

**5<sup>th</sup> Annual SMi  
UAV Technology  
Conference  
28/29 September 2020**

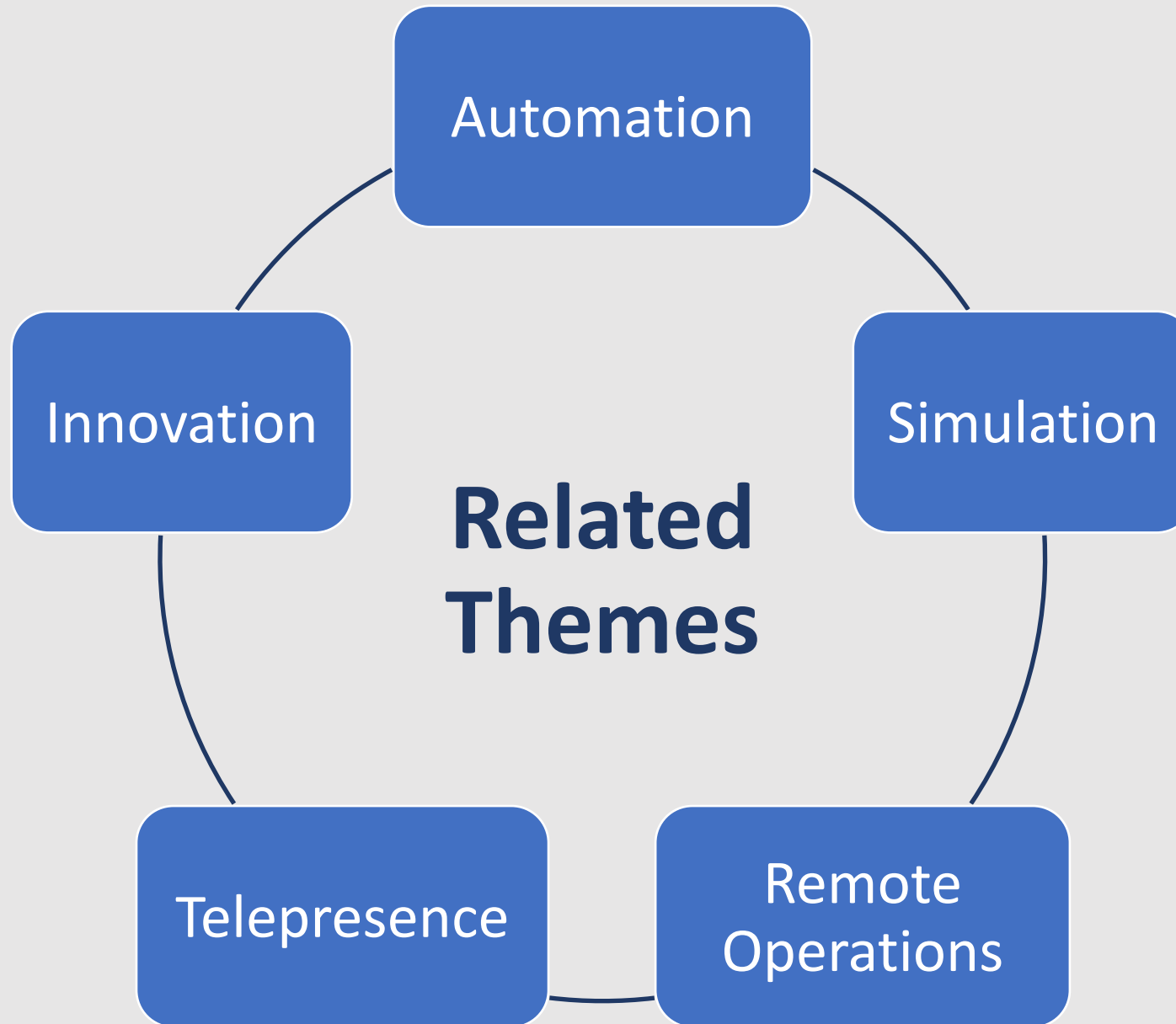
# **Simulation and Training for UAV Operations**

**Andy Fawkes  
FIMechE**



UK MoD

THINKE



# Outline

- **The Military of Today**
- **Simulation and Gaming**
- **Human-Machine Interfaces**
- **Cautionary Tales**

# The Military

1/4



THINKE



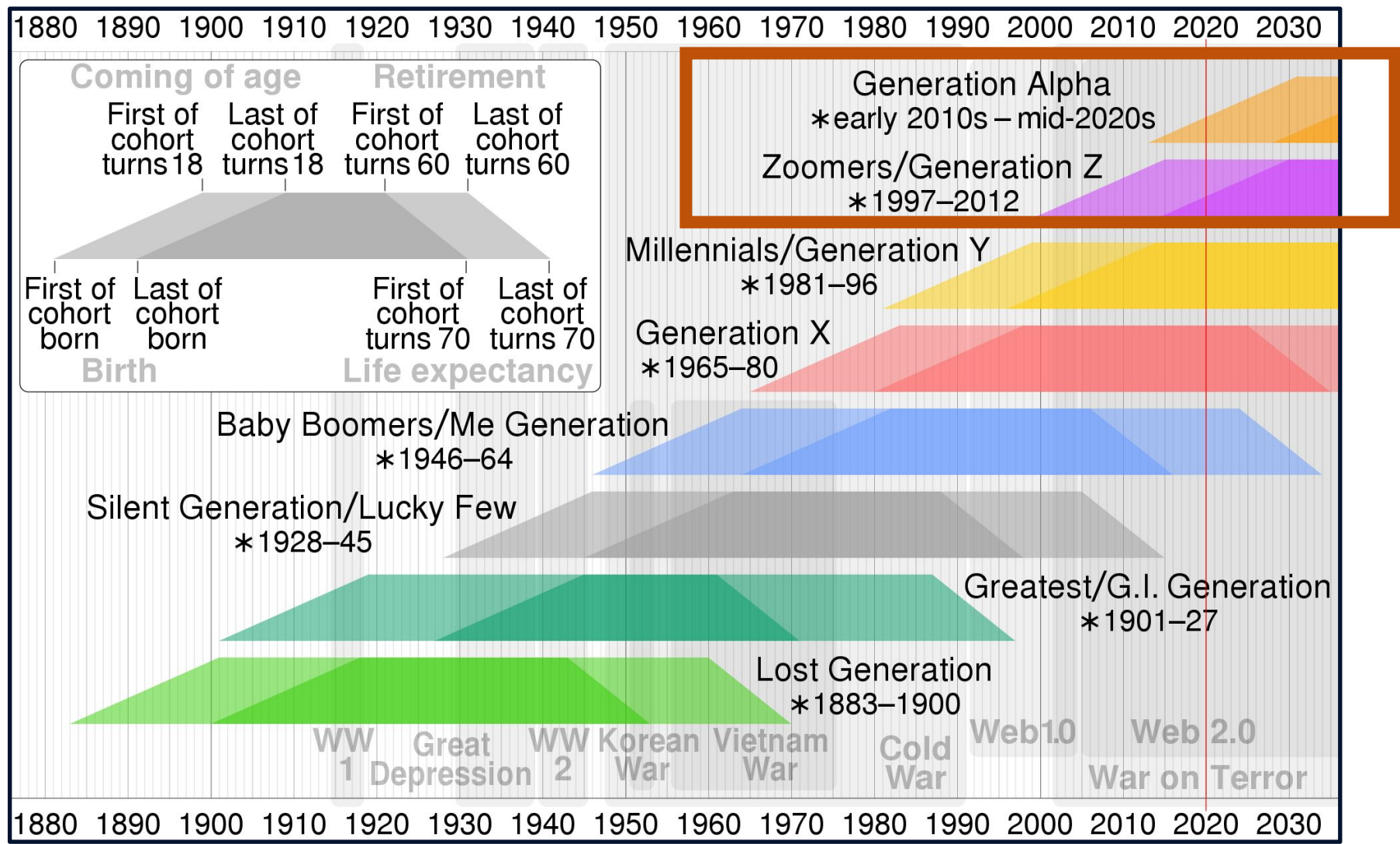
# RAF Age Distribution

**38% of the RAF  $\leq 29$   
and 74%  $\leq 39$**

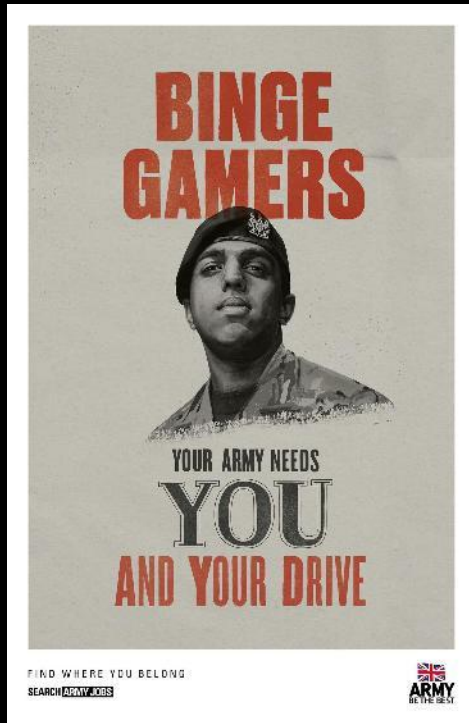
| Royal Air Force    |       | 32 860       |
|--------------------|-------|--------------|
| <b>Under 18</b>    |       | <b>200</b>   |
| Female             | 20    | 8.9          |
| Male               | 180   | 91.1         |
| <b>18 - 19</b>     |       | <b>910</b>   |
| Female             | 100   | 11.2         |
| Male               | 810   | 88.8         |
| <b>20 - 24</b>     |       | <b>4 790</b> |
| Female             | 660   | 13.9         |
| Male               | 4 130 | 86.1         |
| <b>25 - 29</b>     |       | <b>6 470</b> |
| Female             | 980   | 15.2         |
| Male               | 5 490 | 84.8         |
| <b>30 - 34</b>     |       | <b>6 100</b> |
| Female             | 1 040 | 17.0         |
| Male               | 5 070 | 83.0         |
| <b>35 - 39</b>     |       | <b>5 800</b> |
| Female             | 940   | 16.2         |
| Male               | 4 860 | 83.8         |
| <b>40 - 44</b>     |       | <b>3 670</b> |
| Female             | 570   | 15.5         |
| Male               | 3 100 | 84.5         |
| <b>45 - 49</b>     |       | <b>2 710</b> |
| Female             | 320   | 11.7         |
| Male               | 2 390 | 88.3         |
| <b>50 - 54</b>     |       | <b>1 790</b> |
| Female             | 110   | 6.0          |
| Male               | 1 680 | 94.0         |
| <b>55 - 59</b>     |       | <b>410</b>   |
| Female             | 20    | 4.4          |
| Male               | 390   | 95.6         |
| <b>60 and Over</b> |       | <b>10</b>    |
| Female             | ~     | ~            |
| Male               | 10    | 88.9         |
| <b>AVERAGE AGE</b> |       | <b>33</b>    |

UK Armed Forces Biannual Diversity Statistics: 1 April 2019

# The Next Workforce

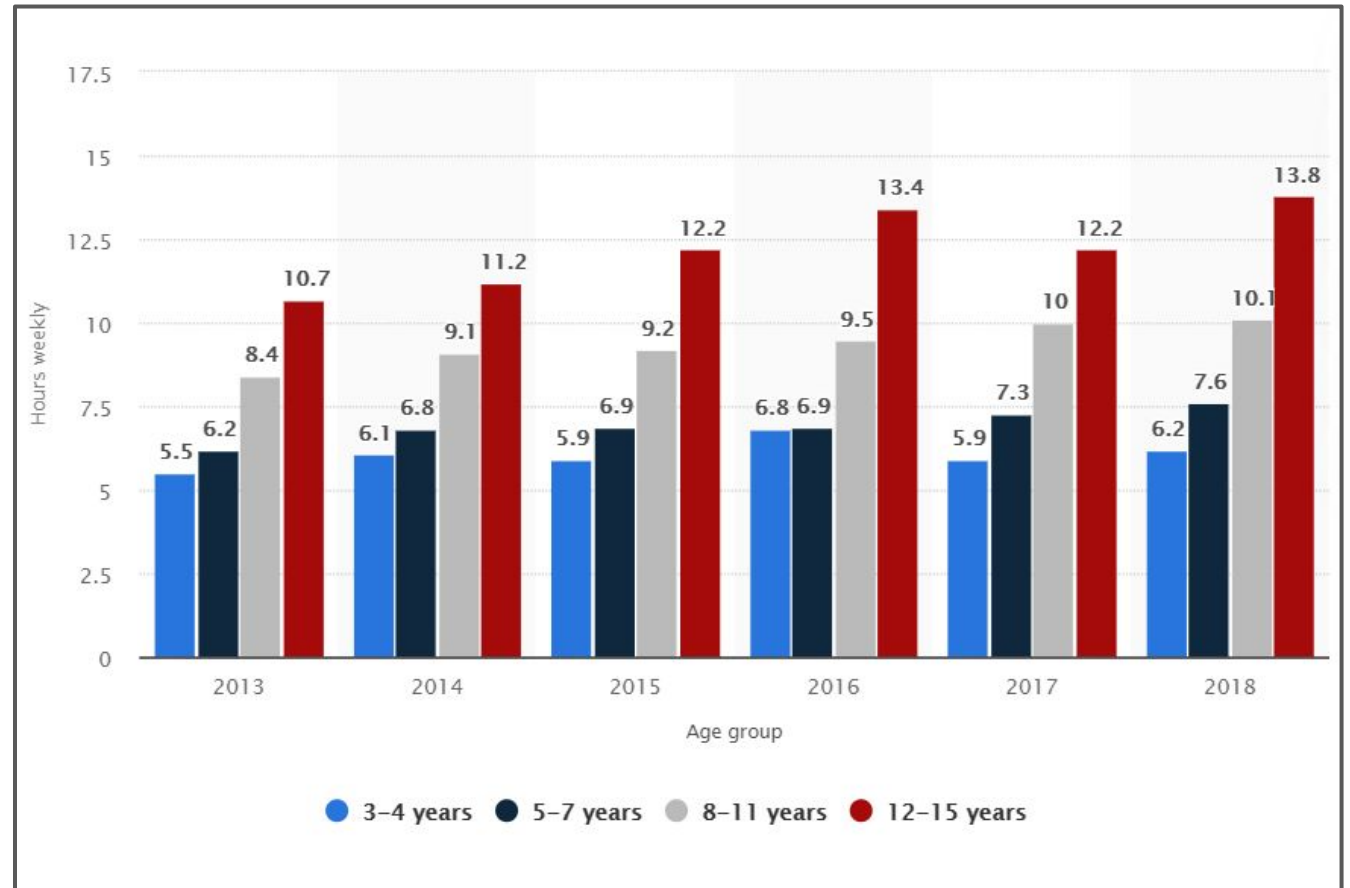


Z  
α



# 93% of Children Play Video Games

Children's Commissioner for England (2019)



**Air Chief Marshal  
Sir Stephen Hillier  
Jan 18**

**“teenagers playing on  
their Xbox at home  
should take their  
gaming to the next  
level and join the RAF  
to operate real drones”**

**MailOnline** News

Home News U.S. Sport TV&Showbiz Australia Femail Health Science Money Video Travel DailyMailTV

Latest Headlines Royal Family News World News Arts Headlines France Pictures Most read Wires Discounts Login

## Join the RAF for the real thing, Xbox teenagers are told: Head of the air force says young gamers should take it to the next level by operating drones

- Air Chief Marshal Sir Stephen Hillier wants more young people to join the RAF
- The service will be celebrating their 100th anniversary with events this year
- Among the major events planned is a flypast along the Mall before the Queen
- RAF chiefs hope a display of military might could provide a boost to recruitment

By LARISA BROWN FOR THE DAILY MAIL  
PUBLISHED: 00:32, 12 January 2018 | UPDATED: 00:53, 12 January 2018

387 shares 194 View comments

Teenagers playing on their Xbox at home should take their gaming to the next level and join the RAF to operate real drones, the head of the air force said yesterday.

Air Chief Marshal Sir Stephen Hillier said the RAF's next 100 years will see a huge shift towards unmanned flying machines as he outlined plans for centenary celebrations.





Olli43  
1.46M subscribers

# Microsoft Flight Simulator 2020

YouTube

Search



Microsoft Flight Simulator 2020 - London Update Pack & Viewer Suggestions!

114,410 views • Streamed live on 18 Aug 2020



3K



95



SHARE



SAVE



Live chat replay ▾



£4.99



US\$9.99



US\$4.99

Fly through tower bridge



Craig Davies HIGH END CPU : Ryzen 7 Pro 2700X or Intel i7 9800X GPU : Radeon VII or Nvidia RTX 2080 VRAM : 8 Gb RAM : 32 Gb SSD : 150 Gb Solid State Drive Bandwidth: 50 Mbps



Navdeep Singh @Olli43 disable Hpet on your computer for smoother gameplay look it up on YouTube.



Siddhant Bhurud thats me



Jackson Scaletta do a roll



Hunt3r - Fly over some stadiums in london



SpursFan214 omg i found you



Kentucky Fried-Chicken Who else live near southampton



DodgeGt6 such a cool gamer moment!



SpLiT pErSoNaLiTY GTA 5 car meet



TheGamingBluejay Did he download London or is this streamed?



Slow mode was enabled



HIDE CHAT REPLAY

# Tip of the Spear Innovation



Combat Recce  
@CombatRecce



WngO 2 for our Virtual Distributed Training event. Detail via our DC page and H Hr is 1900 on Wed 27 May 20 [#online](#) [#training](#) [#skills](#) [#distancelearning](#)



12:45 PM · May 26, 2020 from Tullibody, Scotland



45



See Combat Recce's other Tweets

## THE SCOTTISH AND NORTH IRISH YEOMANRY



# Simulation and Gaming

2/4



# Why Use Simulation in Training?



Simulator?



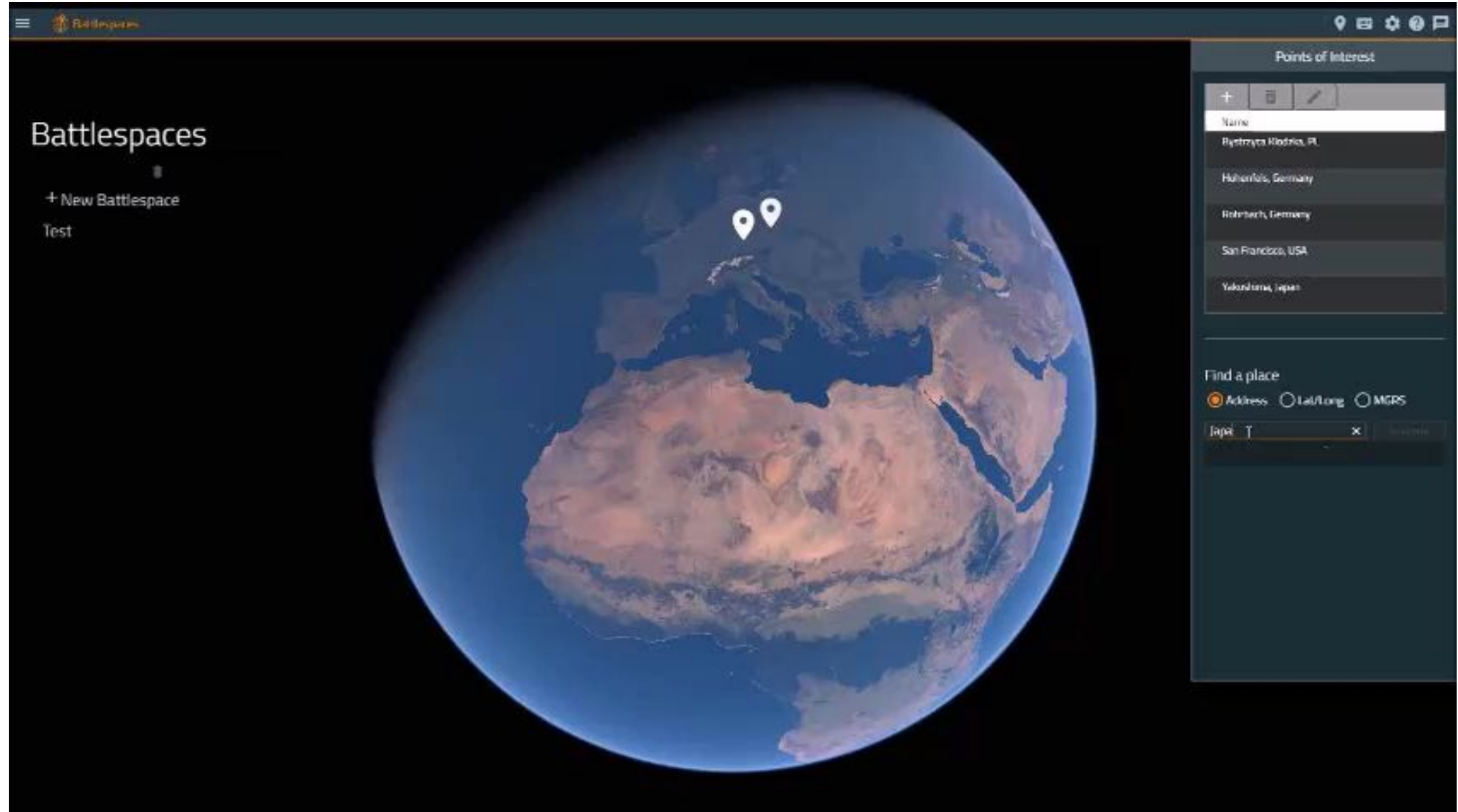
Intelligent UAV

THINKE

# Simulation Now - Land, Sea, Air, Anywhere



# Whole Earth Simulation



# Rapidly Reconfigurable Simulation

**Simulation/Visualisation can be rapidly adapted and exploited for mission training and rehearsal**



**Pix4D**



# Simulation Trends

## Unreal 5 (2021)



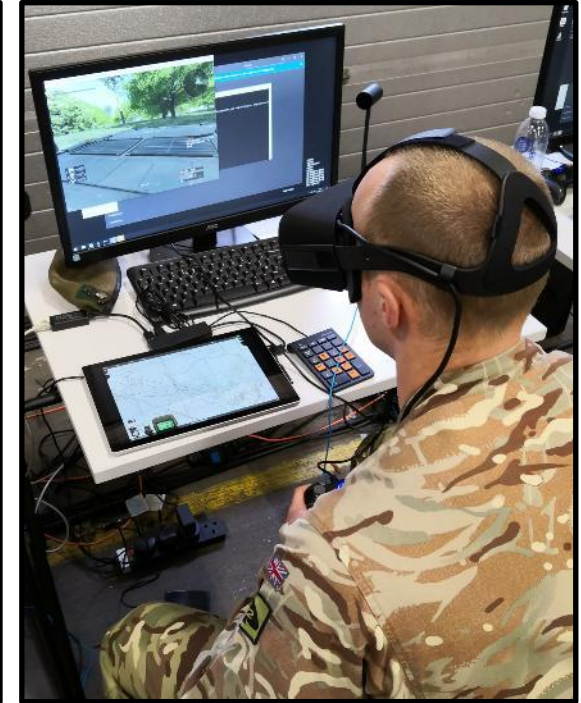
[youtu.be/qC5KtatMcUw](https://youtu.be/qC5KtatMcUw)

**XR**

# **eXtended Reality (XR)**

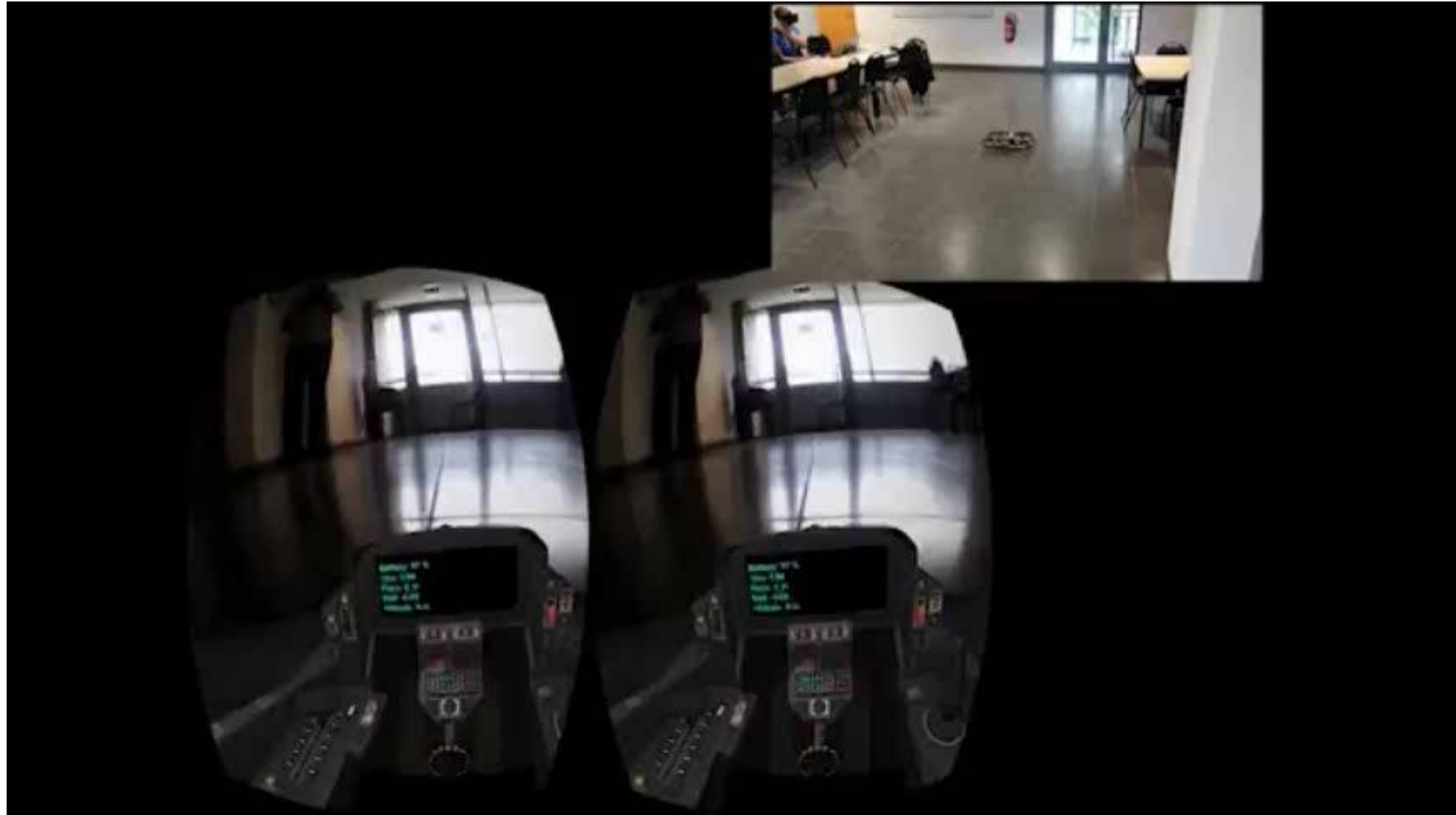
| Reality                                                                            | Augmented Reality                                                                   | Mixed Reality                                                                        | Virtual Reality                                                                      |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| The real world                                                                     | Information layered over vision                                                     | Blend of real & digital information to enhance reality                               | Fully virtual world                                                                  |
|  |  |  |  |

“In Virtual Simulation  
you look at the  
Virtual World,  
in VR you are in it”



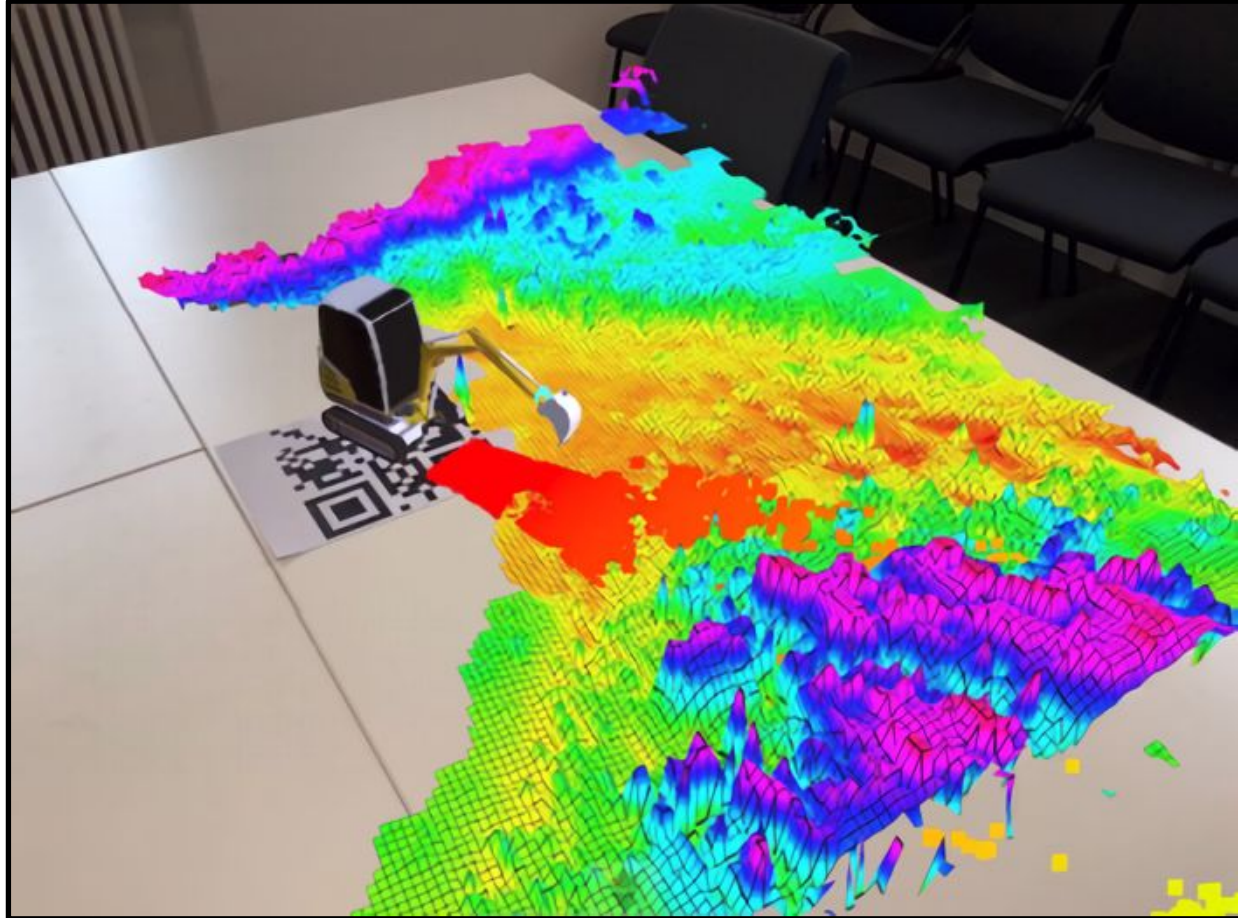
# Rift Drone

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



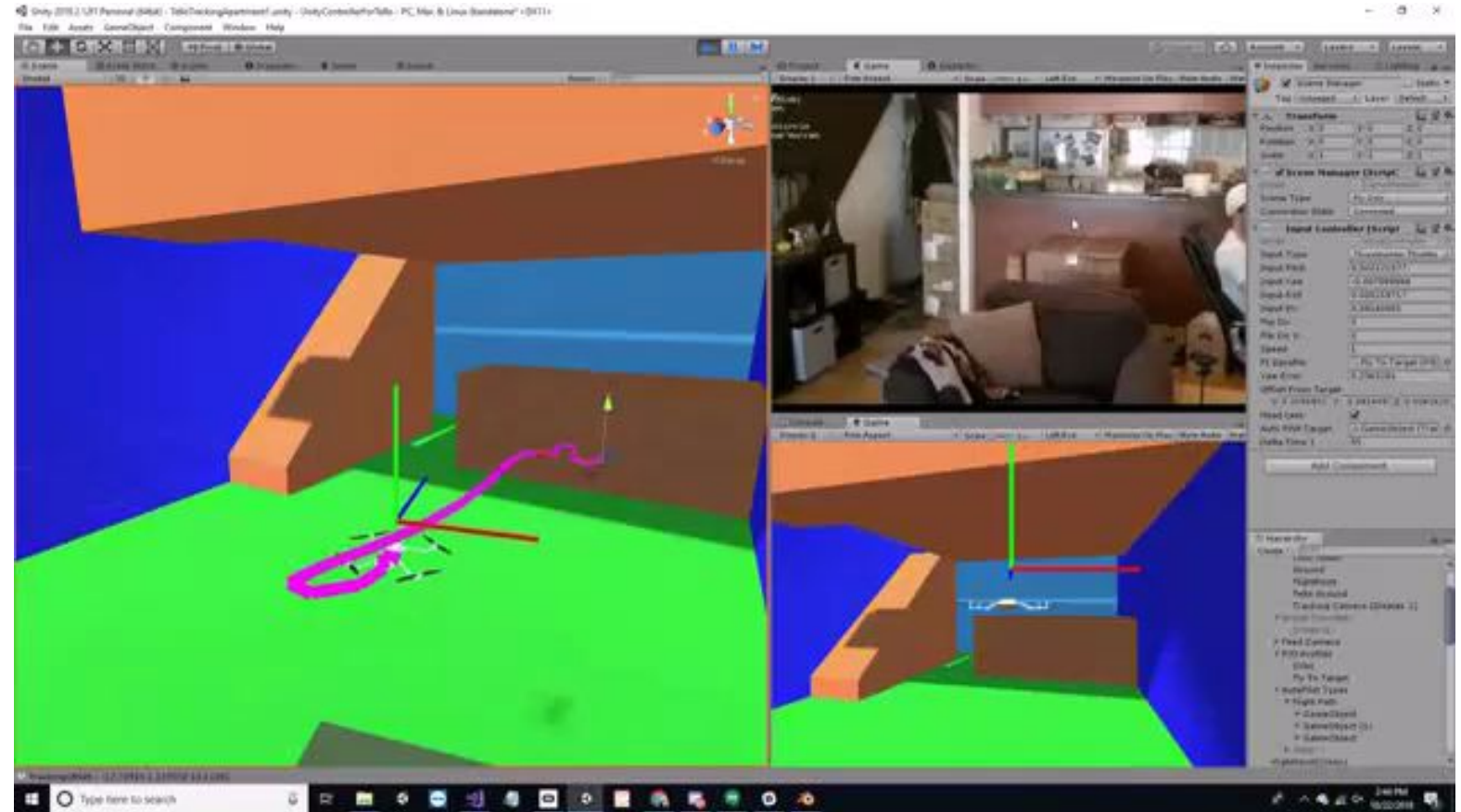
Rift Drone is open source: <https://youtu.be/nD2a0OHRmoM>

# See What the Machine Sees Through AR (Augmented Reality)



C2

# Flight Path Programmed in, and Controlled by, Unity Game Engine



C2

Simulation  
(VBS3)

Experimentation

Autonomous  
Systems



Decision  
Support

UK MoD  
“Single  
Synthetic  
Environment”



Gen Sir Richard Barrons  
Former Commander  
UK Joint Forces Command



# Human Machine Interfaces

3/4



# Voice Controlled Autonomous Systems

UK

[www.cervusdefence.com/case-studies/exploring-voice-controlled-autonomous-systems](http://www.cervusdefence.com/case-studies/exploring-voice-controlled-autonomous-systems)



Voice Control is Fast, Intuitive, Powerful



Dramatically speeds up interfaces and cycle times

Adapts to language in the context of the situation

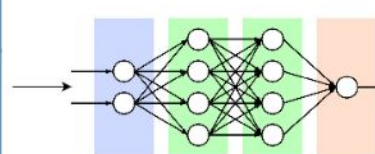
Control of both micro-movements and macro-tactics



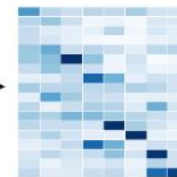
Operator / Mic



Voice processing  
neural network



Encoded action / SQF



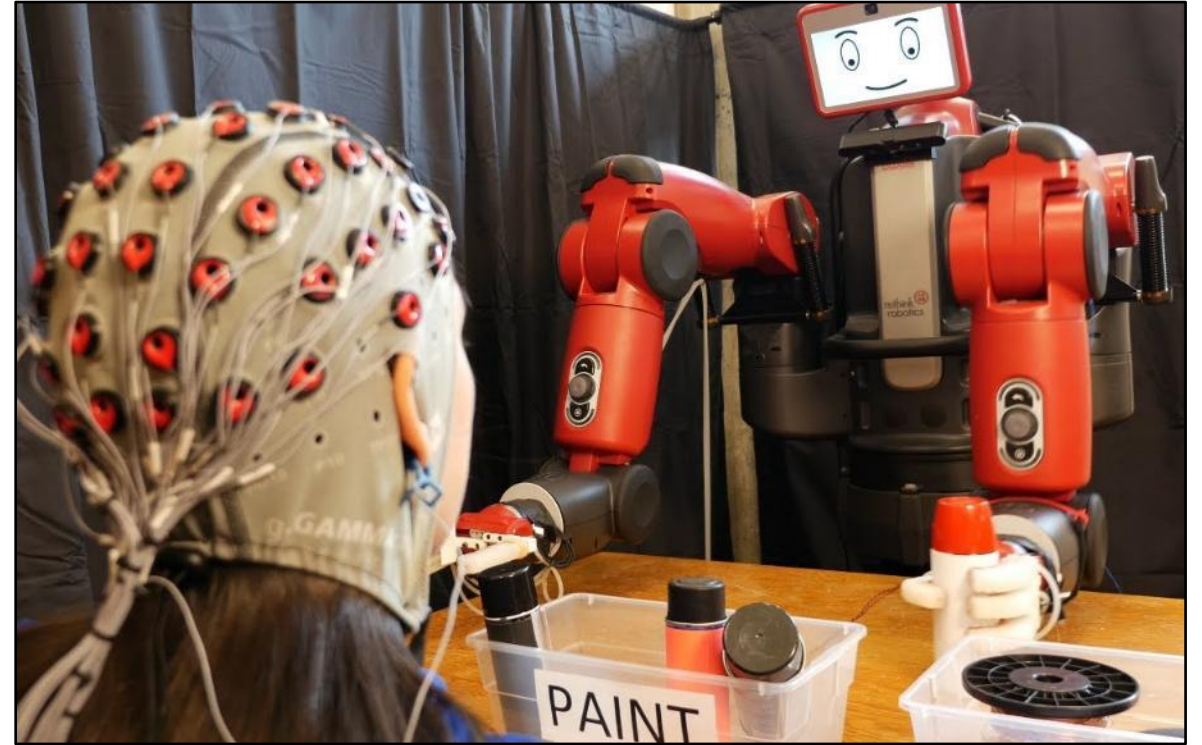
VBS3



UGV



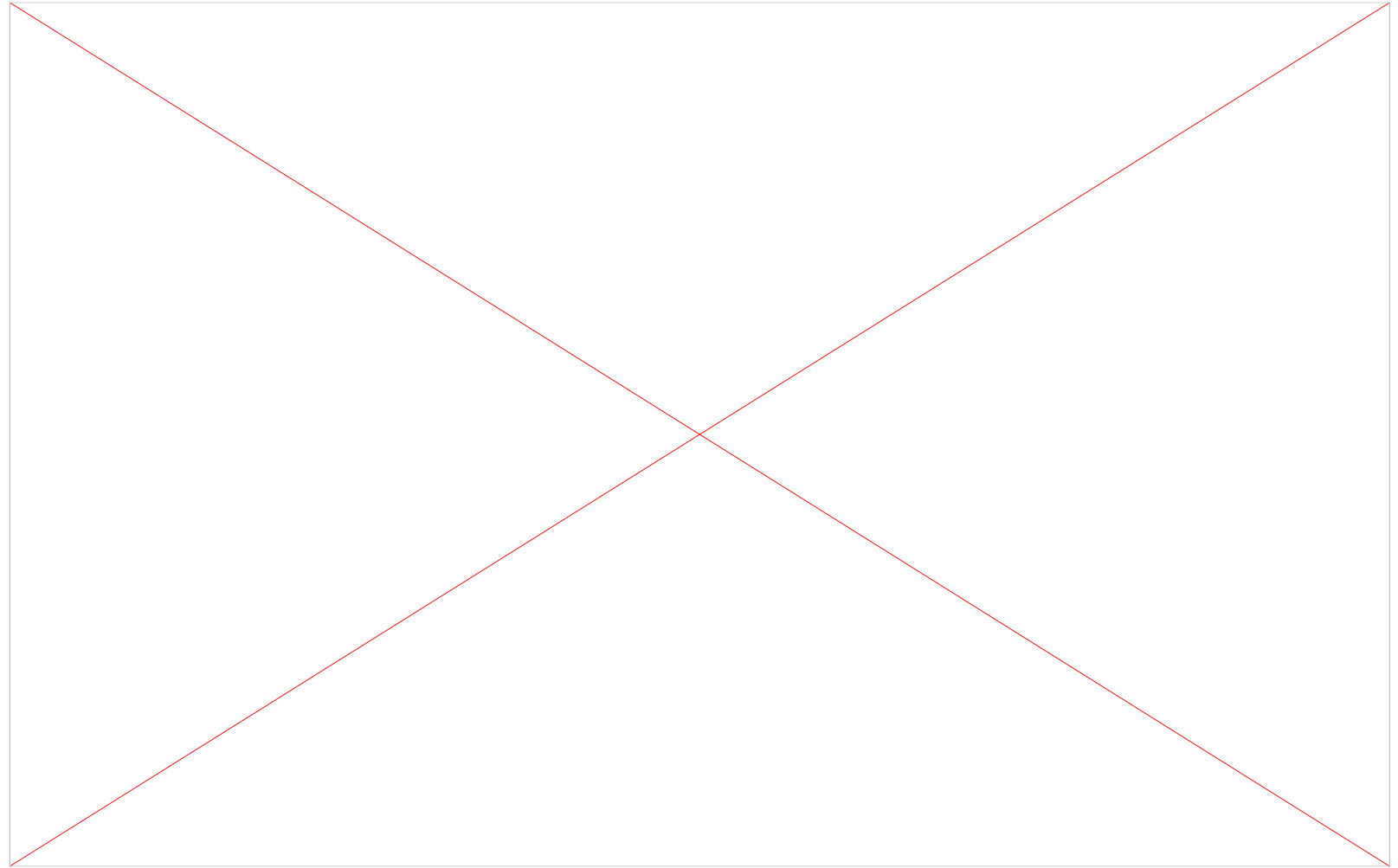
# Brain Interface



# Telexistence



# Gaming Interfaces

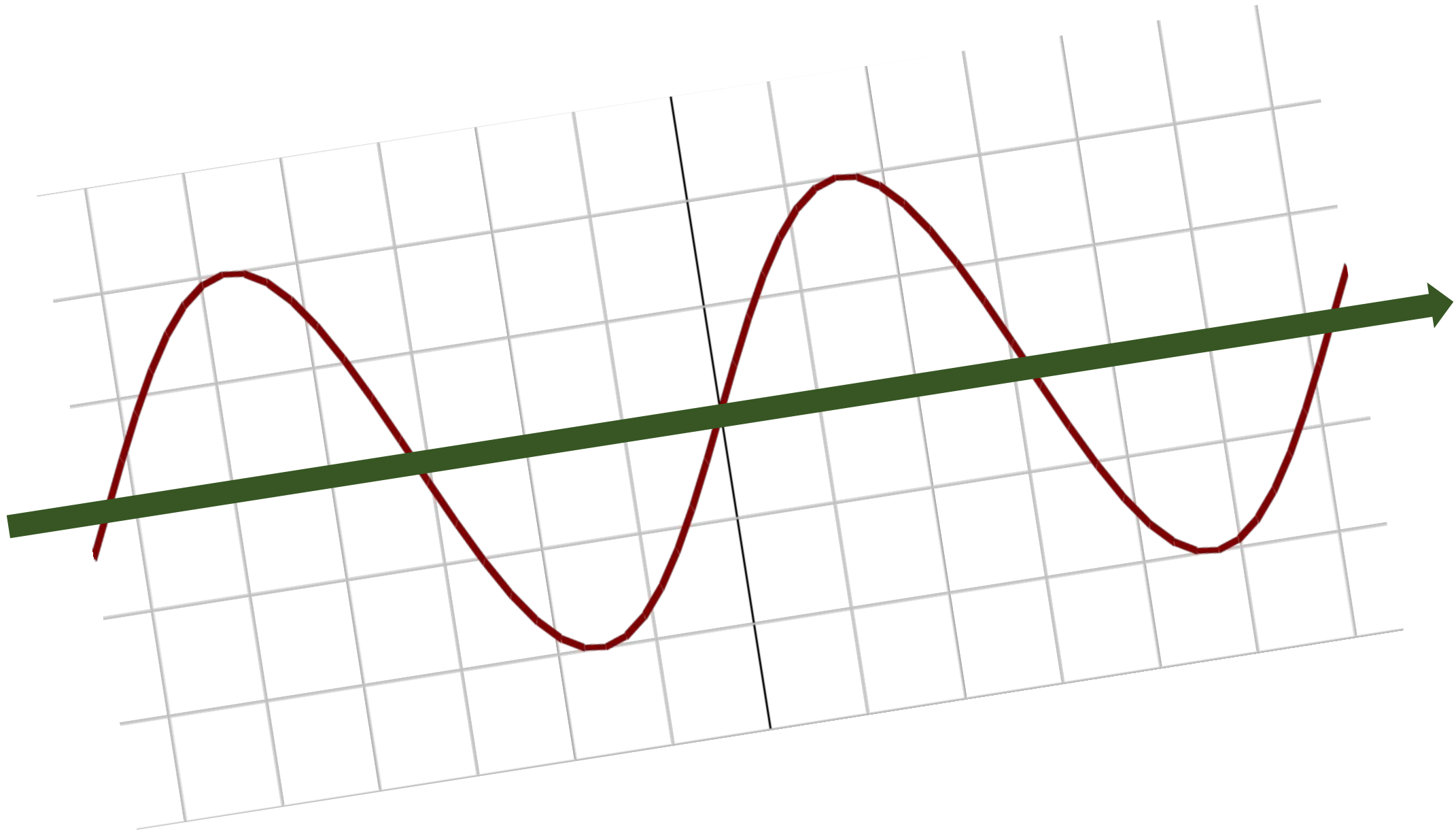


# Cautionary Tales

4/4



# My Feelings on Uncrewed/Automation



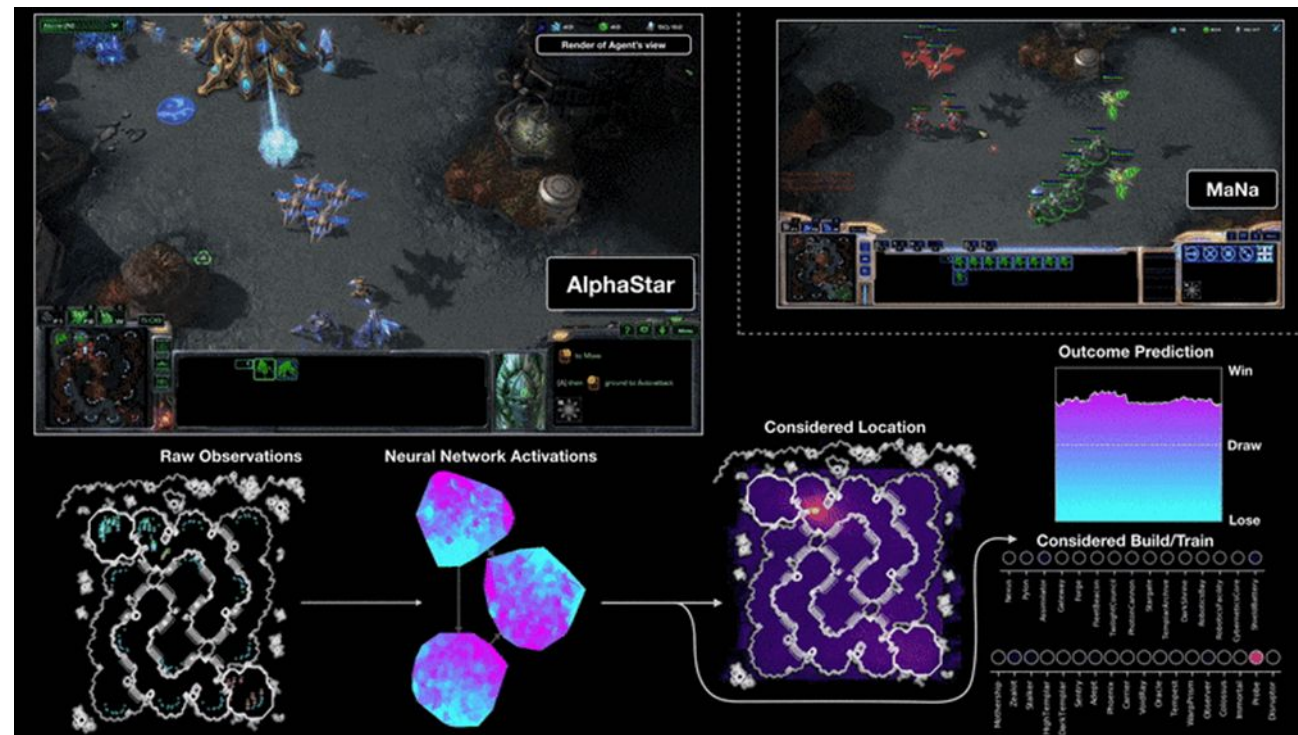
# Google DeepMind 2019

GAMING / TECH / ARTIFICIAL INTELLIGENCE

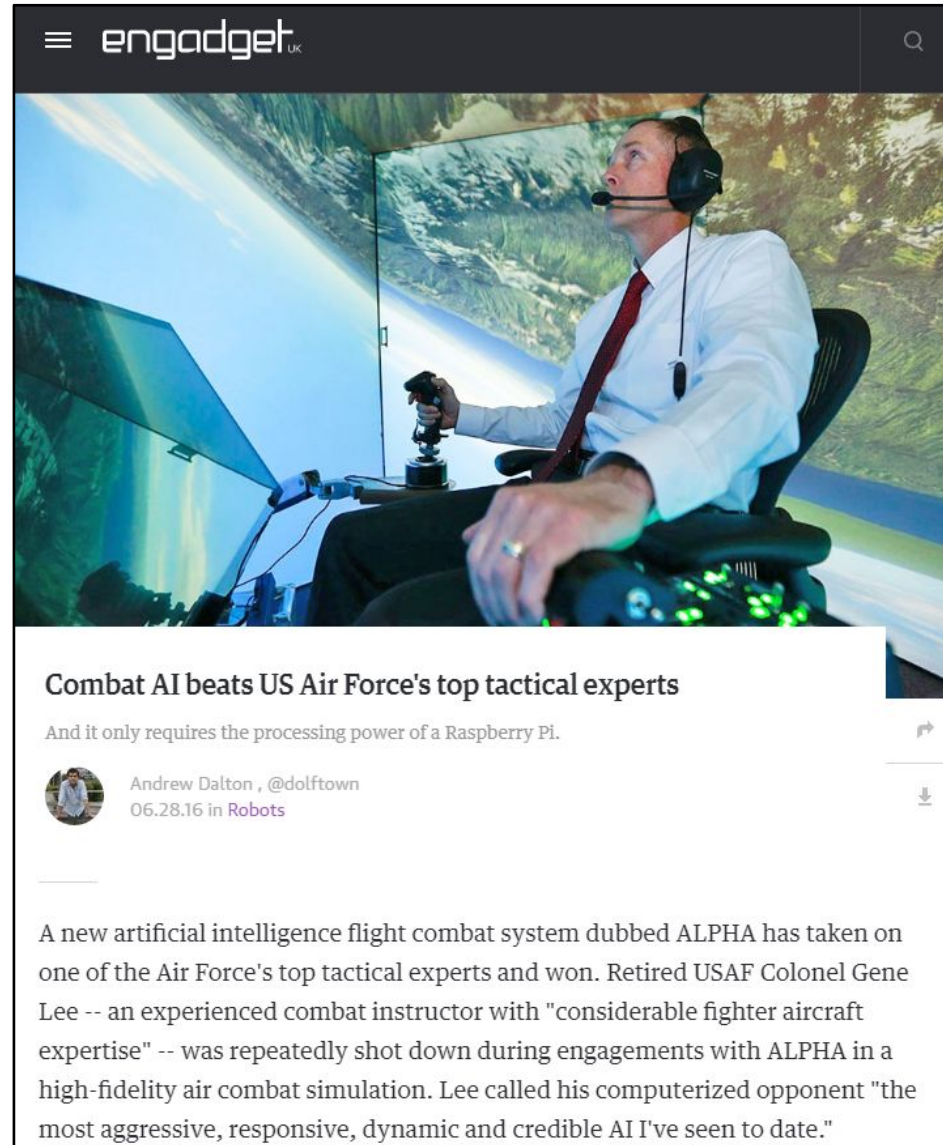
# DeepMind's StarCraft 2 AI is now better than 99.8 percent of all human players

AlphaStar is now grandmaster level in the real-time strategy game

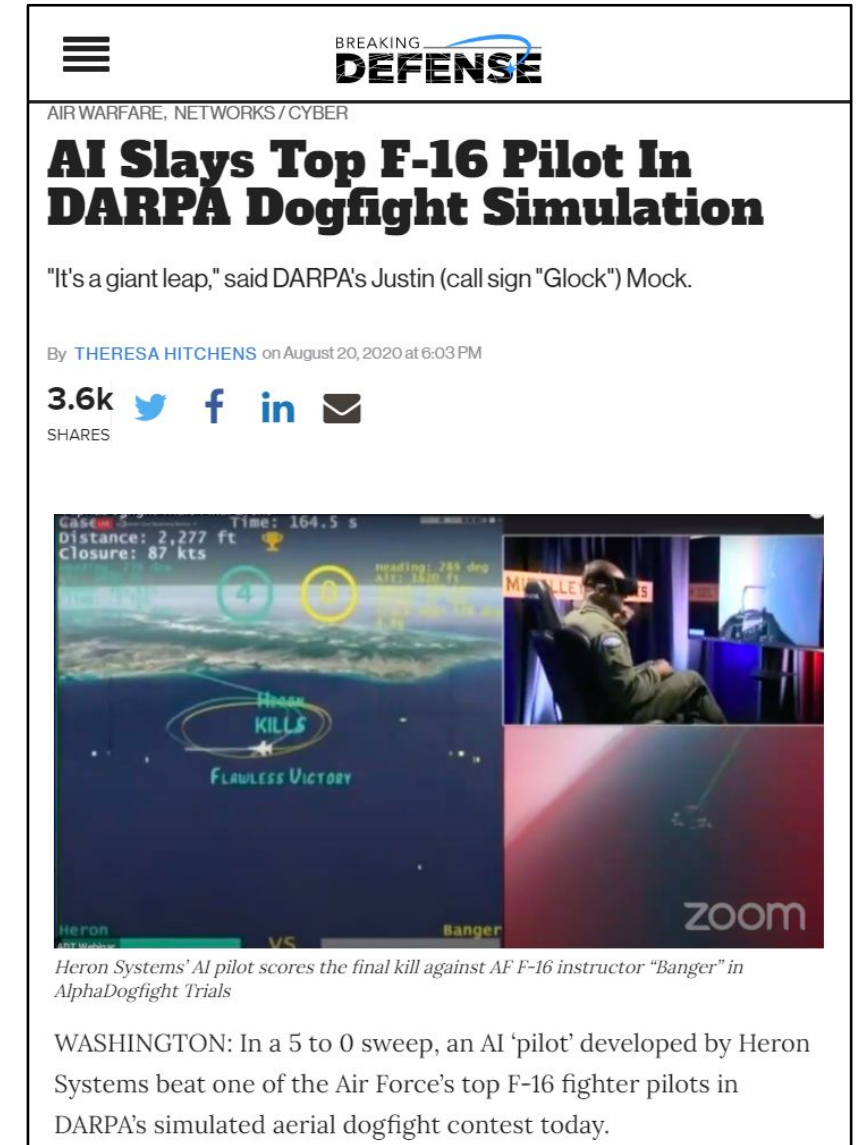
By **Nick Statt** | [@nickstatt](#) | Oct 30, 2019, 2:00pm EDT



# Redundant Pilots?



2016



2020

# Algorithms...

## Security

### Brit Watchkeeper drone fell in the sea because blocked sensor made algorithms flip out

Report scolds maker Thales for poorly understood software

By Gareth Corfield 15 Apr 2019 at 13:58

120 SHARE ▼



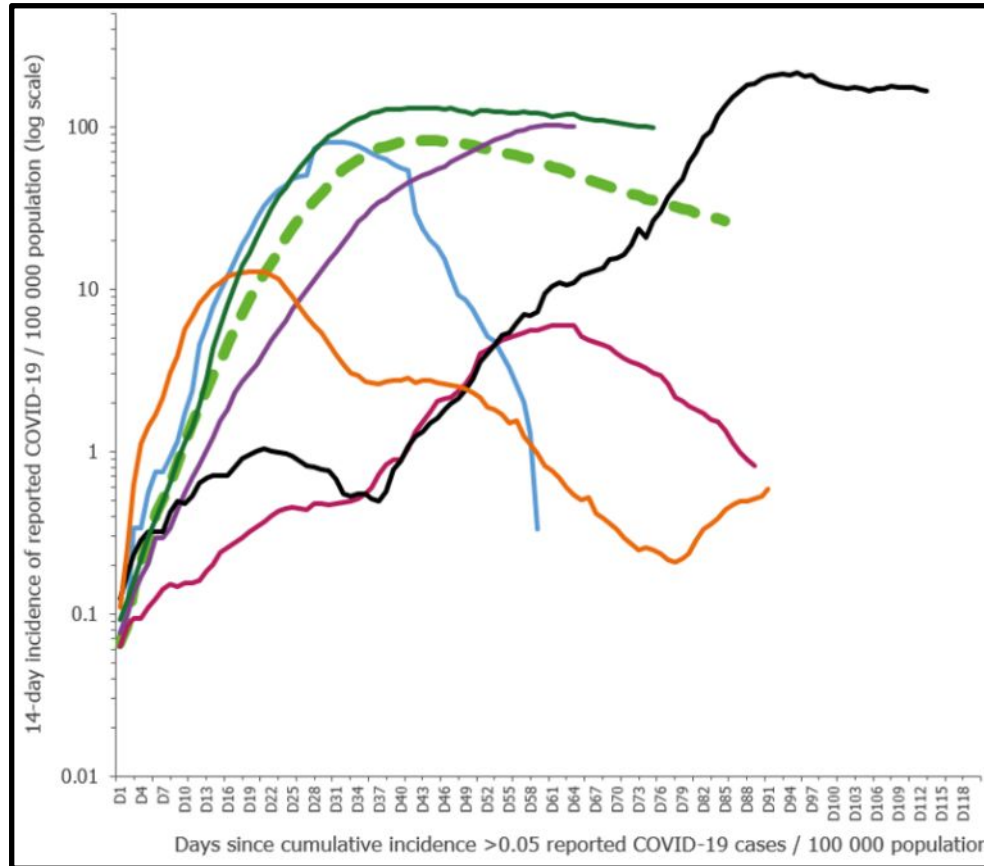
A Thales Watchkeeper drone. File pic, Crown copyright

Investigators concluded that one of its pitot probes used for reading the aircraft's speed and angle of attack (AOA) became blocked, causing the Watchkeeper's onboard flight control logic to enter an erratic series of climbs and dives until it stalled itself and flopped into the sea. They criticised the craft's maker, Thales, for not fully understanding how its algorithms responded to loss of accurate sensor data.

Air Marshal Susan Gray, director-general of the Defence Safety Authority, criticised the Ministry of Defence and Thales for their "incomplete level of detailed technical understanding" regarding the drone and its systems.

A British Army Watchkeeper drone stalled itself and crashed into the sea on a bad weather flight test, military investigators have said – though most of the wreckage was never found.

# AI Limitations



Artificial intelligence / Machine learning

## Our weird behavior during the pandemic is messing with AI models

Machine-learning models trained on normal behavior are showing cracks —forcing humans to step in to set them straight.

by Will Douglas Heaven

MIT  
Technology  
Review

May 11, 2020

Sign in

Subscribe

Topics Magazine Newsletters Events

In the week of April 12-18, the top 10 search terms on Amazon.com were: toilet paper, face mask, hand sanitizer, paper towels, Lysol spray, Clorox wipes, mask, Lysol, masks for germ protection, and N95 mask. People weren't just searching, they were buying too—and in bulk. The majority of people looking for masks ended up buying the new Amazon #1 Best Seller, “Face Mask, Pack of 50”.

When covid-19 hit, we started buying things we'd never bought before. The shift was sudden: the mainstays of Amazon's top ten—phone cases, phone chargers, Lego—were knocked off the charts in just a few days. Nozzle, a London-based consultancy specializing in algorithmic advertising for Amazon sellers, captured the rapid change in this simple graph.

# Monitoring Systems



The Register

{\* INTERNET OF THINGS \*}

## Army Watchkeeper drone flopped into tree because crew were gazing backwards

Live footage of runway and grass verge more compelling than actual flight instruments

Thu 29 Aug 2019 // 10:11 UTC

98 GOT TIPS?

Gareth Corfield BIO EMAIL TWITTER

SHARE

The latest British Army Watchkeeper drone crash happened because its crew became fixated on live footage from an onboard camera instead of their instruments, a Ministry of Defence report has revealed.

An internal Defence Accident Investigation Branch (DAIB) report detailed why the semi-autonomous aircraft, tail number WK050 and flown on the day by two Royal Artillery operators, crashed in June 2018.

The report, dated February 2019, was [published online](#) by the MoD after the BBC made a Freedom of Information request for it, leading to [news reports](#) over the past few weeks.

WK050 flopped into a tree just beyond the runway of Aberporth airport on the Welsh coast after its Army operators, under the supervision of contractors from a Thales joint venture company, cut its throttle immediately after the drone had landed and lifted off again.

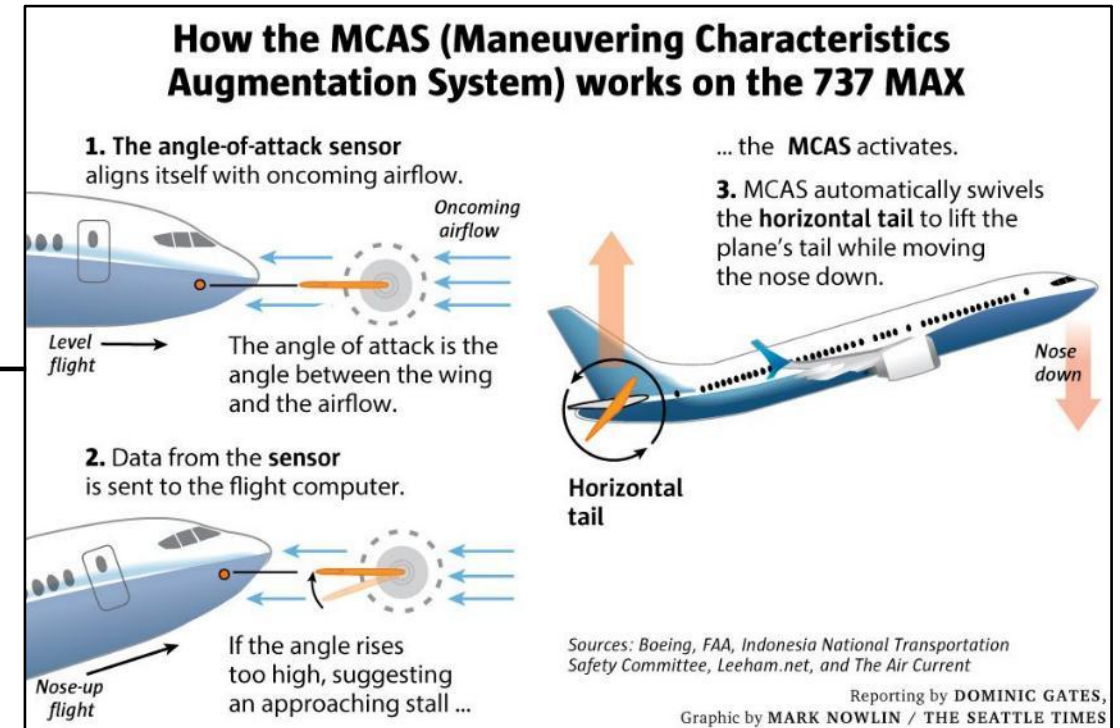
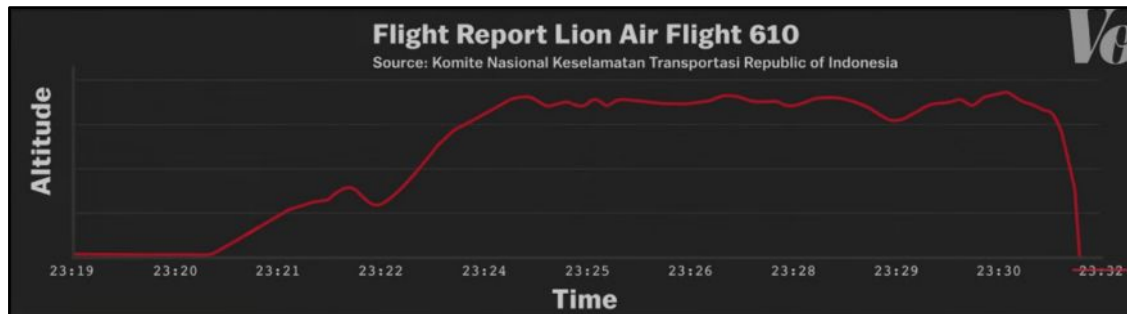
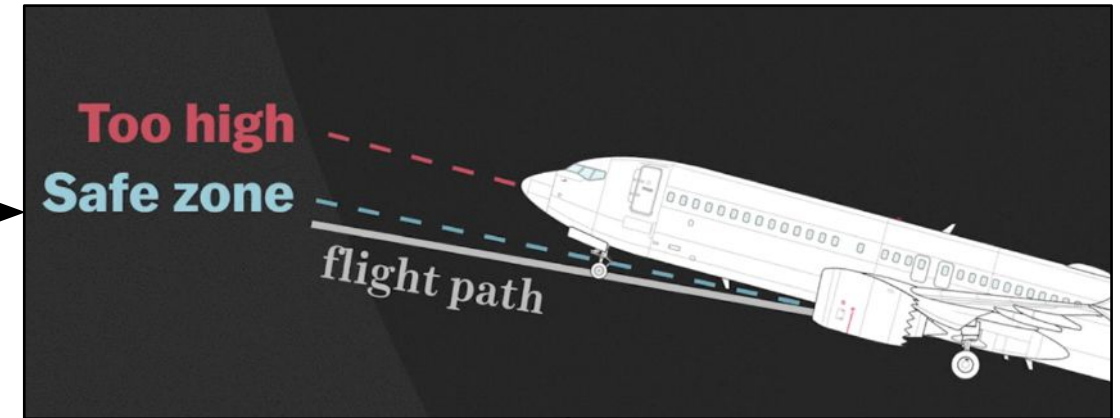
"Had no action been taken, the [Watchkeeper] would have completed its automatic go-around from which it could have been commanded to conduct a further approach," said the DAIB in its Safety Investigation Report, which was written by a major and a Warrant Officer 1 (WO1).



# Easier Controls? (MS Flight Sim)

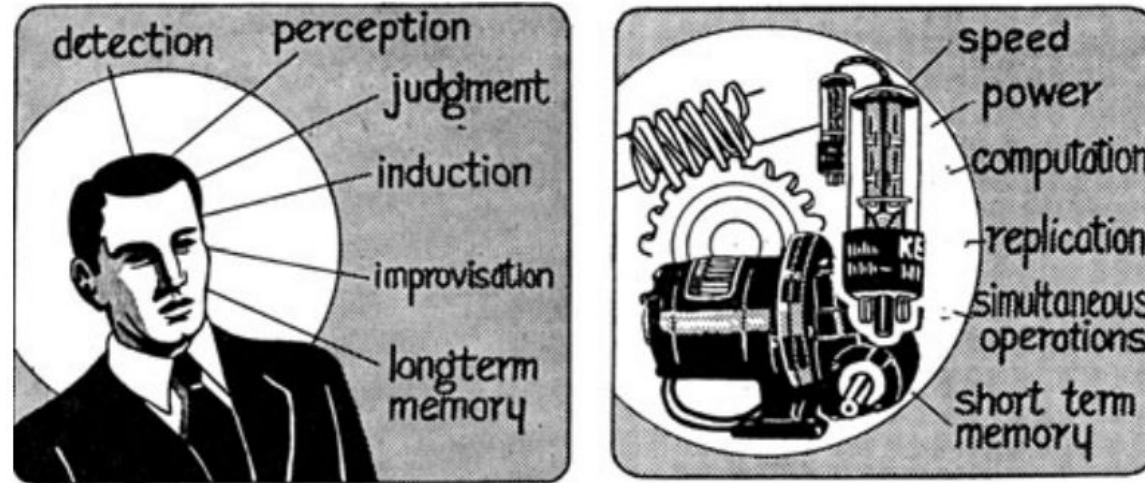


# Boeing 737 MAX



# Paul M Fitts (1951)

## Human Engineering for an Effective Air Navigation and Traffic Control System



- “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



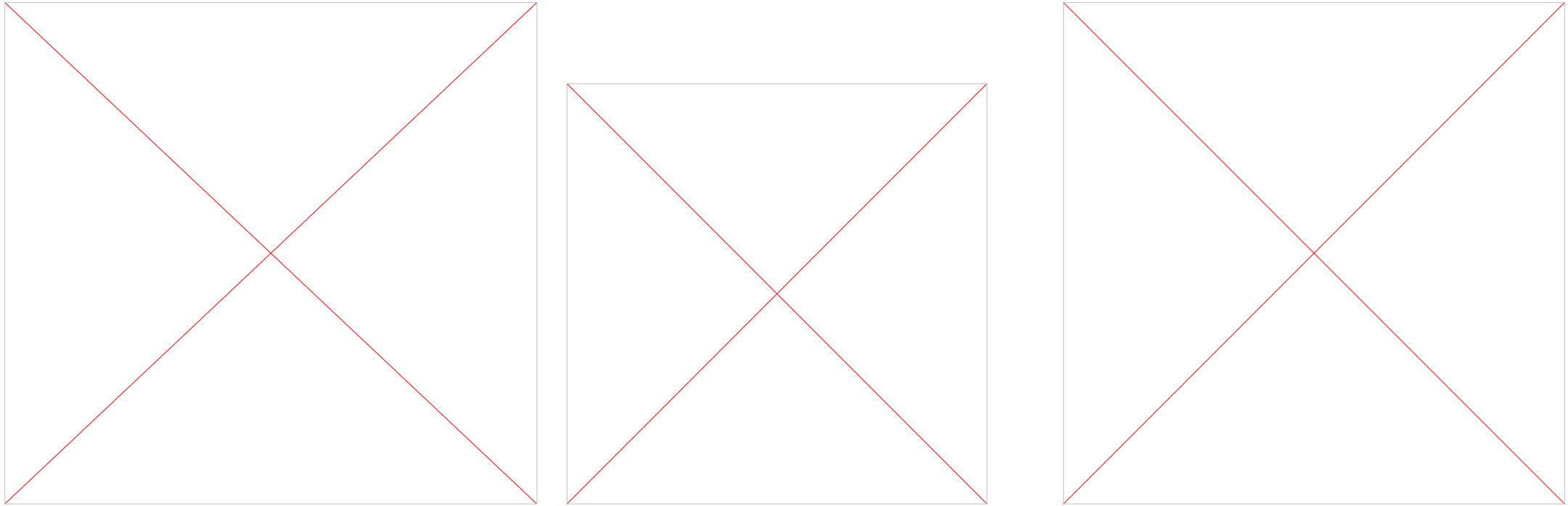
# Responding...

**"If I'm in the loop mentally I can respond more quickly than if I have to watch an automatic system and take over and then get my mind into the loop.**

**So I was more comfortable in flying a manual descent than an automatic descent... my mental computer is already running at full speed."**

**David Scott  
Apollo 15 Commander (1971)**

# Autonomy and Communications

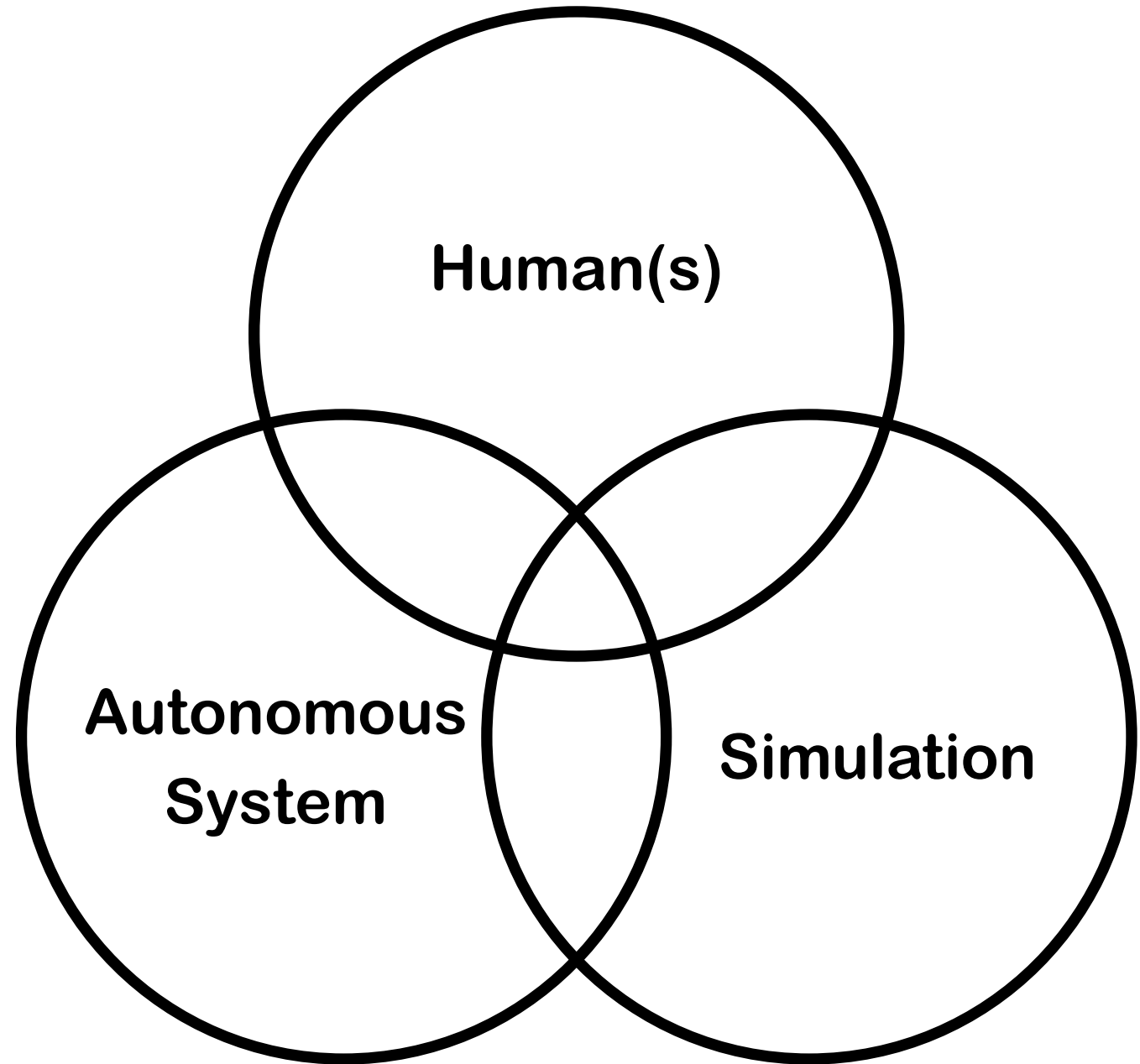


**The Human Needs to  
Understand What the  
Machine is Thinking(?)**

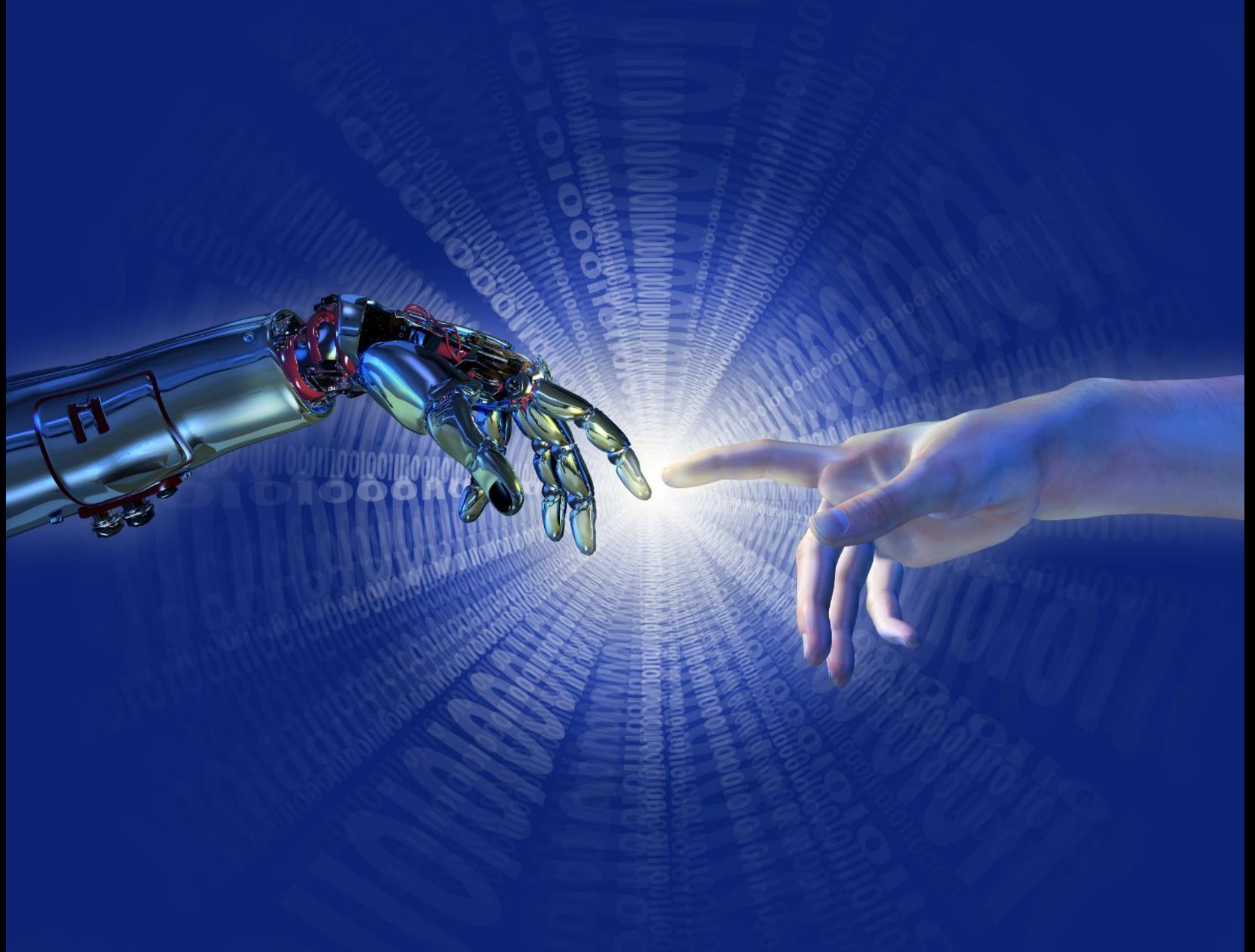
**Test & Train  
Test & Train  
Test & Train**

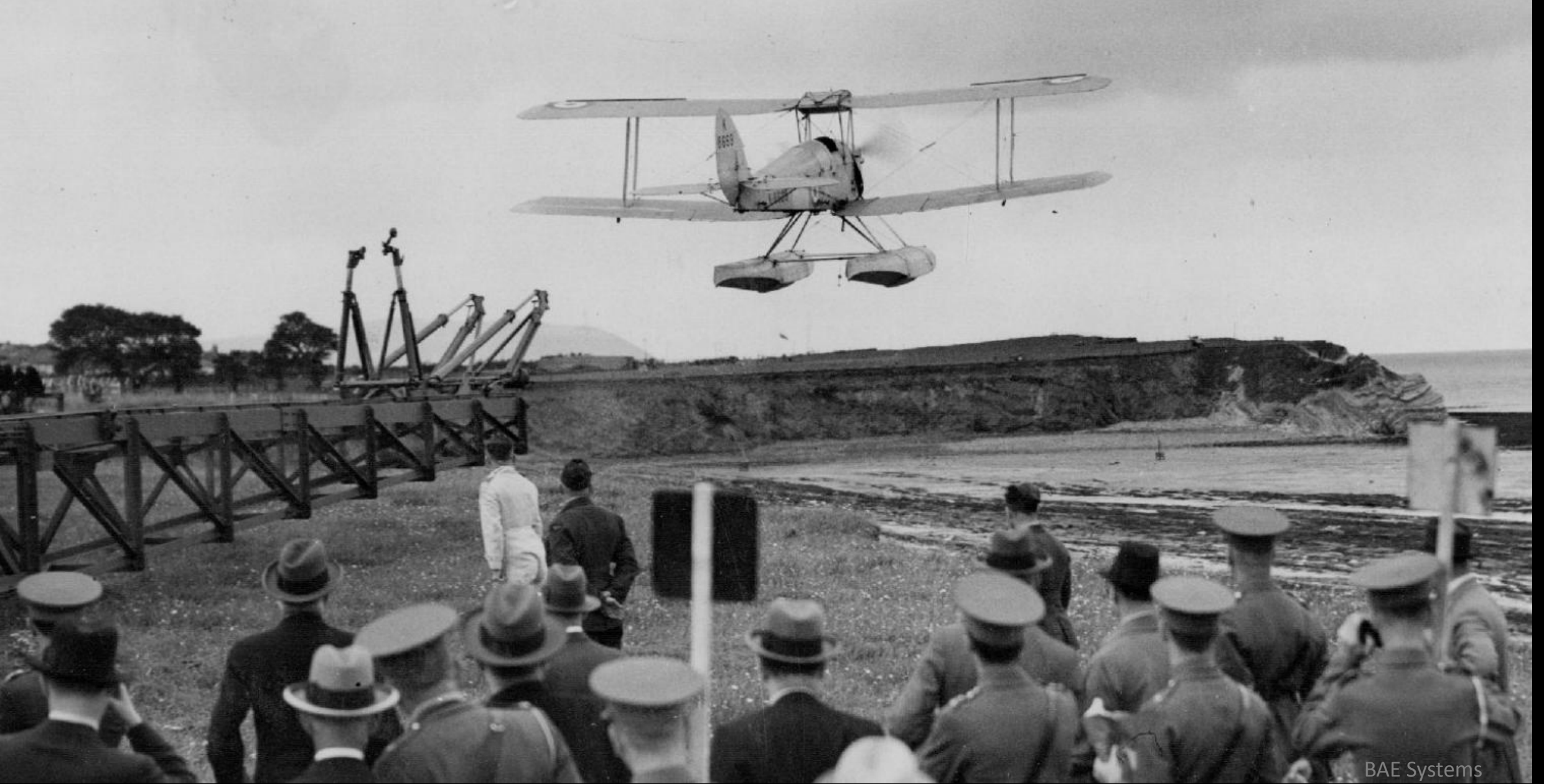
**.....**

**Test & Train**



**Maximise  
the  
Strengths  
of Both**





**Questions?**