

Queen Mary University of London
31 October 2025

Training and Simulation in Aerospace

Andy Fawkes
External Lecturer





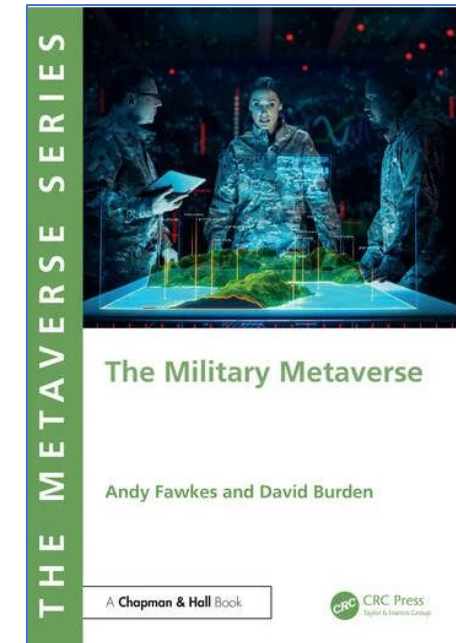
The Presenter

FIMechE
MRAeS

Previously



Now



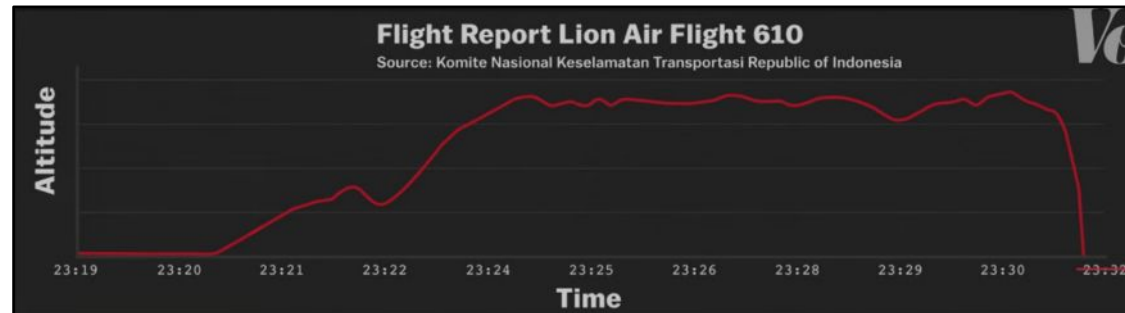
Humans & Flight - 1903



Storm Eunice – Bristol Airport – 18 Feb 22

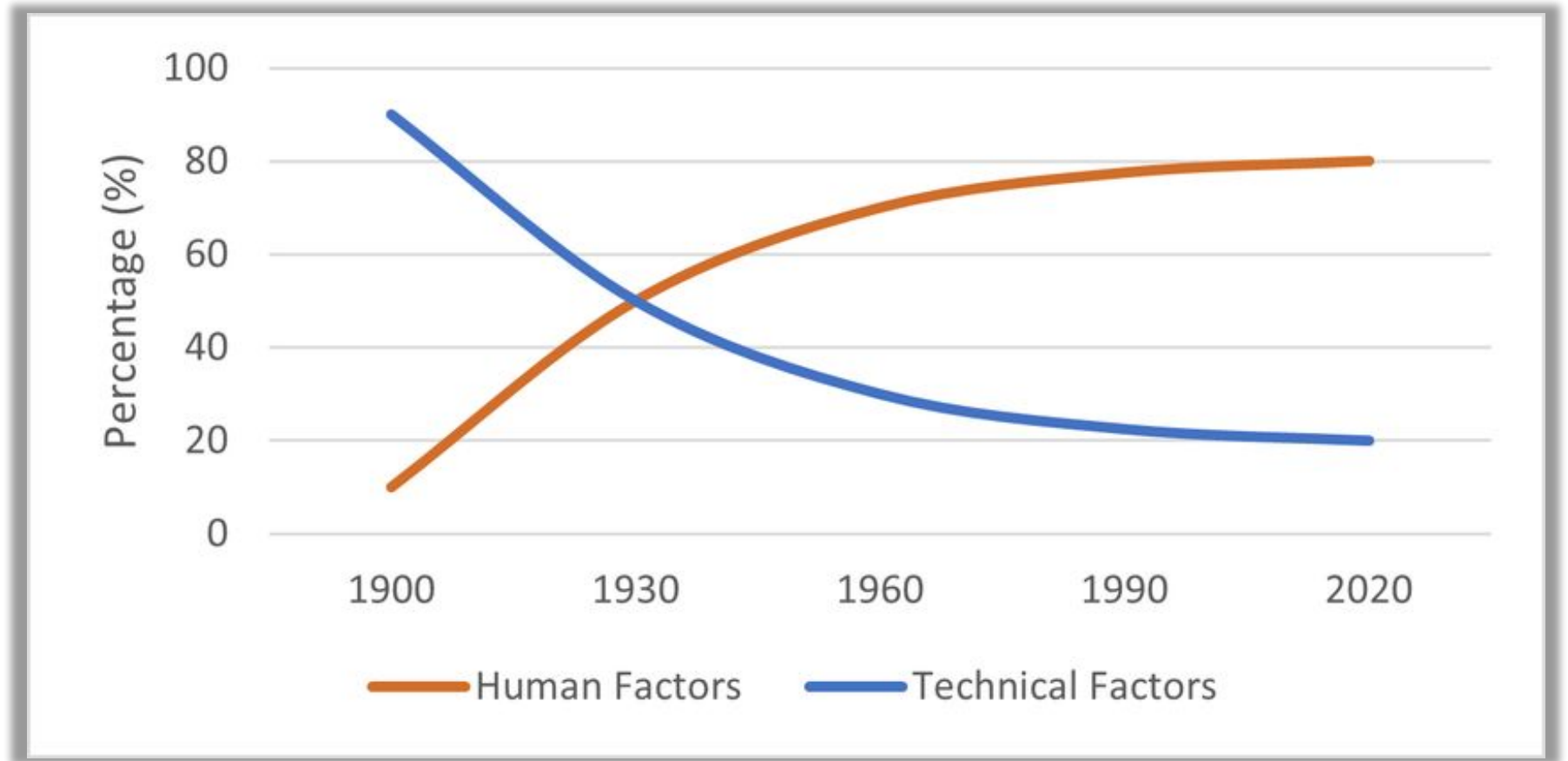


Boeing 737 MAX (2018 & 2019)



Humans and Aircraft

Evolution of Aviation Accident Causes



Drone Racing League (DRL)

&

Drone Racing League Simulator



Pilots of the Future?



- **What will they do?**
- **Who will they be?**
- **Where will they be?**
- **How will they train?**
- **Will we need them?**

Outline

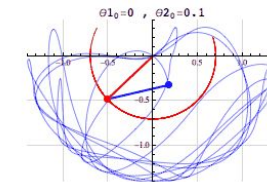
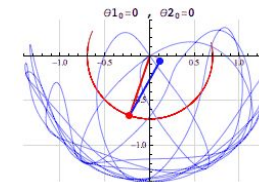
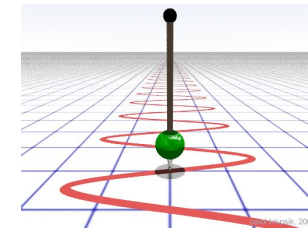
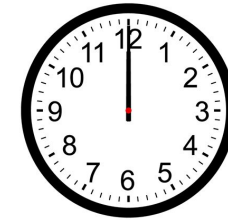
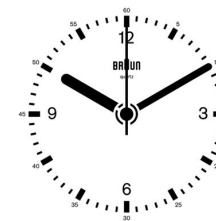
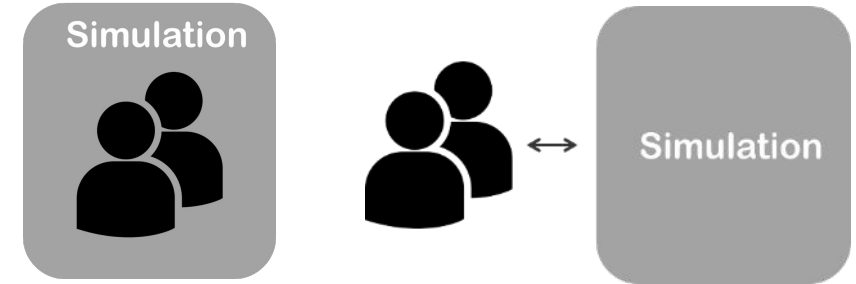
- 1. What is, and Why, Simulation?**
- 2. Past & Present of Fight Simulation**
- 3. Training & Simulation Futures**
- 4. The Human Dimension of Flight**
- 5. Thoughts on Careers**

1/5

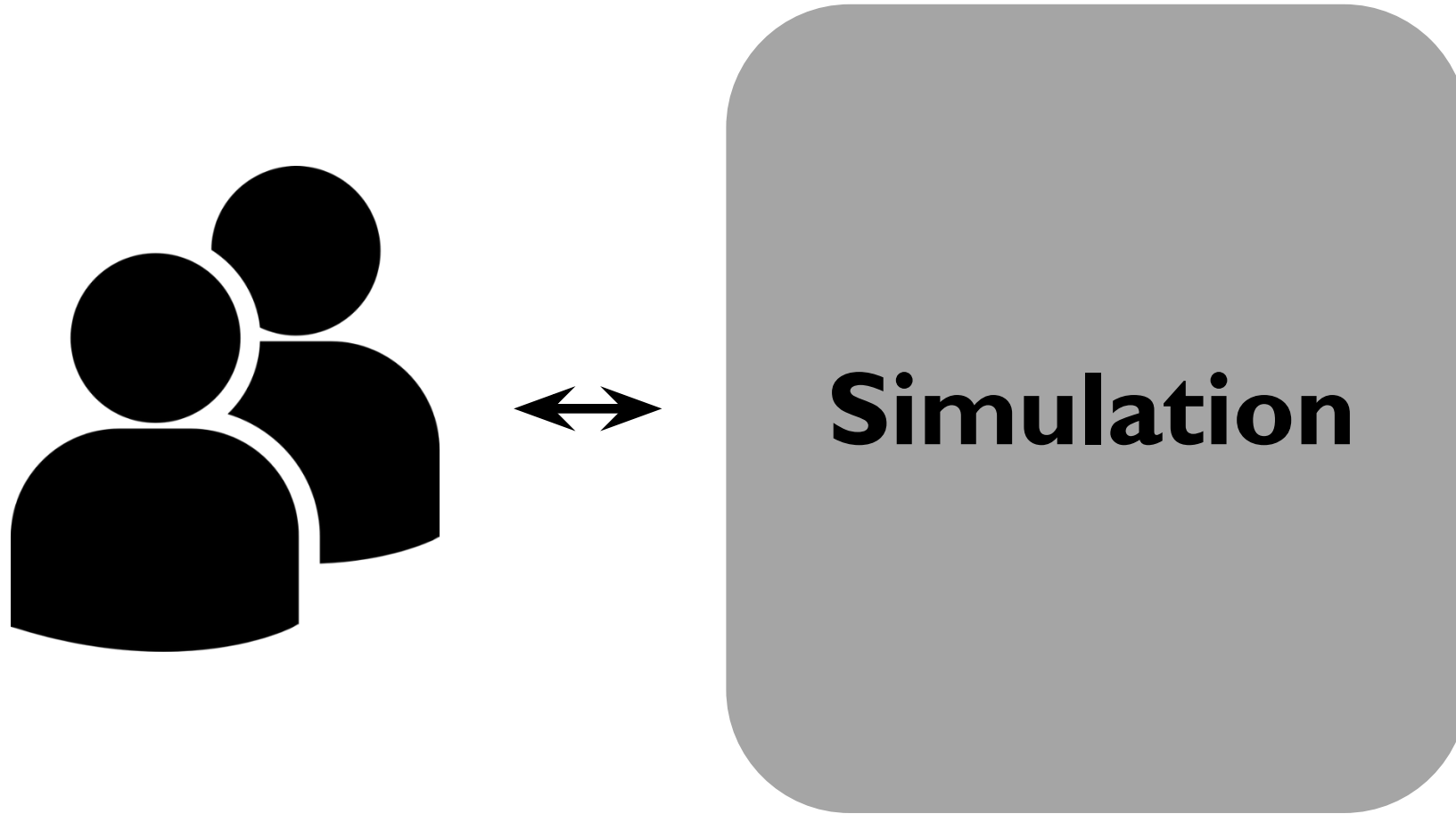
What is, and Why, Simulation?

What is a Simulation?

- Humans Inside or Outside
- Runs in Real or Non-Real Time
- Some Systems have Order
- Some Systems are Chaotic
- Some are Random

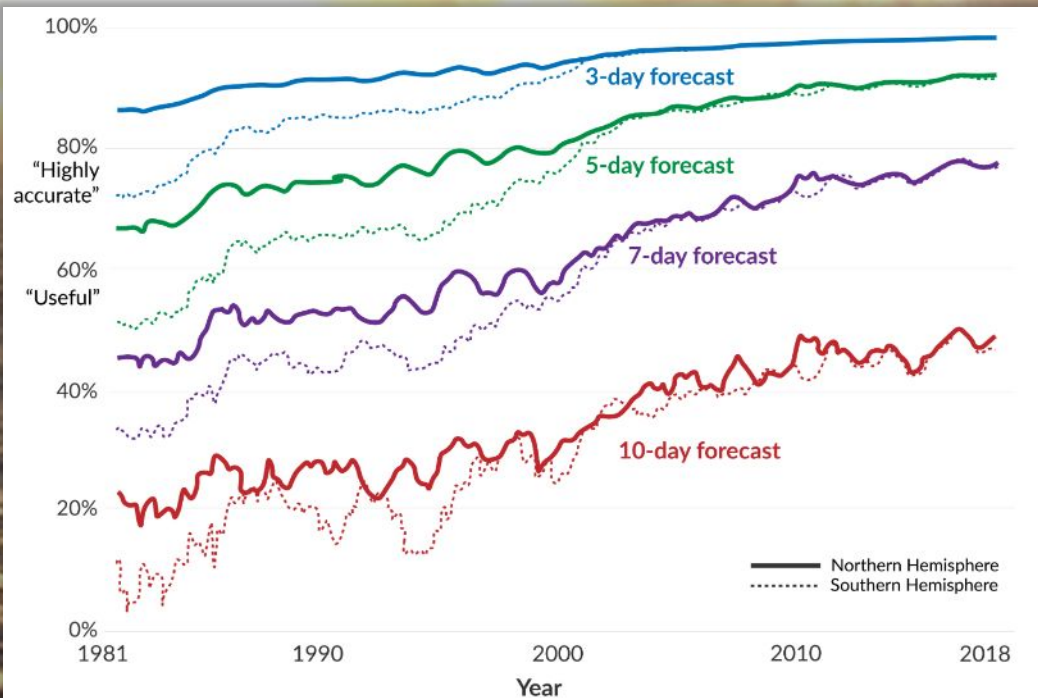


Human(s) Outside the Simulation



"Met Office's 4-day forecast is as accurate as its 1-day forecast was 30 years ago"

Met Office (15 Nov 2023)



Source: European Centre for Medium-Range Weather Forecasts (ECMWF).

Licensed under CC-BY by the author Hannah Ritchie.

Human(s) Inside the Simulation



Flight Simulator



Simulation Technology Drivers

- Computing
- Games
- Networking
- Graphics
- Audio
- Human Interfaces
- Sensors
- AI and Data



Why Flight Simulation?

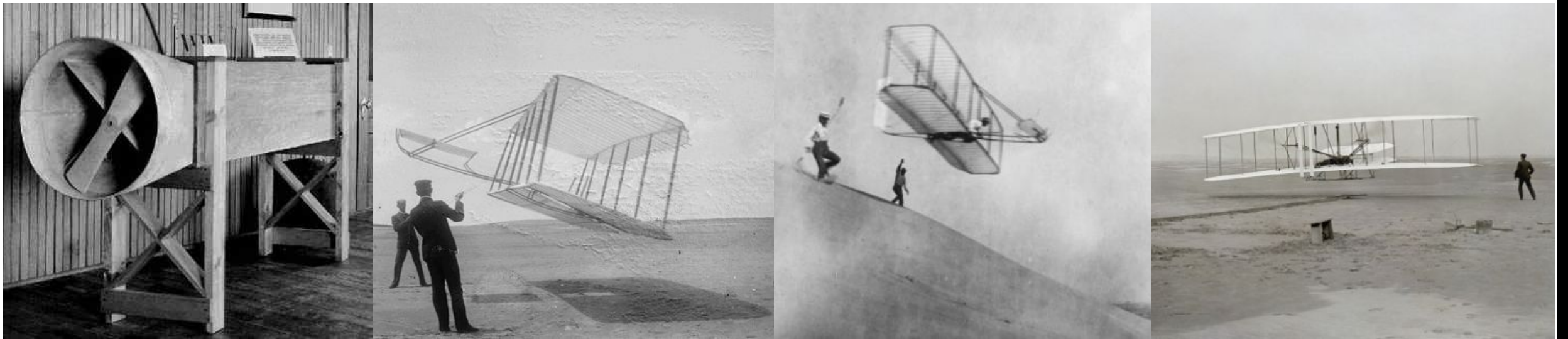


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Past & Present of Fight Simulation

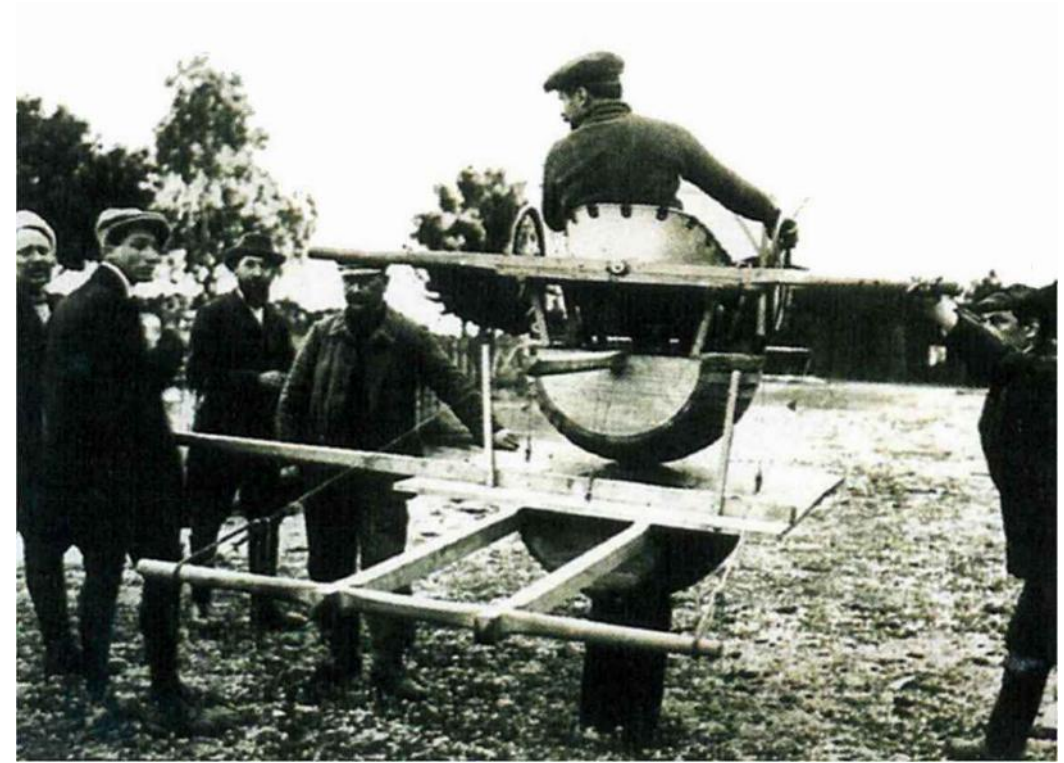
1903 – Wright Brothers

- Test
- Train
- Fly



1910s

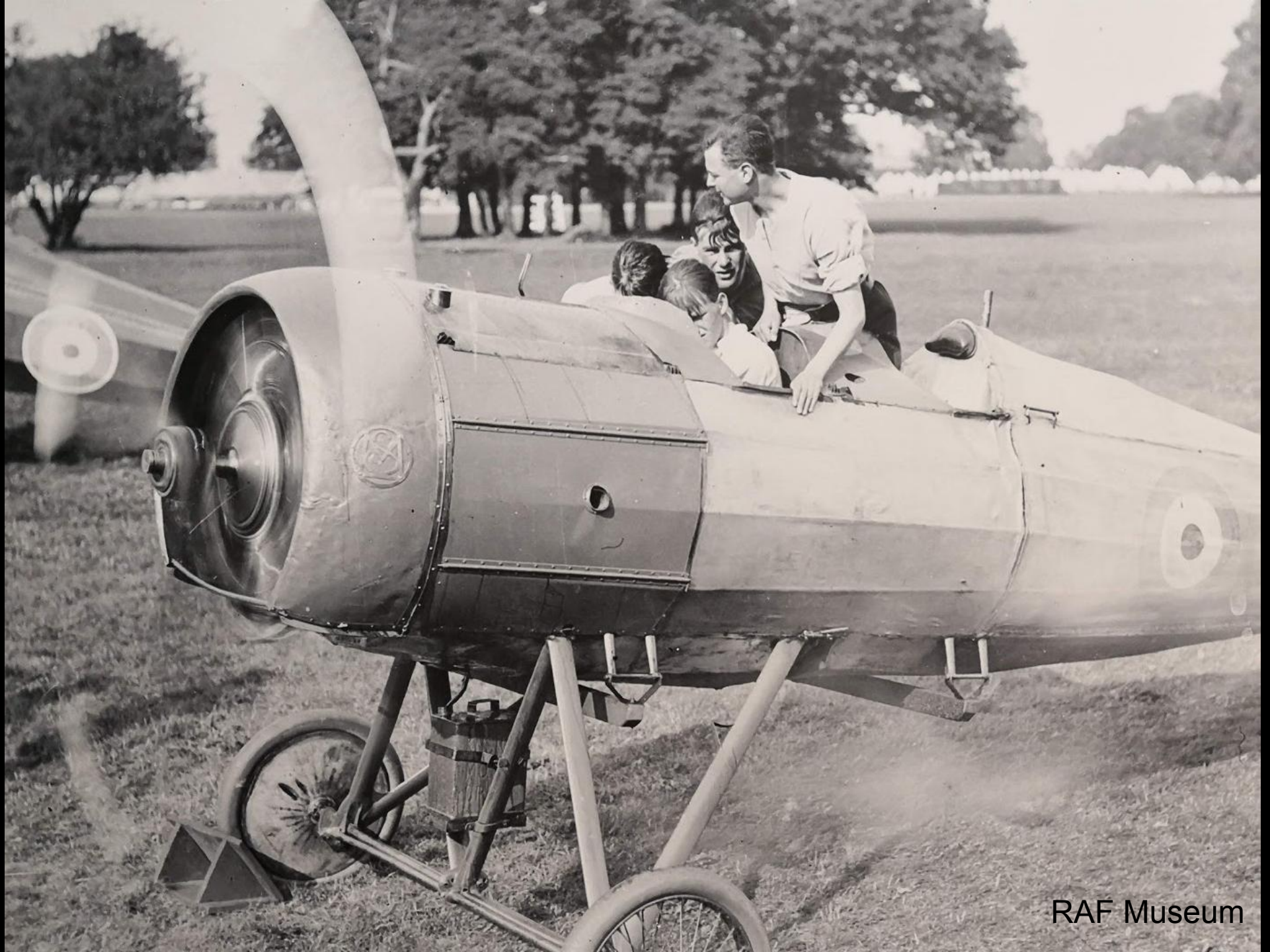
Leon Levavasseur's Antoinette Barrel – France 1910



**1918 -
“Penguin”**

**Cadets and
Instructor**

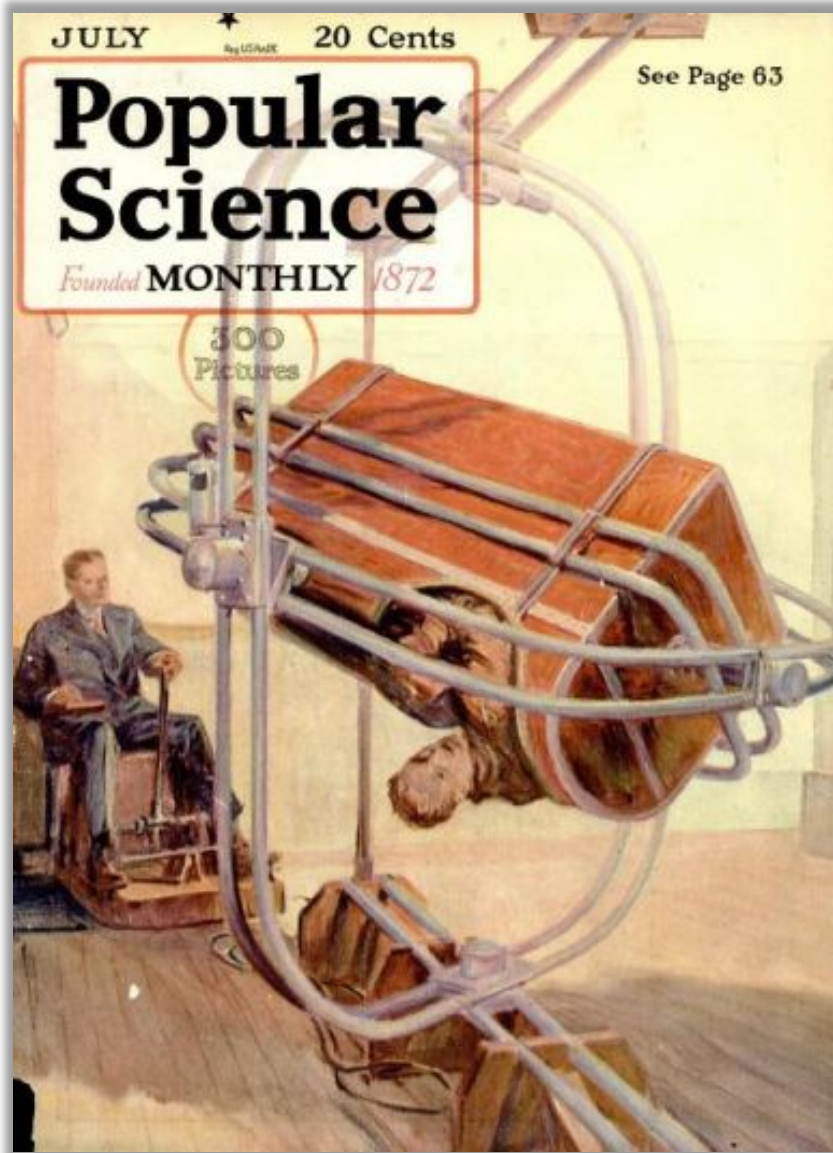
**No.1 School of
Aeronautics,
Reading**



RAF Museum

THINKE

Popular Science - July 1919



Ruggles Orientator

“90% of the flying casualties during the war were caused not by bullets, or badly built machines, but by "the failure of the man”

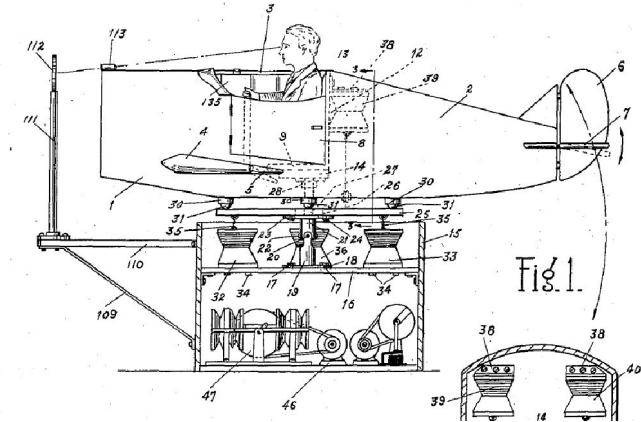
Maj.-Gen. George W. Squier

1920s/30s – Edwin A Link

- Trainer based on Automatic Piano technology
- 1931 Patent “Combination Training Device for Student Aviators and entertainment Apparatus”
- The Link Trainer came into widespread use during WWII
- 10,000 trainers used to improve safety and shorten training time for over 500,000 pilots

Sept. 29, 1931.

E. A. LINK, JR.
COMBINATION TRAINING DEVICE FOR STUDENT
AVIATORS AND ENTERTAINMENT APPARATUS
Filed March 12, 1930 4 Sheets-Sheet 1



WW2 Link Trainer

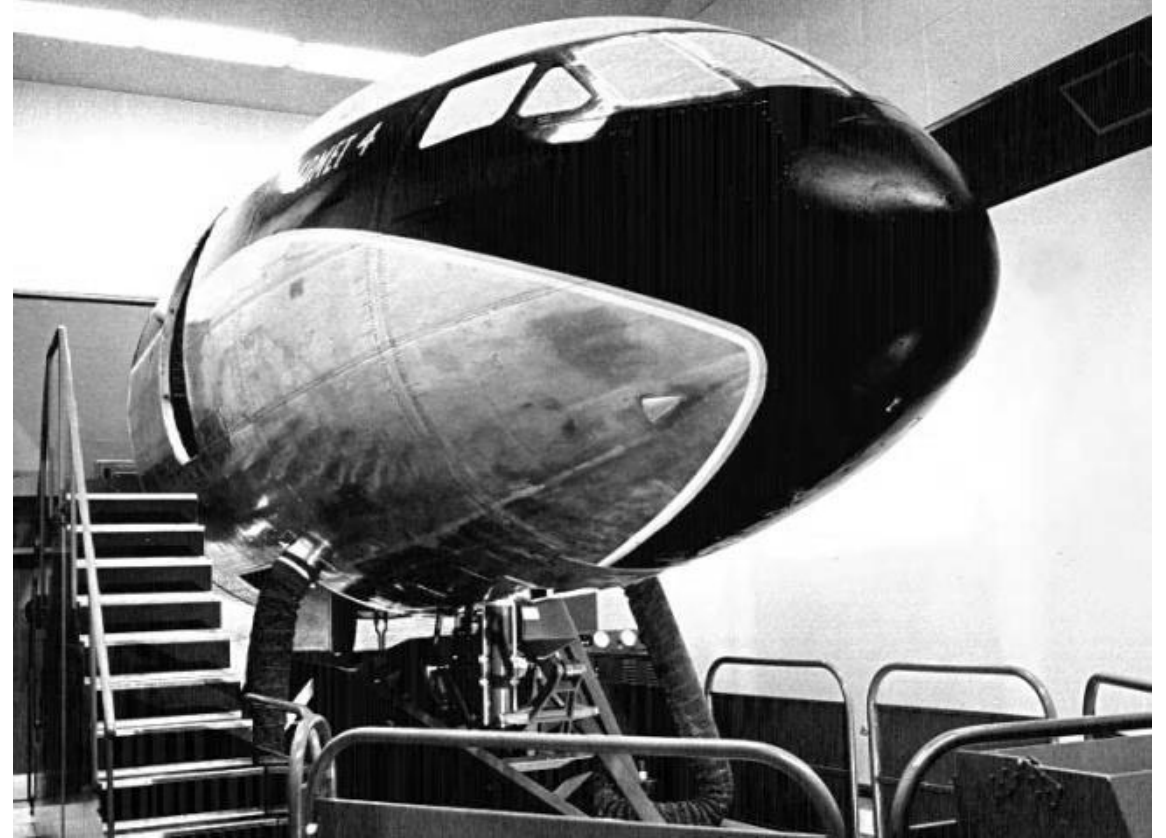


Queen Bee Drone – 1930s/40s



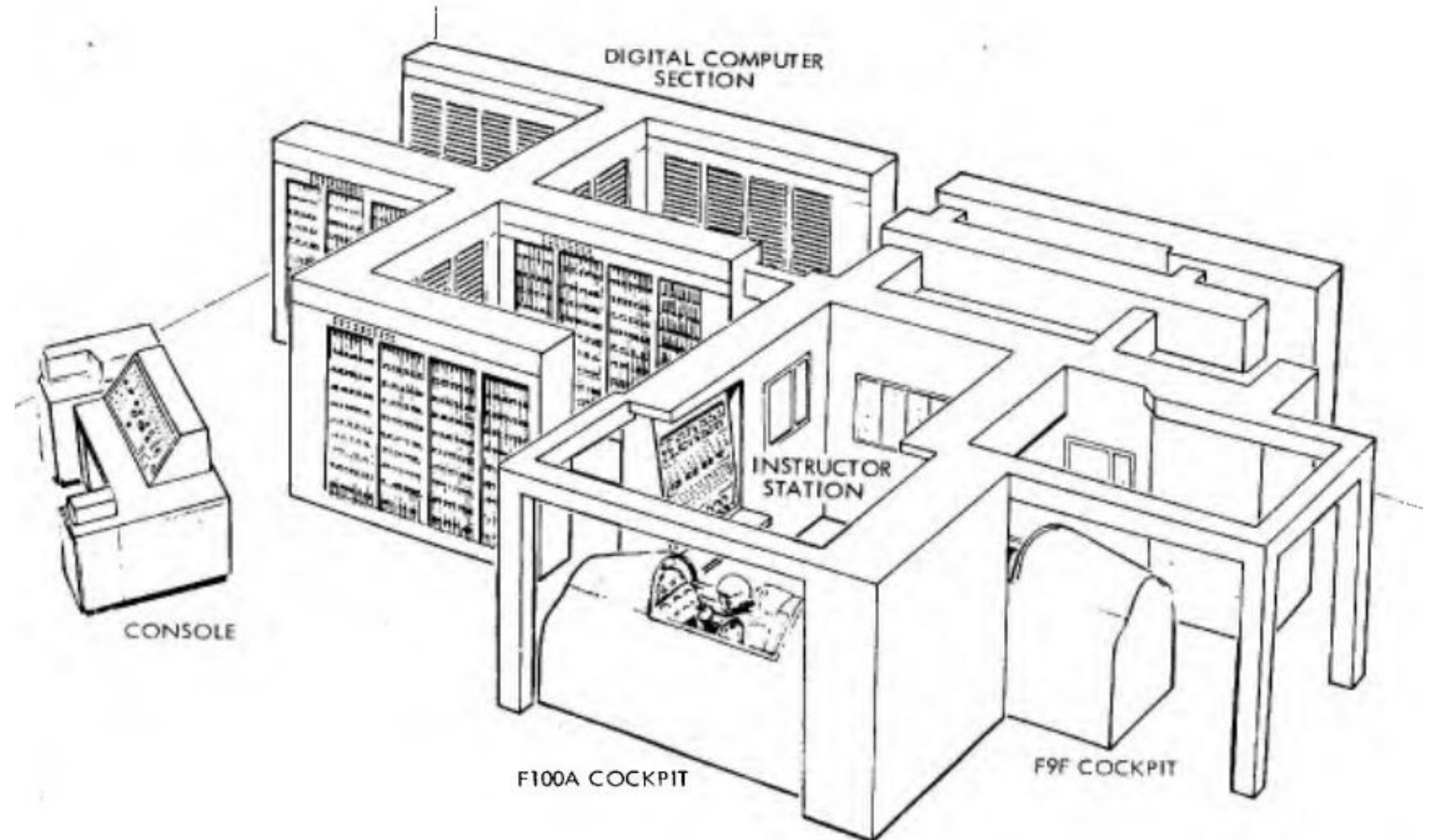
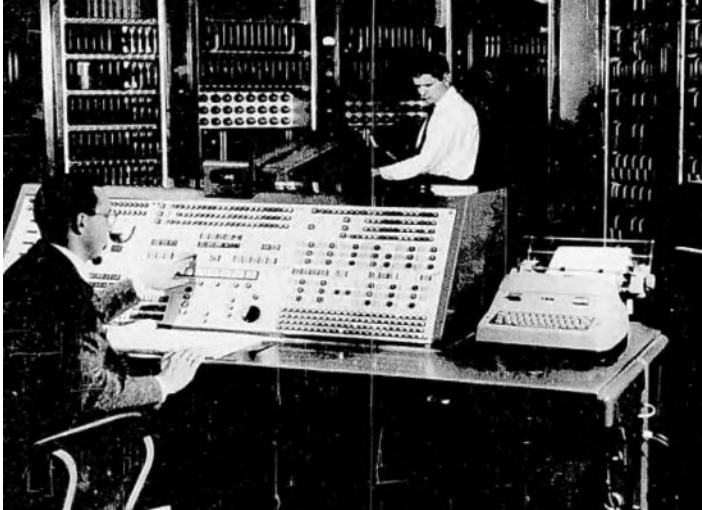
1950s

- Analogue to Digital Computing
- More complete Aircraft Data
- Motion Simulators



1960

USAF/USN Universal Digital Operational Flight Trainer (4 years, \$2m)



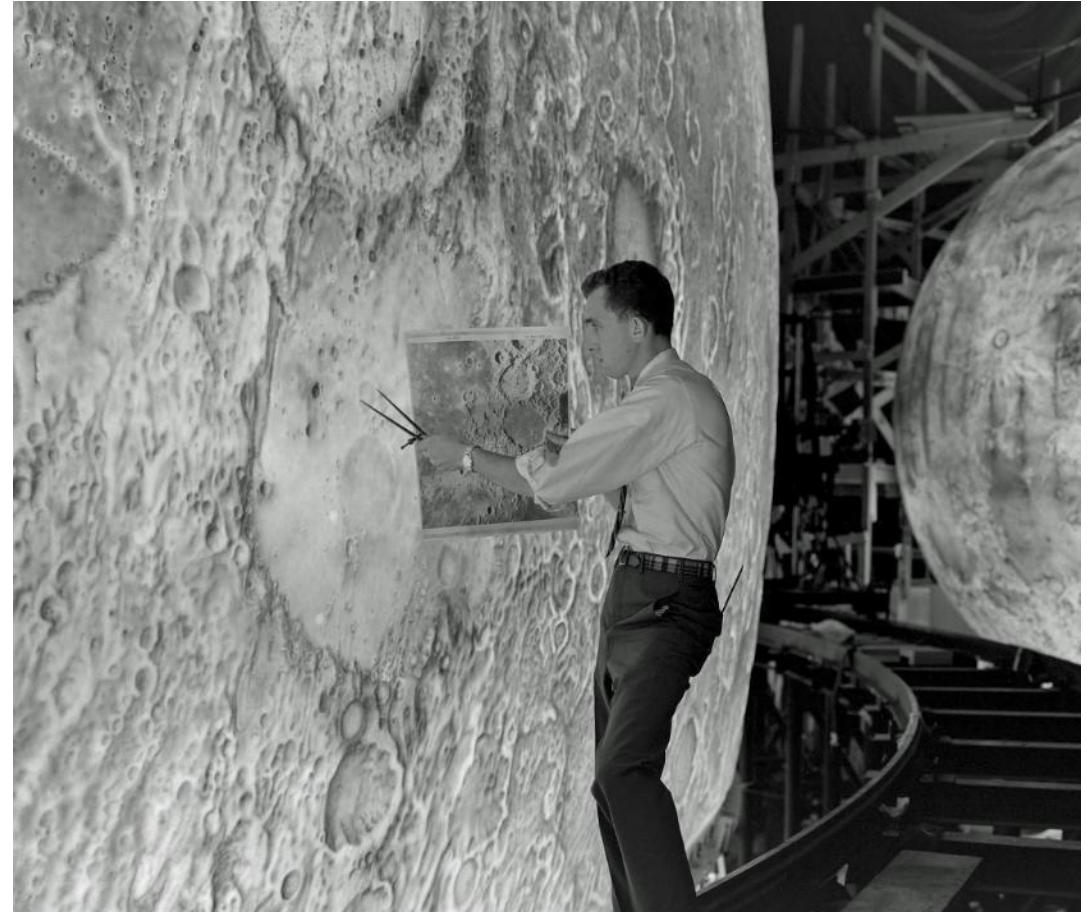
Spacewar! - 1962

- Generally considered the first Shooter game
- The basic PDP-1 model cost US\$120,000 (\$1.25m in 2024)



1960s

NASA Moon Landing Simulator



SR-71 Blackbird

Fred Forehand, Singer-Link's SR-71 PM:

- “They created the mission upstairs, and the tape they produced for the simulator was the same tape used onboard in the aircraft computer.”



1970s/80s Flight Simulation

BBC Open
University
“Million
Pound Man”
(1980)

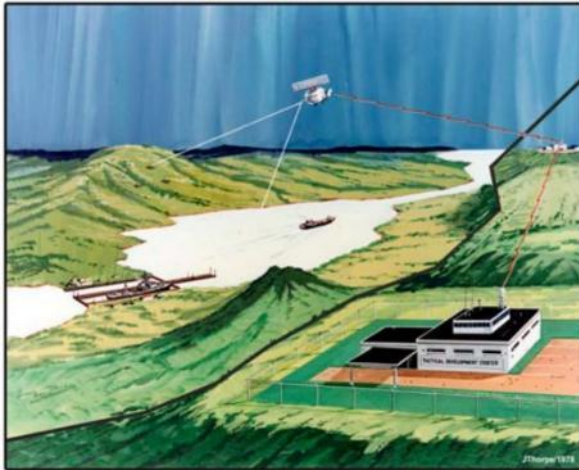
1960/70s

REDIFON



THINKE

USAF Capt Jack Thorpe's White Paper (1978)



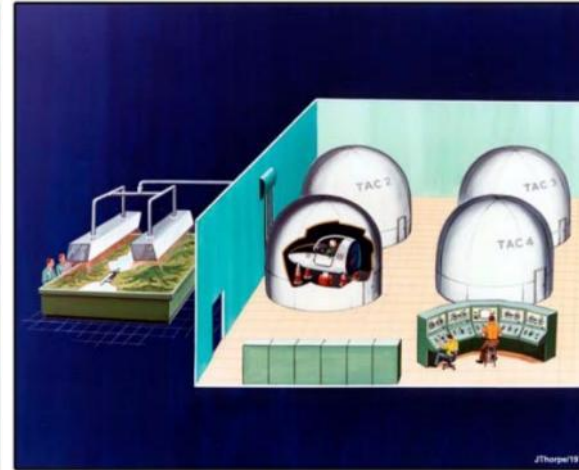
1

Enemy aggression
detected by overhead
sensor



2

Planning a response
using the holographic
electronic sand table



3

Air crews rehearse
the plan and planners
assess suitability



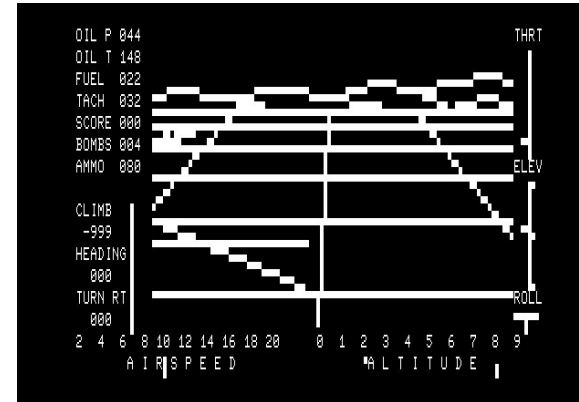
4

Mission execution
with real time
observation

(Microsoft) Flight Simulator



**subLOGIC Flight Simulator 1 for
Apple II, 1979
(sold Jan 80)**



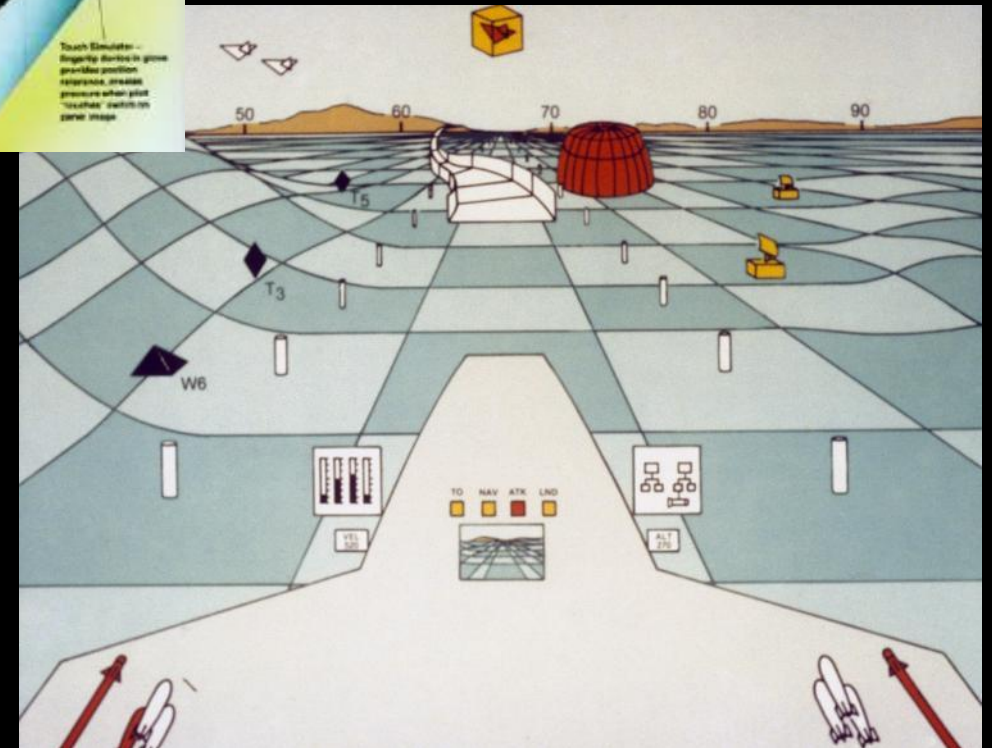
**subLOGIC Flight Simulator 1 for
TRS-80, 1980**



Microsoft Flight Simulator 1.00, 1982



USAF Super Cockpit Program 1986-89



Rift Drone (2014)

AR.Drone 2.0
Oculus Rift
Unity

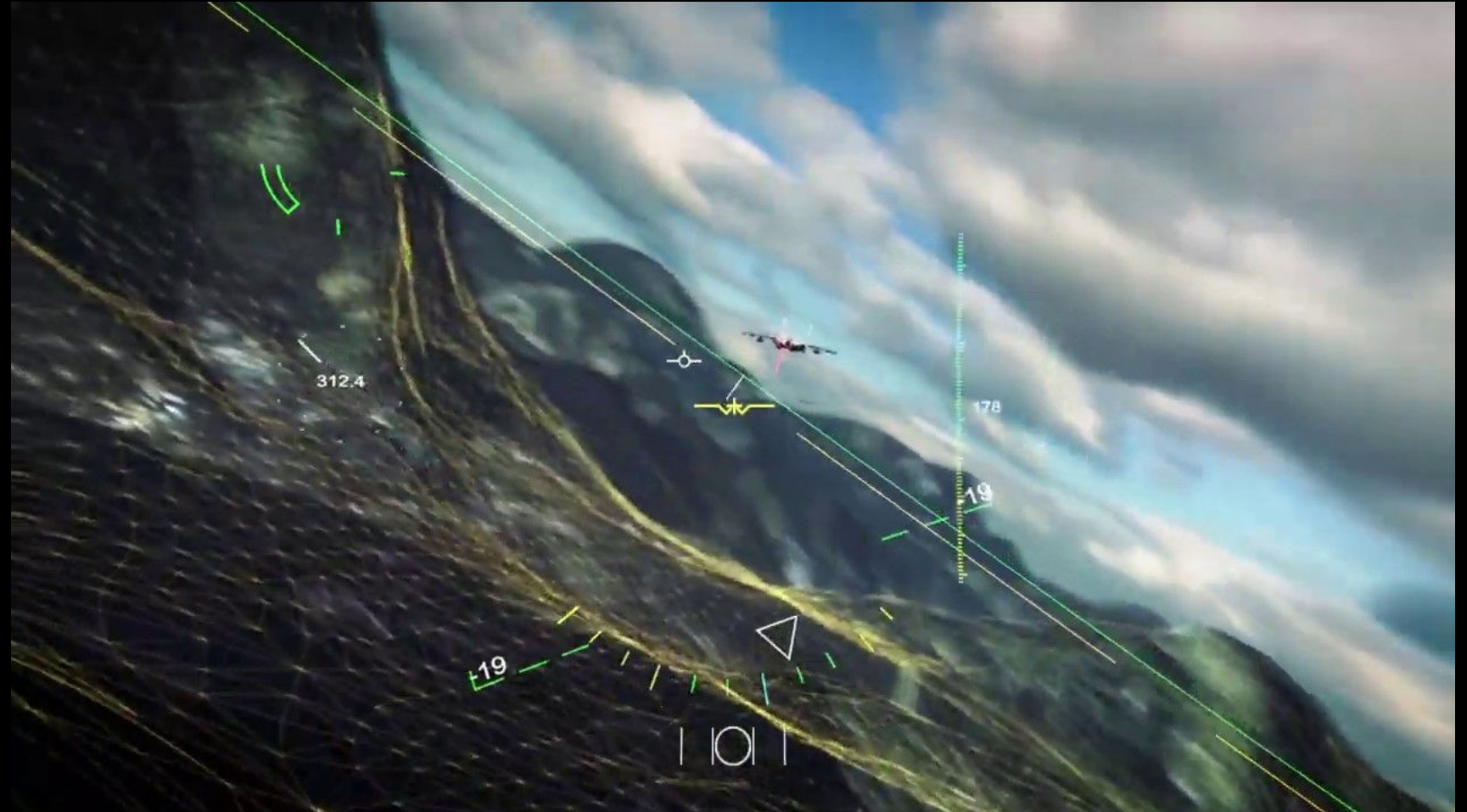
Xbox 360 Controller
Open-Source Software

<https://github.com/daraosn/oculus-drone>



https://youtu.be/3WmQ1_8ytaM?si=nsmukHRH8IEMII33

BAE Systems' Striker® II Helmet-Mounted Display (HMD) – Late 2020s



Simulation Now - Land, Sea, Air, Anywhere



Consumer Flight Simulation Now



Unreal Games Engine Software in CAE Flight Simulator (now)



Fast Jet Training at RAF Valley (UK)



Full Flight Simulator (FFS)

- 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
- 1795 Fixed and Rotary FFSs in 2023



VR for Professional Use



HalldaleGroup

Pioneering simulation training, education, and learning

[Shop](#)

[Civil Aviation](#) ▾

[Defence](#) ▾

[Safety Critical Training](#) ▾

[Performance](#)

[Magazines](#) ▾

EASA Qualifies World's First VR Flight Training Device



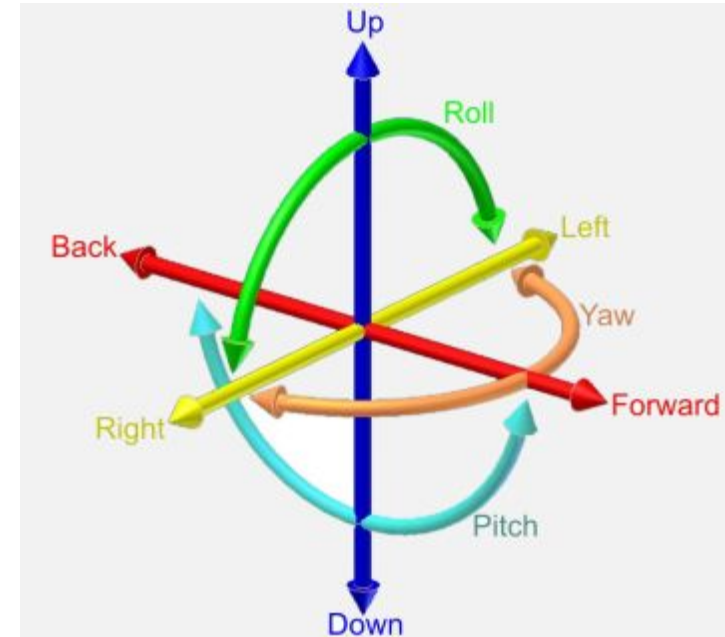
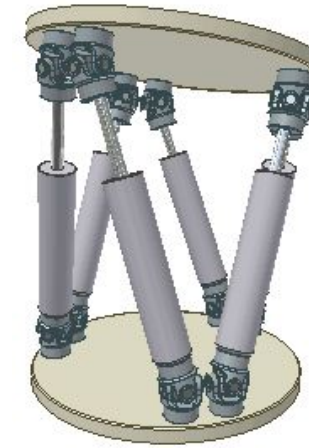
EASA calls the VRM Switzerland Virtual Reality FSTD qualification "a further step towards Agency and industry objectives to improve overall rotorcraft safety by 50% by 2028." Image credit: VRM Switzerland.

[RICK ADAMS](#)

APRIL 26, 2021

VRM Switzerland has received approval from the European Union Aviation Safety Agency (EASA) for pilot training credits in a type-specific Robinson R22 virtual reality flight simulation training device, the world's first VR-driven FSTD to receive approval from an aviation regulatory authority.

Stewart Platform - 6 Degrees-of-Freedom



High-G Motion Simulator v Zero-G Simulator

Flight Simulation Without Physiological Stresses...
Is Not Flight Training

With Stress		VS	Without Stress	
Aircraft	Pilot		Pilot	Aircraft
2.15 G	2.15 G		1.00 G	1.8 G
				

The diagram illustrates the difference between high-G and zero-G flight simulators. On the left, the 'With Stress' simulator shows a pilot and aircraft both experiencing 2.15 G. On the right, the 'Without Stress' simulator shows a pilot at 1.00 G and an aircraft at 1.8 G. A central 'VS' graphic with arrows points to a 'Battlepace' diagram, which shows a yellow arrow (representing high-G) and a blue arrow (representing low-G) in a circular path. The 'With Stress' simulator includes a small inset image of a ship, while the 'Without Stress' simulator includes a small inset image of a building.

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Training and Simulation Futures

**Who Owns
the
Technology
Future in this
Space?**

- Military & Aerospace?
- Commerce & Entertainment?

Themes

XR

Virtual Worlds

Digital Twins

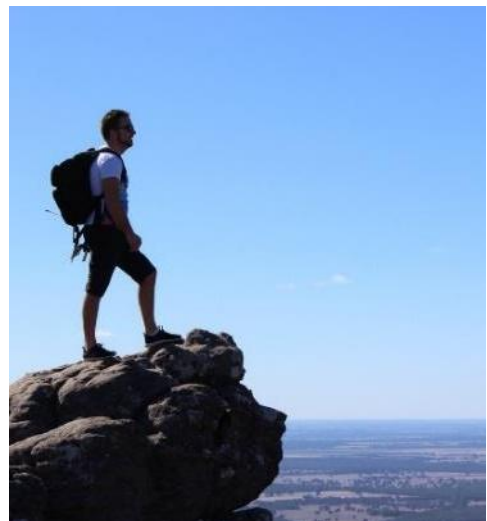
**Open
Ecosystems &
Standards**

AI

eXtended Reality (XR)

Reality

The physical world



Augmented Reality

Information layered over physical world



Mixed Reality

Blend of real & digital information



Virtual Reality

Fully virtual world





First Person View (FPV) Controlled Drone (Wikimedia)

Ukraine's
Defense
Ministry plans to
purchase 4.5
million FPV
drones in 2025



XR Gaming Skills

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Call of Duty: Defence secretary John Healy wants online gamers to join up for real to become drone pilots as he plans to ease entry requirements for 'console warriors'

By [DAVID WILCOCK](#), DEPUTY POLITICAL EDITOR FOR MAILONLINE

PUBLISHED: 14:28, 22 September 2024 | **UPDATED:** 14:28, 22 September 2024



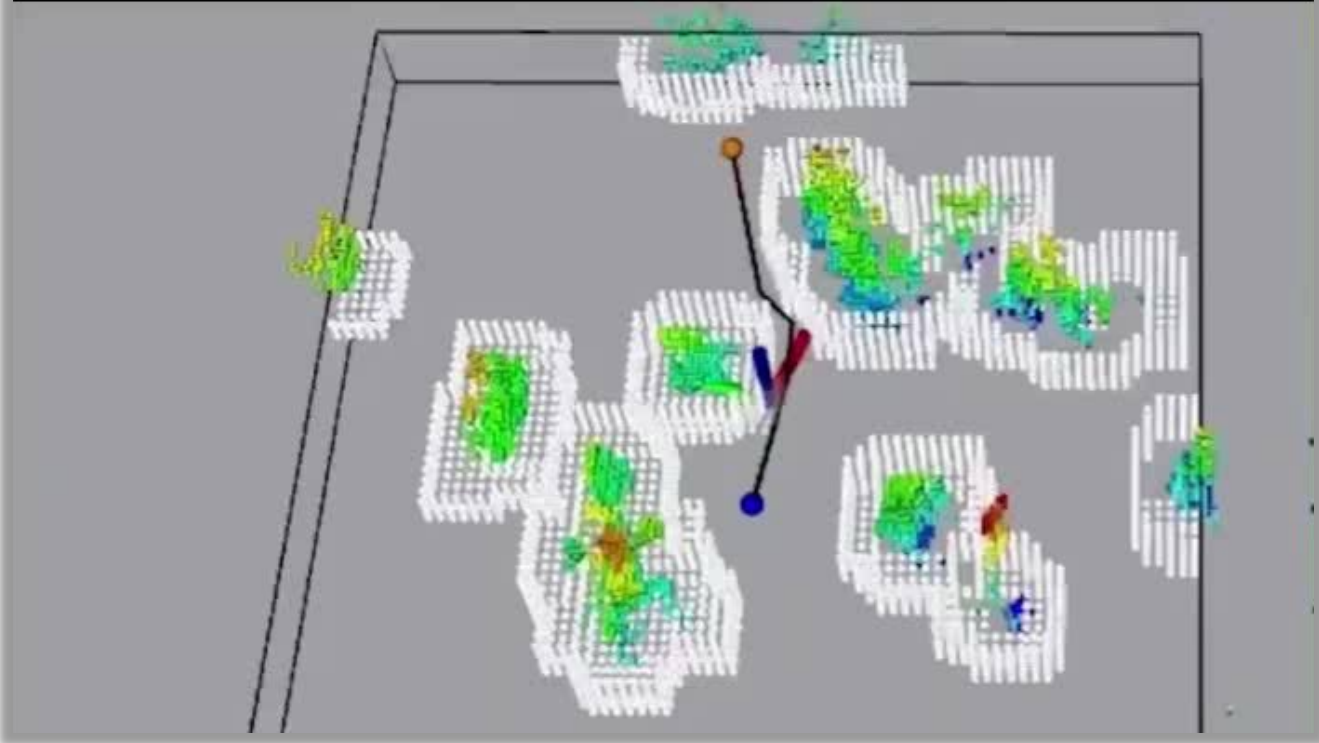
Share



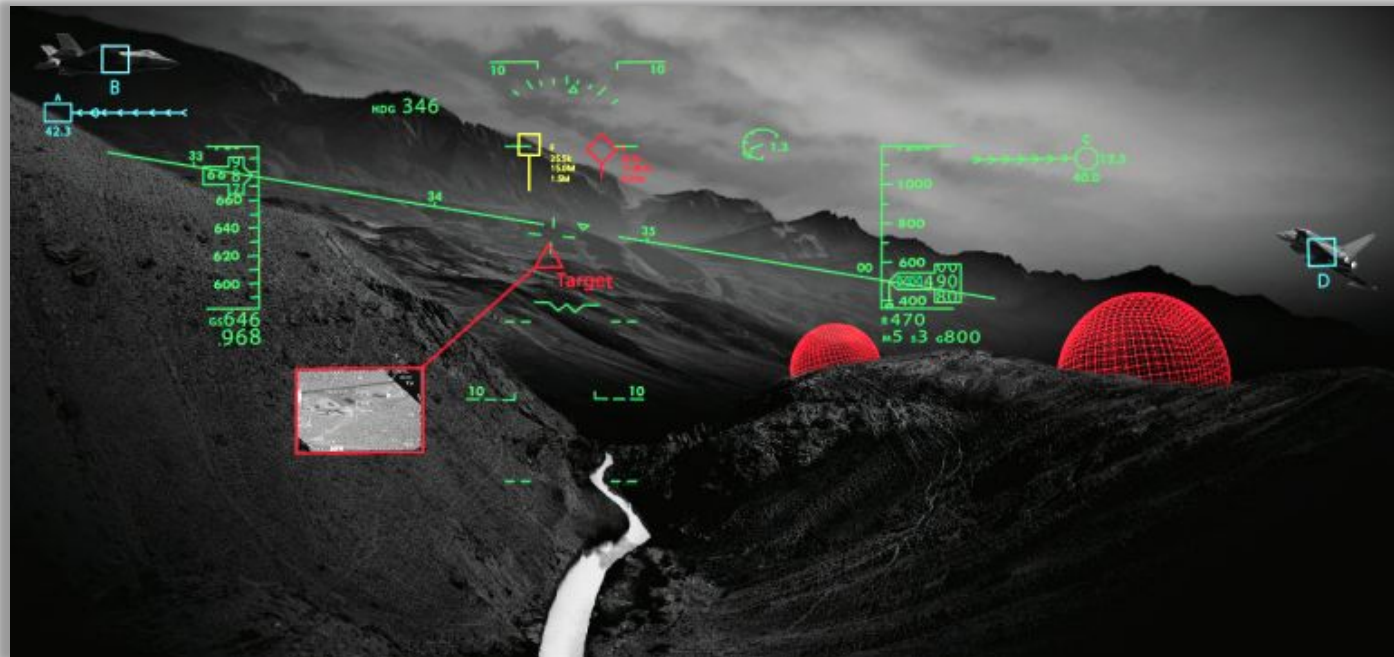
51
shares

129
View comments

Performance Drone Works (PDW)



BAE Systems Striker® II



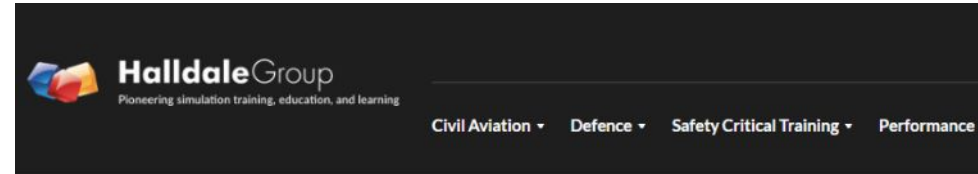
Other Crew (CAE)



Maintenance



Credit – Kognitiv Spark



RAAF Test Microsoft HoloLens



Image credit: RAAF.

MIKE RAJKUMAR

SEPTEMBER 4, 2020

The Royal Australian Air Force (RAAF) recently commenced a trial initiative for maintenance of its C-17A Globemaster III transport aircraft using Microsoft HoloLens mixed-reality devices with software developed by Boeing. The trials commenced in July with aircraft technicians from No. 36 Squadron at RAAF Base Amberley, the service announced in a statement.



Eye Tracking



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THINKE

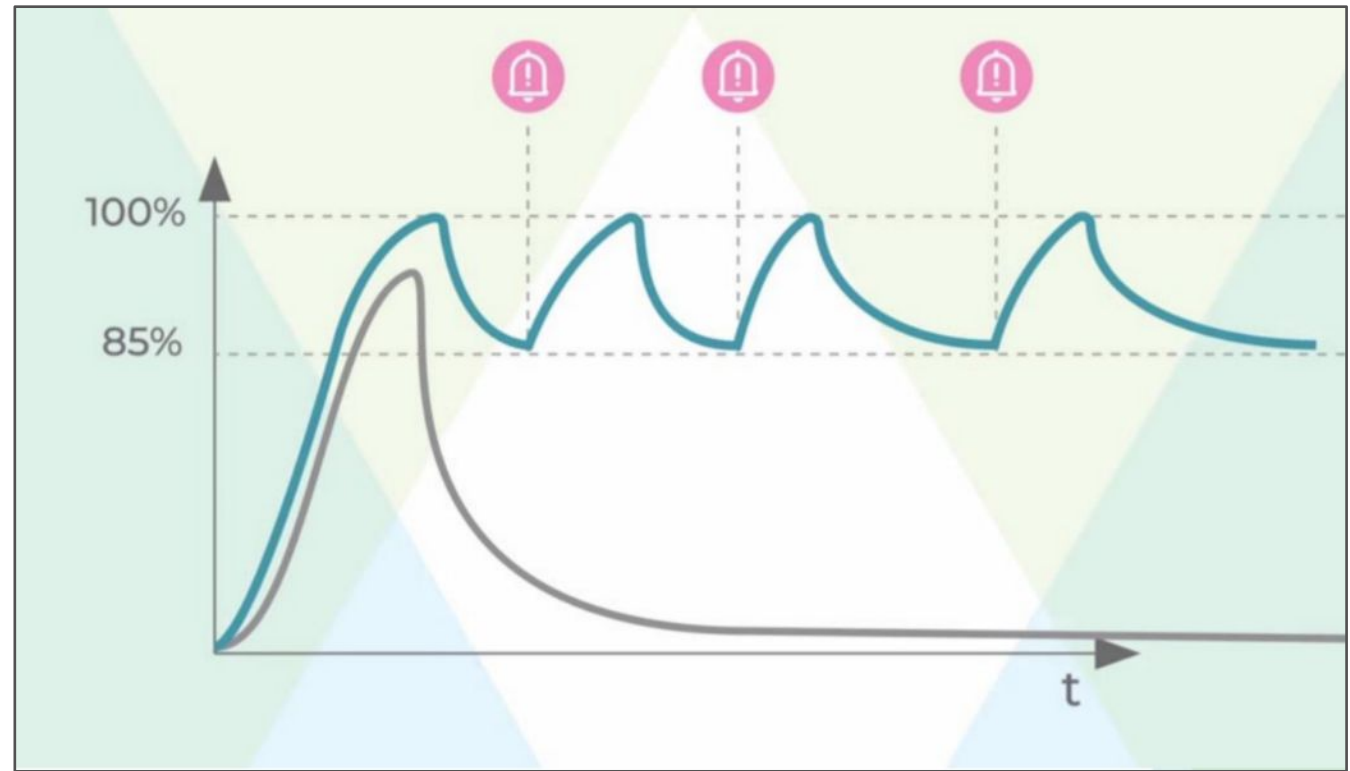
Emteq Labs “Sense”

Facial Expression Smart Glasses

-  Eating behaviour
-  Attention
-  Engagement & Valence
-  Facial expressivity
-  Activity (walking, sitting, reading etc.)
-  Regulatory Compliance CE mark, RoHS, WEE.



Skill Fade



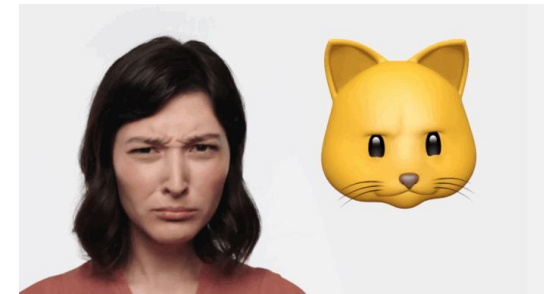
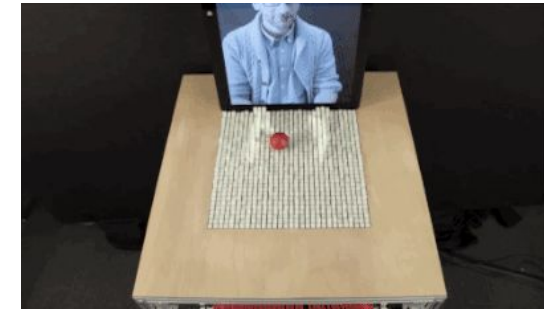
Digital Twins

digital twins connect the physical and virtual realms



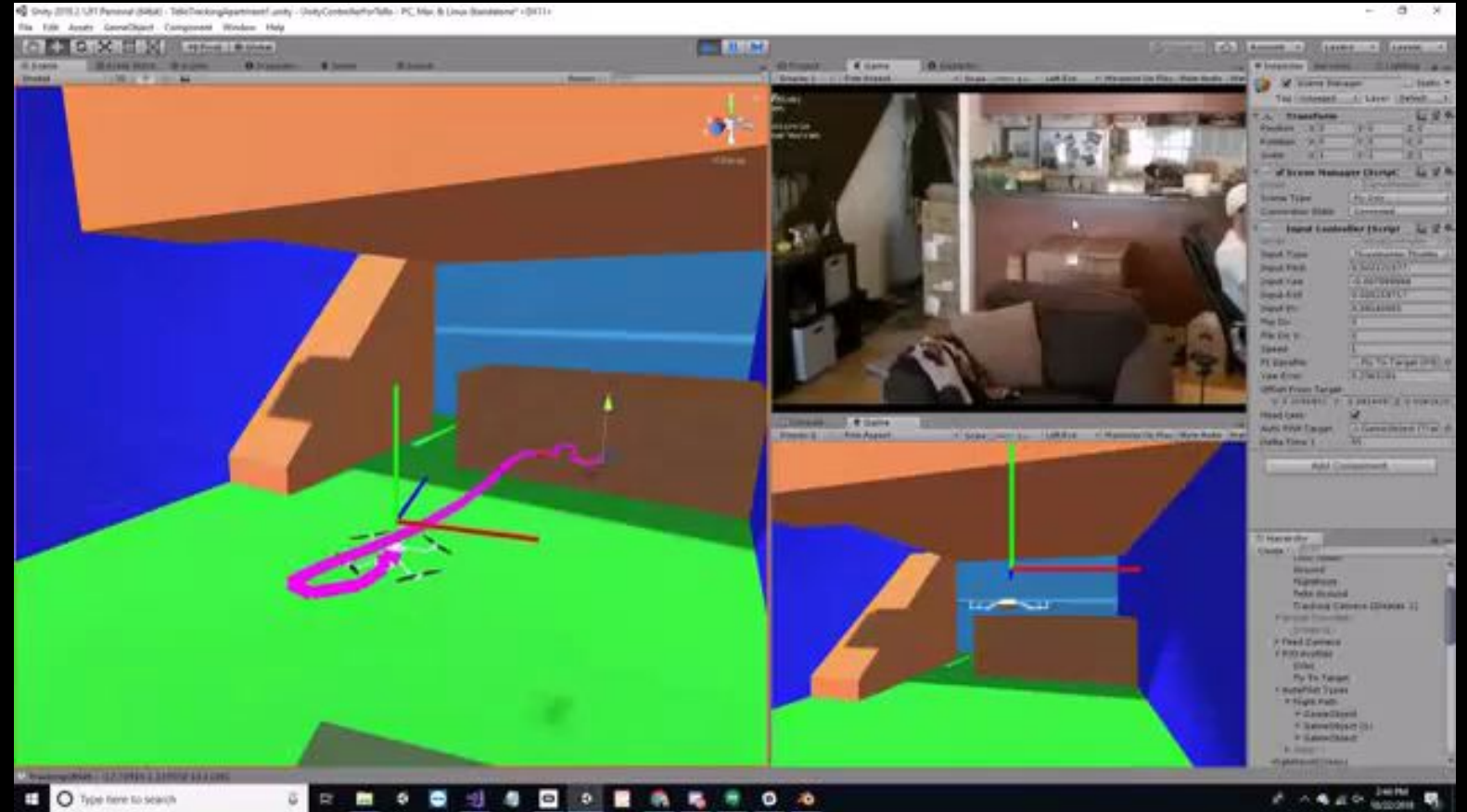
Next-Generation User Interfaces

- Gesture Interfaces
- Tangible User Interface
- Emotion Sensing
- Brain-Computer Interface

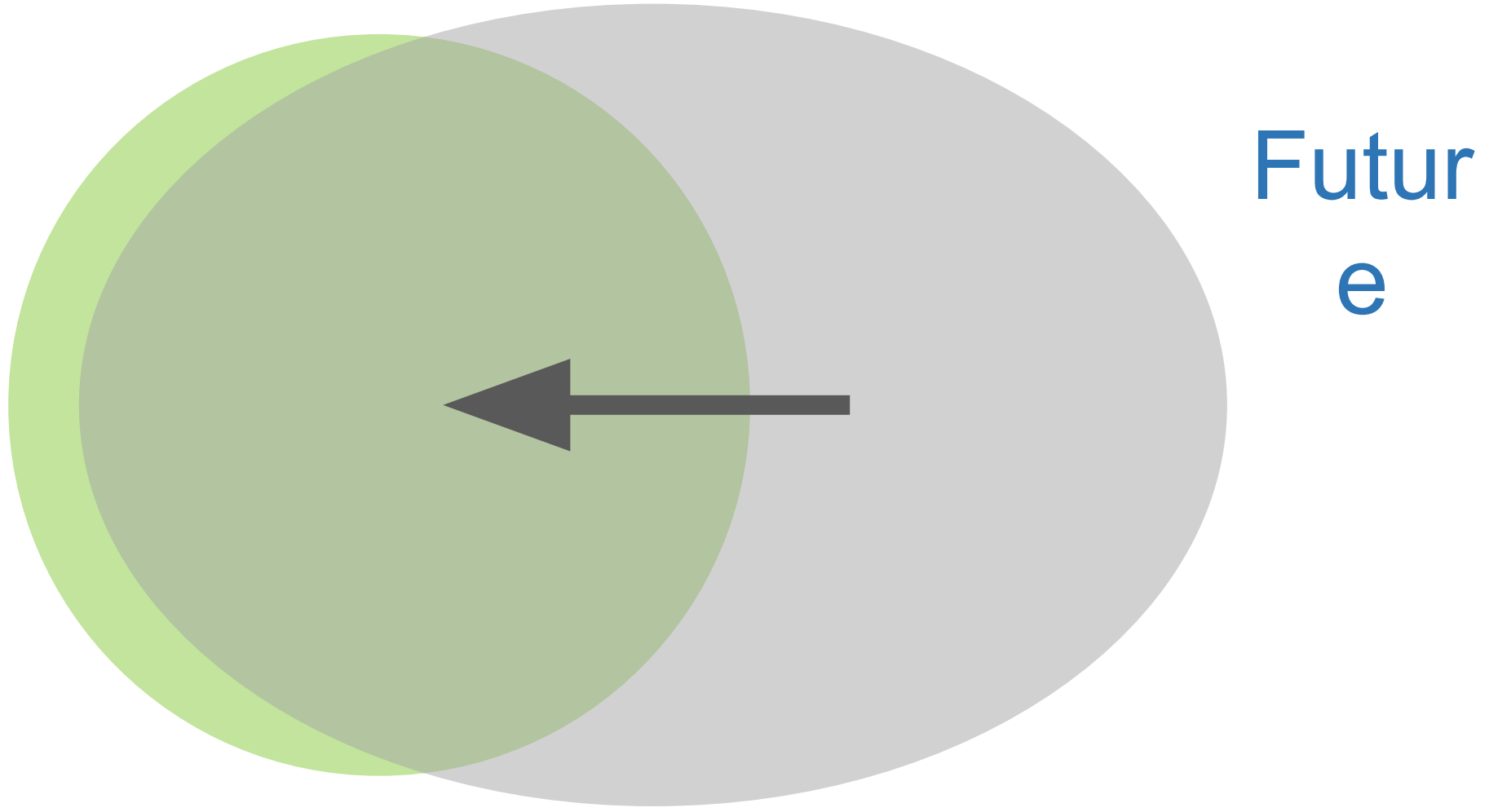


Command and Control

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



The 3D Digital World Expanding & Moving into the Physical World



Physical & Digital Worlds

4/5

The Human Dimension of Flight

Pilots of the Future?



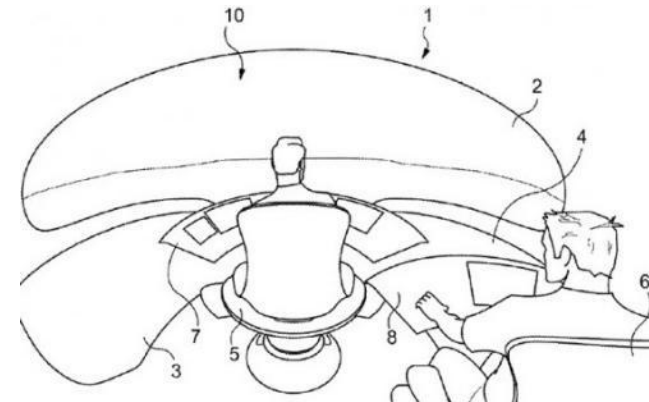
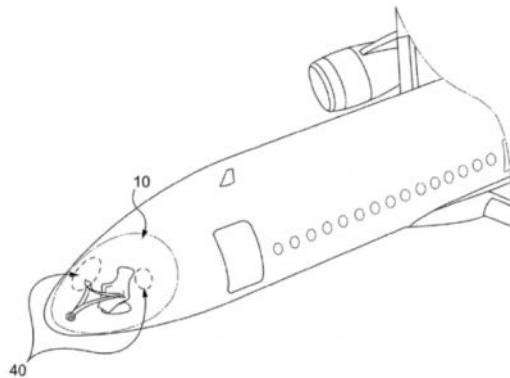
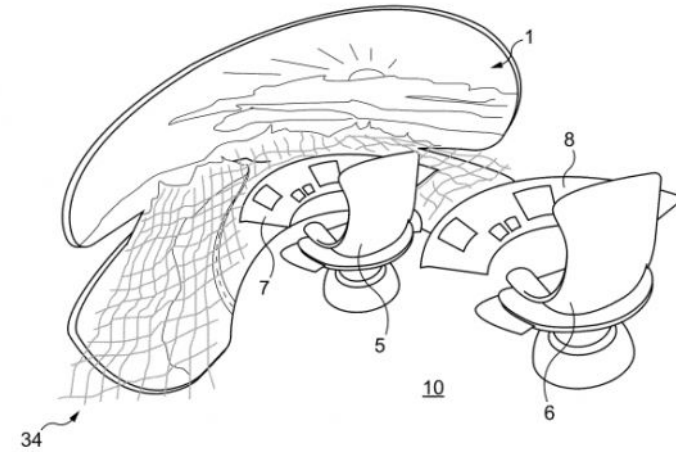
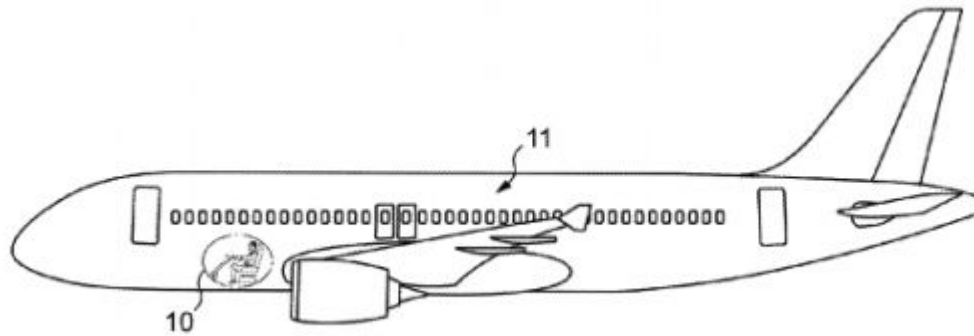
- **What will they do?**
- **Who will they be?**
- **Where will they be?**
- **How will they train?**
- **Will we need them?**

BOAC VC10 Automatic Landing (1968)

Source – Pathe



Airbus Windowless Cockpit Patent



Redundant Pilots?



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."

2016



AIR WARFARE, NETWORKS / CYBER

AI Slays Top F-16 Pilot In DARPA Dogfight Simulation

"It's a giant leap," said DARPA's Justin (call sign "Glock") Mock.

By THERESA HITCHENS on August 20, 2020 at 6:03 PM

3.6k    
SHARES



Heron Systems' AI pilot scores the final kill against AF F-16 instructor "Banger" in AlphaDogfight Trials

WASHINGTON: In a 5 to 0 sweep, an AI 'pilot' developed by Heron Systems beat one of the Air Force's top F-16 fighter pilots in DARPA's simulated aerial dogfight contest today.

2020

New Pilots & Industries



https://youtu.be/4vWuEKhE6Xc?si=EoS_9x1qEuNdlb8j

New Pilots (KTV)



Training for Drone Pilots



Cautionary Tales



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

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.

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.

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).



In the Loop ...

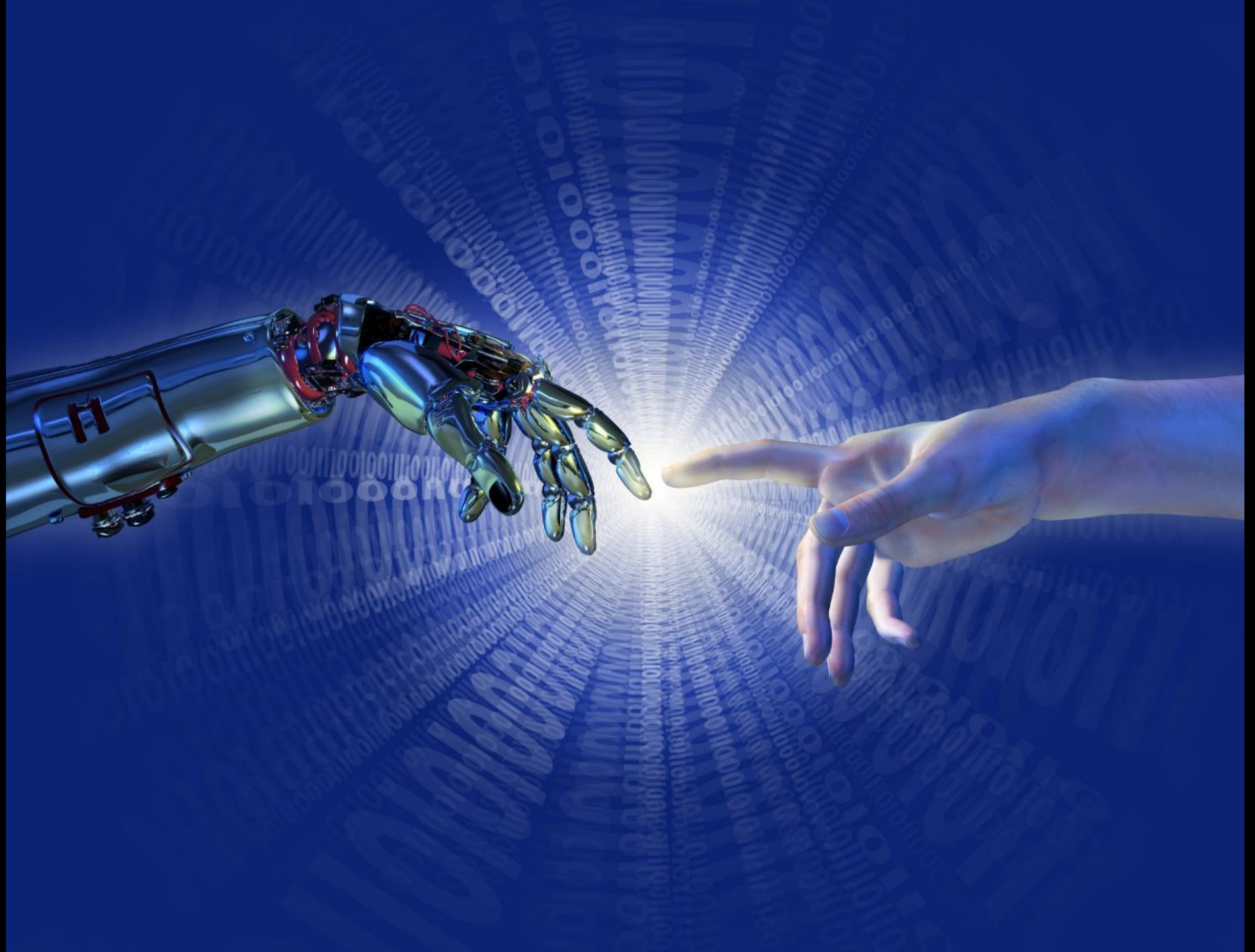


"If I'm in the loop mentally I can respond more quickly than if I have to watch an automatic system and take over and then get my mind into the loop.

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)

**Maximise
the
Strengths
of Both**



... and Human Teams?

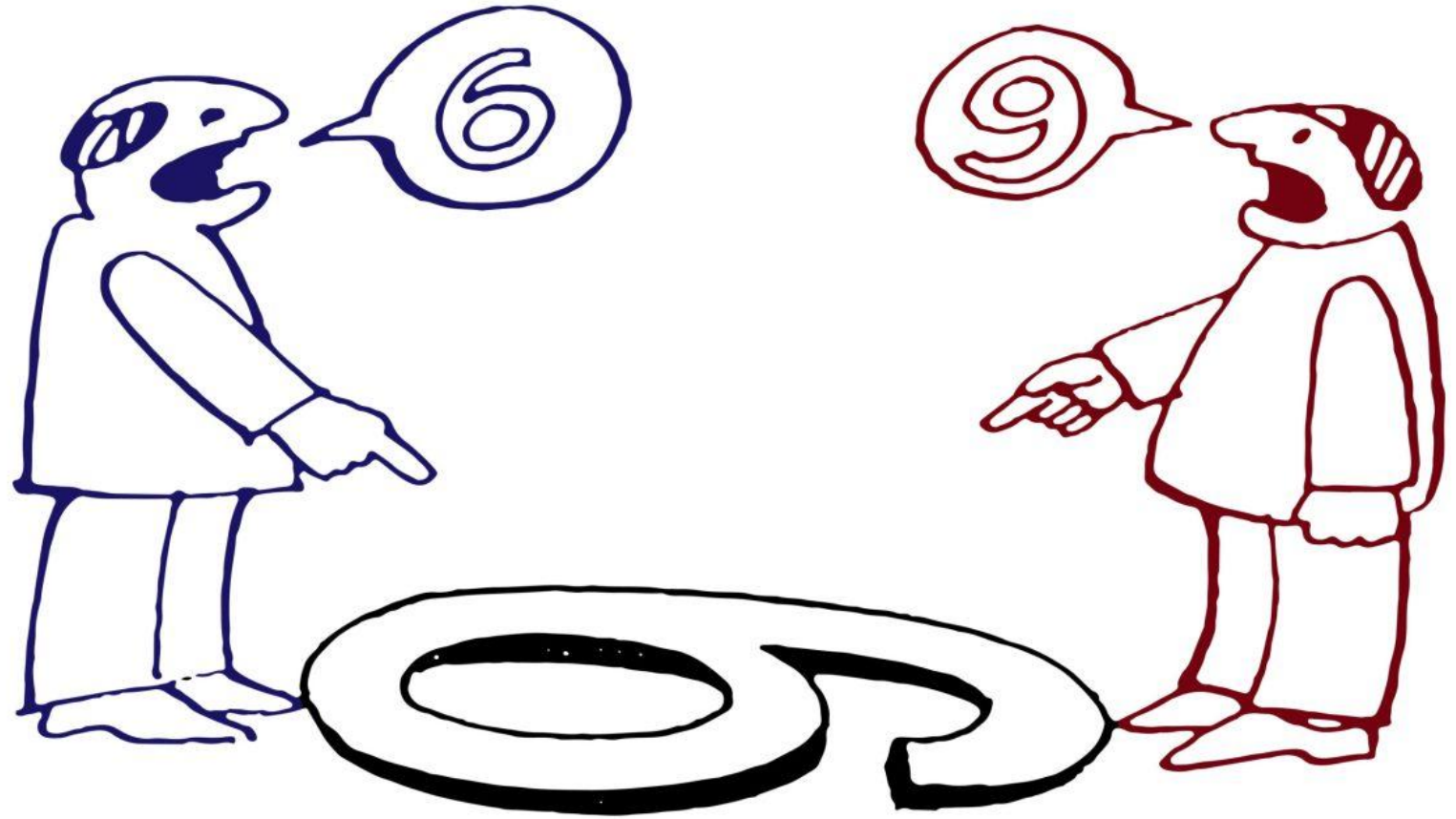
The High and the Mighty (1954)



Air France Flight 447 (2009)



Differences of Perception



**Humans need to
Practice, Practice, Practice!
Individually and in Teams**



5/5

Thoughts on Careers



Why Be An Engineer



- “It’s not boring - no two days are the same”
- “I feel I am making a difference to the world”



**It is an Exciting &
Important Time of
Change in Aerospace**

- **AI & Data Analytics**
- **Autonomous Flight**
- **Digital Twins and Digitisation**
- **Drones**
- **Electrification**
- **Space**
- **Sustainability**

Professional Engineer

- **Chartered Engineer**
 - **Emphasis on Technology Development**
 - **Masters Level**
- **Incorporated Engineer**
 - **Emphasis on Technology Application**
 - **Bachelors Level**



Professional Engineer Competences (UK SPEC)

- A. Knowledge and understanding:**
The ability to apply both general and specialist engineering knowledge to complex problems.
- B. Design, development, and solving engineering problems:**
The competence to use theoretical and practical methods to analyze and solve engineering challenges.
- C. Responsibility, management, and leadership:**
Demonstrating the ability to manage projects, teams, and resources, as well as showing technical and commercial leadership.
- D. Communication and interpersonal skills:**
The ability to communicate effectively with both technical and non-technical stakeholders.
- E. Professional commitment:**
A personal commitment to professional standards, recognizing obligations to society, the environment, and the profession. This includes a commitment to continued professional development (CPD).



Some Professional Organisations



**ROYAL
AERONAUTICAL
SOCIETY**



Thoughts on Careers

- **Be Kind**
- **Don't worry too much...**
 - **It's mostly beyond our control**
 - **Go to the next interesting job**



Questions?

LinkedIn
andyfawkes



Hélène Dutrieu c. 1911