws of Robotics. This paper will continue using that common format since they form an early version of ethical laws that determined the progress of robotics and artificial intelligence research. Their widespread usage formed the basic constraints necessary for the development of interactions between robots and humans and the ethical considerations involved in those interactions:

> 1--A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
> 2--A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
> 3--A robot must protect its own existence as long as such protection does not conflict with the First or Second Law. (Asimov, 1963)

According to the Oxford English Dictionary, Asimov was also responsible for coining the term "robotics" in a 1941 short story. (1989) Asimov complicated the relations and extent of the laws in each of the stories contained in I, Robot and added an additional "zeroth" law in his 1986 book, Prelude to Foundation, "A robot may not harm humanity, or, by inaction, allow humanity to come to harm." These laws form a canonical point for this discussion of technology, determinism, ethics, and the future of military robotics.

The military's plan to fund research into military robotics and their plan to support and implement robotic soldiers in combat situations violates the first and consequently the zeroth law. The military's wants to pursue this technology in an effort to increase the efficiency and reduce the risk of soldiers in the field. The Department of Defense published an Unmanned Aircraft Systems Roadmap for 2005-2030, an Unmanned Systems Roadmap for 2007-2032, and updated those with the Unmanned Systems Integrated Roadmap for FY 2009-2034. Over the brief four years, the change in the titles of those documents reflect the advances from unmanned aircraft to multi-terrain systems to systems used by multiple branches of the military. These roadmaps define the expectations the military has for the development of technology to aid the warfighter, a generic term for military personnel in active combat situations.

A Brief History of Technology in Warfare

In the earliest Stone Age civilizations, since they already possessed some form of rudimentary technology, war has always "involved the use of technical devices." (van Creveld, 1989) Men in ancient tribes were usually both hunters and warriors and frequently warfare was treated as a form of hunting. (Anglim, Jestice, Rice, Rusch, & Serrati, 2002) Around 9000 BC, as settled agricultural states formed, they fought wars with disciplined armies of soldiers fighting in close ordered phalanxes of soldiers using pikes or throwing spears with bronze tips, axes and short knives. (Anglim, et al., 2002) The bronze in the Middle East was of low quality and when the Assyrians discovered iron, they were able to mass-produce iron weapons and became feared and ferocious warriors, due to easily produced and improved weapons. (Parker, 2008) Metallurgy was not the only force at work; there was also a human component. When technological developments in the form of bows, slings, horses and chariots came about, they required skill, training, and regular practice in their use. These technological developments influenced the outcome of battles and the structure of the society. These innovations required a dedicated class of soldier to master their use (Parker, 2008), yielding social castes and hierarchies.

Fundamental changes in technology yielded agricultural systems that required defense and armies of people to defend those states. Greek soldiers, called "hoplites" were named for one of their defensive weapons, the hoplon shield made of wood and later edged in bronze. The Greeks also developed coordinated techniques to strengthen warriors by bringing them together into ordered phlanxes, using both offensive and defensive weaponry, training and coordinated attacks to dominate the Persians at Marathon. (Anglim, et al., 2002) Simple shields became part of their attack and defense strategies, but these strategies of arraying soldiers on the battlefield can also be considered technologies.

One of the most famous uses of technology in warfare is usually considered to be the introduction of gunpowder, but Max Boot, military historian and Senior Fellow at the Council of Foreign Relations, considers that a combination of technologies changed warfare in Europe. In the late 15th century, many citizens of Italy no longer fought wars because mercenaries had taken their place. When these mercenaries employed by different European states, faced off against each other they could fight elaborate battles with little damage to each other. In 1494, the king of Naples died and Charles the VIII of France believed that he had a claim to the throne. He brought 27,000 men across the Alps with some of the best military technology of the time. During the 15th century, France developed five technologies that altered the political structures in Europe: corning gunpowder, bronze cannons, solid iron cannonballs, mobile cannons, and the revival of a national army. The process of corning gunpowder forms gunpowder into a paste and then it is dried (this keeps the individual chemicals from separating), broken up, and made into a powder, which increases its explosive force compared to regular gunpowder. Bronze cannons were strong and light in comparison to their antecedents. This strength allowed the use of solid iron cannonballs; the reduced weight permitted the cannons to be mounted on wheels and pulled by teams of horses. This mobility allowed quick repositioning and accuracy. The use of these technologies permitted the French to breech castle walls in hours instead of months. The national army maintained loyalty and fought fiercely for their king and country, frequently killing all the residents of castle after the siege was ended by the artillery. In less than a year, France had moved across Italy by using more advanced military technologies. (Boot, 2007)

History is rife with examples of technology changing the balance of power between countries and cultures. The Inca Empire fell to Spanish technologies, along with disease borne by the conquistadors; otherwise native enemies would have overthrown the empire before the Spanish arrived. (Boot, 2007) Technologies developed for peaceful purposes, including communication systems, timekeeping, and mapmaking allowed the accurate deployment of forces during wartime. (van Creveld, 1989) Muskets changed the tactics of battlefields. (Parker, 2008) Max Boot believes that there are five major themes associated with technology and warfare:

1. "Technology alone rarely confers an insurmountable military edge; tactics, organization, training, leadership, and other products of an effective bureaucracy are necessary to realize the full potential of new inventions."
2. "Countries able to take advantage of these shifts have been history's winners…"
3. Countries need to know the capabilities and limitations of these technologies and use them for realistic strategies
4. "No military revolution has ever conferred an indefinite advantage upon its early innovators. Rivals copy what they can…"
5. Innovation has been accelerating. The gunpowder revolution occurred over 200 years, the First Industrial revolution over 150 years, forty for the Second Industrial revolution and thirty for the information revolution.

These themes show that societal forces shape military technology, but the acquisition and use of new technology by one side in a struggle is usually short lived. When one side develops a better weapon and uses it, the rival or other countries frequently acquire or develop their own version of the technology and the military technology race continues.

A Brief History of Artificial Intelligence and Robotics Research

Artificial intelligence is defined as "The capacity of computers of other machines to exhibit or simulate intelligent behaviour." (OED, 1989) It was first used by John McCarthy as the name of a conference held at Dartmouth in 1956. (Moravec, 1999) AI research can be traced to Norbert Weiner's work in trying to develop a system to guide anti-aircraft guns to fire at the predicted location of enemy bombers during World War II. (Hall, 2007) His gun-guidance engineering team tried to construct a model and found that the model weapon would occasionally start oscillating. They later consulted a medical professor from Harvard who found that the oscillations were similar to a neurological illness known as purpose tremor. As the researchers continued their multi-disciplinary collaboration, they found parallels between mechanical communication and control systems and those in the human body. (Hall, 2007) These oscillations are known as feedback and formed part of Claude Shannon's theory of communication. This research became the first work in cybernetics.

During World War II, Alan Turing developed mechanical computers to break "German U-boat codes, allowing allied shipping to evade the wolf packs and win the war." (Moravec, 1999) He also developed a criterion for determining when computers would equal the human mind, instead of trying to define the vague terms, "thinking" and "machinery." If a human judge could communicate in a freewheeling conversation for a fixed length of time and not be able to tell if she was communicating with a machine or another human, then the machine would pass the "Turing Test."(Moravec, 1999) In a paper published in 1950, Turing predicted that a computer could pass a five-minute version of this test in 2000. Morovec estimates Turing was off by about twenty years.

Concepts of feedback and artificial intelligence come together in the design of robotic systems. Sensors give the robots input about the world around them and their actions are controlled based on that feedback. Artificial intelligence research gives them the capacities to interpret that world and make decisions.

There are two ways to use computer technology to solve problems, brute force serial processing or parallel processing that mimics the processes in the human brain. Serial processing uses discrete linear steps to solve computer problems. Programs that played chess were some of the first computer programs in artificial intelligence. A serial processing strategy for a chess program would play each potential move in the game and record the best potential result. A parallel program would use multiple processors and each processor might simultaneously calculate a branching structure of potential moves. There have been advances in both approaches, but for true artificial intelligence, these systems need to mimic the capacities of the human, which is very efficient at signal processing and multitasking. In an article published this month, researchers at IBM announced "that they have created the largest brain simulation to date on a supercomputer." (Adee, 2009) This simulator "recreates 1 billion neurons connected by 10 trillion individual synapses," equivalent processing capability to that of a cat. (Adee, 2009) This project received $40 million in funding from the U.S. Defense Advanced Research Projects Agency (DARPA). DARPA specified that the conclusion of this research in 2015 should be this processing capability contained on a chip that would use less than 1 kilowatt of power and occupy a volume of less than two liters. This could give a mobile robot the equivalent of a mammalian brain in about five years. IBM estimates that the processing capability of the human brain, 20 billion neurons connected by 200 trillion synapses could be achieved by 2019 if a sufficient computer could be developed. Within a decade, computers may be able to have a cortical simulator equivalent to human capabilities. There are concerns about power, but the past decades have demonstrated significant advances in processing capabilities.

The Current Status of Military Robotics

Epistemological Concerns of Robotics

Ethical Implications

In the history of military technology, almost every advance distances combatants, which makes it easier to overcome humans' reluctance to kill. Arkin quotes Joanna Bourke, the author of *An Intimate History of Killing: Face-to-Face Killing in Twentieth-Century Warfare*, "Combatants were able to maintain an emotional distance from their victims largely through the application of...technology." There is a historical, legal precedent for controls being put on the military's use of technology in combat. "The crossbow was banned by Pope Innocent II in 1139 for use against Christians, due to its immoral point-and-click interface, which enabled killing at a distance." (Arkin, 2009)

Technological Determinism and Military Robotics

Works Cited

Bibliography

Adee, S. (2009). IBM Unveils a New Brain Simulator. *IEEE Spectrum, 2009*(November).

Anglim, S., Jestice, P. G., Rice, R. S., Rusch, S. M., & Serrati, J. (2002). *Fighting Techniques of the Ancient World 3000 BC - AD 500: Equipment, Combat Skills and Tactics*. New York: St. Martin's Press.

Arkin, R. C. (2009). *Governing Lethal Behavior in Autonomous Robots*. Boca Raton, FL: CRC Press.

Asimov, I. (1963). *I, Robot*. Garden City, NY: Doubleday.

Boot, M. (2007). *War Made New: Technology, Warfare, and the Course of History 1500 to Today* (Kindle ed.): Gotham Hardcover.

Hall, J. S. (2007). *Beyond AI: Creating the Conscience of the Machine*. Amherst, NY: Prometheus.

Moravec, H. (1999). *Robot: Mere Machine to Transcendent Mind*. Oxford: Oxford UP.

OED (Ed.) (1989) Oxford English Dictionary Online (2nd. ed.). Oxford University Press.

Parker, G. (Ed.). (2008). *Cambridge Illustrated History of Warfare: The Triumph of the West*. Cambridge: Cambridge University Press.

Robotic, a. and n. (1989) (2nd. ed.). Oxford University Press.

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

van Creveld, M. (1989). *Technology and War: From 2000 B.C. to the Present*. New York: Free Press.

Preparing a literature review is a very important part of writing a dissertation. 50% of success depend on your ability to identify and stick to the proper literature review structure. Here you can find a good example of the literature review structure and a definition of two ways of how to properly structure your literature review.Â The remaining 50% depends on your ability to identify and stick to the proper literature review structure, and that is when you need a good example in front of your eyes. In fact, its format is similar to a casual essay. If you have an idea of how to write a literary essay you should not face any troubles with creating a literature review.