

Southern Illinois University Carbondale  
**OpenSIUC**

---

Research Papers

Graduate School

---

2013

# AUTONOMOUS ROBOTS IN LAW ENFORCEMENT: FUTURE LEGAL AND ETHICAL ISSUES

Kelly Y. Greeling

*Southern Illinois University Carbondale*, [kgslaite@gmail.com](mailto:kgslaite@gmail.com)

Follow this and additional works at: [http://opensiuc.lib.siu.edu/gs\\_rp](http://opensiuc.lib.siu.edu/gs_rp)

---

## Recommended Citation

Greeling, Kelly Y., "AUTONOMOUS ROBOTS IN LAW ENFORCEMENT: FUTURE LEGAL AND ETHICAL ISSUES" (2013).  
*Research Papers*. Paper 329.  
[http://opensiuc.lib.siu.edu/gs\\_rp/329](http://opensiuc.lib.siu.edu/gs_rp/329)

This Article is brought to you for free and open access by the Graduate School at OpenSIUC. It has been accepted for inclusion in Research Papers by an authorized administrator of OpenSIUC. For more information, please contact [opensiuc@lib.siu.edu](mailto:opensiuc@lib.siu.edu).

AUTONOMOUS ROBOTS IN LAW ENFORCEMENT:  
FUTURE LEGAL AND ETHICAL ISSUES

by

Kelly Greeling

B.A., Southern Illinois University Carbondale, 2004

A Research Paper  
Submitted in Partial Fulfillment of the Requirements for the  
Masters of Arts

Department of Criminology and Criminal Justice  
in the Graduate School  
Southern Illinois University Carbondale  
May 2013

RESEARCH PAPER APPROVAL

AUTONOMOUS ROBOTS IN LAW ENFORCEMENT:  
FUTURE LEGAL AND ETHICAL ISSUES

By

Kelly Greeling

A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Masters of Arts

in the field of Criminology and Criminal Justice

Approved by:

Dr. Joseph Schafer, Chair

Dr. George Burrus

Dr. Julie Hibdon

Graduate School  
Southern Illinois University Carbondale  
12/18/2012

AN ABSTRACT OF THE RESEARCH PAPER OF

KELLY GREELING, for the MASTER OF ARTS degree in CRIMINOLOGY AND CRIMINAL JUSTICE, presented on 12/18/2012, at Southern Illinois University Carbondale.

TITLE: AUTONOMOUS ROBOTS IN LAW ENFORCEMENT: FUTURE LEGAL AND ETHICAL ISSUES

MAJOR PROFESSOR: Dr. Joseph Schafer

As with all new technologies, autonomous robots bring with them a bevy of new legal and ethical issues. In no place is this more evident than in the law enforcement industry. This paper will examine the manner in which the next generation of autonomous robots will likely be put to use by police and other law enforcement personnel—from reconnaissance to explosive ordinance disposal (EOD)—and examine the legal and ethical controversies that they may bring with them. It will do so by delving into the current use of robots in policing and considering the challenges they have brought to date. Then, by examining of new technology that is being developed over the world, specifically in the field of autonomy, this paper will posit how such robots might be used in the future and what disputes they may introduce to the law enforcement world. Will humans ever be removed from the decision-making process? What happens when you take the human controller out of the equation? Will they, perhaps, be allowed to gather evidence at a crime scene and if so, how will the evidence gathered under the sole direction of the robot be processed and accepted in court? Who is at fault if something goes wrong? How will police in the field avoid this legal and moral minefield that autonomous robots will drag along with them when they arrive? By examining the past and current use of this generation of robots within the law-enforcement community and combining it with the technological advantages autonomous robots will be bringing to the table, we might begin to answer these questions.

Keywords: robots, autonomous, law enforcement, legal, ethical, drones

## TABLE OF CONTENTS

CHAPTER	PAGE
ABSTRACT .....	i
CHAPTERS	
CHAPTER 1 – Introduction.....	1
CHAPTER 2 – Current Usage vs. New Technology .....	3
CHAPTER 3 – Ramifications of Practical Use .....	6
CHAPTER 4 – Law and Rule Creation .....	28
CHAPTER 5 – Conclusion .....	30
REFERENCES .....	32
VITA .....	39

## INTRODUCTION

The man on the stage points and a video begins. In the video, there are three screens. On one screen, a small flying quadrotor robot enters a non-descript gray building. On the second and third screens, respectively, a topographical and 3D rendering of the inside of the building begin to grow. The man's voice is overlaid on the video, telling you

“...(this clip) shows this robot entering a building for the first time and creating this map on the fly. So, the robot then figures out what the features are. It builds the map and figures out where it is in respect to the features and then estimates its position a hundred times per second...the robot can figure out where to go on its own...” (Kumar, 2012).

The man on the stage is Professor Vijay Kumar, School of Engineering & Applied Sciences, University of Pennsylvania and the robot is one of his Autonomous Agile Aerial Robots. It, and other robots like it, is the next step up in the wave of robotics that is sweeping law enforcement all over the United States. A wave that includes nine Predator based drones that are run by U.S. Customs and Border Protection and has recently led to Congress passing the FAA Reauthorization Act, which orders the Federal Aviation Administration (FAA) to “develop regulations for the testing and licensing of commercial drones by 2015” (Smith, 2012).

With this new technology, this progression to autonomy, also come many ethical and legal questions about how law enforcement can use these robots. This paper will examine how law enforcement might use these new robots. It will also look at the some of the ramifications of those practical applications. It will also examine what laws and regulations might lawmakers enact before this technology reaches the hands of the front-line officers, so as to be prepared.

To answer all of these questions it is vitally important to know what exactly autonomous robots are, how they differ from the current robots being used by law enforcement, and what new technology they will bring to the table.

## CURRENT USAGE VS. NEW TECHNOLOGY

McGraw-Hill describes a robot as “a mechanical device that can be programmed to perform a variety of tasks of manipulation and locomotion under automatic control”.

(Robots,n.d.) Robots themselves tend to come in two forms, mobile and fixed-base manipulative.

The fixed-base robot can usually be found on a production line, doing repetitive tasks. Mobile robots, on the other hand, can move through their assigned environments, be it land, sea, air, or space. (Cook, 2011, xiii) The majority of robots used by law-enforcement agencies and the military today are mobile. They are what is known as “remotely-operated” and can be divided into two types. The first type are Unmanned Ariel Vehicles (UAVs), like the well-known Predator drone (Singer, 2009) now used by the Border Patrol to survey our national borders (Lavendera, 2010). Examples of the second type, Unmanned Ground Vehicles (UGVs), might be Explosive Ordinance Disposal (EOD) robots or surveillance robots like the Recon Scout Throwbot (Lasar, 2011). In both cases, UAV or UGV, the robot is controlled remotely, i.e. the operator is in a separate location away from the vehicle. The type of system used to control the robot can vary from a simple hand remote, like those used to control a toy car, and have a distance of a few meters (iRobot, 2012); or they can be entire flight control station that can be separated thousands of miles via satellite link-up (Wuschka, 2007 p.896).

A fully autonomous robot will be one that can perform an assigned task without a human at the controls. The human can, in theory, tell the robot what to do and then walk away, assured that the task will be completed. While not completely there, robots are on their way to being capable of this. Examples of such could be the Liquid Robotic’s Wave Glider, which recently made history by setting the record for the longest distance traveled by an autonomous robot. This robot, having been dropped off in San Francisco, made its way



9,000 miles to Australia all on its own, stopping only once in Hawaii for a maintenance check-up, all the while collecting oceanographic and atmospheric data.

While the question of what exactly full autonomy is can be debated, this paper, shall use Bekey's (2005, p.1) definition of autonomy, "a system capable of operating in a real-world environment without any form of external control for extended periods of time."

An autonomous robot suitable for law enforcement work will have to be able to do many different things. The robot will have to be able to gather information about its environment, everything from the architectural makeup of the room to the chemical composition of the air. It must be able to move itself through that environment without human intervention. To be able to operate for a long period of time in the field, they will likely also have to be able to maintain and repair themselves to some extent. Finally, if armed, they must be able to do all of this without harming humans or property unless specifically programmed to do so. Some new robots being developed by the military that can do almost all of these things. One example might be the Legged Squad Support System (LS3), aka BigDog, a quadruped robot being designed by DARPA for the Marines as a support system capable of following soldiers through rugged terrain. Now being tested to carry four hundred pounds over twenty miles, the robot can, using sensors, track a human and distinguish between obstacles like rocks and trees all while maintaining its stability in bad footing and even recovering itself should it happen to fall.

In the UAV category, the quadrators being developed by Vijay Kumar (2012) can operate without a remote control or Global Positioning System (GPS). They can, quite literally, recognize objects within their environment and use them to create a map. Using that self-created map, the robot can then navigate itself and others like it, from one place to another and even complete, in an independent manner, a specified task, all by using a synthesized, biology-inspired, swarming behavior that has been synthesized for large,

networked groups of autonomous vehicles. They can, in essence, talk to each other and share information, pooling their limited processing power to create one large network to figure out complex problems and achieve their goals.

When it comes to the UGV, perhaps some of the most compelling technology has come out of the Multi-Autonomous Ground-Robotic International Challenge that was held in Australia in 2010. There,

“a minimum of three unmanned ground vehicles (UGV’s) supervised by a maximum of two operators must autonomously coordinate their activities to safely, efficiently, and effectively explore and map their environment and detect, map, locate, classify, recognize, track, and neutralize a number of static and mobile objects of interest (OOI)”. (Defence, Science, & Technology Organization, 2009, p. 9) The winning team, from the University of Michigan, actually won with a squad of 14 robots working together with only 2 handlers. These robots and others like them will be the next generation of robots to be used in the law enforcement field.

## **RAMIFICATIONS OF PRACTICAL USE**

Autonomous robot will have many different ways that they can be of use in the field. They will be able to be used in reconnaissance, both short and long ranged. They will also be of use as portable laboratories, bringing the capabilities of a top notch forensics lab out into the field. Autonomous robots will likely also be put to use as intermediaries for police, providing assistance to regular citizens on a level never seen before. They might also be of assistance with arresting or subduing suspects, providing their law enforcement partners with less-than-lethal and even lethal response options. The practical applications of autonomous robots in the field of law enforcement are many, but the legal and ethical ramifications of such usage must be considered and discussed.

### **Short/Long Range Reconnaissance**

Perhaps one of the best things a robot can do for a law enforcement office is short-range reconnaissance. Law enforcement is a job fraught with the unknown. Officers often do not know what kind of situation they are entering when they arrive on a call-for-service. Information about the situation, such as the layout of the area or building and how many people might be involved, is at a premium. In today's world, to gain information about a situation, the officer must often put her or himself in harm's way by entering a building they have no, or outdated, blueprints for or by searching for a criminal using only their own, limited, five senses (Jones, Rock, Burns, 2002). The autonomous robot could be used to do such operations in the future.

Robots are currently being employed in limited amounts for reconnaissance. The Predator drone, perhaps the most famous UAV, is being used by Homeland Security to patrol over 2,000 miles of borderland. There, Homeland Security claims these long-range drones have been responsible for helping impound 40,000 pounds of drugs and catch 7,000 illegal immigrants (Orr, 2010). However, these drones, and others like them, are still limited to

GPS positioning systems. They are also too big for most short-ranged reconnaissance and rather expensive, the camera alone can cost two million dollars (Lavendera, 2012) this limits their uses when it comes to short-range reconnaissance for local law enforcement use.

In an evaluation of a SWAT team using a drone in the field, researchers found that the drone lacked flexibility and could not adapt to changing operational conditions (Jones, Rock, and Burns, 2002). The team was then given an MLB Bat, a drone that weighs 10lbs, has a 60 inch wingspan, flight duration of 1 hour, telemetry of 2 miles, and a payload capacity of 1lb. The team was then asked to try the drone out during one of their exercises and evaluate its usefulness. One of the limits that they had with the drone was the way points (GPS coordinates) that had to be pre-programmed into the drone. While the drone could complete the task assigned, there was little room for flexibility once it was up. As the authors put it "Many robotic systems take advantage of prior information to provide accurate information to the robot for navigation purposes." (p.8). This makes sense in a stable environment, when there is time to plan a route and exact maps and GPS coordinates are available, but as any officer will tell you, little is stable in the field, with GPS lacking pinpoint accuracy and almost useless in indoor situations and maps and blueprints sometimes containing out of date information.

Autonomous robots, however, should be able to act and react to the situation fluidly. They will be able to go into an unknown location, map it, and even be able to find suspects all on their own. This has applications for all types of law enforcement tasks, from patrol to SWAT and EOD to Traffic, Rescue, and Narcotics departments.

Imagine a simple traffic stop. The officers on the scene will observe and look for inconsistencies on the rear of the stopped vehicle. They may then, perhaps, enter the license plate into the database to discover if the vehicle is registered as stolen. Next, they might engage their in-car camera to record the scene and approach the vehicle itself. Here,

however, comes the dangerous part. Aside from the license plate search and their own intuition, the officer has no real idea what they will be encountering when they go up to the driver. They could be encountering a drug dealer, a terrorist, or a simple citizen late for work.

Now add in the capabilities of an autonomous robot to this situation. The officer could deploy the robot from the safety of his or her own vehicle. Upon approach, the robot could, completely on its own, scan the vehicle with heat-sensing technology, to tell the officer exactly how many people are present inside. It could also employ its x-ray camera, informing the officer if there is anything hidden inside the frame itself. Perhaps, if the officer is suspicious enough, it could even deploy a chemical analyzer to check for bombs or drugs. Finally, the robot could scan the faces of everyone in the vehicle and use facial recognition software, check their identities, and see if any of them have a criminal record or a warrant for their arrest.

It sounds like science fiction, but the technology to do all of this is coming. Today's drones, like iRobot's Packbot, are equipped with multiple types of sensors. They come with attachments for thermal cameras, temperature gauges, and even chemical analyzers (iRobot, 2012). It is safe to say that as robot technology advances, so will the amount of sensors and data collection devices that can be mounted on them.

Tomorrow's drones will also be able to communicate with their fellow robots and other computer systems. They will have to. On an individual level, robots cannot compete with humans; they cannot carry the processing power. It is when multiple robots come together and pool their knowledge that they can begin completing complicated tasks like map making and locating OOI (Olson, Strom, Goeddel, Ranganathan, Richardson, 2010, p.2). With all of these tools at their fingertips, tomorrow's law enforcement personnel will

have access to an unprecedented amount of data thanks to their robot assistants, but how much of that data can they legally use?

Let us once again consider our hypothetical situation. When approaching the vehicle, will a warrant be required to deploy the drone itself or any of its various sensors? The International Association of Chiefs of Police (IACP) has recently released a set of recommended guidelines for the use of drone use (2012). While these guidelines are specifically for UAV's, they can provide a good guideline for some future legal issues that all law enforcement drones may face.

When it comes to warrants, the IACP suggest that

“Where there are specific and articulable grounds to believe that the UA will collect evidence of criminal wrongdoing and if the UA will intrude upon reasonable expectations of privacy, the agency will secure a search warrant prior to conducting the flight.” (International Association of Chiefs of Police Aviation Committee, 2012, p.1)

This leads to the question of probable cause and reasonable suspicion. What laws should they look to when deciding whether they can x-ray a vehicle or not? There must be guidelines created that the officer can follow when it comes to deploying all this new technology. In looking for precedents for creating these rules administrators might examine both the technological and the biological.

When it comes to searches, the drones that will be deployed will not be too unlike the police dogs that are employed today when it comes to using simple sensors or chemical analyzers that do not extend to the inside of the vehicle. The Supreme Court held that the Fourth Amendment is not violated when the use of a drug-sniffing dog during a routine traffic stop does not unreasonably prolong the length of the stop (*Illinois v. Caballes*, 543 U.S.

405, 2005). The dog uses its nose much like the drone will use its chemical analyzers. Using this precedent, when it comes to probable cause, the drone would likely be free to engage its analyzers on the outside of the vehicle. Sensors or x-ray technology that extends into the inside of the vehicle will likely require a warrant, or at the very least, probable cause.

Officers would have to be careful of not going beyond that line, especially when it comes to dealing with people's homes. *Kyollo vs. The United States* (2001) held that the use of a thermal imaging device from a public vantage point to monitor the radiation of heat from a person's home was a "search" within the meaning of the Fourth Amendment, and thus required a warrant. Law enforcement management can use these sorts of legal precedents as a guide for creating initial rules and regulations for the police use of autonomous drones when it comes to probable cause and reasonable suspicion.

There still remains the question of the drone's use of facial recognition technology to identify the driver and passengers, however. Here, we might turn to technology that already exists today, namely automatic license plate recognition system (APLR). APLR (Patrick, 2012) uses cameras mounted atop patrol cars to randomly take photos of vehicle license plates. Those photos are they stored in a database that can be accessed by police to do anything from track a suspect's vehicle or identify a stolen vehicle.

Law Enforcement agencies all over the country use the technology, citing it as being very successful. However, recent research shows that there is actually a severe lack of evidence based research being done and little information about any concerns the communities may have about this technology (Lum, Merola, Willis, Cave, 2010). Even here there are varying regulations on data storage, some agencies keeping the photos for as little as thirty days and some as long as one year, there being no overall legal guidelines as to how long data can be kept. There are also no standing guidelines for the on what the data can be used for. Most usage so far has been limited to locating stolen vehicles and parking

violations (Police Executive Research Series) and some evidence does exist that communities where such technologies are used might hold issue with how the data being stored is used (Lum, Merola, Willis, Cave, 2010).

Issues with the extent of information gathered also exist. In Washington D.C. the City Council has restricted police from using the system to take picture of the front of the vehicle, to avoid photographing faces, citing privacy issues (Patrick, 2012). Lum, et al. (2010) also raises the issue of if and how courts will distinguish the check of individual license plates from the mass collection being done by APLR. Courts now hold that while the individual collection does not violate privacy expectations because people are in a public venue, but the mass collection of such data might lead to a recreation of their daily lives, thus violating their privacy and making the courts regard them differently.

Tomorrow's robots will, in all likelihood, have access to more than just license plate photos for identification, however. They could, theoretically, access both secure police databases and the internet. So, when one is considering the future of autonomous robots in law enforcement, it seems wise to ask two questions. The first, what databases is the drone using to gather its data from and does this breach their expectation of the public's expectation of privacy? The second, if the drone is recording footage, where is that data stored, who has access to it and what can it be used for?

Everyday our world becomes more connected. Our cities are vast, interconnected webs of information and technology. The transportation systems alone are becoming more and more computer based. The U.S. Department of Transportation is going more and more towards Intelligent Transportation Systems, a platform they describe as "a combination of well-defined technologies, interfaces, and processes" that "makes the most of multi-modal, transformational applications" and "requires a robust, underlying technological platform" (U.S. Department of Transportation Research and Innovative Technology Administration,



2012). Meaning that multiple types of technological platforms, from CCTV to complex algorithms that control the timing on lights and signals, control our traffic today and that it's going to become even more based on technology in the future. Tomorrow's systems will likely contain things like connected vehicle technology, where the cars will "talk" to each other and the system via Radio Frequency Identification (RFID) chips and other advanced systems. It does not just stop with our transportation systems either.

In 2011 the Institute for Creative Technology (ICT) reported that one third of the world's population was online. In Chicago alone, police now have access to over 20,000 public and private video feeds as part of Operation Virtual Shield and more management systems are being put in place today in cities like Atlanta, Memphis, and New York. (Collins, 2012) In 2008, when adding up the total amount of service and industrial robots, the world's robot population reached 8.6 million (Guizzo, 2010). That is an amazing amount of technology present in our world today. To give a robot the processing power to be autonomous, it needs to connect and access other robots and networks. Law-makers and the public need to decide how much of that information they will be allowed access to

Say the officer tasks her drone with finding a suspected criminal. One way the robot might go about doing this is tasking the other law enforcement drones in the area. It could also, theoretically, tap into the network of other public system robots like those being used by the Department of Transportation or Department of Sanitation. They might even be allowed into the security systems of private corporations that have opened themselves up to police monitoring, like those in Chicago's Operation Virtual Shield. The drone could, theoretically, even dive into the internet and track social networks or perhaps track a phone via GPS using the cellular network. Autonomous robotic assistants assigned to police officers could do all of these things to comply with the officers order to track down a suspect, but should they be allowed to?

As the United States does not specifically recognize privacy rights, websites on the Internet are only required to follow their posted privacy policy (Raposa, 2008, as cited in McGrath, 2012). This has left things up in the air in regards to law enforcement when dealing with things like social networks and email. A recent bill has been introduced that “would allow more than 22 agencies -- including the Securities and Exchange Commission and the Federal Communications Commission -- to access Americans' e-mail, Google Docs files, Facebook wall posts, and Twitter direct messages without a search warrant” (McCullagh, 2012). If passed, could a law like this allow autonomous robots access to user’s information for surveillance or identification purposes?

The future of autonomous robots will offer law enforcement an unprecedented amount of access to information once considered private and so guidelines must be developed now to make sure that they do not infringe upon the civil rights of the people they are supposed to protect. While the question of what “privacy” is exactly is a complex one, it must be tackled and standards for what type of information people wish to protect, created. Is there a distinction between social networking sites like Facebook and Twitter and email accounts like Gmail or Hotmail, even when it comes to private messaging within those sites? Should drones be allowed to access either type in order to monitor or identify an individual?

This protection should also extend to the massive amounts of surveillance data that the drones will be collecting. Let us return to that original traffic stop. During the commission of its search, the robot will likely be constantly recording audio and visual information. Should all that data be stored? If so, where and who will have access to it and how can it be used?

One might look to how the law handles the video and audio surveillance equipment that is presently available for officers for answers. Perhaps the best known would be the in-car camera that is attached to the dashboard of over 72% of total state patrol vehicles

(Rosenblatt, et al., 2004, p.9). The IACP states that “all recordings should be treated as potential evidence until it can be established that the contents are not required in either a criminal, civil, or administrative manner” (Rosenblatt, Cromartie, Firman, Baker, Fergus, Wang, Fowler, 2004, p.36). If you consider that you will have access to thousands of hours of surveillance from the drones, it seems imperative for a secure and organized manner of storage to be developed and strict guidelines be kept to maintain the chain of evidence.

Laws must also be put into place to make sure there is no extraneous use of information. Here there are already examples of controversies developing around drone usage. An unclassified U.S. intelligence report (2007) recently revealed that’s surveillance data collected by Air Force Predator drones inside of the United States may be accessed by local law enforcement.

The report states that

“Air Force Unmanned Air Systems (UAS) operations, exercise and training missions will not conduct nonconsensual surveillance on specifically identified US persons, unless expressly approved by the Secretary of Defense, consistent with US laws and regulations” (p.11).

However, it later goes on to state that the “civil law enforcement agencies...will control any such data collected” and that “if...Air Force intelligence components receive information identifying US persons as an alleged threat to DoD or civilian individuals, entities or structures, such threats should be reported..” (U.S Air Force. 2007, p.11). While these flights are of a high-altitude nature and the video taken in public venue, even here, the lines are becoming blurred when it comes to the question of who has access to drone information. Military agencies, which have normally been kept strictly out of domestic law enforcement, are being tapped for their surveillance data. Where will the courts draw the line when it comes to expectations of privacy in this world of rapid, technological interaction

and information sharing? What will happen when law enforcement agencies themselves have hundreds, if not thousands of drones themselves? What rules will there be about who can dip into that pool of knowledge?

One could perhaps simply dismiss this concern by using the oft-quoted argument of “If you don’t have anything to hide, why should you be worried?”. However as Solove (2011) points out,

“The nothing-to-hide argument focuses on just one or two particular kinds of privacy problems--the disclosure of personal information or surveillance--while ignoring the others. It assumes a particular view about what privacy entails, to the exclusion of other perspectives.”

Our understanding of what exactly privacy is has changed drastically in the past decade. The invention of the internet and social networking, not to mention surveillance technology, has opened our lives up in a way generations before never imagined. People spend more time today interacting via technology than they do face-to-face (Baxter, 2012). Where and how we draw the lines that define privacy is still a topic that law makers and citizens need to address. When it comes to autonomous robots, it must also be decided about how far into that well of information laws will allow them to reach.

### **Portable Laboratory**

Surveillance is not the only way autonomous robots will be useful to law enforcement officers in the future. More and more, robots are coming equipped with analyzing equipment of all sorts. To get an example of the types of tech that might be loaded onto a robot of the future, one can look to perhaps one of the most advanced robots of our time, NASA’s Mars Rover Curiosity. The instruments aboard Curiosity “include a gas chromatograph, a mass spectrometer and a tunable laser spectrometer with combined

capabilities to identify a wide range of organic (carbon containing) compounds and determine the ratios of different isotopes of key elements” (NASA, 2012, p.2).

Granted, Curiosity is ten feet long and three times as heavy NASA’s twin Mars Explorations Rovers, Spirit and Opportunity (NASA, 2012), but its mission is of an exploratory nature rather than a law enforcement one. However, even given these differences, it does give one a glimpse of the amount of technology that can be packed into a robot and the sort of jobs it can be tested with. Curiosity is literally a mobile laboratory. Can you imagine the benefits of providing each and every police officer with one of their own?

Today’s crime solving tools are becoming more and more technology based. DNA testing alone has vastly changed how police solve crimes. The Federal Bureau of Investigation (FBI) reported that in 2010 there were 1,911,767 violent crimes reported alone. If one imagines that during the course of those investigations the officers request that only two tests be performed by the crime lab, perhaps a DNA test and a blood test (assuming that such evidence exists), that would make 3,823,534 tests that the labs have to perform, and that is accounting for non-violent crimes. This overwhelming surge for scientific testing has created a huge backlog in crime lab testing. In 2009 in Los Angeles alone, there were 12,669 untested sexual assault kits (rape kits) sitting in police storage facilities in Los Angeles County alone (Human Rights Watch, 2009,, p.1). While not all departments have such a high rate, lack of funding and standardized training has caused harm to clearance rates all over the country (Johnson, 2010)

Now imagine if, instead of having to transport the sample all the way back to the laboratory and have it sit in a storage facility for years, exposing it to the possibility of contamination or degradation and thus breaking the chain of evidence, the officer could simply give the evidence to their mobile robotic laboratory and have it perform the tests on

site. This ability to have access to crucial evidence in a timely manner could help police catch criminals much faster, thus eliminate the waiting period for victims and making the wheels of justice turn much faster. This ability will bring its own set of legal issues with it, however.

Before robots can be used to do this, lawmakers and law enforcement administrators must look to several issues, like regulations for the officers processing the evidence so that the chain of evidence might be protected. At the present time, when a crime occurs, a murder for example, skilled forensic technicians must come in to process the evidence from the scene, however even basic patrol officers can be called upon to perform roadside breath tests during the course of a Standardized Field Sobriety Test (SFST) to determine the Blood Alcohol Concentration (BAC) (Rubenzer, 2008, p.1).

It would seem most logical then, to design a robot specifically for the front line officer, perhaps giving it the ability to conduct a more limited amount of tests, like alcohol or drug concentration levels. Autonomous robots that will be assigned to forensic technicians could also be designed specifically for them and be loaded with more complicated and comprehensive equipment. Very strict regulations would have to be designed for both officers and technicians however, to maintain the evidence's reliability.

### **Citizen Assistance**

Autonomous robots will also be able to help in many other ways than just surveillance. Interacting and assisting citizens is at the core of all police work, if the public's confidence in the police is low, they cannot do their jobs well (Casey, 2008). If autonomous robots are going to be an integral part of police work in the future, it is important to consider not only how they will interact with law enforcement personnel, but also how the citizens that they are protecting will view them.

One of the jobs that autonomous robots will likely have in the future is citizen assistance. Given the fact they do not require sleep and little maintenance, assistance robots could likely be stationed in a specific place or even patrol an area continuously, responding to calls for help faster than a human patrol. Should a citizen be in trouble, need to contact the police, or even if they just want to ask a question, they could simply flag down or summon a robot.

This process would likely increase response times and help take some of the burden off of police and other law enforcement personnel. However, one must carefully consider a few issues when considering this type of interaction, so as to make sure to not add another layer of separation between police and the public that they protect. The regulations and legality behind what the autonomous robots, either acting completely on their own or in a telepresence capacity, will actually be allowed to do while on those patrols should also be evaluated.

Cooperation from the citizens that they protect is vital for the police to do their jobs (Tyler, Huo, 2002, p.6). The question becomes, would autonomous robots lessen the amount of cooperation and legitimacy that the police currently hold. To evaluate if and how this might happen and how officials might lessen this action, one might look to the current technology available and how it has affected customer satisfaction within the world of business. A new type of technological interaction in the world of business and even education is telepresence. With telepresence the robot, via a screen and wi-fi connection, acts as an emissary for the real operator, who could be situated hundreds or even thousands of miles away.

Telepresence robots are being used in both corporations like Cisco and Elance Inc. as a way for employees that are increasingly spread out across the world to interact (Silverman, 2012). They can even be found in classrooms in South Korea, taking the places of English

Teachers that live as far away as America or Australia (Palk, 2010). Cisco, a company that creates such robots, has found that employees were often more often and honest with the robot than with real people, perhaps due to its lack of body language (Silverman, 2012). In the law enforcement world, robots could be developed so that an officer could be located at head quarters and operate multiple drones, thus expanding their presence and reaction time. However, care must be taken to assure the clarity of the connection and the reliability and maneuverability of the robot, as some technical glitches still appear in today's telepresence robots and can cause communication issues (Silverman, 2012). Further study should also be done to see if any amount of information is lost via this type communication between the officer and citizen.

One other popular type of technology that businesses use to interact with citizens is Interactive Voice Response (IVR). IVR is "an automated telephony system that interacts with callers, gathers information and routes calls to the appropriate recipient" (Interactive Voice Response, n.d.). IVR systems are on the front line of customer service for many businesses and are supposed to help handle inbound call volume. However, if you have a bad system, customers will most likely abandon the call and, in response, form a bad opinion of the company (Korzeniowski, 2011, p.1). When enough negativity forms around a company, it will fail. That effect is worse when negativity begins forming around law enforcement. If the public will not work with the police, they become less able to do their jobs correctly (Tyler, Huo, 2002, p.6). Care must be taken in the user interface that the law enforcement autonomous robots will be use to interact with the citizens so that they do not negatively impact the police's relationship with the public they are protecting.

The public view the police as legitimate and are willing to follow their orders and directions, when they see them as being morally upstanding (Tyler, 2006). If the public sees the police as using drones for less than moral purposes or abusing the power that drones



provide them, that moral authority could be harmed. It could also be adversely affected by the drones creating too much of an informational and emotional gap between the police and the people they protect, leaving the police looking down upon the community and the citizens unable to communicate their problems to the police. If that relationship, that moral authority that the public perceives the police as having, is damaged, all that will be left is fear, which could lead to a loss of police legitimacy.

The legality of what services these citizen interaction robots can provide must also be taken into account. If a citizen informs a robot of a crime in process, should the robot then contact a human handler, or can it dispatch police help itself? Is a robot allowed to take a statement from a person who witnesses a crime? Can they, perhaps, interview a suspect? Can they arrest people and if so, how will they secure the suspect? Rules, regulations, and laws must be created to deal with these situations. Further study must also be done in the field of human and robot interaction, especially when it comes to the issue of public perception.

### **Less-than-Lethal and Lethal Response**

When discussing any issue about robots and law enforcement, one must address the question of weaponry. Robots being used in Iraq by the US military have already been weaponized. Armed with a payload mix of 1,500 lbs on each of its two inboard weapons stations, 500-600lbs on the two middle stations and 150-200lb on the outboard stations, the MQ-9 Reaper, previously known as the Predator B, is a drone specifically designed to be a hunter-killer (MQ-9, n.d.). Its smaller cousin on the ground would be the Special Weapons Observation Remote Reconnaissance Direct-Action System (SWORDS). SWORDS are armed with Squad Automatic Weapon (SAW), M249 Light Machine Guns (Popular Mechanics, 2009). These robots are not only staying within the theater of war.

The TALON, a robot platform that has been deployed overseas by the military since 2002, is now being marketed to the domestic police, both as an EOD platform and a SWAT platform. The TALON SWAT/MP can be mounted with Multi-shot TASER electronic control device with laser-dot aiming, loudspeaker and audio receiver for negotiations, night vision and thermal cameras. They even give the officer the choice of weapons for lethal or less-than-lethal responses, including a 40 mm grenade launcher – 2 rounds, 12-gauge shotgun – 5 rounds, and a FN303 less-lethal launcher – 15 rounds (QuinetiQ North America, n.d.). It seems it is only a matter of time until other armed robots created specifically for law enforcement are created.

While these robots are armed and they can kill, it is important to remember that this generation of robots is still remotely operated. They still have, as they say, a human “in-the-loop”. However, the technology is growing so fast that humans might not be able to keep up. The Army’s current Future Combat System (FCS) requires that two humans jointly supervise a team of ten land robots (Singer, 2009). Recall though, that the winning team of the Autonomous Ground-Robotic International Challenge, from the University of Michigan, actually won with a squad of fourteen robots working together with only two handlers (Defence, Science, & Technology Organization, 2009). With new discoveries being made every day in communications, it is not inconceivable that the next generation of robots will be operated at a twenty to one ratio.

It is one thing for a human to remotely operate one drone by himself with no assistance, but imagine trying to monitor three or five or even ten at the same time, your attention would be spread so thin. Operator performance begins to degrade when humans are forced to operate so many robots without the use of more technology (Chen, 2009). Now take that to the next step and arm the systems. What sort of mistakes would be made by the operator in charge of multiple armed robots?

Another thing to consider when it comes to operation of multiple or even one armed system is the health of the operators themselves. In a study done by the US Air Force, it was found that “nearly half the operators of drone aircraft have high levels of job-related stress” (Bumiller, 2011). The long hours and erratic work schedules combined with another factor, having that ability to go back and watch the video and assess the damage they had inflicted over and over again creates a unique situation for the pilots. Though their operations and missions are obviously very different, would this sort of stress transfer over to the operators of law enforcement robots?

When trying to answer this question and create guidelines and rules for drone operator, police administrators might turn to the current literature being done on the stressors officers encounter during critical stress situations. Klinger and Brunson (2009) conducted a recent study involving eighty officers from over nineteen municipal and county law enforcement agencies in four states regarding 113 incidents in which they shot citizens. During the face to face interviews, it was found that 82 percent experienced diminished sound, while 20 percent perceived some sounds as extremely loud. 51 percent of the officers experienced tunnel vision and 56 percent reported heightened visual acuity. The officers were experiencing “multiple sensory irregularities during single incidents” (p.129).

Slottje et al. (2008) also did a historic cohort study on all the police and firefighters involved in the 1992 crash of a cargo plane into an apartment complex, in which 43 people were killed and 226 apartments were destroyed. The eight and a half year study looked into the post-traumatic stress symptoms that exposure to such an incident might create. Those officers and firefighters involved reported more multiple physical systems than their unexposed colleagues. These numbers went up even more when they involved officers or firefighters directly involved with tending the wounded, identifying the victims, or among those that directly witnessed the incident or its immediate aftermath. One would posit that

having to view such incidents over and over again, as a drone operator might have to do to search for evidence or review a situation, might lead to many different kinds of problems. Further study would be needed on the stress that drone operators undergo.

With all of these problems of a human having complete control over the actions of multiple robots there seems only two roads to go down; 1. keep the human in the loop and limit the amount of robots to one or perhaps two, or 2. increase the amount of robots and lessen the amount of human interaction, letting the robots take more control. There are issues to be discussed if either path is chosen.

Imagine, for example, an unknown hostage situation. The SWAT team sends in the robot to survey the situation. Imagine further that the robot is armed. The robot turns a corner and encounters the suspect holding a civilian hostage. In a one robot to one handler situation, this might have an easy ethical solution; the handler can authorize the robot to employ force, but not an easy technical one, because of something called time lag.

Time lag is defined as the time delay between the user's input and its displayed response (Davis, Smyth, McDowell, 2010). This lag can be the result of many things, including lack of sufficient bandwidth and limits in computation power. Whatever the reasons, any delay between an officer giving the order to fire and the robot acting on the order could have disastrous results.

During a SWAT assault, for example, "action takes place amazingly quickly...movements seem to happen in the blink of an eye...robots that participate in this aspect of SWAT operation must have fast reactions or they would not be able to participate" (Jones, Rock, Burns, Morris, 2002, p.9). In a firefight, the officers accompanying the robot must know that it will be able to react in the correct manner. What would happen if the robot is even two or three seconds behind the action in a firefight or in a situation where it is being relied upon?

Let us also consider the possibility that our robot is not alone. What if it has fifteen other robots in its group? What if, at the same time as our original robot is encountering the original suspect, another robot is encountering a different suspect of its own? How will one or even two handlers be able to keep up with monitoring all sixteen robots and keep track of what they are doing? That will create a kind of lag in its own. Perhaps the robot will also experience a complete loss of communication with its handler. In these situations, is the robot allowed to take over control and employ lethal or less-than-lethal force?

Let us propose for a moment that the robot is authorized to take over from the handler and employ lethal or less-than-lethal options. Here, there are also many ethical and legal questions to deal with. First, what kind of program is the robot using to identify the suspect and what level of statistical level of fallibility will it be required to have? As with any electronic system, facial recognition databases will have errors. While the best commercial systems can give a 90 percent probability of verification with a 1 percent error rate, that rate is dependent on the quality of the image. A study by the National Institute of Standards and Technology (NIST) found that that rate can fall to 47 percent in unconstrained outdoor conditions and that false-negative rates for face-recognition verification can go as low as 43 percent using photos of subjects taken just 18 months earlier (National Institute of Standards and Technology, 2002). The same study stated that fingerprint identification is even more accurate and that accuracy grows given the amount of fingers printed, but one can hardly expect the robot to request the suspect stand still and be printed in the middle of a firefight. A certain level of standards for identity recognition would have to be put in place for suspect identification before allowing robots to have any control over lethal and less-than-lethal operations.

Go further forward in time and suppose that all of these rules and regulation have been put into place and standards have been set for software and hardware, but something

still goes wrong. Instead of shooting the suspect and eliminating the threat, the robot shoots the civilian. Who, then, is held accountable?

In 2007 (Shachtman, 2007) a South African National Defence Force antiaircraft cannon malfunction and killed nine soldiers and seriously injured 14 others during a shooting exercise. In 2010 (Kovach, 2010) a military test facility in southern Maryland lost control of an unmanned helicopter for about 20 minutes before reestablishing its communications, the robot came within 40 miles of Washington. Accidents happen. A normal robot that is unarmed can be dangerous enough, but when you add a gun or a Taser into the mix, accidents can quickly turn deadly.

They happen in the world of law enforcement today. In September of 2012 (Katz, Hayes, 2012), a police officer shot and killed a convenience store worker who ran into him on a sidewalk while fleeing from an armed robbery. The difference between a robot killing or harming someone and a human doing the same is that we already have laws, rules, and regulations established for dealing with such incidents. When it comes to robots, the law is rather unclear on who would be responsible. Do you blame the robot's handler? What if there is none, if it's completely autonomous? Do you blame the person who made the software or hardware? Do you blame the company that made the robot or the police agency that employed it?

One Though not entirely compatible, given that they have developed and used many of the robots being used by law enforcement today, one of the places law enforcement might turn to when establishing such rules is the military. When it comes to military robots there is

“a list of characters throughout the supply chain that may be held accountable: the programmer, the manufacturer, the weapons legal review team, the military

procurement officer, the field commander, the robot's handler, and even the President of the United States, as the commander-in-chief" (Lin, Abney, Bekey, 2011)."

Though not all the rules would apply, given the differences between military and civilian law, the core of the code the military has created would seem a wise framework for law makers and law enforcement management to consult. However, most of these regulations are still dealing with human controlled robots, not autonomous ones. How else might civilian law be influenced by this?

Product liability laws seem to be trending more and more toward protecting the manufacturer (Lin, Abney, Bekey, 2011). It also becomes even more problematic when one considers that the hardware and software that make up a robot do not all come from one place. Do you blame the person that put it all together, or do you go after each individual a manufacturer? Wallach and Allen, in their book *Moral Machines: Teaching Robots Right from Wrong* (2009), make the argument that because their machinery and programming is so complex, thus making their behavior extremely hard to prognosticate, robots should be placed in their own subset of product type.

Outside of the strict liability of product liability, when it comes to most criminal law, the robot itself cannot be held responsible for the crime because it lacks mens rea, or guilty mind (Mens Rea, n.d.), but that too might be changing. Felix Growing, a research project involving six countries, is designing robots that will "learn from humans and respond in a socially and emotionally appropriate manner" (BBC News, 2007). This and other programs like it are creating robots that may be able to understand the complexities of human emotion and perhaps even be able to make ethical and moral decisions in the future. Will the introductions of such technology change how the law looks at accidental shootings in the field? Instead of product liability law or finding out which human made the programming or hardware mistake, will the robot itself be held accountable?

One might also consider the question of liability outside of the application of force. What will happen in the robot simply crashes into a home or car or person? Who then, will be held responsible for the damage it inflicts? Here though, we have some precedent being created today that officials might look to. Nevada recently made headlines for becoming the first state to license self-driving, autonomous, cars. California also joined in, signing Senate Bill 1298 into law, which allows self-driving cars to begin test driving and for the California Highway Patrol and Department of Motor Vehicles to make recommendations for safety or other requirements. (Martell, 2012)

These vehicles have brought up many questions concerning liability laws. For example, if the vehicle is in an accident, who is at fault, the “driver” or the manufacturer who made the car? Scholars and experts from all around have recently gathered together at the Santa Clara’s Law Review annual symposium to try to find the answers to some of these questions. One of the problems they found was that liability and insurance laws change from state to state. For example, in Nevada, the person who “starts” the car is technically at fault, so according to their laws; the driver would be at fault, regardless of whether the automated system was driving or not. California law, however, requires that insurance premiums be set based on the driver’s record, which would be ridiculous to try to do if a computer is driving the car (Martell, 2012). How law makers, manufacturers, and insurance companies go about creating laws and regulations for these automated vehicles will provide good precedent for law enforcements own automated robots.



## LAW AND RULE CREATION

Autonomous robots will bring with them a host of legal and ethical issues that must be addressed, especially when they are put to use by law enforcement. Who, though, is best suited to create solutions for these problems? Given the vast and varying degree of issues to be addressed, the creation of solutions will likely be a multi-faceted, multi-agency approach. Federal lawmakers will have to address broad issues of privacy and they also seem best suited to create national standards for data storage, surveillance, and the application of less-than and lethal response. Given the differing standards of insurance and liability law, state by state solutions will likely have to be discussed by regional legislators, manufacturers, and insurance companies. Top down solutions seem the most logical solution, with the federal government establishing broad goals and standards, with each state finding its own, best way, to reach said goals.

Regulations, rules, and training standards will also have to be decided upon by law enforcement agencies on issues such as evidence handling, less-than and lethal response, and citizen interaction. Agencies on all levels, from national like the FBI and Department of Homeland Security, to state and local like State Police and Sheriff Departments, will have to create rules for their officers to follow. Training regimens will also have to be considered. In an increasingly technological world, officers will have to be able to operate and even trouble-shoot their robots. In an increasingly technological world, officers will have to be able to operate and even trouble-shoot their robots. They will have to be able to tell when something is wrong and how to repair it or who to take it to get it repaired. Support structures, such as in-house research and repair, will also have to be developed for each department. Studies should also be done on how such requirements would also affect officer morale, given that such duties are not currently assigned them.

Given all these requirements for autonomous robots, coordination and cooperation between law makers, law enforcement agencies, and even civilian corporations will be key in this process. Lawmakers will have to poll law enforcement to see what their needs for robots are. Police will have to question the public to see how deep they are willing to allow the robots to go into their lives. Scientists must coordinate with law enforcement to see what new technologies they can create. Private corporations will have to deal with law makers and law enforcement to see what services they can provide. More and more, the sharing of information is being shown to be key to stopping crime and this trend will not change with the advent and adoption of autonomous robots, rather, it will even more increase the need for it.

## CONCLUSION

Our future will be one filled with wonder. Robots the likes of which we only dreamed of and read of in science fiction novels are already here and many more new kinds will soon be coming. Robots that can help our law enforcement personnel keep our citizenry and themselves safer by putting themselves on the front line. They will be able to go places we could never reach, put themselves into dangerous situations so that police officers do not have to, and collect and organize information on a level we can barely even conceive of now. All of this will be wonderful, but as with all things in real life, robots will bring with them their own set of problems.

This is not an insurmountable problem, however. By examining law enforcements current use of robots and the combining this information with the new and upcoming technology, one might be able to posit future issues before they happen. Issues, such as the legal requirements for warrants and what exactly substantiates probable cause and reasonable suspicion for a drone, can be answered by basing future regulations on current legal precedents.

Ethical problems, such as data storage and access, will likely be harder to deal with. It seems likely that in the coming years the question of what exactly Americans equate as “privacy” will have to be discussed and codified. No matter what is decided, however, the security of drone information storage will have to be of the highest priority for future law enforcement personnel, for both privacy and evidentiary reasons. How law enforcement officials go about doing this will truly effect how citizens view their use of drone technology.

Another matter that will affect public perception is how those drones interact with the citizens themselves. It will be impossible to separate citizens from the robots that are supposed to be protecting them, so much thought should be put into the matter when creating future robots. Software and hardware factors will have to be considered and laws codified

as to exactly how such interaction should take place so as to maintain the cooperation of the citizens and the legitimacy of the police in their eyes.

Such legitimacy must also be maintained by addressing the issue of less-than-lethal and lethal response when it comes to autonomous robots before it even happens in the field. The arming of robots is already happening and will likely continue into the future. Given the rapid manner in which technology is developing robots and how humans are struggling to stay “in-of-the-loop” when it comes to the actions of the robots they are supervising, it seems wise to develop a set of standards the robots must be able to operate by before giving lethal or even less-than-lethal options to them. Laws must also be established that ascertain who exactly will be at fault when accidents occur, because simple logic dictates that they will happen.

Simply hoping that these issues will not occur or dealing with them in a piecemeal manner seems optimistic at best and pure foolishness at worst. To get ahead of the controversies and matters of contention that autonomous robots might bring about, federal law makers must start working now to create broad federal standards so that each state might have time to develop solutions to reach them. Law enforcement agencies must also begin working together to create policies and regulations for their officers in the field. The speed at which new technologies are being developed will constantly bring up new issues, so joint By getting out in front of the problem, they can be prepared to deal with the worse when it does happen or possibly even prevent the worse from happening to begin with. Sound reasoning based on current issues and emerging technologies can prepare law makers and law enforcement personnel of what they will soon be facing and give them to tools to face it prepared.

## REFERENCES

- "MQ-9 Reaper". (n.d). MQ-9: Predator B. *GlobalSecurity.org*. Retrieved from <http://www.globalsecurity.org/military/systems/aircraft/mq-9.htm>
- Alpert, G. P., & Smith, W. C. (1994). How reasonable is the reasonable man?: POLICE AND EXCESSIVE FORCE. *The Journal Of Criminal Law And Criminology (1973-)*, (2), 481. doi:10.2307/1144107
- Autonomous robots. (n.d.). In *Access Science from McGraw-Hill*. Retrieved from <http://accessscience.com/overflow.aspx?SearchInputText=AUTONOMOUS+ROBOTS&ContentTypeSelect=4>
- Baxter, T. (2012). Low expectations: How changing expectations of privacy can erode fourth amendment protection and a proposed solution. *Temple Law Review*, 84(3), 599-636.
- BBC News. (2007, February 23). Emotion robots learn from people. Retrieved from <http://news.bbc.co.uk/2/hi/technology/6389105.stm>
- Bekey, G. A. (2005). *Autonomous robots: From biological inspiration to implementation and control*. Cambridge: A Bradford Book.
- Bumiller, E. (2011, December 18). Air force drone operators report high levels of stress. *New York Times*. Retrieved from [http://www.nytimes.com/2011/12/19/world/asia/air-force-drone-operators-show-high-levels-of-stress.html?\\_r=0](http://www.nytimes.com/2011/12/19/world/asia/air-force-drone-operators-show-high-levels-of-stress.html?_r=0)
- Chen, J.Y.C. (2009). Concurrent performance of military and robotics tasks and effects of cueing in a simulated multi-tasking environment. *Presence: Teleoperators & Virtual Environments*, 18(1), p.1-15.
- Collins, H. (2012, February 1). Video camera networks link real-time partners in crime-solving. *Government Technology*. Retrieved from <http://www.govtech.com/public-safety/Video-Camera-Networks-Link-Real-Time-Partners-in-Crime-Solving.html>
- Cook, G. (2011). *Mobile robots: Navigation, control and remote sensing*. Oxford :IEEE.
- Davis, J., Smyth, C., & McDowell, K. (2010). The effects of time lag on driving performance and a possible mitigation. *IEEE Transactions On Robotics*, 26(3), 590.doi:10.1109/TRO.2010.2046695
- Defence, Science, & Technology Organisation. (2009). *Multi-autonomous ground robotic international challenge*. Edinburah South Australia: Department of Defence.
- Dillow, C. (2012, December 5). Oceangoing robot comes ashore in Australia, completing a 9,000 mile journey. *Popular Science*. Retrieved from <http://www.popsci.com/technology/article/2012-12/oceangoing-robot-comes-ashore-australia-completing-9000-mile-autonomous-pacific-crossing>
- Goradia, Amit, Xi, Ning, Elhaji, Imad H. (2005). *Internet based robots: Applications, impacts,*

- challenges and future directions. *2005 IEEE Workshop on Advanced Robotics and its Social Impacts.*, p.1-6.
- Griffey, J. (2012). It just gets weirder. *Library Technology Reports*, 48(3), p. 25-29.
- Guizzo, E. (2010). World robot population reaches 8.6 million. *IEEE Spectrum*. Retrieved from <http://spectrum.ieee.org/automaton/robotics/industrial-robots/041410-world-robot-population>
- Hornyak, T. (2012, February 8). Darpa takes bigger Bigdog out for walkies. *CNET*. Retrieved from [http://news.cnet.com/8301-17938\\_105-57373477-1/darpa-takes-bigger-bigdog-out-for-walkies/](http://news.cnet.com/8301-17938_105-57373477-1/darpa-takes-bigger-bigdog-out-for-walkies/)
- Illinois v. Caballes, 543 U.S. 405 (2005)
- Institute for Creative Technology. (2011). *ICT facts and figures* [Data file]. Retrieved from <http://www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf>
- Interactive voice response.(n.d.). In *Search CRM*. Retrieved from <http://searchcrm.techtarget.com/definition/Interactive-Voice-Response>
- International Association of Chiefs of Police Aviation Committee (2012). Recommended guidelines for the use of unmanned aircraft. Retrieved from [http://www.publicrecordmedia.com/wp-content/uploads/2012/08/IACPAC20120\\_pd\\_001.jpg](http://www.publicrecordmedia.com/wp-content/uploads/2012/08/IACPAC20120_pd_001.jpg)
- iRobot. (2012) 510 Packbot [Video File]. Retrieved from <http://www.irobot.com/us/robots/defense/packbot.aspx>
- Jansen, B. (2012, February 7). FAA told to make room for drones in U.S. skies. *USA Today*. Retrieved from <http://usatoday30.usatoday.com/news/nation/story/2012-02-06/unmanned-drones-share-faa-airspace/52994752/1>
- Johnson, A.M. (2010, February 12). Already under fire, crime labs cut to the bone. *NBC*. Retrieved from [http://www.msnbc.msn.com/id/35319938/ns/us\\_news-crime\\_and\\_courts/t/already-under-fire-crime-labs-cut-bone/#.UMgPanmaaSo](http://www.msnbc.msn.com/id/35319938/ns/us_news-crime_and_courts/t/already-under-fire-crime-labs-cut-bone/#.UMgPanmaaSo)
- Jones, H.L., Rock, S.M., Burns, D., Morris, S. (2002). Autonomous robots in swat applications: Research, design, and operations challenges. *Proceedings of the 2002 Symposium for the Association of Unmanned Vehicle Systems International (AUVS '02)*, p.1-15.
- Katz, A., Hayes, T. (2012, September 8). NY city police accidentally shoot shop worker. Yahoo. Retrieved from <http://news.yahoo.com/ny-police-accidentally-shoot-shop-worker-death-161129771.html>
- Klinger, D. A., & Brunson, R. K. (2009). Police officers' perceptual distortions during lethal force situations: Informing the reasonableness standard. *Criminology & Public Policy*, 8(1), 117-140. doi:10.1111/j.1745-9133.2009.00537.x

- Korzeniowski, P. (2011). Voice user interface designers learn to cope with rejection. *Speech Technology Magazine*, 16(6), p.26.
- Kovach, B. (2010, August 26). Military loses control of helicopter drone near Washington. *CNN*. Retrieved from <http://edition.cnn.com/2010/US/08/25/runaway.helicopter/index.html>
- Kumar, V. (2012). Robots that fly...and cooperate. [Video File]. Retrieved from [http://www.ted.com/talks/lang/en/vijay\\_kumar\\_robots\\_that\\_fly\\_and\\_cooperate.html](http://www.ted.com/talks/lang/en/vijay_kumar_robots_that_fly_and_cooperate.html)
- Kyllo v. United States, 533 U.S. 27 (2001)
- Lasar, M. (2011, April 19). Army Surveillance bot approved for use by police, firemen. *Ars Technica*. Retrieved from <http://arstechnica.com/tech-policy/2011/04/military-surveillance-robot-unleashed-for-public-safety-use/>
- Lavandera, E. (2010, March 12). Drones silently patrol u.s. borders. *CNN U.S.* Retrieved from [http://articles.cnn.com/2010-03-12/us/border.drones\\_1\\_border-patrol-predator-unmanned-aircraft?\\_s=PM:US](http://articles.cnn.com/2010-03-12/us/border.drones_1_border-patrol-predator-unmanned-aircraft?_s=PM:US)
- Lin, P., Abney, K., Bekey, G. (2011). Robot ethics: Mapping the issues for a mechanized world. *Artificial Intelligence*, 175, p. 942-949.
- Louis, C. (2008). Engaging communities in fighting crime: A review. *London, Cabinet Office*.
- Lucas Jr., G.R. (2010). Postmodern war. *Journal of Military Ethics*, 9(4), p289-298.
- Lum, C., Merola, L., Willis, J., Cave, B. (2010). License plate recognition technology (LPR): Impact evaluation and community assessment. *Center for Evidence-Based Crime Policy, Department of Criminology, George Mason University*. 1-135.
- Martell, S. (2012, May 11). Self-driving cars and the liability issues they raise. *ProtectConsumerJustice.org*. Retrieved from <http://www.protectconsumerjustice.org/self-driving-cars-and-the-liability-issues-they-raise.html>
- McDonough, F. (2012). As technologies evolve, will governments change for the better?. *World Future Review*, 4(2), p170-178.
- McGrath, L. C. (2011). Social networking privacy: Important or not?. *Interdisciplinary Journal of Contemporary Research In Business*, 3(3), 22-28.
- Mens rea (n.d.). In *Encyclopedia Britannica*. Retrieved from <http://www.britannica.com/EBchecked/topic/375243/mens-rea>
- Mitchell, R. (2010, May 4). Police head cameras capture action, evidence [Video File]. *CBS News*. Retrieved from

<http://www.cbsnews.com/stories/2010/04/04/eveningnews/main6363152.shtml>

- Monahan, T. (2007). "War rooms" of the street: Surveillance practices in transportation control centers. *Communication Review*, 10(4), p.367-389.
- National Institute of Standards and Technology. (2002). Summary of standards for biometric accuracy, tamper resistance, and interoperability. Retrieved from [http://biometrics.nist.gov/cs\\_links/pact/NISTAPP\\_Nov02.pdf](http://biometrics.nist.gov/cs_links/pact/NISTAPP_Nov02.pdf)
- Nguyen, H.G., Bott, J.P. (2000) Robotics for law enforcement: Applications beyond explosive ordnance disposal. *SPIE International Symposium on Law Enforcement Technologies, Boston, MA, Nov.2000*, p.5-8.
- Nissan, E. (2009). Legal evidence, police intelligence, crime analysis or detection, forensic testing, and argumentation: An overview of computer tools or techniques. *International Journal of Law & Information Technology*, 17(1), p1-82.
- Olson, E., Strom, J., Goeddel, R., Ranganathan, P., Richardson, A. (2010). Exploration and mapping with autonomous robot teams results from the magic 2010 competition. *University of Michigan*. Retrieved from <http://april.eecs.umich.edu/pdfs/olson2012cacm.pdf>
- Palk, S. (2010, October 22). Robot teachers invade south Korean classrooms. *CNN*. Retrieved from <http://edition.cnn.com/2010/TECH/innovation/10/22/south.korea.robot.teachers/index.html>
- Park, S., Jeppesen, R. (2012, March 7). Standoff suspect surrenders to robot. *KSL News, Utah*. Retrieved from [http://www.ksl.com/?nid=148&sid=19605587&title=standoff-suspect-surrenders-to-police-robot&s\\_cid=featured-1](http://www.ksl.com/?nid=148&sid=19605587&title=standoff-suspect-surrenders-to-police-robot&s_cid=featured-1)
- Patrick, R. (2012, November 28). Police cameras gobbling up driver data in St. Louis. *St. Louis Post Dispatch*. Retrieved from [http://www.stltoday.com/news/local/crime-and-courts/police-cameras-gobbling-up-driver-data-in-st-louis/article\\_69e3fb59-9fb2-5757-a5b6-820827eec7a3.html](http://www.stltoday.com/news/local/crime-and-courts/police-cameras-gobbling-up-driver-data-in-st-louis/article_69e3fb59-9fb2-5757-a5b6-820827eec7a3.html)
- Police Executive Research Forum. (2012). Critical issues in policing series: "How are innovations in technology transforming policing?". *Washington, DC*. 1-60.
- Popular Mechanics. (2009, October 1). The inside story of the swords armed robot "pullout" in Iraq: Update. Retrieved from <http://www.popularmechanics.com/technology/gadgets/4258963>
- QuinetiQ North America. (n.d.) TALON. Retrieved from <http://www.qinetiqna.com/products/unmanned-systems/talon/>
- Rapoza J. (2008). "Privacy policy" as oxymoron. *EWeek*. 25(30) p. 48.
- Robots. (n.d.). In *Access Science from McGraw-Hill*. Retrieved from <http://accessscience.com/overflow.aspx?SearchInputText=ROBOTS&ContentType>



- elect=4&p=2
- Rosenblatt, D.N., Cromartie, E.R., Firman, J., Baker, W.G., Fergus, M., Wang, H., Fowler, K. (2004). The impact of video evidence in modern policing. *Research and Best Practices from the International Association for Chiefs of Police (IACP) Study on In-Car Cameras*. Retrieved from <http://www.theiacp.org/LinkClick.aspx?fileticket=5k3IK9SZuz4%3d&tabid=340>
- Rubenzler, S.J. (2008). The standardized field sobriety tests: A review of scientific and legal issues. *Law and Human Behavior*, 32(4), p.293-313.
- Sanfeiu, A., Llacer, M.R., Gramunt, M.D., Punsola, A., & Yoshimura, Y. (2010). Influence of the privacy issue in the deployment and design of networking robots in European urban areas. *Advanced Robotics*, 24(13), p1873-1899.
- Shachtman, N. (2007, October 17). Robot canon kills 9, wounds 14. *Wired*. Retrieved from <http://www.wired.com/dangerroom/2007/10/robot-cannon-ki/>
- Silverman, R.E. (2012, August 7). My life as a telecommuting robot. *The Wall Street Journal*. Retrieved from <http://online.wsj.com/article/SB10000872396390443517104577575454164490344.html>
- Singer, P.W. (2009). Military robots and the laws of war. *The New Atlantis*, 23, p. 25-45. Retrieved from <http://www.thenewatlantis.com/publications/military-robots-and-the-laws-of-war>
- Singer, P.W. (2009, January 28). In the loop? Armed robots and the future of war. *Brookings*. Retrieved from <http://www.brookings.edu/research/articles/2009/01/28/robots-singer>
- Slottje, P., Witteveen, A., Twisk, J., Smidt, N., Huizink, A., van Mechelen, W., & Smid, T. (2008). Post-disaster physical symptoms of firefighters and police officers: role of types of exposure and post-traumatic stress symptoms. *British Journal Of Health Psychology*, 13(Pt 2), 327-342.
- Smithson, S. (2012, February 7). Drones over U.S. get ok by congress. *The Washington Times*. Retrieved from <http://www.washingtontimes.com/news/2012/feb/7/coming-to-a-sky-near-you/>
- Solove, D.J. (2008). The future of privacy. *American Libraries*, 39(8), 56-59.
- Solove, D. J. (2011). Why privacy matters even if you have 'nothing to hide'. *Chronicle Of Higher Education*, 57(37), B11.
- Supreme Court Debates. (2006). Probable cause and reasonable suspicion: Overview of fourth amendment case law on police searches. *Supreme Court Debates*, 9(7). p.195-199.
- Tanasichuk, C.L., Wormith, J.S. (2012). Changing attitudes toward the criminal justice system: results of an experimental study. *Canadian Journal of*

*Criminology & Criminal Justice*, 54(4), p.415-441.

- Technology Technical Assistance Program. (2004). Technology desk reference: in-car cameras. *International Association of Chiefs of Police*. Retrieved from <http://www.theiacp.org/LinkClick.aspx?fileticket=pnaQ%2fDcmpXg%3d&tabid=539>
- Tyler, T. R. (2006). *Why people obey the law / Tom R. Tyler ; With a new afterword by the author*. Princeton, N.J. : Princeton University Press, c2006.
- Tyler, T. R., & Huo, Y. J. (2002). Trust in the law: Encouraging public cooperation with the police and courts. New York, NY US: Russell Sage Foundation. Retrieved from [http://books.google.co.kr/books?hl=en&lr=&id=L5EQ7iN5kiUC&oi=fnd&pg=PR&dq=Trust+in+the+law:+Encouraging+public+cooperation+with+the+police+and+courts.&ots=9LhSsT5EIL&sig=biy1TgmlfzAFsBVdXtrjZlwriZQ&redir\\_esc=y](http://books.google.co.kr/books?hl=en&lr=&id=L5EQ7iN5kiUC&oi=fnd&pg=PR&dq=Trust+in+the+law:+Encouraging+public+cooperation+with+the+police+and+courts.&ots=9LhSsT5EIL&sig=biy1TgmlfzAFsBVdXtrjZlwriZQ&redir_esc=y)
- U.S Air Force. (2007). Air Force policy directive (afpd) 14-1 intelligence, surveillance, and reconnaissance (isr) planning, resources, and applications. *Oversight of Intelligence Activities, Department of Defense*. Retrieved from <http://cbsla.files.wordpress.com/2012/06/drones1.pdf>
- U.S. Department of Transportation Research and Innovative Technology Administration (2012, October 10). Connected vehicle research. Retrieved from [http://www.its.dot.gov/connected\\_vehicle/connected\\_vehicle.htm](http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm)
- Van de Berg, B. (2011). Robots as tools for techno-regulation. *Law, Innovation & Technology*, 3(2), p319-334.
- Vogal, R.J. (2011). Drone warfare and the law of armed conflict. *Denver Journal of International Law & Policy*, 39(1), p101-138.
- Wallach, W., & Allen, C. (2009). *Moral machines: Teaching robots right from wrong*. Oxford: Oxford University Press.
- Weiss, J. (2007) Autonomous robots for law enforcement. *Law Enforcement Technology*., p.1-4.
- Wuschka, S. (2011). The use of combat drones in current conflicts – A legal issue or a political problem?. *Goettingen Journal of International Law*, 3(3), p891-905.

VITA

Graduate School  
Southern Illinois University

Kelly Greeling

kgslaite@gmail.com

Southern Illinois University Carbondale  
Bachelors of Arts, Administration of Justice, May 2004

Research Paper Title:

Autonomous Robots in Law Enforcement: Future Legal and Ethical Issues

Major Professor: Dr. Joseph Schafer