RoboGuard For Hire?

questions about robots as a commercial security solution

- Bruce Arnold -

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Introduction

Robots are arriving, just not in the shape you expected.[1]

For over a hundred years people have dreamed about robots … devices that do not need sleep, never ask for a raise or a day off, do not have an attitude problem, have the strength of ten and do not look the other way when a workmate wants to illicitly empty the warehouse.[2] Bullets bounce off them (think *Terminator*, *The Day the Earth Stood Still* and *RoboCop*).[3] They are not afraid of the dark or a spot of rain at 3am. They are not allergic to kitty litter or crims with a Bandidos tattoo. They embody the "rhetoric of the electrical sublime", a utopian fantasy of cheapness, effectiveness and beneficence.[4]

Reality is more interesting. Security robots are starting to be used in military, commercial and domestic environments.[5] Unfortunately for sci-fi fans, they are more likely to look like a vacuum

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[1] For a technical introduction to robotics see Bruno Siciliano & Oussama Khatib [ed], *Springer Handbook of Robotics* (Berlin: Springer 2008); Maja Mataric, *The Robotics Primer* (Cambridge: MIT Press 2007); and Roland Siegwart & Ilah Nourbaksh, *Introduction of Autonomous Mobile Robots* (Cambridge: MIT Press 2004). A concise introduction to domestic devices is provided by Haydar Sahin & Levent Güvenç, 'Household Robotics: Autonomous Devices for Vacuuming and Lawn Mowing', *IEEE Control Systems Magazine* (2007) 20. Issues are highlighted at www.caslon.com.au/robotnote.htm. Robert Geraci, *Apocalyptic AI: Visions of Heaven in Robotics, Artificial Intelligence and Virtual Reality* (New York: Oxford University Press 2010) unpacks some of the hype.

[2] Among historical introductions see Gaby Wood, *Living Dolls: A Magical History of the Quest for Mechanical Life* (London: Faber 2002); Timothy Hornyak, *Loving the machine: the art and science of Japanese robots* (Tokyo: Kodansha 2006); and works highlighted at note 40 below.

[3] *Terminator* (d. James Cameron, 1984), *The Day the Earth Stood Still* (d. George Pal, 1956) and *RoboCop* (d. Paul Verhoeven, 1987). Precursors and successors include *Metropolis* (d. Fritz Lang, 1921), *Forbidden Planet* (d. Fred Wilcox, 1956), *Lost In Space* (d. Irwin Allen, 1965), *Westworld* (d. Michael Crichton, 1973), *The Stepford Wives* (d. Bryan Forbes, 1975), *Star Wars* (d. George Lucas, 1977) and *AI* (d. Steven Spielberg, 2001). For perspectives on security robots in popular culture see Fred Glass, 'The 'new bad future': Robocop and 1980s Sci-Fi Films', 1(5) *Science as Culture* (1989) 7; Roger Rollin, 'Deus in Machina: Popular Culture's Myth of the Machine', 2(2) *Journal of American Culture* (1979) 297; Rosaleen Love, 'Robot Futures: Science Fiction and Futures Studies Methodologies in Action', 33(10) *Futures* (20001) 883; Michael Robertson, 'Property and Privatisation in Robocop', 4 *International Journal of Law in Context* (2008) 217; Philip Leonard, 'Teach Phenomenology the Bomb: Starship Troopers, the technologized body and humanitarian warfare', 25(1) *Electronic Journal of American Culture* (2005) 31; Donal Lloyd, 'Renegade Robots and Hard-wired Heroes: Technology and Morality in Contemporary Science Fiction Films', in Paul Loukides & Linda Fuller [ed], *Beyond The Stars III: The Material World in American Popular Film* (Bowling Green State University Press 1993) 216; Amanda Fernbach, 'The Fetishization of Masculinity in Science Fiction: The Cyborg and the Console Cowboy', 27(2) *Science Fiction Studies* (2000) 234 and Jay Telotte, *Replications: A Robotic History of the Science Fiction Film* (Cambridge: Cambridge University Press 1995).

[4] Kevin Robins & Frank Webster, 'Athens without slaves … or slaves without Athens? The neurosis of technology', 1(3) *Science as Culture* (1988) 20.

[5] Automated domestic appliances are popular: the United Nations Economic Commission for Europe and International Federation of Robotics (2006) suggested that by 2004 over 600,000 robot vacuum cleaners and

cleaner, a self-propelled CCTV camera[6] or a radio-controlled toy helicopter than a big tin man. They lack versatility. Away from the battlefield they are a poor security solution.

This article looks at security robotics. Are robots available for security applications? What are their disadvantages and advantages? Are they legal? How is the industry developing? Are they closer to the Tin Man in the *Wizard of Oz* than to the devices in *Terminator*? One of those cute ideas, like a flying car, rather than a viable tool for commercial and domestic security?[7]

What is a robot?

Philosopher Emil Cioran claimed that "Man is a robot with defects".[8] The reality for the Australian security industry is more complex.

Robots come in different shapes and sizes, off-the-shelf or strictly custom-made.[9] They usually share four basic characteristics –

- intelligence
- sentience
- mobility
- agency.[10]

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lawn mowers had been sold (though many appear to have been abandoned). Over 150,000 *Aibo* dog robots were sold (80% in Japan) before production ceased in 2006. The number of *RoboSapiens* toys is unknown. See also Nigel Thrift, 'Closer to the machine: Intelligent environments, new forms of possession and the rise of the supertoy', 10(4) *Cultural Geographies* (2003) 389; Monica Schofield, 'Service robots: the end of the beginning?', 26(6) *Industrial Robot* (1999) 456.

[6] For example the experimental device described in Andreas Birk & Holger Kenn, 'RoboGuard: A Teleoperated Mobile Security Robot', 10(11) *Control Engineering Practice* (2002) 1259:

> RoboGuards are semi-autonomous mobile robots providing video streams via wireless Intranet-connections to watchguard systems, supplemented by various basic and optional behaviors. RoboGuards fill several market-niches. Especially, they are a serious alternative to the standard approach of using Closed Circuit Television (CCTV) for surveillance.

[7] Bruce Sterling, 'Robots and the Rest of Us', 12(5) *Wired* (2004); Marco Ceccarelli, 'A historical perspective of robotics towards the future', 13(3) *Journal of Robotics and Mechatronics* (2001) 299.

[8] Emil Cioran, *The Trouble With Being Born* (New York: Viking Press 1976). Cioran's aphorism is unsurprising, given his enthusiastic support of fascism, highlighted in Marta Petreu's *An Infamous Past: E M Cioran and the Rise of Fascism in Romania* (Chicago: Ivan R Dee 2005). Isaac Asimov, in *I, Robot* (New York: Gnome 1950) had a character laconically explain robots as "a cleaner, better breed than we are".

[9] Jennifer Robertson, 'Robo Sapiens Japanicus: Humanoid Robots and the Posthuman Family', 39(3) *Critical Asian Studies* (2007) at 372 comments that –

> Already in Japan there is a market for "intelligent," autonomous humanoid robots that can: operate power shovels and forklifts (*Enryuu*), patrol premises and extinguish fires (*ReBorg-Q*, *Guardrobo D1*), replace human service sector employees (*Actroid*, *Asimo*), babysit and tutor children (*PaPeRo*, *Wakamaru*), housesit (*Nuvo*), nurse the infirm and elderly (*Ri-man*), provide companionship and entertainment (*ifbot*, *Pino*, *Posy*, *Robovie*), and even provide sex (*Kaori*). By 2016, the size of the household robot market is expected to top 18.6 million units.

[10] The International Organization for Standardization (ISO) defines industrial robot as "an automatically controlled, reprogrammable, multi-purpose, manipulative machine with several degrees of freedom, which may be either fixed in place or mobile for use in industrial automation applications". That has been glossed as a mechanical device that is easily reprogrammable without physically rebuilding and has memory and logic attributes that allow it to work independently and automatically. Australian Standard *AS 3877:1991* characterises a 'manipulating industrial robot' as "an automatically controlled, reprogrammable, multi-

Firstly, they have some intelligence, an ability to make decisions. That intelligence does not have to be very large. Typically it consists of a device that uses a computer program and/or responds to instructions that come from a human operator via a wireless or cable connexion.

The most advanced robots still have less intelligence than an ant, something that is evident when they face an unfamiliar problem (eg because their vocabulary does not include 'possum' or 'locked door') or get into difficulty.

What about sentience, jargon used by artificial intelligence researchers, robotics engineers and developers trying to sell you an expensive piece of plastic and metal?

Sentience is simply the ability to sense something about the robot's environment. That sensing might be that –

- temperature or movement within a warehouse (a burglar, a cleaner, the pesky possum) is outside preset limits,
- a stamp is missing from an envelope,
- the family cat has left its fur-ball on the floor,
- an obstacle impedes the movement of a self-guided warehouse cart,
- the parcel being sniffed by a bomb-disposal robot contains smelly socks rather than explosives,
- a piece of metal has arrived at a workstation and needs to be welded.

Sentience usually involves some discrimination, for example the ability to tell the difference between the metal and the maintenance engineer or cleaner (weld the car chassis, not the cleaner).

The sensing may be processed by the robot or relayed to a human operator or remote database.

A throwaway drone aircraft for example might send video of what is happening in one of the scarier streets of Baghdad (followed by the unannounced arrival of a missile from the drone's operator).[11] A drone might instead record what is happening in your backyard, surveillance used by the drug squad in dealing with marijuana plantations, by paparazzi or by providers of corporate intelligence.[12]

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purpose manipulative machine with several degrees of freedom, which may be fixed in place or mobile for use in in industrial automation applications". There is no standard for a security robot.

[11] Fred Kaplan, 'Eyes over Baghdad: Our secret street-fighting machine', *Slate* 7 April 2003; and Elizabeth Bone & Christopher Bolkcom, 'Unmanned Aerial Vehicles: Background and Issues for Congress' (Congressional Research Service Report RL31872, 2003).

[12] William Bloss, 'Transforming US police surveillance in a new paradigm', 10(3) *Police Practice & Research* (2009) 225-238; Stephen Russell, 'The potential of using UAVs in Australian security applications', in Priyan Mendis, Joseph Lal, Ed Dawson & Hussein Abbass [ed], *Recent Advances in Security Technology (Proceedings of the 2007 RNSA Security Technology Conference)* (2007) 388.

As that example demonstrates, robots are not restricted to metal facsimiles of Hollywood film stars.[13] Most have some mobility. Very few have legs (robots with legs are more likely to look like crabs, centipedes or the family dog rather than the machines featured in *RoboCop*).[14]

Some move around on wheels or tracks (especially if they are designed for an environment such as your house, an office or a warehouse).

Some fly; the big money in robot development has gone into devices the size of small planes (some of which have a range of over 2,000 km) or model aircraft for remote surveillance by military and police agencies.[15]

Finally, robots have agency: they do things. That agency might be very restricted: automatically coming out at 3 AM to vacuum the floor at home, working 24/7 to sort widgets on a production line or travelling inside a water pipe looking for leaks.[16]

Contrary to upbeat media releases from research labs, most robots are unromantic.[17] They are used in factories where there is repetitious activity, a health hazard and a need for accuracy, such as welding or spray-painting.[18] Most robots are large, expensive, specialised and found on production lines.[19] Think car factories, not bullet-proof replacements for sleepy nightwatchmen or automated carers in aged care homes.[20] Emptying the bedpans is still a job for the traditional 'carbon-based

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[13] As an illustration of popular culture's conceptualization of domestic devices through reference to The Terminator see J Biersdorfer, 'Neato Introduces the XV-11 Vacuum Robot', *New York Times* 29 June 2010

> You might mistake the new Neato XV-11 Vacuum Robot for an earlier version of a robotic vacuum cleaner. That would be a mistake. While predecessors drunkenly bounced around the room until the job was done, the XV-11 is more *Terminator* than Ray Milland. Guided by sensors and a laser-based positioning system, the XV-11 scans and maps the area for obstacles, then meticulously vacuums a room's rugs, hardwood or tile in tidy rows — avoiding walls, furniture and stairs. Once finished, the vacuum cleaner finds an open doorway and moves on to the next room. At less than four inches high (for scooting under beds) and programmable (for cleaning during the day while people are out of the house), the Neato XV-11 is dangerously close to being fully self-aware. When it senses its battery running low, the robot automatically returns to its floor-based docking station, connects itself to recharge and then returns to the place it left off to continue vacuuming.

[14] Linda Paulson, 'Biomimetic Robots', 37(9) *Computer* (2004) 48.

[15] Bone & Bolkcom (2003), op cit.

[16] Kurt Kleiner, 'Bottle-brush robot goes where 'pigs' can't reach', *New Scientist* 4 August 2008.

[17] Jordan Pollack, 'Seven Questions for the Age of Robots' (Yale Bioethics Seminar, January 2004) comments that –

> Humanity's hopes and fears about robots have been exaggerated by fantasy movies. … Robots are just real-world machines controlled by algorithmic processes. The only machines which "reproduce" are the ones which earn a return on the investment in their design and production. Robots are not sentient and cannot obey Asimov's Laws. Today's most common robots are ATM's and ink jet printers, who cannot know that you stuck your finger in the wrong place! Yet these robots have collapsed the job markets for bank tellers and typists, respectively.

[18] Shimon Nof [ed], *Handbook of Industrial Robotics* (New York: Wiley 1999).

[19] For uptake see for example Kristina Dahlin, 'Diffusion and Industrial Dynamics in the Robot Industry', in Bo Carlsson [ed], *Technological systems and economic performance: the case of factory automation* (Dordrecht: Kluwer 1995) 323 and Mikell Groover, *Automation, Production Systems and Computer Integrated Manufacturing* 3 ed (Upper Saddle River: Prentice Hall 2007).

[20] The *Paro* 'baby seal pet-therapy robot' has not taken the world by storm. See Anne Tergesen & Miho Inada, 'It's not a stuffed animal, it's a $6,000 medical device – Paro the Robo-seal aims to comfort the elderly but is it ethical', *Wall Street Journal* 21 June 2010; Marian Banks, Lisa Willoughby & William Banks, 'Animal-assisted therapy and loneliness in nursing homes: use of robotics versus living dogs', 9(3)

biped' (ie you and I) and will be for the foreseeable future.[21] Robots are good at repetition but lack judgment and versatility. Those deficiencies are critical in many security environments.

Security bots

Security robots perform three 'i' functions –

- Intruder detection
  reporting that someone or something has entered a room, building or campus without permission and tracking that movement
- Interdiction
  stopping the intruder or incapacitating a target, which might involve becoming an obstacle to the intruder's movement through a building or destroying/damaging the target
- Intelligence acquisition
  gathering information in environments where a human presence would be impossible (eg checking a drain), hazardous (eg where a person might be killed) or undesirable (eg where covert surveillance is needed)

Robo economics and security

Why do people use robots? The answer to that question, as you will have gathered from above, is largely about dollars and votes.

Robots cost more to produce than people but can be cheaper to operate than their human competitors. Most are not particularly flexible but programming may be cheaper than training and supervising a succession of employees. They may be more reliable (they do not take flex days or sickies and do not have a union or rights)[22]. They do not expect extra pay for service on public holidays or need a redundancy payment. They can be standardized and thus offer potential economies of scale. They do not object to being monitored (no problems with workplace surveillance). They do not look for or accept bribes, so they are a compliance officer's dream come true.

The bad news is that they are not very good employees, particularly for employers who assume that 'electronic equals smart' and that a single device can perform all the functions of a man, a woman or a guard dog. If you want multiple functionalities you need multiple devices. Getting

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Journal of the American Medical Directors Association (2008) 173; and Robert Sparrow, 'The March of the Robot Dogs' (Centre for Applied Philosophy and Public Ethics Working Paper 2002/7, 2002).

[21] Jodi Forlizzi, 'Robotic products to assist the aging population', 12(2) *Interactions* (2005) 16; Veronique Faucounau, Ya-Huei Wu, Melodie Boulay, Marina Maestrutti & Anne-Sophie Rigaud, 'Caregivers' requirements for in-home robotic agent for supporting community-living elderly subjects with cognitive impairment', 17(1) *Technology & Health Care* (2009) 33; and Robert Sparrow & Linda Sparrow, 'In the hands of machines?', The future of aged care', 16(2) *Mind & Machines* (2006) 141.

[22] Blay Whitby, 'Sometimes it's hard to be a robot: A call for action on the ethics of abusing artificial agents', 20(3) *Interacting with Computers* (2008) 326.

those devices to cooperate is generally harder than persuading your employees/contractors to work together seamlessly. Full systems integration remains a holy grail that is going to be discovered by the next generation: do not hold your breath.

Cost savings may be illusory. One reason is that costs are often displaced rather than eliminated. Proposals to use robots as night watchmen, for example, usually ignore the costs of the staff in the control room (the people who use those devices as their eyes and ears) and having back-up personnel on standby. Robots do not take kickbacks but the operators might.

More importantly, most devices are not flexible. Unlike Hollywood, where Robbie the Robot was good at changing a tyre, mixing a martini and subduing a burglar, you can not get your automated vacuum cleaner[23] or floor polisher[24] to weld a car, defuse a bomb, shear sheep, remove the asbestos from a building, represent you in court or collect debts from a delinquent client.

Robots make mistakes or simply fail to perform. It is thus unsurprising that the much of the popular literature about failures centres on the 'robot vacuum cleaner swallows the baby and family cat' scenario[25] or on military devices running amok.[26] Your night watchman might go to sleep but does not shut down after experiencing the famous 'blue screen of death' when there is a bug in the latest software update.

Unless they are being guided by an operator robots have limited autonomy and less initiative. Operators often experience major stress and frustration because they cannot get the machines to do what is wanted or because the right machine simply is not available. Operator fatigue and the keyboard equivalent of road rage is a hidden cost that few vendors will disclose, although it is attracting increasing attention in specialist cyberwarfare literature.[27]

Why worry about votes? Votes are important because robots, although expensive, can be thrown away or destroyed without tears. They do not bleed and do not leave behind a family or friends.[28]

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[23] Jodi Forlizzi & Carl DiSalvo, 'Service Robots in the Domestic Environment: A Study of the Roomba Vacuum in the Home', *1st Annual Conference on Human-Robot Interaction* (Salt Lake City, 2006) 258; Ja-Young Sung, Lan Guo, Rebecca Grinter & Henrik Chistensen, 'My Roomba is Rambo: Intimate Home Appliances', in John Krumm [ed], *UbiComp 2007 (Lecture Notes in Computer Science 4717)* (Berlin: Springer 2007) 145; Erwin Prassler & Kazuhiro Kosuge, 'Domestic Robots', in Bruno Siciliano & Oussama Khatib [ed], *Springer Handbook of Robotics* (Berlin: Springer 2008) 1253 and Jodi Forlizzi, 'How Robotic Products Become Social Products: An Ethnographic Study of Cleaning in the Home', *Human Robot Interaction 07* (2007) 129.

[24] Erwin Prassler, Arno Ritter, Christoph Schaeffer & Paolo Fiorini, 'A Short History of Cleaning Robots', 9(3) *Autonomous Robots* (2000) 211.

[25] Serge Rijsdijk & Erik Hultink, 'Honey, have you seen our hamster? Consumer Evaluations of Autonomous Domestic Products', 20(3) *Journal of Product Innovation* (2003) 204.

[26] Examples include Noah Shachtman, 'Robot Cannon Kills 9, Wounds 14', *Wired* 18 October 2007 at www.wired.com/dangerroom/2007/10/robot-cannon-ki/.

[27] Among other works see Susan Hill & Barry Bodt, 'A Field Experiment of Autonomous Mobility: Operator Workload for One and Two Robots', *ACM/IEEE International Conference on Human-Robot Interaction* (2007) 169.

[28] The author of this article is unpersuaded by the claim that by 2050 marriage with robots will be legalised, not least because as of 2010 Australia does not allow same sex marriage. 'Marrying' your vacuum cleaner or

Defence forces are exploring robots for battlefield applications because devices are more expendable than people.[29]

We do not like using people or dogs to clear minefields because some just will not come back when the smoke clears.[30] If a robot gets destroyed the accountants groan but the Prime Minister does not have to console the grieving kids and partner. Aerial drones do not watch *Top Gun* and do not need to worry about toilet breaks and hamburgers, so they can stay in the air longer.[31] We do not worry if they are shot down and a mad dictator orders his henchmen to cut off fingers or gouge out eyeballs of the pilot (who instead can be sitting in an Aeron chair on another continent).[32]

Making sense of the robot industry

What does the robot industry look like? Can you buy a bot? Will a security solution be in a store soon? Where will the device come from?

Robot development essentially has three sectors.

Defence and public safety

There has been a trickle down from military/justice applications,[33] where government is paying the bill and development costs do not count.[34] Typical high-end public sector devices include

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a kill bot will remain a matter of Don't Ask, Don't Tell. See the deliriously upbeat David Levy, *Love and Sex With Robots: The Evolution of Human-Robot Relationships* (London: Duckworth 2008).

[29] Marcus Fielding, 'Robotics in future land warfare', III(2) *Australian Army Journal* (2006) 99.

[30] Douglas Page, 'Get Smart: A Bomb Bot With Know How', 29(7) *Law Enforcement Technology* (2002) 136; Hoa Nguyen & John Bott, 'Robotics for law enforcement: Applications beyond explosive ordnance disposal', SPIE International Symposium on Law Enforcement Technologies, Boston, 2000).

[31] Elizabeth Bone & Christopher Bolkcom, 'Unmanned Aerial Vehicles: Background and Issues for Congress' (Congressional Research Service Report RL31872, 2003); John Klein, 'Strategic Implementation of Navy and Marine Corps Unmanned Combat Air Vehicles with Respect to Military Transformation' (US Naval War College, 2002).

[32] Weber (2010), op cit.

[33] Among introductions see the upbeat Peter Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin 2009) and gloomy Noel Sharkey, 'Robotics Today: The Good, Bad and Ugly', *Proceedings of the 15th Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems* (2008) 3-4. For legal and ethical frameworks see Ronald Arkin, *Governing Lethal Behavior in Autonomous Robots* (CRC Press 2009); Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons* (Aldershott: Ashgate 2009); Jutta Weber, 'Armchair Warfare on Terrorism: On Robots, Targeted Assassinations and Strategic Violations of International Law', in Jordi Vallverdu [ed], *Thinking Machines and the Philosophy of Computer Science* (Hershey: IGI Global 2010).

[34] Pollack (2004) op cit comments that –

> My definition of a robot is a physical machine that interacts with the real world, is controlled by an algorithmic process (i.e. a program or circuit) and can operate 24x7 and earn their own return on investment (ROI), often by putting humans out of work. While they don't know it is your finger caught in the gears, robots *do* hurt: The M&A frenzy of banks, and laying off of tellers, is directly due to the prevalence of ATM machines. The personal printer has killed the market for typists. Robots are just tools, not people. They are already here, and they will make progress as long as they provide a positive ROI. A machine is sold whenever a customer judges its value to be greater than its cost. Automation already exists for every manufacturing industry, where the value of a $100,000 machine or a $3B factory can be proven, such as chip production, pharmaceutical testing, and Disk copying/software packaging. But general purpose automation is still in its infancy.

surveillance robots (especially drone aircraft and small vehicles for exploring smoke-filled rooms occupied by terrorists) and machines that come in handy for defusing or delivering bombs.[35]

In 2001 the US government announced that by 2015 a third of its 'operational ground combat vehicles' would be unmanned.[36] The US Defence Department's 2007 Unmanned Systems Roadmap proposed spending US$4 billion on 'unmanned systems technology' in the three years to 2011. In the past four years the Pentagon has released highly ambitious master plans for development of unmanned ground, undersea and air vehicles.[37] In practice most of those robots are likely to be small and highly expendable: think the equivalent of a sniffer dog (or a Saint Bernard with a Semtex collar) rather than something the size of a tank.

Look behind the hype about 'cyber battlefields' and 'wireless warcraft' and you will discover that few of the prototypes are getting into production and that projects get cancelled after the usual media release about "promising", "valuable" and "interesting" results. Trials of getting large numbers of battlefield robots to act in a coordinated manner – and keep on acting, as a replacement for old-fashioned grunts – have been disappointing.[38] There is a large academic literature about research into things such as –

- 'stealth bots' that would stalk through the fog to disrupt communications,
- neural networks for commanding fleets of devices on "the e-battlefield of the future",
- bots that would immobilise bad people with curare-tipped blowdarts or nets, and
- 'sniper bots' that would unfailingly sort out the terrorists from the hostages.

Actual performance seems to be disappointing.[39]

Factory bots

Industrial development has involved what one writer characterises as factory bots. They are specialist work stations that are the descendants of the manually-operated lathes, drills, sorters and presses found in many factories prior to the 1980s. They might be the size of a filing cabinet or the size of a large room.

Factory bots also include robotic forklifts and 'picking devices' that deliver supplies in some factories (often relying on a wire embedded in the floor) or retrieve computer disks, files and other items from storage and pipeline inspection devices. They exist alongside rather than driving the development of robotic security systems.

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[35] Ian Roderick, 'Considering the fetish value of EOD robots', 13(3) *International Journal of Cultural Studies* (2010) 235; J-D Nicoud, 'Vehicles and robots for humanitarian demining', 24(2) *Industrial Robot* (1997) 164.
[36] *National Defense Authorization Act for 2001*, s 220.
[37] Roadmap at www.acq.osd.mil/usd/Unmanned Systems Roadmap.2007-2032.pdf.
[38] Stuart Young & Alexander Kott, 'Control of Small Robot Squads in Complex Adversarial Environments: A Review', US Army Research Laboratory (2009).
[39] Tim Weiner, 'An Army Program to Build a High-Tech Force Hits Cost Snags', *New York Times* 28 March 2005.

Consumer devices

That is in contrast to the 'percolate up' effect of consumer electronics/household appliances, where developers have emphasised cheapness, specialisation and standardisation in trying to roll out –

- automated vacuum cleaners, internet coffee pots (and internet toilets),
- animatronic toys (dogs, cats, seals and ferrets),[40] and
- 'home security systems' (essentially networked monitoring systems that replace the babysitter or teenage child, ringing your mobile or a security company if the roof leaks, the dishwasher floods, the kitchen catches fire or an uninvited hoodie comes through a window).

Most 'whitegoods' security robots have been gimmicks, like the internet fridge and washing machine (lots of breathless media coverage, indifference on the part of retailers, little use by consumers once the novelty wears off or the warranty expires).[41] There has not been much interest in domestic robots that are supposed to stop vandalism by playing loud music, trapping burglars with nets, delaying intruders with slime or confusing them by emitting bad smells – all proposals from Japanese vendors – and that can be readily disabled or eluded.[42]

There is a large academic literature on sensing, communication or decision-making capabilities and on making devices more 'human centric' but that research has not filtered off the campus onto production lines and retail display shelves. Do not expect to buy the equivalent of R2D2, C3PO or Klaatu for your house, office or warehouse in the near future.

"We have the technology"

Much of the forecasting about security robots, particularly military bots, assumes that – like the *Six Million Dollar Man* – only we "have the technology", only we (the good guys, not the enemy) "can build it".[43] Silicon Valley, MIT and the US Department of Defense will rule.

Unfortunately for the Australian security sector, that is unlikely to be the case. Bad guys will build or steal technology. As we saw with the Pakistan a-bomb program, rogue nations or rogue developers will give or sell robots.[44] Some of those sales will come from Australia, remembering that in the past five years we have seen Australian defence force and police personnel selling guns,

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[40] For traditional animatronics see Wood (2002) op cit; Jay Telotte, *The Mouse Machine: Disney and Technology* (Champaign: University of Illinois Press 2008); Pamela McCorduck, *Machines Who Think: a personal inquiry into the history and prospects of artificial intelligence* (New York: Freeman 1997); Stefano Franchi & Güven Güzeldere [ed], *Mechanical Bodies, Computational Minds: Artificial Intelligence from Automata to Cyborgs* (Cambridge: MIT Press 2005); and George Hersey, *Falling in love with statues: artificial humans from Pygmalion to the present* (Chicago: University of Chicago Press 2009).

[41] 'Internet Fridge' (2008), www.caslon.com.au/fridgenote.htm.

[42] For example 'Japanese Security Robot nets intruders', *Robo Space* 22 January 2009; Hobart Everett & Douglas Gage, 'A Third Generation Security Robot' (SPIE Mobile Robot and Automated Vehicle Control Systems, Boston 1996).

[43] *The Six Million Dollar Man* (1974).

[44] David Albright & Corey Hinderstein, 'The A Q Khan Illicit Nuclear Trade Network and Implications for Nonproliferation Efforts', V(6) *Strategic Insights* (2006); D Auerswald, 'Deterring Nonstate WMD Attacks', 121(4) *Political Science Quarterly* (2006) 543.

explosives, missiles and data.[45] Some robots will be bought or borrowed by Australian criminals. Some will be hijacked.

Terrorists were prepared to crash planes full of passengers into buildings full of people and to send children on suicide missions. They are unlikely to be scrupulous about flying a drone over the barricades in Pitt Street or Collins Street and delivering some high explosive to supremos gathered for a CHOGM or APEC meeting.[46] Removal of rubbish bins and diligent searches by sniffer dogs – or by sniffer robots – for concealed roadside explosives will be in vain.[47]

Security challenges are not restricted to protection from a jihadi or eco-terrorist. Some robots will be built by Australians, with for example anecdotal accounts of enthusiasts attaching small cameras to wireless aircraft for an overhead view of what is happening next door. The toy you buy from Dick Smith or Kmart is the basis for DIY satellite snaps of what is happening behind Nicole Kidman's hedge, in a bikie gang's backyard, or at a neighbour's factory.[48]

Security, Robots and the Law

What does Australian law say about security robots?

The answer is that, at the moment, it does not say much.

Sci-fi author Isaac Asimov articulated[49] a fundamental law of robotics –

- A robot may not harm a human being, or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
- A robot must protect its own existence, as long as such protection does not conflict with the First Law and Second Law.[50]

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[45] For lurid examples see 'Taha Abdul-Rahman jailed for buying stolen rocket launchers', *Daily Telegraph* 10 December 2008; Ross Coulthart, 'Ex-bikie blows the whistle on stolen arms', *The Australian* 30 August 2008; and Ross Coulthart & Duncan McNab, *Dead Man Running* (Crows Nest: Allen & Unwin 2008).

[46] Eugene Miasnikov, *Threat of Terrorist Uninhabited Aerial Vehicles: Technical Aspects* (Center for Arms Control, Energy and Environmental Studies at MIPT, 2004); Dennis Gormley, UAVs and Cruise Missiles as Possible Terrorist Weapons (Center for Nonproliferation Studies Occasional Paper 12) (Washington: Center for Nonproliferation Studies 2003); Jay Mandelbaum, James Ralston, Ivars Gutmanis, Andrew Hull & Christopher Martin, *Terrorist Use of Improvided or Commercially Available Precision-guided UAVs at Stand-off Ranges: An Approach for Formulating Mitigation Considerations* (Alexandria: Institute for Defence Analyses 2005).

[47] Michael Head, 'Thirty Years Since Sydney's Hilton Hotel Bombing: Unanswered Questions', 12 *Legal History* (208) 241.

[48] Hille Koskela, 'Hijacking Surveillance: The New Moral Landscapes of Amateur Photographing', in Katja Aas, Helene Gundhus & Heide Lomell [ed], *Technologies of Insecurity: The Surveillance of Everyday Life* (London: Routledge Cavendish 2009) 147-168; David Rolph, 'The Mechanical Eye: Looking, Seeing, Photographing, Publishing' (Sydney Law School Research Paper 10/37, 2010).

[49] Isaac Asimov, 'Runaround', *Fantastic Science Fiction* (1942).

[50] For a positive view of Asimov's rule-making see Yueh-Hsuan Weng, Chien-Hsun Chen & Chuen-Tsai Sun, 'Safety Intelligence and Legal Machine Language: Do We Need the Three Laws of Robotics?' (2008).

Those rather woolly rules have not been recognised in Australian or overseas law and have not been incorporated in formal national standards.[51]

International law is contested, with debate centred on robotic aircraft and 'targeted killing'.[52] There is no global or Australian *lex robotica*[53] and little case law.[54] All states have workplace safety law about industrial robots:[55] if the automated welder injures an employee you are in trouble with tort law and with for example Victoria's *Equipment (Public Safety) Regulations*.

There is no specific law about 'security robots' because Australian law does not recognise such a category. It deals with legal questions using existing categories such as privacy,[56] evidence,[57] injury, liability[58] and weapons registration.[59]

Readers of *Security Solutions Magazine* will be aware that law restricts use of mantraps and similar devices.[60] It restricts who can lawfully obtain and use a firearm.[61] Do not expect that you can buy a

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[51] Lee McCauley, 'AI Armageddon and the Three Laws of Robotics', 9(2) *Ethics and Information Technology* (2007) 153 for example quotes criticisms that –

> The problem with these laws is that they use abstract and ambiguous concepts that are difficult to implement as a piece of software. What does it mean to "come to harm"? How do I encode that in a digital computer? Ultimately, computers today deal only with logical or numerical problems and results, so unless these abstract concepts can be encoded under those terms, it will continue to be difficult

and

> The trouble is that robots don't have clear-cut symbols and rules like those that must be imagined necessary in the sci-fi world. Most robots don't have the ability to look at a person and see them as a person (a 'human'). And that is the easiest concept needed in order to follow the rules. Now, imagine that they must also be able to recognize and understand 'harm', 'intentions', 'other', 'self', 'self-preservation', etc, etc, etc.

[52] Anthony Finn, 'Legal considerations for the weaponisation of unmanned ground vehicles', 1(1) *International Journal of Intelligent Defence Support Systems* (2008) 43-74.

[53] References in Australian statute law and regulations as of mid-2010 are restricted to industrial machinery and workplace safety, notably the *Bounty (Metal Working Machines and Robots) Act 1985* (Cth) and model *Occupational Health & Safety (Safety Standards) Regulations 1994* (Cth) – *Reg 4.26 Industrial robots and other remotely or automatically energised equipment*.

[54] Litigation predominantly concerns bounty claims (ie government encouragement of investment in high technology machining), workplace safety claims and workplace restructuring disputes. Examples are *W&D Engineering Pty Ltd v Chief Executive Officer of Customs* [2000] FCA 440, *Hillman v Caroma Industries Ltd* [2009] SAIRC 39 and *Liquor, Hospitality & Miscellaneous Workers Union v Unibic Australia Pty Ltd* [2007] AIRC 284. Examples of other litigation include *Marchmont Group Pty Ltd and Town of Vincent* [2007] WASAT 177 (a noisy "demonstration golf robot") and *Bell v Linfox Australia Pty Ltd* [2006] NSWIRComm 1025.

[55] For example *Workplace Health and Safety Regulations* (NT) s 127; *Petroleum (Occupational Health & Safety) Regulations* (NT) s 108; and *Equipment (Public Safety) Regulations 2007* (Vic).

[56] For example *Privacy Act 1988* (Cth) and state/territory workplace surveillance statutes.

[57] For example *Evidence Act 1995* (Cth) and its state/territory counterparts.

[58] For workplace principles see John Etherton, 'Industrial Machine Systems Risk Assessment: A Critical Review of Concepts and Methods', 27(1) *Risk Analysis* (2007) 71-82 and Martin Helander, 'Ergonomics and safety considerations in the design of robotics workplaces: A review and some priorities for research', 6(2) *International Journal of Industrial Economics* (1990) 127-149.

[59] For example *Firearms Act 1996* (Vic).

[60] See for example *Crimes Act 1958* (Vic) ss 25-26 and *Hogarth v R* [1965] HCA 43; (1965) 114 CLR 48.

[61] Rick Sarre & Tim Prenzler, *The Law of Private Security in Australia* (Pyrmont: Lawbook Co 2005). Statutes include the *Security Industry Act 1997* (NSW); other statutes are identified at www.caslon.com.au/privatesecuritynote2.htm

device that looks like a vacuum cleaner, works 24/7 and patrols your warehouse giving an electric shock to any intruder[62] or spraying acid in a burglar's face. That is strictly B Grade Hollywood.

You will not be able to get a firearms licence (or insurance) for a robot guard that sits near the counter and shoots any robber. There will still be nightclub jobs for bouncers. Investment in technology by operators of entertainment venues is likely to centre on identity verification such as card scanner and fingerprint readers[63] rather than in testing robot gatekeepers, given the wariness of regulators and the inability of researchers to come up with an effective substitute for humans in event management.

What about the robot that hovers like a dragonfly, reporting on who is misbehaving in the corner office on the 46th floor or tracks an employee on an unauthorised visit to your competitor? If you notice that you are being watched, can you blow the bug away? Can you hire an 'eye in the sky'?

One response is that *use* rather the particular form of the robot is what matters.

Invasions of personal privacy[64] are often addressed through state covert surveillance law,[65] as some paparazzi and private investigators have discovered. Restrictions are likely to become more comprehensive through the strengthening of the national *Privacy Act* that has been recommended by the Australian Law Reform Commission.[66] Law concentrates on outcomes regarding industrial espionage,[67] not whether the camera was a standalone device, part of your mobile phone or attached to the remote-control plane from the hobby shop.

There is no Australian case law specifically about taking a shotgun to a private drone. However, using a tennis racket, rescue flare, fire-hose or shotgun is covered by a range of law. You may decide that self-help in dealing with paparazzi is too expensive or that the penalty for destroying peeping tom's robot is worth paying.

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[62] US experiments with taser-equipped patrol bots appear to have been disappointing, with devices having trouble differentiating between friend and foe, and in aiming. An upbeat view is provided by 'iRobot and TASER Team to Deliver New Robot Capabilities for Military, Law Enforcement' (iRobot 28 June 2007 media release) … "the new TASER-equipped robots will add a new ability to control dangerous suspects while keeping personnel, the suspect and bystanders out of harm's way".

[63] 'Scanning the stairways to heaven: Privacy, Gatekeeping and the Entertainment Sector' (2006), www.caslon.com.au/publications/clubscanning.pdf.

[64] For an introduction to issues see M Ryan Calo, 'Robots and Privacy', in Patrick Lin, George Bekey & Keith Abney [ed], *Robot Ethics: The Ethical and Social Implications of Robots* (Cambridge: MIT Press 2010) and Daniel Solove, *The Digital Person: Technology and Privacy in the Digital Age* (New York: New York University Press 2004).

[65] For example the *Listening & Surveillance Devices Act 1972* (SA); *Surveillance Devices Act 1999* (Vic) and *Workplace Surveillance Act 2005* (NSW).

[66] Australian Law Reform Commission, *For Your Information: Australian Privacy Law & Practice* (ALRC Report 108) (Sydney: Australian Law Reform Commission 2008).

[67] As points of entry to the large and very uneven literature on 'competitive intelligence' see Hedieh Nasheri, *Economic Espionage and Industrial Spying* (Cambridge: Cambridge University Press 2005) and Andrew Crane, 'In the company of spies: when competitive intelligence gathering becomes industrial espionage', 48 *Business Horizons* (2005) 233.

Is information from robots legally admissible?[68]

The answer is yes. Data acquired or recorded by industrial robots has been used in court cases. Australian courts would almost certainly apply existing principles in dealing with robot-based evidence (eg geospatial data, video, audio, instructions and responses),[69] drawing on the *Evidence Act* in each jurisdiction and on other legislation such as the national *Electronic Transactions Act*.[70] Using software and a silicon chip does not mean that evidence problems simply go away.

Will you need a license? The answer to that question is 'depends'.

Security robots do not exist in a regulatory vacuum. In the UK, for example, Merseyside Police grounded their traffic surveillance drone (a CCTV-equipped remote-control minicopter) over concerns it was being used without the requisite licence from the Civil Aviation Authority. That Authority licenses use of all 'unmanned aircraft' for aerial surveillance, with permission needed for flight within 50 metres of people and 150 metres of buildings.[71] Licensing does not cover putting a toy into the sky, so presumably if the Mersey boys had used something smaller than their unmanned copter they could have ignored airspace regulation and instead only needed to worry about compliance with the UK surveillance regime.

We can expect Australian state/territory governments to license ambulatory security bots, in the same way that they have licenced particular activities and use of devices or substances, eg forklifts and explosives.

Law will keep pace with commercial adoption of 'bots and borgs', particularly if a security bot injures an offender, operator or bystander in a colourful way and there is public pressure for meaningful regulation. Headlines matter.

The insecurity of security

A preceding paragraph noted that robots do not take bribes or choose to look the other way when they are threatened. Unfortunately, the same cannot be said for all operators. Apart from the technical inadequacies of devices – for example their inability to climb stairs or think creatively – a fundamental weakness of robot-based security systems is the human factor. The people behind the

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[68] See note 57 above.

[69] Questions of legal admissibility are identical to those faced by the security sector in dealing with evidence from cctv (or still) cameras, radar guns, automated teller machines, personal computers, networked financial databases, biometric perimeter control systems, pre-digital Bundy clocks, fingerprint and DNA registers. Introductions to the Australian regime are provided by Stephen Odgers, *Uniform Evidence Law* 7th ed (Pyrmont: Lawbook Co 2006); John Dyson Heydon, *Cross on Evidence* 8th ed (Chatswood: LexisNexis Butterworths 1995) and Allison Stansfield, *Computer Forensics, Electronic Discovery & Electronic Evidence* (Chatswood: LexisNexis Butterworths 2009).

[70] *Electronic Transactions Act 1999* (Cth).

[71] BBC, 'Unlicensed Merseyside Police drone grounded' (BBC News) 16 February 2010, at http://news.bbc.co.uk/2/hi/uk_news/england/merseyside/8517726.stm. Australian airspace law resembles the UK regime.

keyboards and monitors can be coerced or seduced. Some will go to sleep. Some will point the robots in the wrong direction while the operator takes a five-finger discount.

Concerns about personnel misbehavior in the security industry are not unique. They have gained more attention than demonstrations of the insecurity of domestic devices. Critics have recurrently argued that much of the insecurity apparent across the internet is attributable to two factors: the inadequacy of dominant operating systems and applications on personal computers and the inexperience, inattention or indifference of the people who use those computers (and for example respond to phishing scams, download malware by clicking on dodgy links or fail to update their anti-virus protection).

Householders who are using a robot vacuum cleaner – or an off-the-shelf specialist domestic security bot – to surveil their residence and report when something goes wrong (eg alert a commercial security service or SMS the owner) may well find that their electronic friend has been hijacked or that the wireless communication is being monitored by a potential intruder.

What about devices in factories, warehouses and major retail premises? Much of the enthusiasm for non-military patrol bots is misplaced because offenders will not respect those devices. Australian thieves and vandals hesitate to kill or maim human security personnel. One reason for that inhibition is recognition that killing people attracts serious penalties. It is unlikely that a robber, someone engaged in insurance fraud or kid who expresses his anger and sexual insecurity with a spray-can will be similarly inhibited in interactions with a security robot. Robots do not have rights and, utopians to the contrary, will not get them in the near future. 'Killing' or 'maiming' a bot is not an offence against a person. Broadly, it involves destruction of property. Under the current legal system it will not attract a life sentence.

Some offenders will thus have fun spraypainting the bot, disabling it with a crowbar or sending it to robot heaven via a sawn-off. Some of that destruction will be purely expedient. Other attacks will emulate the righteous 'war against the bots' that is a theme in popular culture … every spotty delinquent with a sledgehammer can channel one of the heroes in *Terminator* or *Westworld*.

Replacing People?

Are you going to be able to buy a robot that will replace your security guard?

The news – good or bad – is 'no': people are here to stay, at least for a couple of years.

Robots simply do not have the functionality and smarts of humans, despite thirty years of headlines that "artificial intelligence" is just around the corner. If you want something that will check doors, wave a torch at the possums, chase after graffiti kids and use initiative in investigating a break-in you will still be relying on a human.

Given questions about corporate liability and licensing we are not going to unleash a device that uses a shotgun or teargas, despite the enthusiasm and assurances of a geek with a bad case of robot

fever. Human-sized robots are unlikely to patrol your perimeter, irrespective of whether they are independent or used as mobile cameras; it is still cheaper to build electronic walls using fixed cctv and motion detectors.[72] Enthusiasts for pervasive micro-sensor systems, such as RFID 'smart dust',[73] plausibly suggest that future availability of ultra-cheap readily-networked sensors means that security robots will only be seen on the big screen or on the battlefield.

If you have specific needs you can usually find vendors that sell specialised devices. They will not catch the burglar but might let you know one has arrived.

Some of those devices are simply cute, opportunities for conspicuous consumption. Others meet a particular need, although traditional in-ceiling fire and movement detectors may do a better job, will be more available, will be more robust and will be cheaper. At the moment the Australian market for home and commercial security robots is small, compared to Japan. That is because of cultural reasons rather than just the unavailability of cheap reliable devices and after-sales support.[74]

We have not been big buyers of internet fridges, internet coffeepots or the wireless noodle-cookers that automatically ring the hospital when an aged person living alone has been inactive for three days.[75] We have not been big buyers of briefcase-size robots that will scurry around the warehouse floor at weekends sensing an unauthorised human presence or robot vacuum cleaners that emerge from under the sofa at 3 AM and sounding the alarm if kitty invites the neighbours in for a spot of R&R. We favour traditional back-to-base perimeter security systems, locked doors and car/foot patrols of facility precincts.

One reason is that those systems work. Another reason is that we know they sometimes do not work but worry that a bot would be even less reliable. For household and commercial applications

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[72] Clive Norris, *The Maximum Surveillance Society* (Oxford: Berg 1999); Clive Norris, Jade Moran & Gary Armstrong [ed], *Surveillance, Closed Circuit Television and Social Control* (Aldershot: Ashgate 1998); and Adam Sutton & Dean Wilson, 'Open-street CCTV in Australia: The Politics of Resistance and Expansion', 2(3) *Surveillance and Society* (2004) 310.

[73] For an introduction see 'RFIDs' (2005, 2009) at www.caslon.com.au/rfidprofile.htm.

[74] Frederic Kaplan, 'Who is afraid of the humanoid: Investigating cultural differences in the acceptance of robots', 1(3) *International Journal of Humanoid Robotics* (2004) 1-16; Ylva Fernaeus, Mattias Jacobsson, Sara Ljungbla & Lars Holmquist, 'Are we living in a robot cargo cult?', *Proceedings of the 4th ACM/IEEE International Conference on Human Robot Interaction* (2009) 279-280; Mark Gilson, 'A Brief History of Japanese Robophilia', 31(5) *Leonardo* (1998) 367-369; Frederik Schodt, *Inside The Robot Kingdom: Japan, Mechatronics and the Coming Robotopia* (Tokyo: Kodansha 1988); Karl MacDorman, Sandosh Vasudevan & Chin-Chang Ho, 'Does Japan really have robot mania? Comparing attitudes by implicit and explicit measures', 23(4) *Artificial Intelligence & Society* (2009) 485-510; Ja-Young Sung, Rebecca Grinter, Henrik Christensen & Lan Guo, 'Housewives or Technophiles?: Understanding Domestic Robot Owners', Human Robot Interaction 08 (Amsterdam, 2008) 129-136; Christoph Bartneck, 'Who like androids more? Japanese or US Americans?', *Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication* (2008) 553-557; and Robertson (2007) op cit.

[75] See note 41 above.

we are talking a very different environment from the Pentagon's vision of robot warriors that replace things that bleed and always hit the targets.[76]

Australians do not have the luxury of the Pentagon's budget or its imperative to look ahead. We are concerned about performance, not subsidizing IT development. Our expectations have been modest. That concern with fundamental fitness for purpose is not as exciting as something from Hollywood or Cioran but it is realistic.[77]

It is a realism summed up by one security contact, who asks "would you give a sawn-off to your personal computer, particularly if it was aiming at you, and all you really needed was to lock the back door and make sure the fire alarm was working? Could you get insurance for it? Could you persuade your client or your boss to trust it?"

[76] Ja-Young Sung, Henrik Christensen & Rebecca Grinter, 'Sketching the future: assessing user needs for domestic robots', *18th IEEE International Symposium on Robot and Human Interactive Communication* (Toyama, 2009) 153-158

[77] Pollack (2004) op cit comments that –

> Every year, in order to justify some of its R&D programs into robotics, the Defense Department creates scenarios where intelligent robots would aid or replace human soldiers on the battlefield of the future. We need to make a clear distinction between armed telerobots where the fire button is pressed by a human within a chain of command, and an autonomous weapon which chooses when to fire itself. Landmines are the prototype of autonomous robot weaponry, and are already a blight on the world. Given that the psychological age of an autonomous robot is under 1 year old, it seems like quite a bad idea to equip them with guns. First, giving automatic weapons to babies is not something a civilized country would do. In the long term, by removing the cost of war in "our boys," we raise the specter of "adventure for adventure's sake," which would be a net downgrade in human civilization back to the days of barbarians.

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