Killer Robots
&
Just Another Weapon (?)

ACdre. Prof. Dr. Frans Osinga
Chair War Studies
Netherlands Defence Academy
Elon Musk leads 116 experts calling for outright ban of killer robots

Open letter signed by Tesla chief and Alphabet’s Mustafa Suleyman urges UN to block use of lethal autonomous weapons to prevent third age of war

Some of the world’s leading robotics and artificial intelligence pioneers are calling on the United Nations to ban the development and use of killer robots.

Tesla’s Elon Musk and Alphabet’s Mustafa Suleyman are leading a group of 116 specialists from across 26 countries who are calling for the ban on autonomous weapons.
1. Not much new under the sun

- Evolutionary rather than dan revolutionary
- **1945-1980**: LGB, TV-guided, automated weapons (goal keeper, patriot)
- **1980-2000**: fire-and-forget, enhanced stand-off, accuracy up, GPS, costs down, man-in-the-loop
- **2001-present**: armed drones combined with ISR, autonomous navigation, target tracking, return/landing, datalinks (NCW), man-in-the-loop & man-on-the-loop
Five capability objectives: 
1. increase situational awareness, 
2. lighten soldiers’ workloads, 
3. sustain the force, 
4. facilitate movement and maneuver, 
5. protect the force.

<table>
<thead>
<tr>
<th>Over 30,000 lb</th>
<th>Prototype/Deployed</th>
<th>Prototype</th>
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<tbody>
<tr>
<td>Panther w/SRS +40 tons</td>
<td></td>
<td>DEUCE w/SRS 35,000 lb</td>
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<tr>
<td>Abrams Panther w/SRS +80 tons</td>
<td></td>
<td>D7G w/SRS 55,500 lb</td>
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<tr>
<td>AOE 67,000 lb</td>
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<tr>
<th>2,5001 to 20,000 lb</th>
<th>Fielded</th>
<th>Prototype</th>
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<tbody>
<tr>
<td>ARVTS 8000 lb</td>
<td>DEMO III XUV 3,000 lb</td>
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<tr>
<td>Smoke HMMWV w/SRS 11,500 lb</td>
<td>T3 Dzer w/SRS 18,600 lb</td>
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<th>401 to 2,500 lb</th>
<th>Fielded</th>
<th>SDD/ Deployed</th>
<th>SDD</th>
<th>Prototype</th>
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<tr>
<td>RONS 600 lb</td>
<td>Mini -Flak/RCSS 2500 lb</td>
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<tr>
<td>MDARS -I 600 lb</td>
<td>MDARS -E 1500 lb</td>
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<tr>
<td>GLADIATOR 1600 lb</td>
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<tr>
<th>31 to 400 lb</th>
<th>Prototype/Deployed</th>
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<tr>
<td>TALON 34 -80 lb</td>
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<tr>
<td>URBOT 65 lb</td>
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<tr>
<td>MATTDA 40 lb</td>
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<td>BUGS 45-50 lb</td>
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<td>ODIS 45 lb</td>
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Scientists warn of dangers of 'killer' AI drones in dystopian film

The Campaign to Stop Killer Robots is calling on the UN to act on smart drone development.

14 November 2017 13:04

Scientists have called on the United Nations to slow the development of artificially intelligent weapons systems over fears they could lead to "killer robots."
Arguments against drone strikes: it is illegal  
(Carvin, Cronin, Gross, Jenkins, Jordan, Stein)

– It equals assassination & extra-judicial killing, just a form of risk management
– no judicial oversight, no trial, which is immoral & illegal
– Overly liberal interpretation of the meaning of terrorist, imminent threat, participating in hostilities, self-defence
– Violation of sovereignty: licence to kill worldwide?

Arguments against drone strikes: moral disengagement  
(Carvin, Cronin, Gross, Jenkins, Jordan, Stein)

• Playstation mentality, next step towards robotic warfare
• Physical distance produces emotional distance: de-humanization
• Context & consequences are hard to assess from 7000 miles away
  – No sense of proportionality
  – Problematic accountability
• Loss of reciprocity, too asymmetrical: willing to kill but not to die for the cause
• Risk free tactic which lowers the political threshold for using military force:
• Predator Empire?, Droneworld?, Everywhere War? Drone-ification Of foreign policy
1. Not much new under the sun

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**Future:**
- autonomous target recognition, machine learning (AI),
- swarming/complex behavior,
- Combined missions of manned & autonomous systems
- man-on-the-loop & **man-out-of-the-loop**

<table>
<thead>
<tr>
<th>Semi-autonomous</th>
<th>Human-supervised</th>
<th>Fully Autonomous</th>
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<tbody>
<tr>
<td>“Human in the loop”</td>
<td>“Human on the loop”</td>
<td>“Human out of the loop”</td>
</tr>
<tr>
<td>Weapon system that, once activated, is intended to only engage individual targets or specific target groups that have been selected by a human operator. Includes “fire and forget” munitions.</td>
<td>An autonomous weapon system that is designed to provide human operators with the ability to intervene and terminate engagements, including in the event of a weapon system failure, before unacceptable levels of damage occur.</td>
<td>A weapon system that, once activated, can select and engage targets without further intervention by a human operator.</td>
</tr>
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(Note: Definitions per DoDD 3000.09, Autonomous in Weapon Systems)
### From a view to kill

Global, autonomy in existing weapon systems
Analysis of 154 systems with automated-targeting capabilities, November 2017

<table>
<thead>
<tr>
<th>Unarmed systems</th>
<th>Armed systems</th>
</tr>
</thead>
</table>
| **Human “in-the-loop”**
| 50 **Human possibly “in-the-loop”**
| 31 **Human “on-the-loop” & “out-of-the-loop”**
| 49 |

- **24***
  - Decision aid. Human operator retains the decision to engage the target
  - Decision aid. Unclear whether system can engage autonomously
  - System can engage with targets without the direct involvement of a human operator

*Includes one where armed status is unknown
†In “on-the-loop” systems, human operators can override action

Source: SIPRI

The Economist
THE MILITARY SHOULD TEACH AI TO WATCH DRONE FOOTAGE

When the US Air Force deployed Gorgon Stare, a drone video system that consists of 368 cameras covering nearly 40 square miles at a time, in 2011, an official declared, “we can see everything.” The technology, named after snake-haired mythological creatures whose gazes turn people to stone, can surveil an area for hours at a time, take composite images of 1.8 billion pixels each, and create several terabytes of data every minute.
2. AWS will come: Proliferation & Normalization

- Dual use/civilian tech
- In US: global civil commercial market 2400 platforms, 900 companies just for air unmanned, 2025 82 Bn$ turn-over
- Mil spending in 2018 in US: 5 Bn $
- Global Military robotics spending: 2025 16.5 Bn$
- Relatively cheap, rapidly declining costs, Moore’s law
- Normalization effect: rise of robotics/automation of functions throughout societies
- Ban will not materialize nor be effective
Figure 3: R&D spending by sector, 2014–16 (US$ billion)


1,000 EHang UAVs set flying formation record in China

https://youtu.be/5LdaWMNKUHs?t=6

https://youtu.be/roTfrB0XAg?t=25
Intel Choreographed 1,200 Drones for the Winter Olympics Opening Ceremony

It’s going for a world record

By Marty Swant | February 9, 2018

BEST AGRICULTURAL DRONES 2019 — REVIEWS AND SPECS

Agricultural drones have been changing the face of farming and cultivation heavily the past 3-5 years, and completely changing the way that many farmes and other entities go about their business. This drones have the ability to check storm damage, monitor crop progress, and make sure that both crops and herds are healthy.
Drivers for the deployment of lethal autonomous weapons systems technologies

TRUST  CULTURE  AVAILABILITY

Dr. Lydia Kostopoulos, @UKCYBER 2017
2. AWS will come: Proliferation & Normalization

- **Operational advantages & new threats:**
  - High ops tempo,
  - A2AD + use in urban environment (counter sniper, surveillance in streets and buildings, counter IED)
  - Counter A2AD (high speed swarming saturation attacks)
  - Leadership/HVT targeting, counter-terrorism
  - No vulnerable data links
  - Swarming options overwhelming defence

- **Continuation of trend:**
  - Remote/stand-off warfare, Casualty risk reduction, demassification of battlefield,
  - Individuation of warfare, micro-targeting van key leaders and vital command cells

[YouTube video link](https://youtu.be/DjUdVxH6yI?t=30)
Unmanned infantry?

Motives?/driving factors

- Geography versus available mass
- Lethal/cognitive presence & low human risk
- Civil tech leading
- Occupation/surveillance/control de-coupled from boots on terrain

2. AWS will come: Proliferation & Normalization

- **Normative argument:**
  - They may be more accurate (no stress/fatigue/info overload), so lower risk of civcas/coll’ll damage
  - soldiers under combat stress are not better at moral judgement
  - New tool to conduct humanitarian operations (monitoring/protecting refugees, ethnic groups) without need to prolonged deployment of ground troops in wars of choice

- **Strengthening deterrence:**
  - Credible autonomous threat without risk
  - negates counter-coercion options

https://youtu.be/VMmEW0E2J4E?t=5
3. Impact on international security: destabilization

- Vatican: risk of deresponsibilization, dehumanization and depoliticization (CCW meeting 2015)
- Available for big, small states & non-state actors
Yemeni government forces pose for a picture at a position outside Hodeidah on September 1, 2018. EPA

An Al Qaeda militant killed by a suspected United States drone strike in southern Yemen on Sunday reportedly once served as the right-hand man of the terror group's former leader in the country who died in a drone strike in 2016.

Houthi rebels in Yemen have threatened to launch more drone attacks after a deadly strike last week on a Yemeni government military parade killed seven people, stoking tension between the warring parties and threatening UN efforts to broker peace.
3. Impact on international security: destabilization

- **Proliferation & operational advantage will spur arms race:**
  - Incentive to achieve first move advantage
  - Symmetrical *escalation* attractive because absence of humans
  - Escalation risk with opponents without AWS

- **Drone-inification of foreign policy**, everywhere war, extra-judicial operations:
  - No risk of casualties/riskless war attractive for politicians & risk transfer warfare
  - Ease of riskless violation of sovereignty
  - Can be used in areas/for missions previously too dangerous for soldiers
  - Blurring of war-peace-policing boundaries in response to transnational non-state threats
  - More frequent and casual use of military force

- **Race to the ethical bottom/norm shift:**
  - Inhuman/illigimate use by actors who disregard/violate IHL
  - West may be inclined to follow for operational reasons
3. Impact on international security: destabilization

- Vatican: risk of deresponsibilization, dehumanization and depoliticization (CCW meeting 2015)
- Available for big, small states & non-state actors
- Risk of escalation due to inevitable mistakes/failures/incidents of complex systems (swarms): stock market flash crash van 2010 (Charles Perrow, Normal Accidents)
- Change in ops context, fluidity and ambiguity in context, hacking, flaws in algorithm, civilian objects similar to military objects
- Algorithms are black box: what does operator know of parameters to ensure proper employment?
Fully autonomous weapons, also known as “killer robots,” raise serious moral and legal concerns because they would possess the ability to select and engage their targets without meaningful human control. There are also grave doubts that fully autonomous weapons would ever be able to replicate human judgment and comply with the legal requirement to distinguish civilian from military targets. Other potential threats include the prospect of an arms race and proliferation to armed forces with little regard for the law.

Fully autonomous weapons themselves cannot substitute for responsible humans as defendants in any legal proceeding that seeks to achieve deterrence and retribution. Humans associated with the use or production of these weapons—notably operators and commanders, programmers and manufacturers—would escape liability for the suffering caused by fully autonomous weapons.

Human commanders or operators could not be assigned direct responsibility for the wrongful actions of a fully autonomous weapon. In most cases, it would also be unreasonable to impose criminal punishment on the programmer or manufacturer, who might not specifically intend, or even foresee, the robot’s commission of wrongful acts.

Summary HRW Report
Current Western military perspective: obstacles

**Technological:** Autonomous systems need to be more adaptive to operate safely and reliably in complex, dynamic and adversarial environments; new validation and verification procedures must be developed for systems that are adaptive or capable of learning.

**Normative:** There are increasing normative pressures from civil society against the use of autonomy for targeting decisions, which makes the development of autonomous weapon systems a potentially politically sensitive issue for militaries and governments.

**Legal:** International law includes a number of obligations that restrict the use of autonomous targeting capabilities. It also requires military command to maintain, in most circumstances, some form of human control or oversight over the weapon system’s behaviour.

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The targeting process

[Diagram showing the targeting process with phases and decision points for Collateral Damage (CD) including proportionate and disproportionate scenarios.]
CDE Example

12 februari 2019

CDE LVL 1 – Any Weapon / Any Delivery / Fuse

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CDE LVL 1
civilian structure identified

CDE LVL 2
use of any PGM Weapon required
CDE LVL 2
civilian structure identified within blast range of PGM

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CDE LVL 3
select specific PGM with smaller kinetic impact

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CDE LVL 3
more civilian structures identified closer to target

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CDE LVL 3
specified PGM with very limited kinetic effect required

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CDE LVL 3
risk is mitigated

CDE LVL 4
incoming information on Structure Type requires re-assessment: time of attack, impact point shift, fuse setting
4. Be afraid, be a little afraid

- Deja vu all over again: replay of drone warfare debate van 2007-2013
- **Politics, strategy & context rule**
  - Use of AWS may be legitimate in specific contexts: limited geographically, in time and by target category
  - Autonomy not essential against VNSA & leadership targeting
  - Sensitive missions will require man-in-the-loop & control
  - AWS are useful in interstate conflicts where tech superiority matters
- **Technological/pragmatics perspective:**
  - Immature technology
  - Endurance & range limited, small scale? Ops/strategic impact also limited
  - More capable systems will be larger and will resemble traditional systems
  - Costs advantage will diminish
  - Arsenal will be limited
  - Investments in military robotics are relatively low
  - These will invite suitable counter-measures (TBM or AD)
  - Just another new weapon technology: time-honored action-reaction dynamics

Jeffrey Lantis, *Arms and Influence, US Technological Innovations and the evolution of international security norms*, 2016, p. 20
Israel’s Iron Dome rocket shield

Iron Dome is designed to intercept short-range rockets and mortar shells in urban areas. Each battery, which consists of a radars, control center and four launchers, costs $320-460 million, while each interceptor missile costs about $350,000.

System developed by Rafael Advanced Defence Systems. First deployed March 2011. Two batteries currently deployed.

HOW THE IRON DOME WORKS

1. Radar detects projectiles and tracks their trajectory.
2. Battle management and control unit analyses trajectory and calculates impact location.
3. Mobile firing unit launches the interceptors.
4. Tamir interceptor missile:.

- Cost: $1.4 million
- Length: 1.25 m
- Weight: 110 lbs
- Range: 20 km
- Velocity: 3600 m/s
- High explosive

Israel has installed five Iron Dome batteries, the most recent in Tel Aviv. Each battery costs about €700 to install.

Deutsche Telekom to launch drone defense system: report

DARPA looks at ‘drone defense’ for convoys

The US military’s research agency has opened a bid for weapons systems that could defend convoys of fuel vehicles or small ships from attacks by drone swarms, most likely driven by recent experience fighting against ISIS in Iraq.

Germany’s Deutsche Telekom plans to launch a drone defense system this year designed to guard airports, stadiums, car test tracks and critical infrastructure, German weekly Welt am Sonntag reported on Sunday.
4. Be afraid, be a little afraid

- In the west: ethical/legal issues need to be solved first
- Proportionality, distinction, necessity require judgement
- Restricted to predetermined pre-programmed target parameters
- Commanders will want to retain control
- Man-before the loop remains responsible/accountable: meaningful human control
- Relatively restrained use of drones and cyberweapons
- Trend of increasing juridicalization of warfare in the west
- Moral backlash risk: employment counter to western values values? Political fall-out may outweigh tactical advantage
- Setting norms or precedents?
- We need more data: