

RAeS Conference
The Automated Rotorcraft
6 July 2016

Creating an Effective Human-Machine Partnership

Andy Fawkes



Training & Simulation Background

12

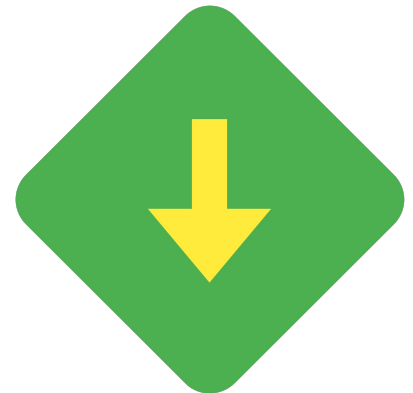
MoD/NATO

4

Industry



Human Factors often the Last Among Equals in Defence Procurement



Bohemia Autonomous Systems Research Projects

Dstl Autonomous Systems (AS) Research

- Develop a simulated operational environment that can be used for AS training, mission planning, rehearsal and execution

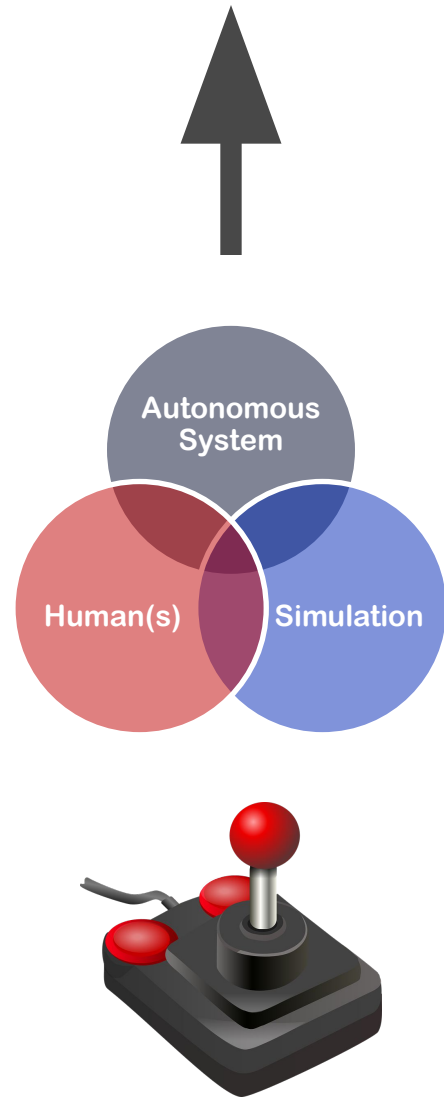
Assistive Technologies Project

- Using simulation to train automated and robotic systems to support indoor journeys and living for the visually impaired



3 Thoughts

- Human factors become more important as automation increases
- Simulation can play a key role in testing and training humans and autonomous systems both separately and together
- Can we learn more from gaming?



Outline

- **Simulation and Humans**
- **Simulation and Autonomous Systems**
- **Humans and Autonomous Systems**
- **In Support of the Human**

Simulation & Humans

Simulation is Safer



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Saves Money



and...

- **Not affected by the Weather**
- **Less effect on the Environment**
- **Real Systems not Required**

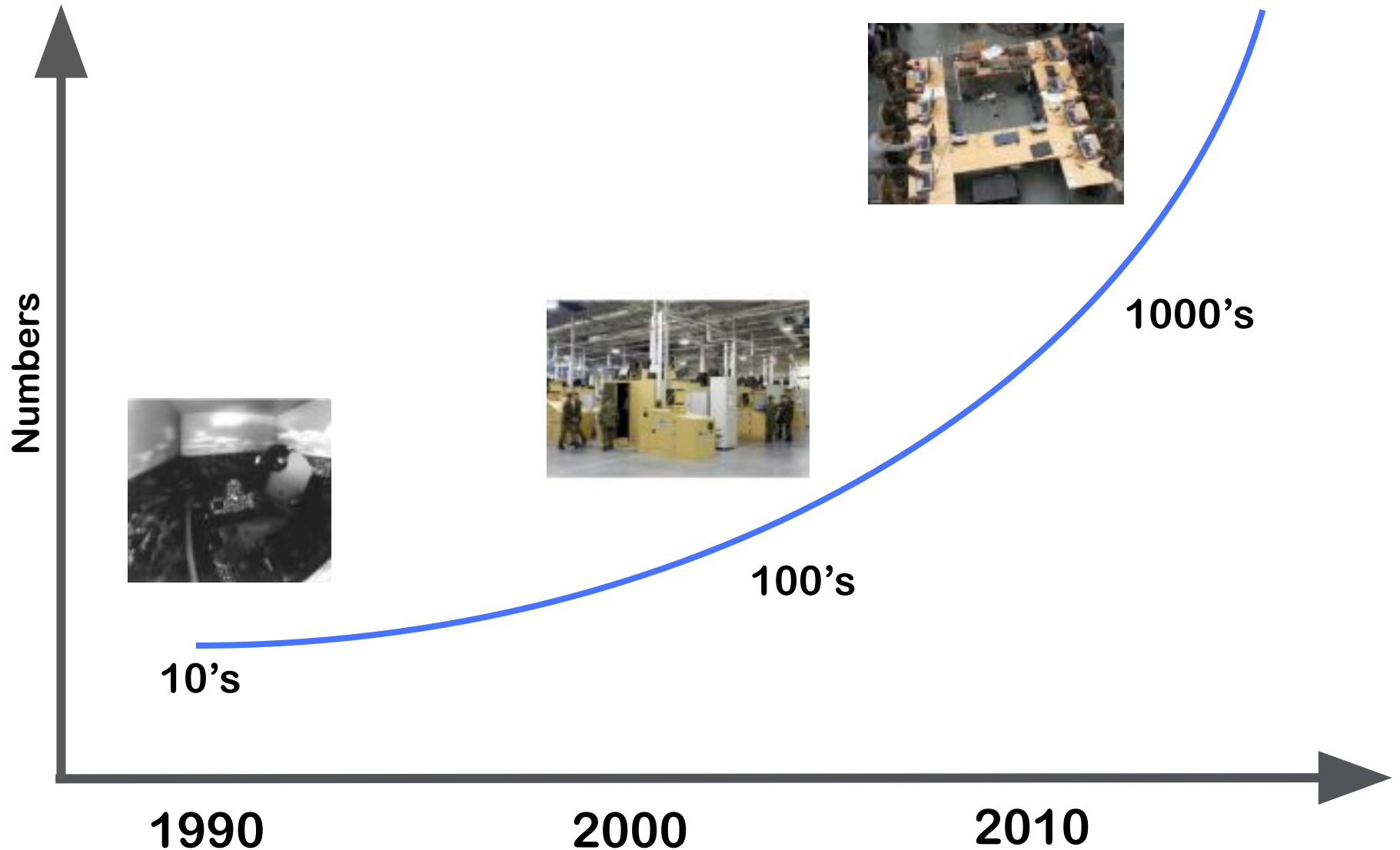


Civil Full Flight Simulator

- **Simulation Fully Integrated into Civil Aviation**
 - Supports conversion to a new aircraft type
 - Airline flight crews train 2 days every 6 months
 - 40-50 Level D FFS simulator purchased per year



Military Access to Simulation



Simulation Now



Simulation Technology Drivers

- Computing
- Games
- Networking
- Graphics
- Audio
- Human Interfaces
- Sensors



30 Years of Game Graphics

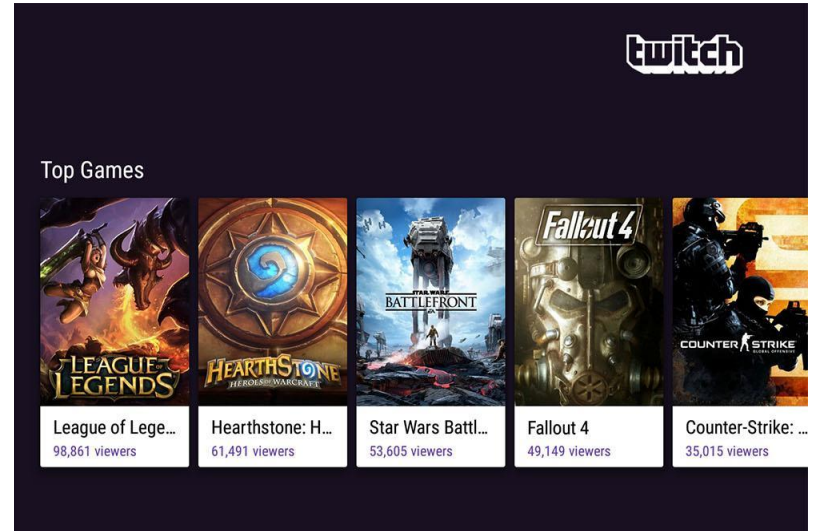


Some Statistics – Call of Duty (2014)

- Call of Duty is played 16.7 million hours each day
- Played for 25 billion hours in total
- 813 million UAVs have been destroyed in Call of Duty online matches
- 18 billion multiplayer matches have been played



Gaming - Easy to Use and Share Experiences



MINECRAFT
FORUMS

Rift Drone

AR.Drone 2.0 + Oculus Rift + Unity + Xbox 360 Controller





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If you can play a video game, you can fly a drone

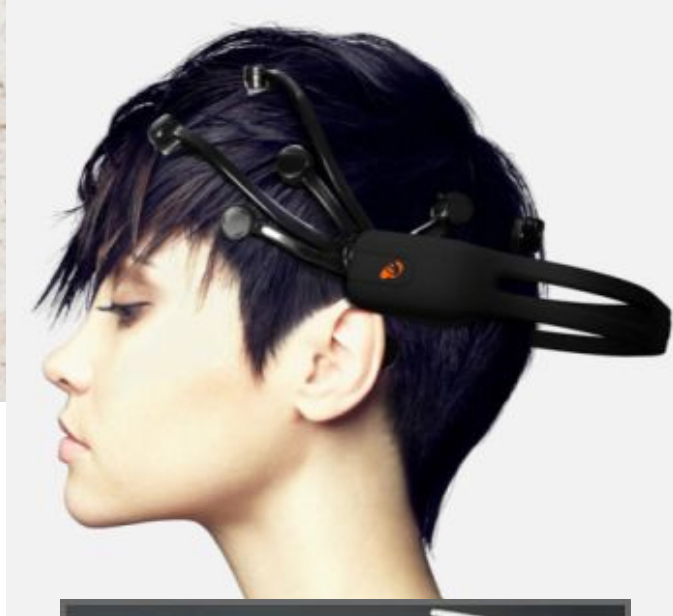
These eyes in the sky are so popular, everyone from farmers to jewellery thieves wants one.

BY [MICHAEL BROOKS](#) | PUBLISHED 13 JUNE, 2012 - 15:03



A Predator drone takes off on a training flight. Photograph: Getty Images

Quantified Human



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Simulation & Autonomous Systems

Training Autonomous Systems in Simulation

9T05Google

PLUS ANDROID CHROME/OS GOOGLE APPS ANDROID TV YOUTUBE

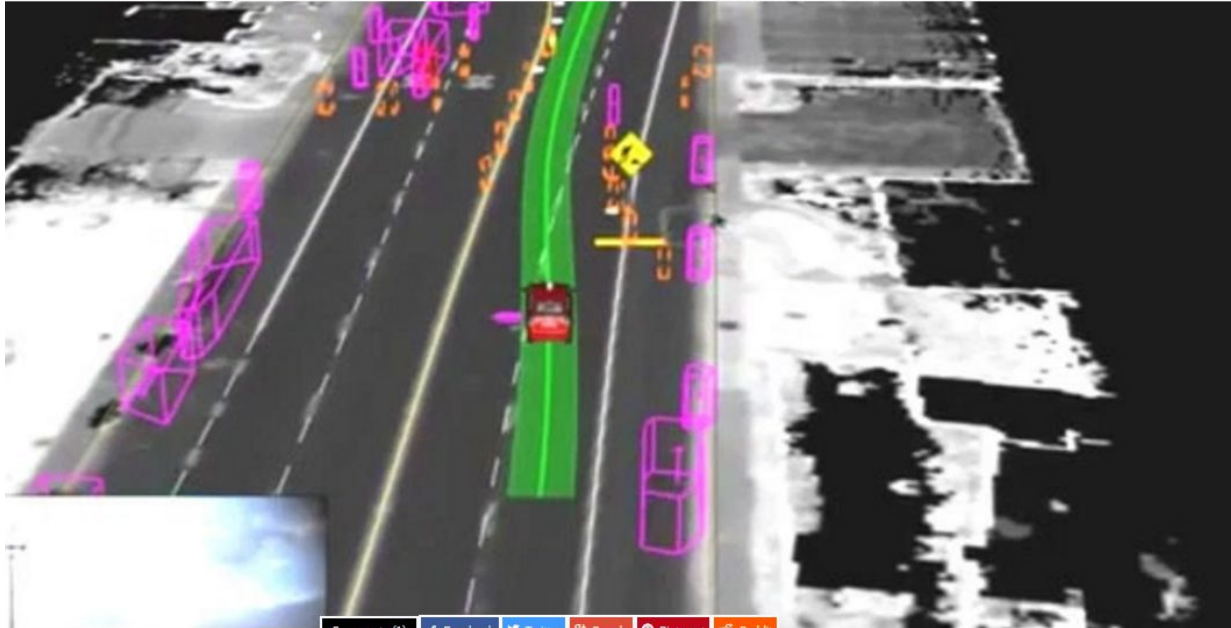
TODAY

GOOG: 764.65 12.65

Google's self-driving cars drive three million miles a day, without leaving the lab

Ben Lovejoy · 11 hours ago [@benlovejoy](#)

SELF-DRIVING CAR X



Comments (1) [Facebook](#) [Twitter](#) [Google](#) [Pinterest](#) [Reddit](#)

Google's self-driving cars have notched up almost 1.5 million miles in autonomous mode since the project began in 2009 – but they drive twice as many miles every single day in the lab. Google's latest monthly report reveals that every software change is tested by using it to simulate driving the entire driving history of the fleet, autonomous and manual.

(Humans) Learning to Drive



- Passing the driving test takes, on average, 45 hours of lessons
 - UK Driver and Vehicle Standards Agency
- The average new driver only feels truly confident after clocking up more than 20,000 miles
 - Co-operative Insurance Research

“Pibot” Robot Pilot (Oct 14)



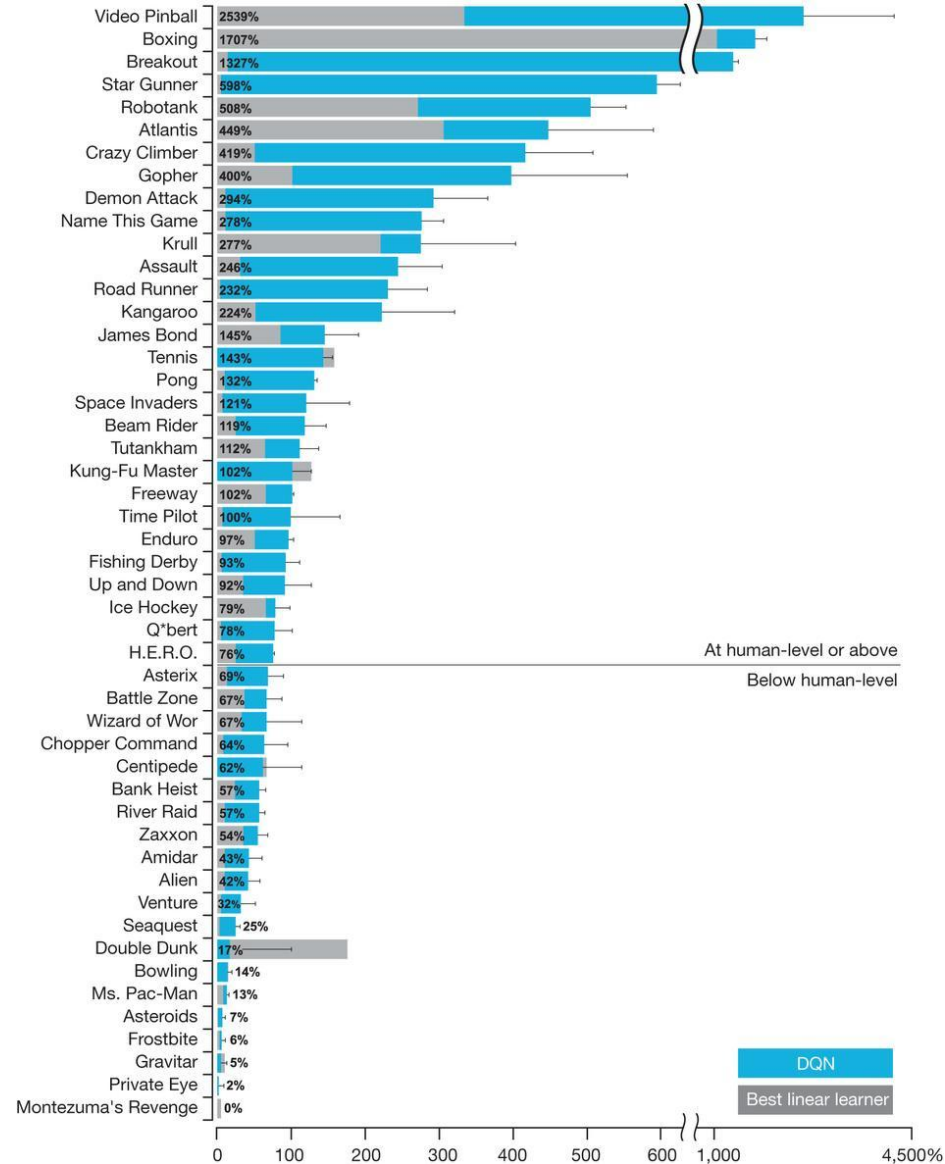
Google DeepMind AI (2015)

Google DeepMind's Deep Q-learning

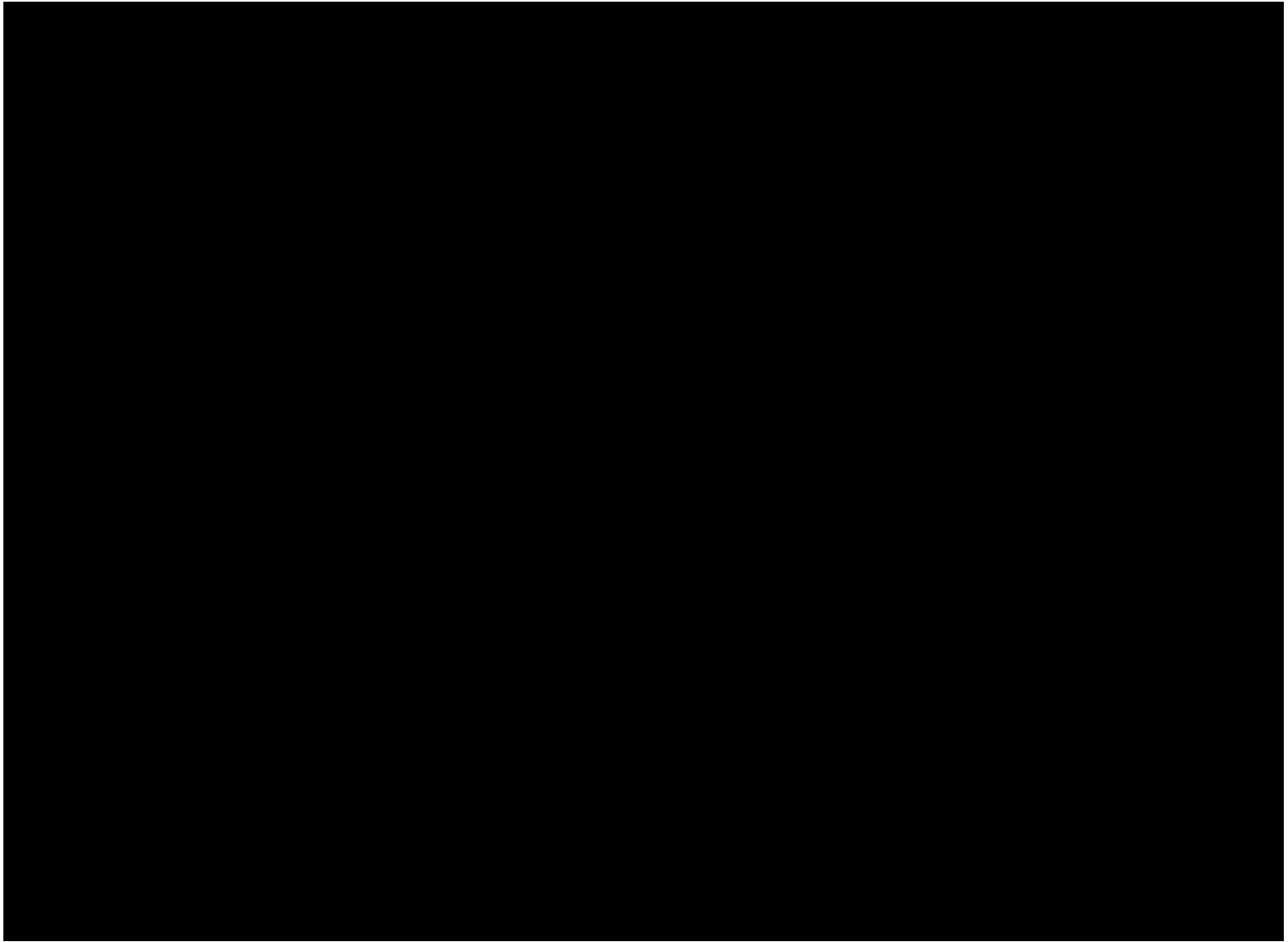
The algorithm will play Atari breakout.

**The most important thing to know is that
all the agent is given is sensory input (what
you see on the screen) and it was ordered
to maximize the score on the screen.**

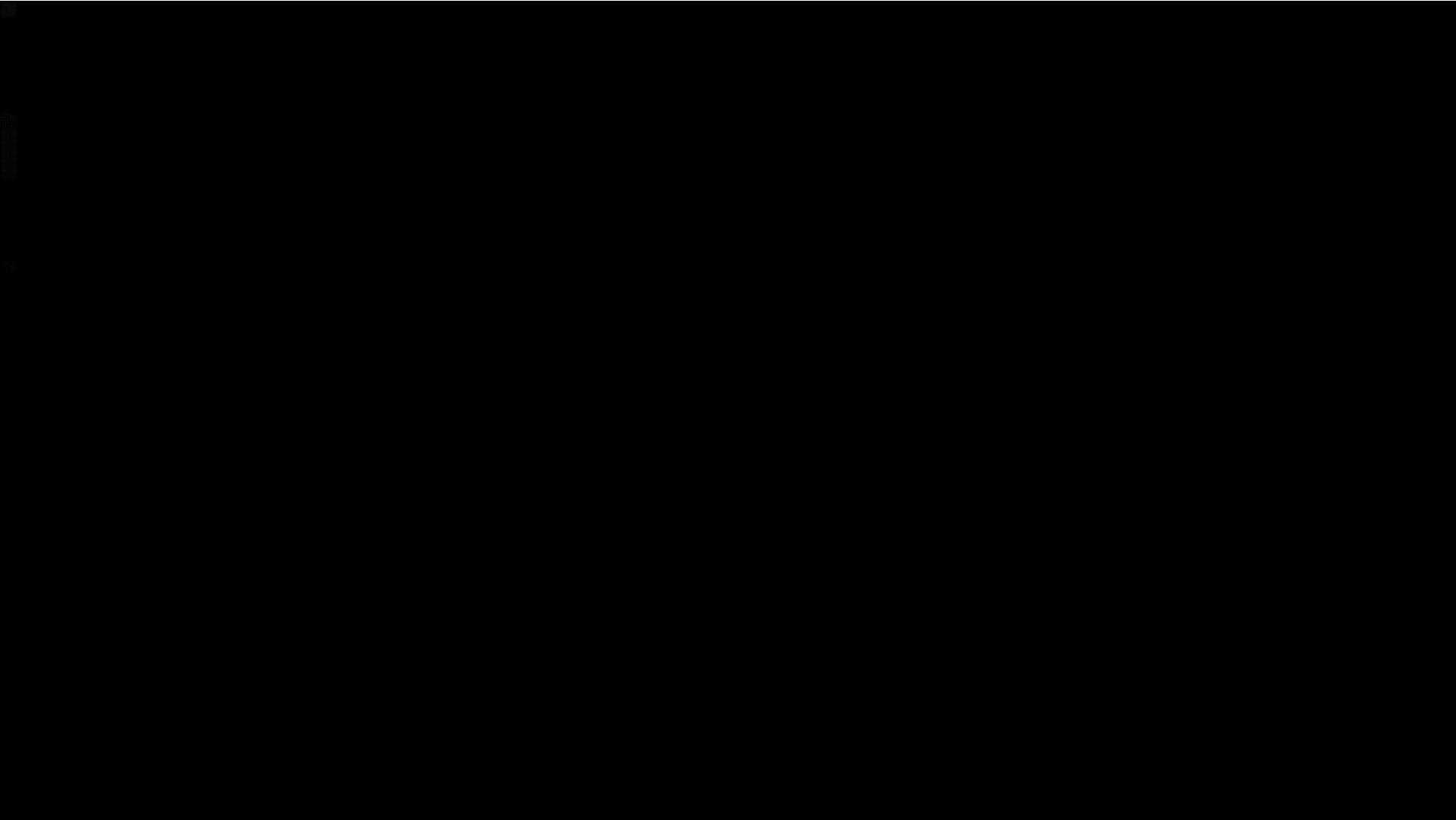
Google DeepMind AI (2015)



Google DeepMind AI - Labyrinth (2016)



Google DeepMind AI – Ant Soccer (2016)



Google DeepMind – Montezuma's Revenge (Jun 16)



So What?

Computers are being
programmed to learn how to
play games, not how to
play games

Humans & Autonomous Systems

Baron Charles Dupin (1826)

(Géométrie et Mécanique des Arts et Métiers)



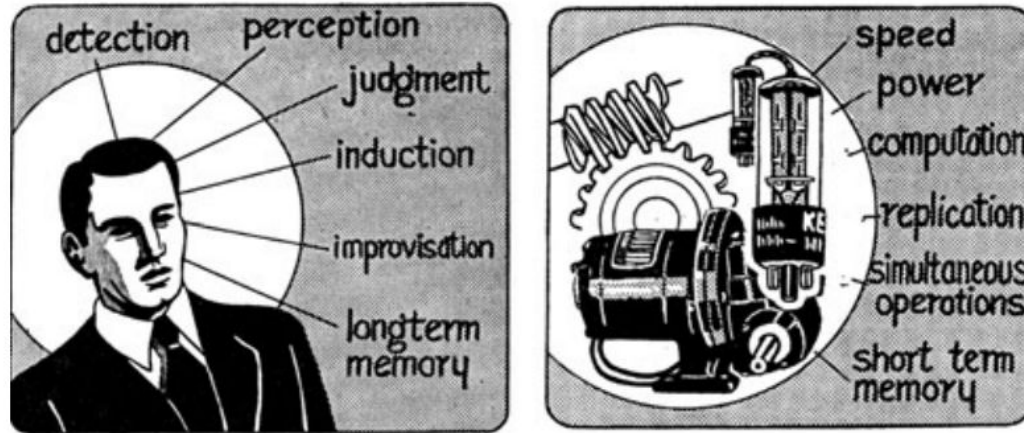
- “We have been very much occupied in perfecting the machines and the tools which the worker uses...
- However, if he were only considered as an instrument, a tool, a motor, he would necessarily be placed in the first rank of all instruments
- since he has the immeasurable advantage of being an instrument who observes and corrects himself, a self-stopping motor which functions with the motivation of its own intelligence and which perfects itself...”

Queen Bee Drone – 1930s/40s



Paul M Fitts (ed) (1951)

Human Engineering for an Effective Air Navigation and Traffic Control System



- We suggest that great caution be exercised in assuming that men can successfully monitor complex automatic machines and take over if the machines break down.
- Engineers should seriously consider systems in which machines would monitor men and prevent them from making dangerous mistakes.

Google DeepMind AI (2016)



At the beginning, I didn't know that I would lose, and I was also surprised because I didn't know that AlphaGo would play in such a perfect manner



Combat AI beats US Air Force's top tactical experts

And it only requires the processing power of a Raspberry Pi.



Andrew Dalton , @dolftown
06.28.16 in [Robots](#)



A new artificial intelligence flight combat system dubbed ALPHA has taken on one of the Air Force's top tactical experts and won. Retired USAF Colonel Gene Lee -- an experienced combat instructor with "considerable fighter aircraft expertise" -- was repeatedly shot down during engagements with ALPHA in a high-fidelity air combat simulation. Lee called his computerized opponent "the most aggressive, responsive, dynamic and credible AI I've seen to date."

Human v Machine

News | Sport | Comment | Culture | Business | Money | Life & style

News > Technology > Artificial intelligence (AI)

2029: the year when robots will have the power to outsmart their makers

Ray Kurzweil, Google expert in artificial intelligence, predicts that by 2029 robots will make jokes and flirt

Nadia Khomani
The Observer, Saturday 22 February 2014 21.00 GMT
[Jump to comments \(361\)](#)



Garry Kasparov versus Deep Blue in 1997. The computer won - as Ray Kurzweil predicted. Photograph: Stan Honda/AFP/Getty Images

Computers will be cleverer than humans by 2029, according to Ray Kurzweil, Google's director of engineering.



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“it can only be attributable to human error”

Communication and Trust



THINKE

Human Boredom

Does cockpit automation foster boredom?

Sometimes we're extremely busy, sometimes it's quiet. Duties ebb and flow. We deal with it

PATRICK SMITH



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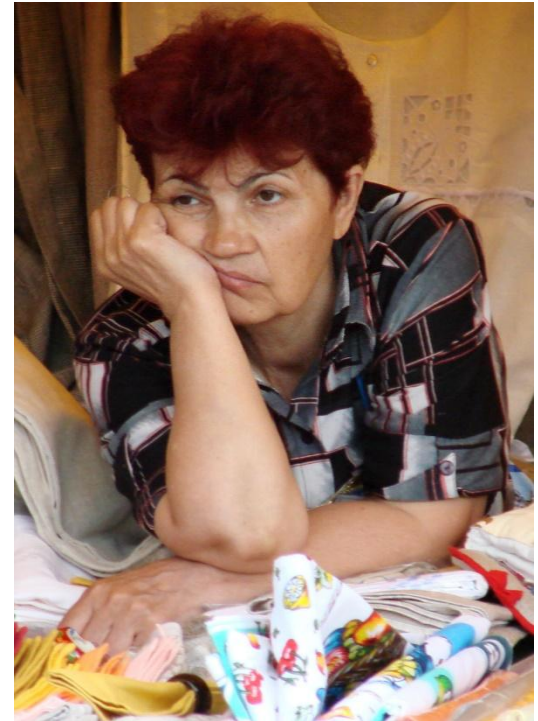
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theguardian

website of the year

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Tesla driver killed while using autopilot was watching Harry Potter, witness says

Driver in first known fatal self-driving car crash was also driving so fast that 'he went so fast through my trailer I didn't see him', the truck driver involved said

Sam Levin and Nicky Woolf
in San Francisco

Friday 1 July 2016 18.43 BST



Shares

1,733



Save for later



📷 Screenshot from a YouTube video by Joshua Brown of a trip from Boston to Orlando using Tesla's autopilot.
Photograph: Youtube

The Tesla driver killed in the first known fatal crash involving a self-driving car may have been watching a Harry Potter movie at the time of the collision in [Florida](#), according to a truck driver involved in the crash.

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A Reason to Automate Cars?

1.24m Road Traffic
Deaths Worldwide

World Health Organization 2010



How Does a UAS Pilot Feel at the End of the Day?

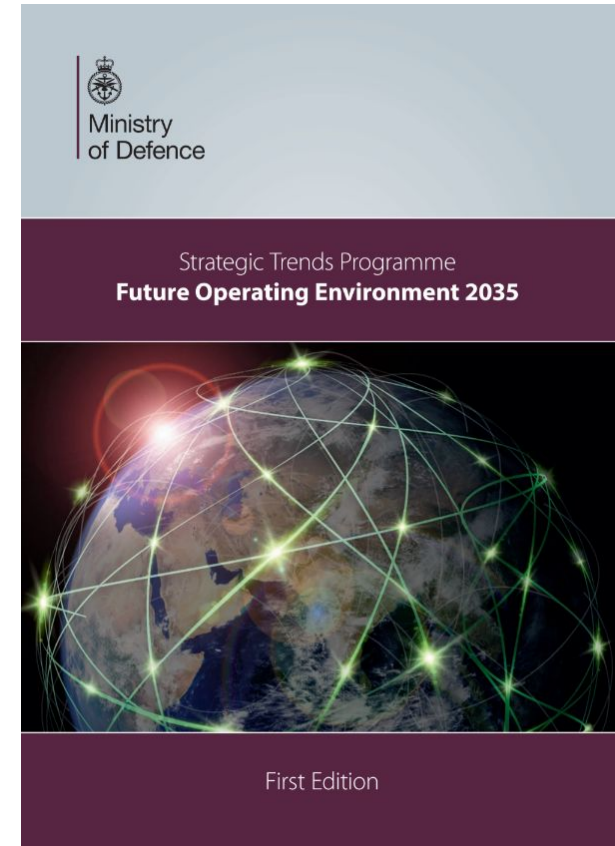


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Future Operating Environment 2035

Remote and automated systems

- “...as capabilities become more advanced and more trusted, their use is likely to become commonplace.
- The level and nature of human control of remote and automated systems will be key.
- Western militaries are likely to insist on humans continuing to make decisions on the engagement of targets by automated systems..”



London Evening Standard
10 Oct 1977

DRIVERLESS TUBES BY 1990

By Norman Leith

UNDERGROUND trains without drivers or guards will be running on the London Tube system by 1990.

First line to have the new unmanned service will be the Central. It will be smoother, faster, safer and more reliable than the present service.

Before then however, driverless trains will be tried on the East London line between Whitechapel and New Cross, and the section of the Central Line between Haldon and Woodford.

3000 staff reduction

By the year 2010, almost the entire London Transport Tube network will have been turned over to fully automatic trains.

These are the firm forecasts today of London Transport's top engineer Mr William Maxwell, member of the Transport executive, responsible for

The introduction of the no-man trains will open the way for the gradual reduction of at least 3000 the road workers—mainly drivers.

INGOTS

The no-man train requires no fundamental technical problem," he states. "The engineering principles are well into automatic train operation on the Victoria Line."

Just two feet

...The Catholic school is the
back of scheduling second
about 50 to 60 men, operators
are so great that circuit
stages will mount in
because it before the into
the country.

Continued on Page 5



JAMES HUNT—forced off the track while trying to pass team mate Jochen Mass.

Grand Prix punch costs Hunt £1500

JAMES HUNT has been fined nearly \$1500 by Canadian motor racing officials after pushing a marshal in a trackside row at the Canadian Grand Prix at Mosport.

Ontario.

The marshal was trying to hold the ex world champion back from the track side as Hunt gesticulated furiously at his least-favorite Jacobson. Mass

my hand to let him go by on the inside. I don't know exactly why he misjudged. Maybe he thought he could go by on the outside."

"I don't do these things on purpose. I've never done them

After train officials found MeLaren, his fire reaction was to threaten Mass, and he had to be restrained from his outbursts at the Georgia

Hunt was fined \$140 for further crossing and walking too close to the track on his way back to the pits after his accident.

Ajax nap wins at 12-1

THE Evening Standard
MIDDAY racing team
wound up last week in
fabulous fashion.

AJAX was the man who put the money in his followers' pockets when he mapped E-1 shot Vladimir Prince and followed up with Great Train. A-1 hit the

THE JUDGE (Tom Hall) backed him up in her style, including Bondi (El-S) and Bright (Susan Lewis).

He took the reins over on Saturday when he landed a 9-1 double with Julio Mariner (map) (4-5) and Yamadani (5-1) and also selected Royal Hatter (7-1).

The Judge is also keeping in touch over the sticks and he emphasized this with four-out-of-six. At Ace — Battlement (3-1), Hindshape (3-1) and Master Ribbet (3-1).

So take a tip? Get the **MIDWAY STANDARD** every day. At 8p it's the greatest value for money, saving money in the bargain.

Hide can score on Gerard

Page 3

Racing inside

• Warwick cont.—Back Page.

form—46 and 47; Fuelled card and form—4 and 7; Depth card—8; Air card and form—46; Reduc thermometer—2 (operated standard—47, 48, 49, 50).

TV and radio Page 48
Entertainment 18

OLD INGOTS

£47.25

Just two Set
gold ingots from
the Ratners
collection.

1870-1871

Continued on Page

Entertainment 15

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Are we there yet?



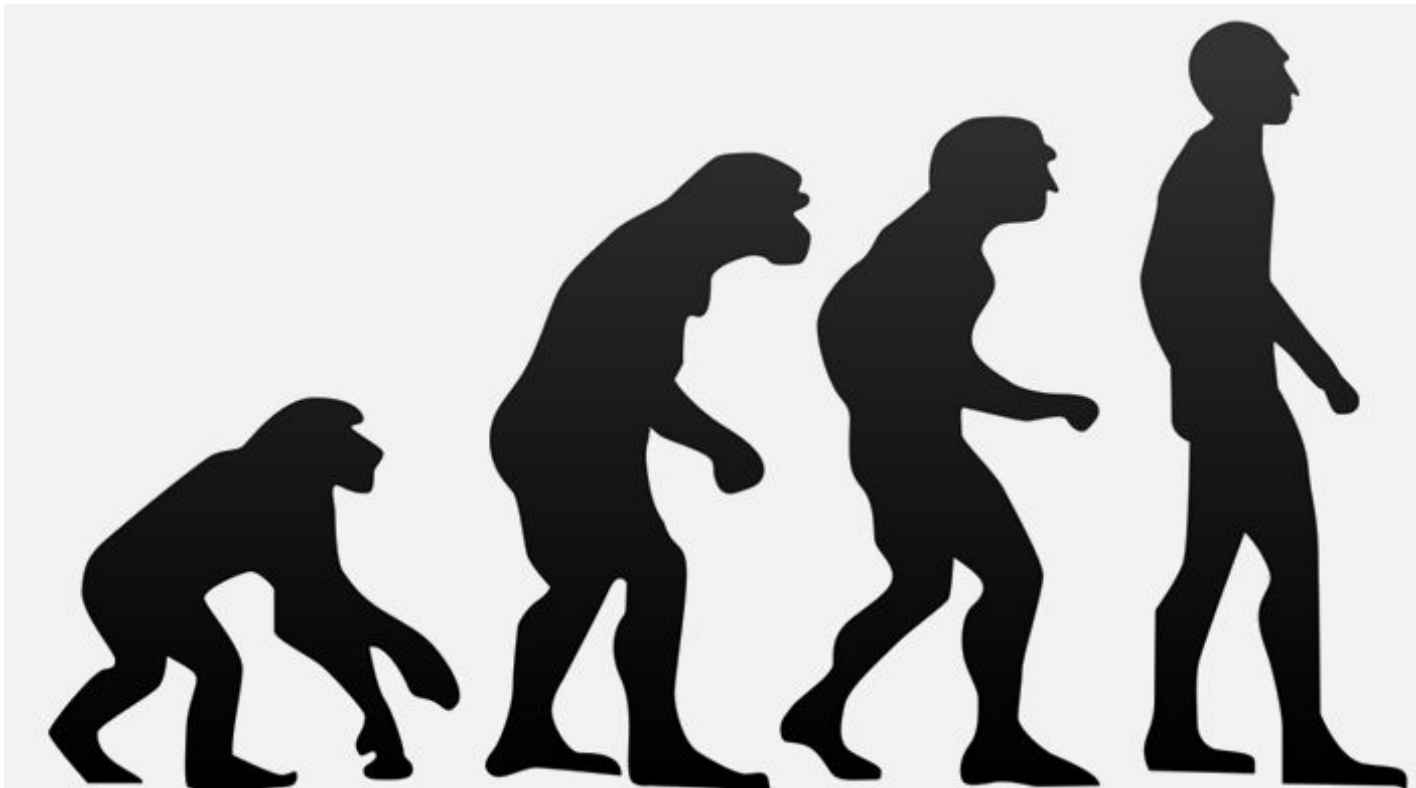
Some Basic Hurdles Remain!



In Support of the Human

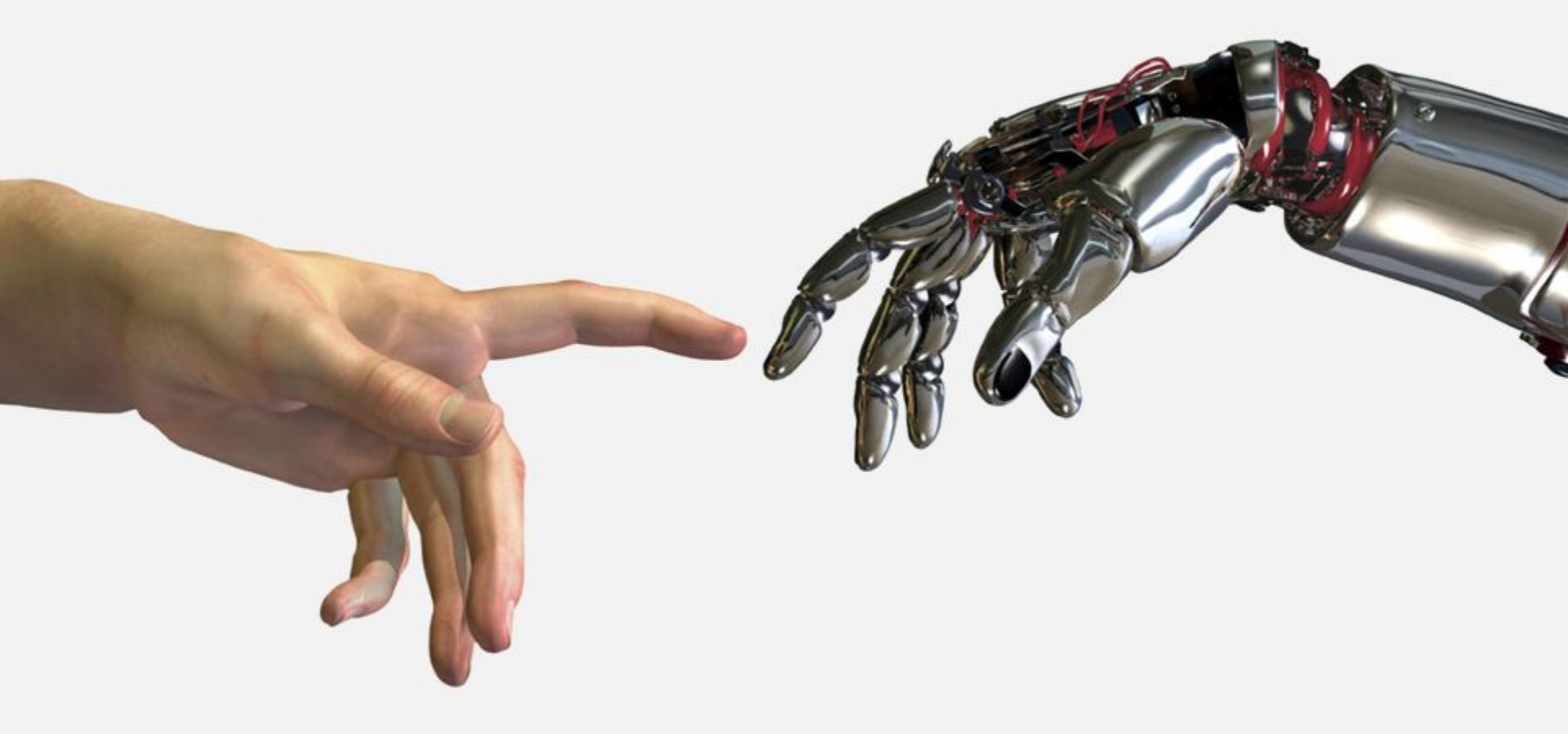
Humans are Special

- **Millions of Years of Evolution**
 - **Highly Developed Body, Senses & Mind**



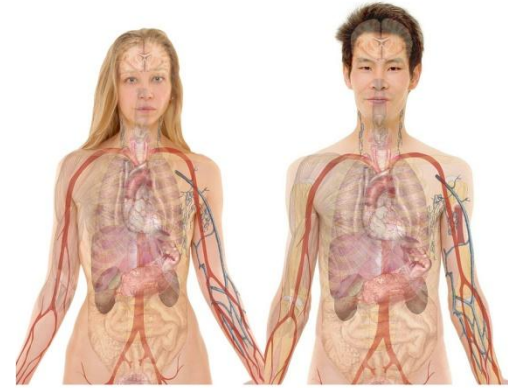
The Optimum Human/Machine Blend

- **Humans & Machines working in Harmony
Maximising the Strengths of Both**



Autonomous Systems - More than Engineering

- **Psychology**
 - study of mind and behaviour
- **Physiological**
 - study of normal function in living systems
- **Psychiatry**
 - study, diagnosis, treatment, & prevention of mental disorders
- **Philosophy**
 - study of reality, existence, knowledge, values, reason, mind, and language
- **Political**
 - practice and theory of influencing other people



http://commons.wikimedia.org/wiki/File:Female_with_organs.png
http://commons.wikimedia.org/wiki/File:Male_with_organs.png

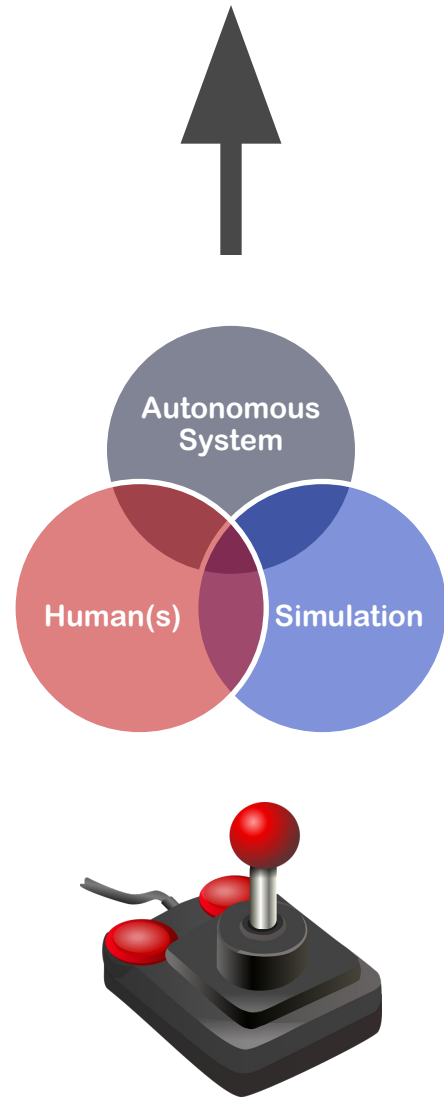
Human Factors & Engineering

**Should there be more Focus on
Human Factors in Engineering
Education?**



3 Thoughts

- Human factors become more important as automation increases
- Simulation can play a key role in testing and training humans and autonomous systems both separately and together
- Can we learn more from gaming?



Humans and Machines

**“THE
ULTIMATE COMPUTER”**



Questions?

