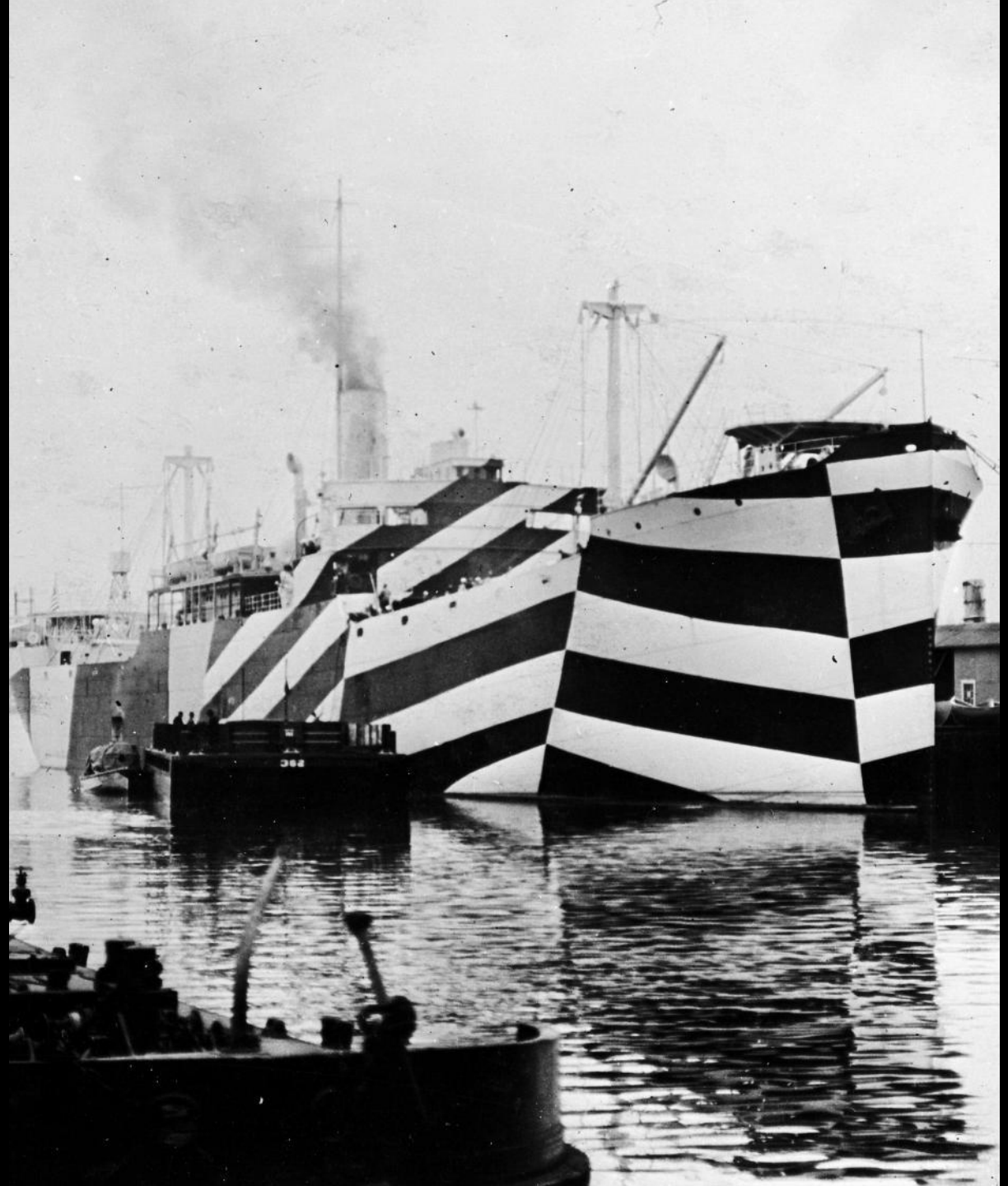


3rd SMi Maritime Information Warfare Conference - London

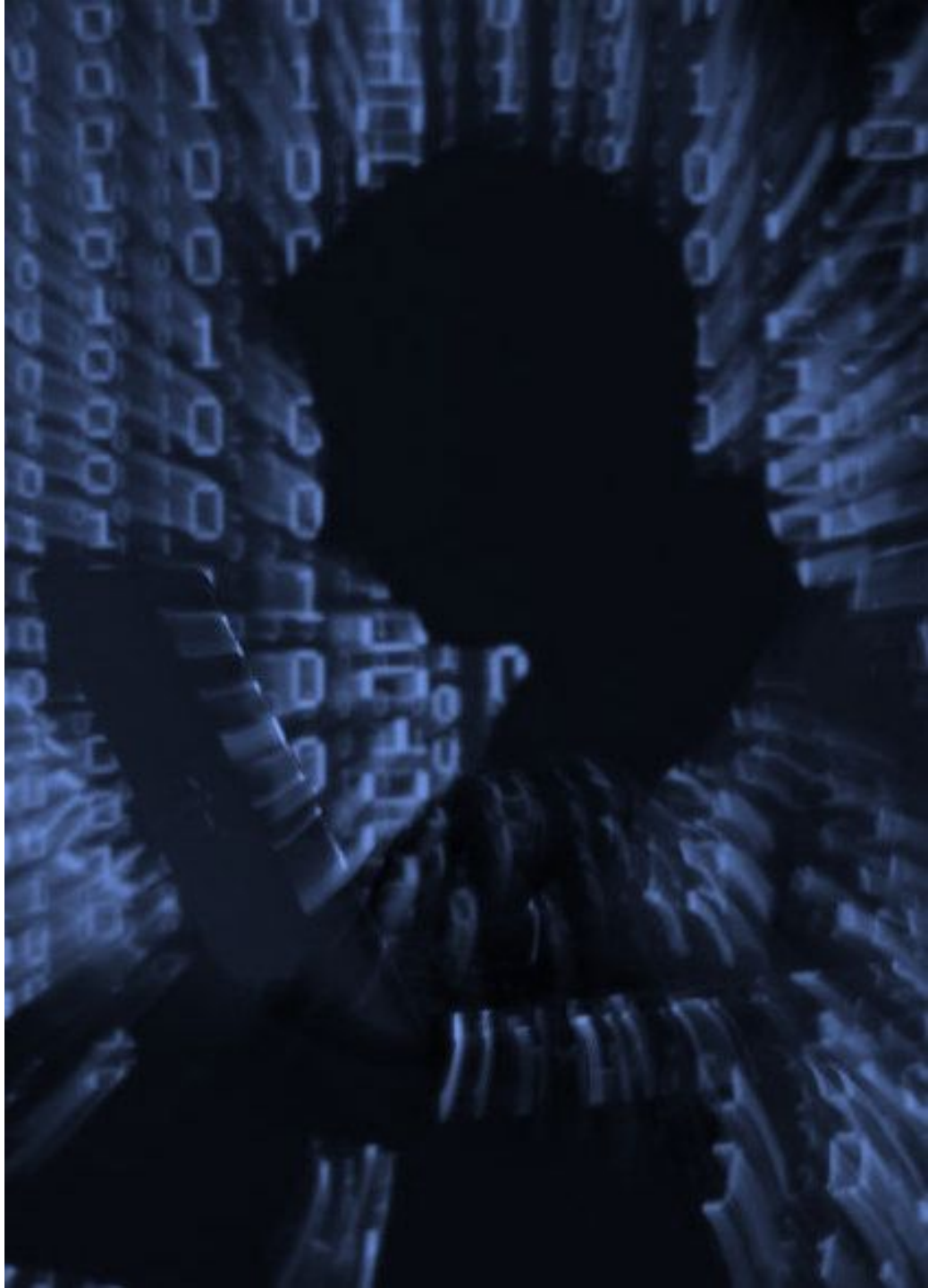
19 November 2019

# A Perspective on the Human Component of Maritime Information Warfare

Andy Fawkes

# Information Warfare

**Information warfare is the battlespace use and management of information and communication technology in pursuit of a competitive advantage over an opponent**



**Wikipedia**

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# Information Warfare

- The Royal Navy must mobilise, modernise and transform to stay ahead of emerging threats
- It is not just about the equipment; our thinking and how we conduct operations in a digital world must also change to keep pace, to adapt and to succeed
- More specifically, it's about embedding the concept of Information Warfare in the psyche of the Naval Service at large

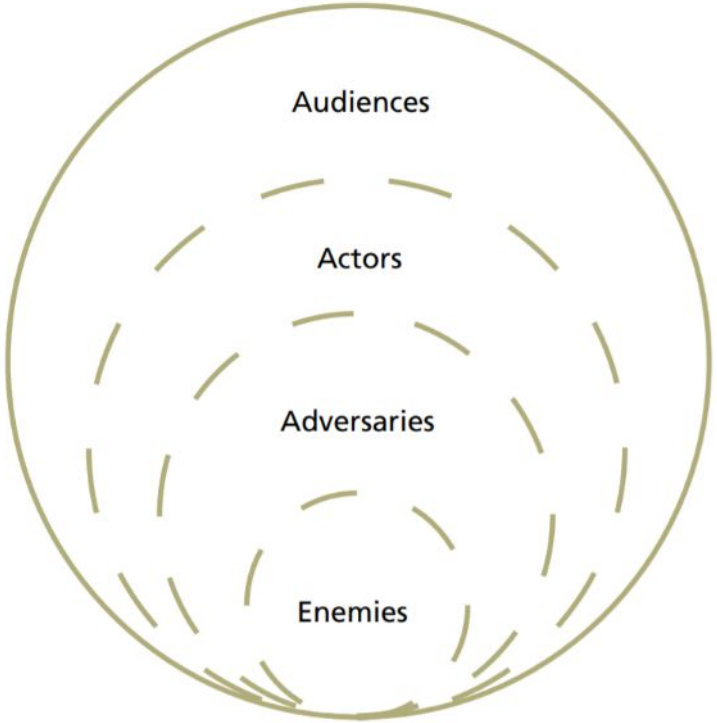

RN Website

THINK

# Integrated Action (2016)

**A unifying doctrine that requires commanders to:**

1. **to identify the desired outcome**
2. **to consider all the audiences relevant to attaining the outcome**
3. **to analyse the effects required on the relevant audience and then**
4. **to determine the best mix of capabilities, from soft through to hard power, to achieve the outcome**




**Audience.** All the groups and individual people whose perception and interpretation of events and subsequent behaviour contribute to the success or otherwise of military action

**Actors.** A group or person that takes action or directly exerts influence

**Adversary.** A group or person that seeks to prevent us from achieving our objectives

**Enemy.** A group or person that seeks to defeat us through armed lethal means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# Presentation Overview

- Thoughts on Information Warfare
- The Modern Sailor
- Training & Simulation Trends
- A More Autonomous Future?
- Innovation

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# Humans and Information Warfare

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# Information Warfare 100 years ago… Big Data




- <u>Velocity</u> - UK RFC 1st Wing No 2 Squadron 10 June 1916
  - 7:50am – aerial photograph taken
  - 8:10am – machine landed
  - 8:32am – finished print despatched to 1st Corps
  - 8:39am – received at 1st Corps

- <u>Volume</u> - A few hundred aerial photographs had been taken during the opening six months of the war, by 1918 well over five million were produced in just nine months

UK National Archives

# A Wake Up Call

~~SECRET UK EYES ONLY~~

D/CDS 3/6/1

16 May 2007

**INQUIRY INTO THE APPREHENSION OF 15 RN/RM PERSONNEL FROM HMS CORNWALL BY IRANIANS ON 23 MAR 07 – OPERATION DEACON**

**INTRODUCTION**

1. At 0445Z on 23 March 2007 a team of 15 RN/RM personnel departed HMS CORNWALL in 2 Rigid Hulled Inflatable Boats (RHIB) to conduct a boarding operation of a merchant vessel in the North Arabian Gulf (NAG). During this operation the boarding team was intercepted and apprehended by men of the Iranian Revolutionary Guard Corp Navy (IRGCN) in gunboats. The RN/RM personnel were released on 4 April 2007 and returned to UK.

The Push and Pull of Intelligence. As the use of web based systems to post intelligence to be sought and 'pulled' by users becomes the norm, we will have to train our people accordingly. There is a real danger of missing important information amongst the mass available, because 'we don't know how much we don't know' and because we don't know whether we have the most up to date information. The commander owns the intelligence requirement and must ensure that he has the systems and processes in place to fulfil his needs.

2015 FOIA request

# Importance of Human Factors (2017)

## USS Fitzgerald

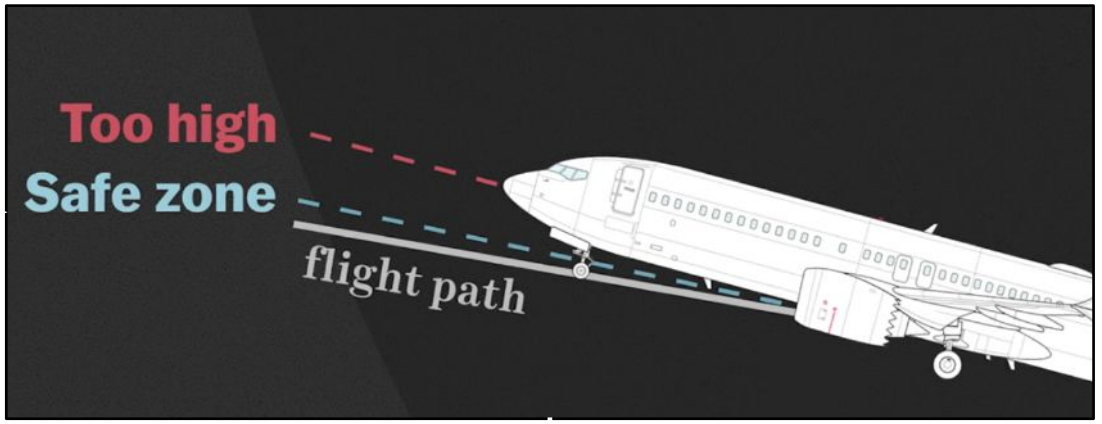
“distraction and incomplete radar information”

## USS John S. McCain

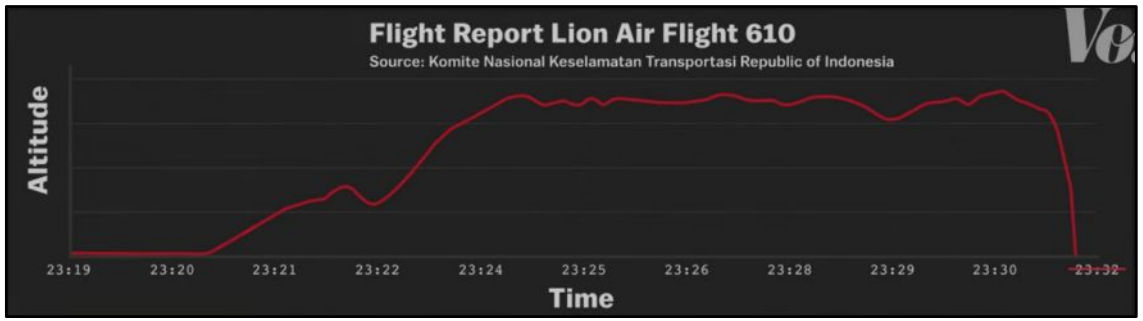
“overly complex touchscreen system used for throttle control and training deficiencies”

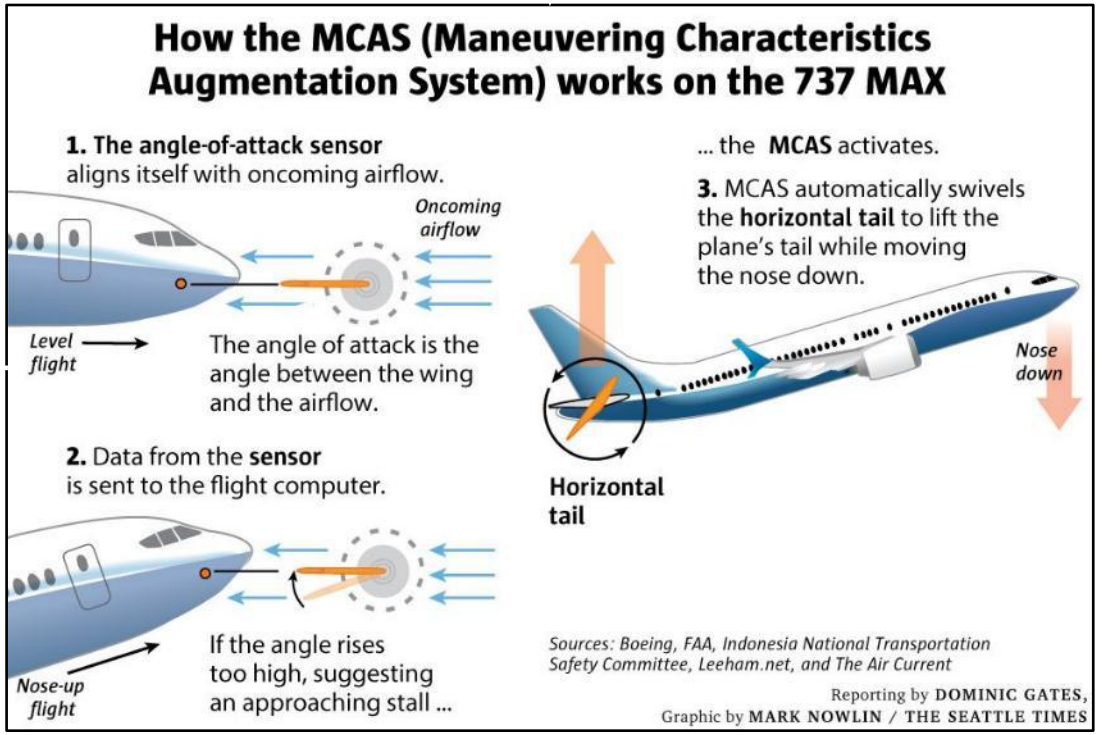
CNN

# Boeing 737 MAX







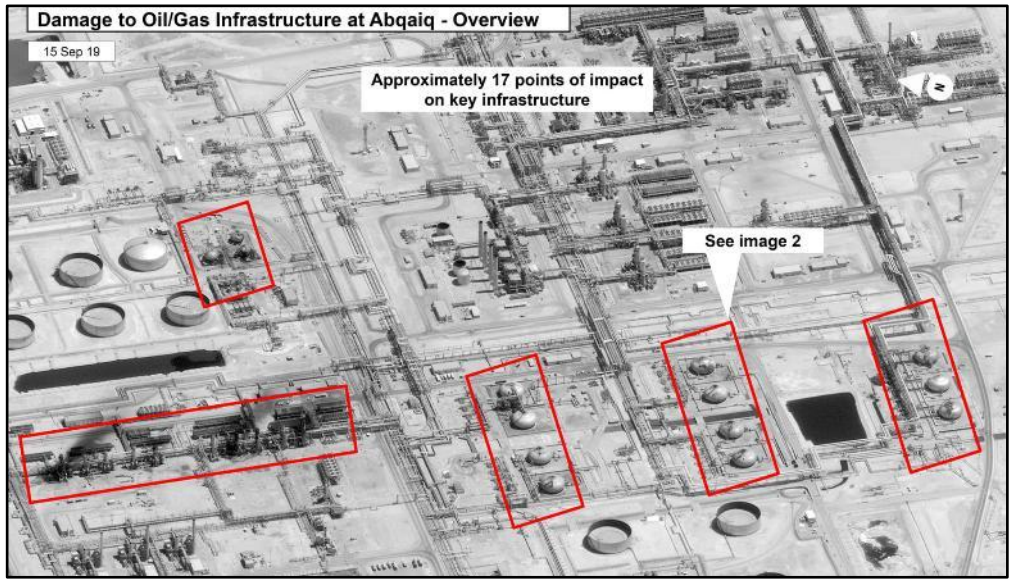



10 Jan 2019

14 Sep 2019


# Think

# Low Cost - High Impact




CNBC

SEARCH QUOTES

MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV

POLITICS

## How Saudi Arabia failed to protect itself from drone and missile attacks despite billions spent on defense systems

PUBLISHED THU, SEP 19 2019 • 4:54 AM EDT | UPDATED MON, SEP 23 2019 • 6:35 AM EDT

Natasha Turak
@NATASHATURAK

SHARE

**KEY POINTS**

- Saudi Arabia in 2018 spent an estimated $67.6 billion on arms — second only to the U.S. and China.

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# The Modern Sailor

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# Sailors of the Future?

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

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# RN Age Distribution

## 50% of the RN is < 30

## and 80% < 40

### UK REGULAR FORCES BY AGE

Full-time trained and untrained personnel, at 1 April 2018

| | Army Service | Naval Service | RAF Service | All services |
|---|---|---|---|---|
| **Under 18-24** | **21,720** | **7,440** | **5,530** | **34,710** |
| Under 18 | 1,630 | 230 | 160 | 2,030 |
| 18-24 | 20,090 | 7,210 | 5,370 | 32,680 |
| **25-34** | **34,770** | **13,550** | **13,220** | **61,530** |
| 25-29 | 19,250 | 7,540 | 6,830 | 33,610 |
| 30-34 | 15,520 | 6,010 | 6,390 | 27,920 |
| **35-44** | **19,640** | **7,490** | **9,330** | **36,470** |
| 35-39 | 12,760 | 4,650 | 5,790 | 23,210 |
| 40-44 | 6,880 | 2,840 | 3,540 | 13,260 |
| **45 and over** | **4,970** | **4,010** | **4,860** | **13,850** |
| 45-49 | 3,270 | 2,360 | 2,790 | 8,420 |
| 50-54 | 1,510 | 1,390 | 1,740 | 4,640 |
| 55-59 | 190 | 250 | 330 | 770 |
| 60 and over | ~ | 10 | ~ | 20 |

UK Defence Personnel Statistics - CBP7930, 12 June 2018

# “Digital Native”

**generally considered a person born in the 1980s and after growing up in the digital age with day to day access to computers, games, Internet, etc.**

# Broadly, 2/3$^{rds}$ of the RN now are Digital Natives and 90% by 2030

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Oxford Dictionary – Flikr/cwasteson

# What's Next?

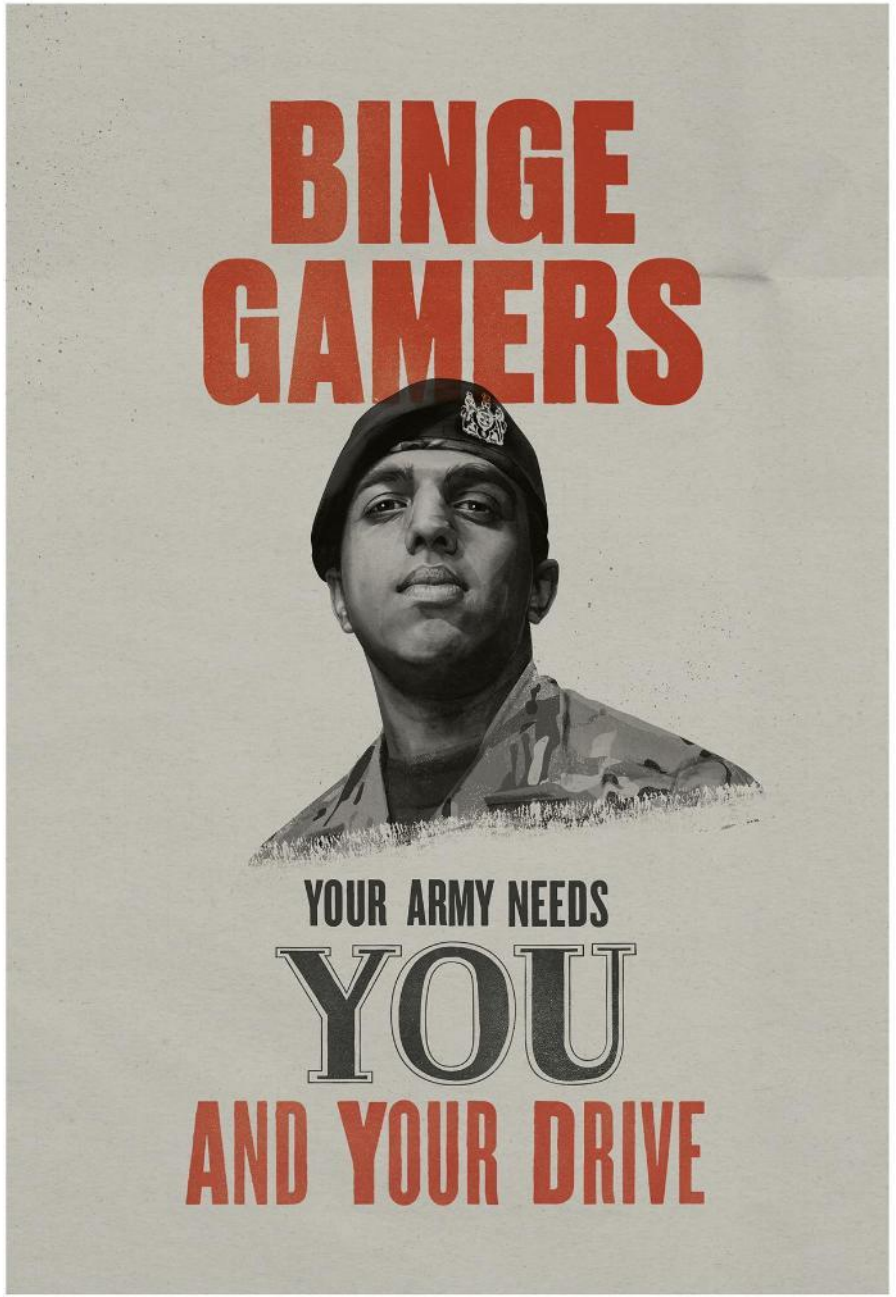
**Digital Native**

**AI Native?**

Pixabay/YouTube

# UK Children aged 12 to 15 spend 12.2 hours a week gaming in 2017

# and 11 to 64 year-olds 8.9 hours



# 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”

Mail Online News

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## 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

Share 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.

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# Training & Simulation Trends

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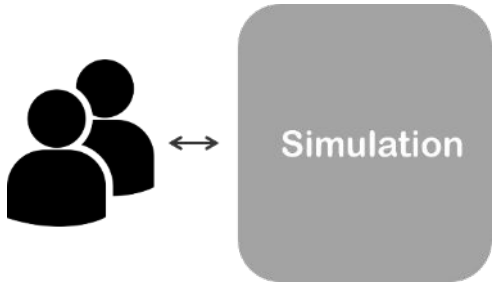
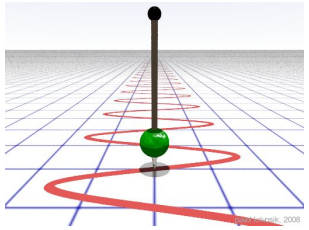
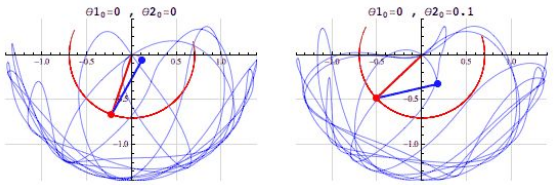
# What is Simulation?

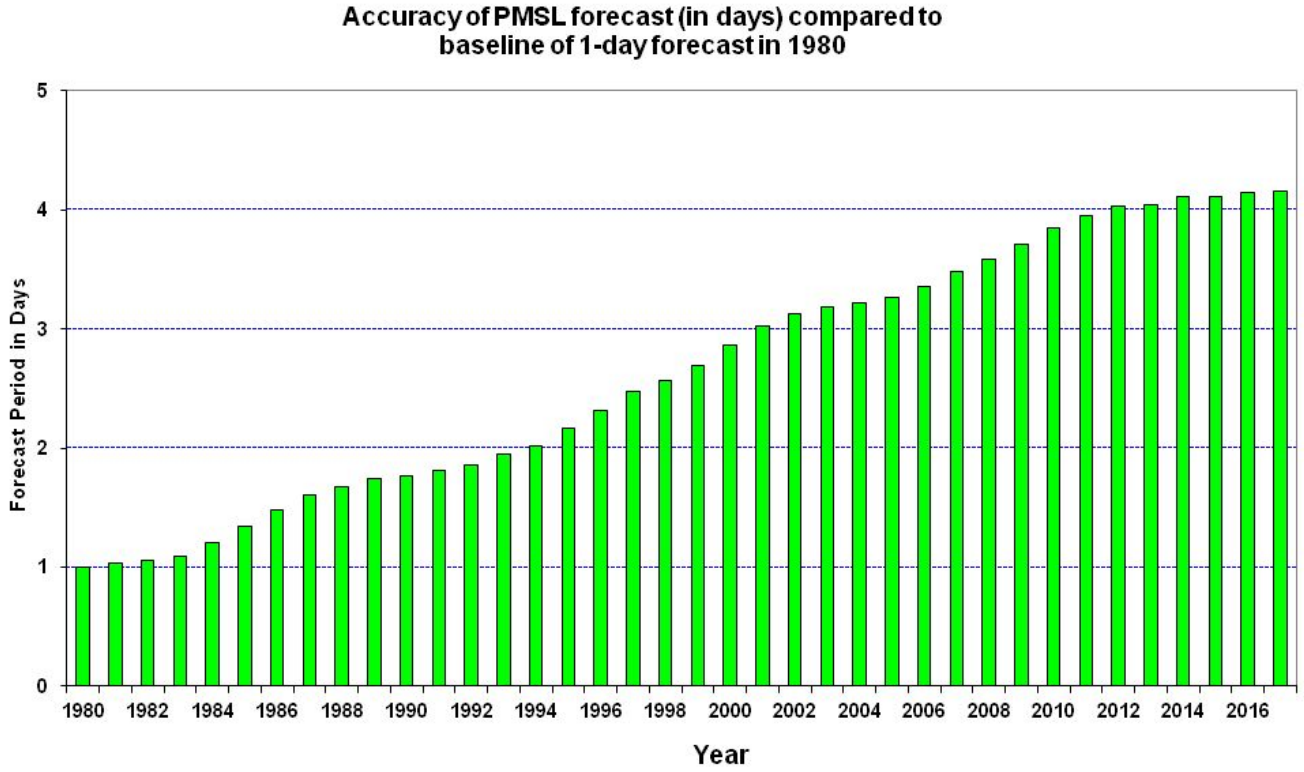
- Humans Inside or Outside
- Runs in Real or Non-Real Time
- Some Systems have Order
- Some Systems are Chaotic
- Some are Random



# UK Met Office Weather Forecasting

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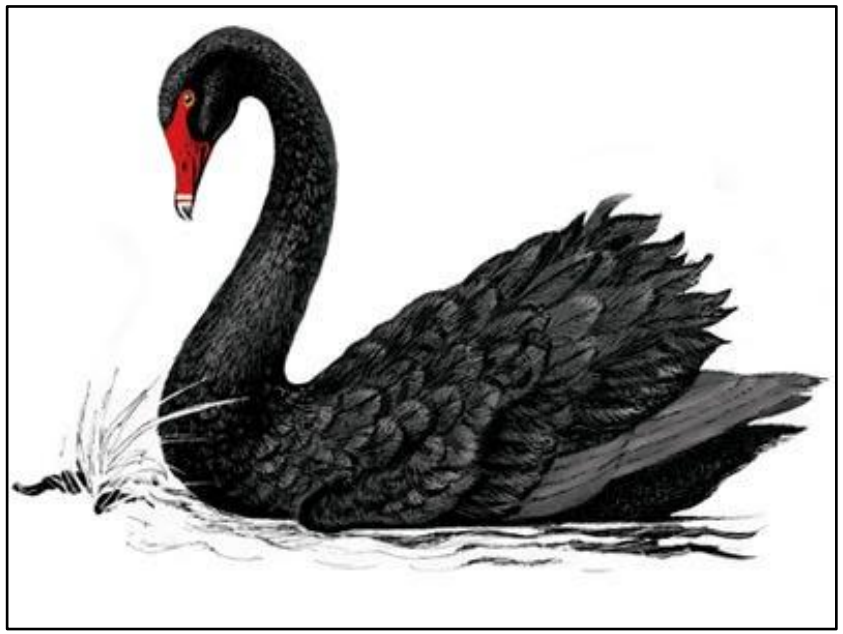
**War is chaotic**

**No battle plan withstands contact with the enemy**

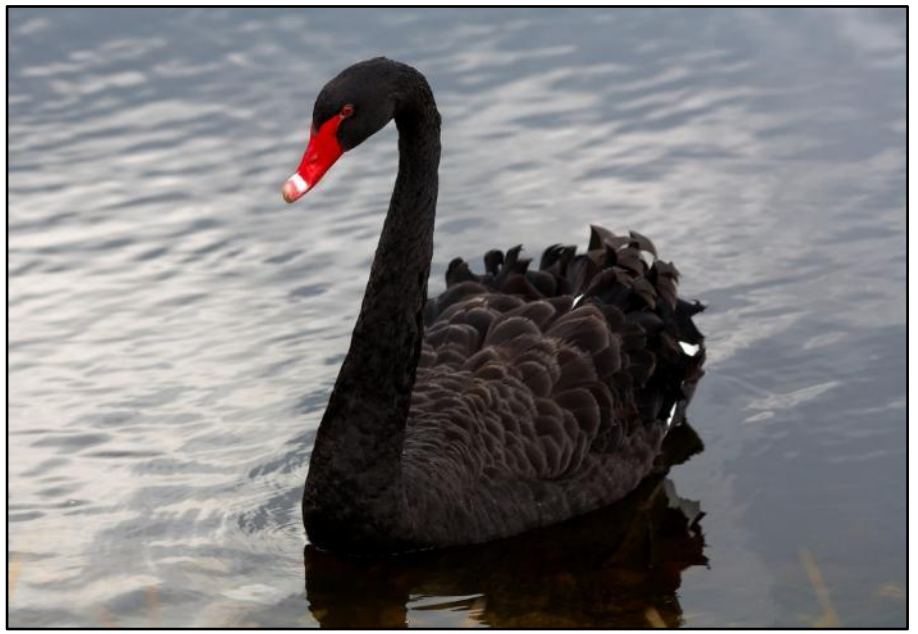
**“All but war is simulation”**

# Black Swans (from a European Perspective)

## Before 1697



## After 1697



**The challenge of modelling and simulating a world with unknowns**

# Why Training Simulation?

Safer

Saves Money


Security Controlled

Weather Independent

Release Platforms

Environmental Benefits

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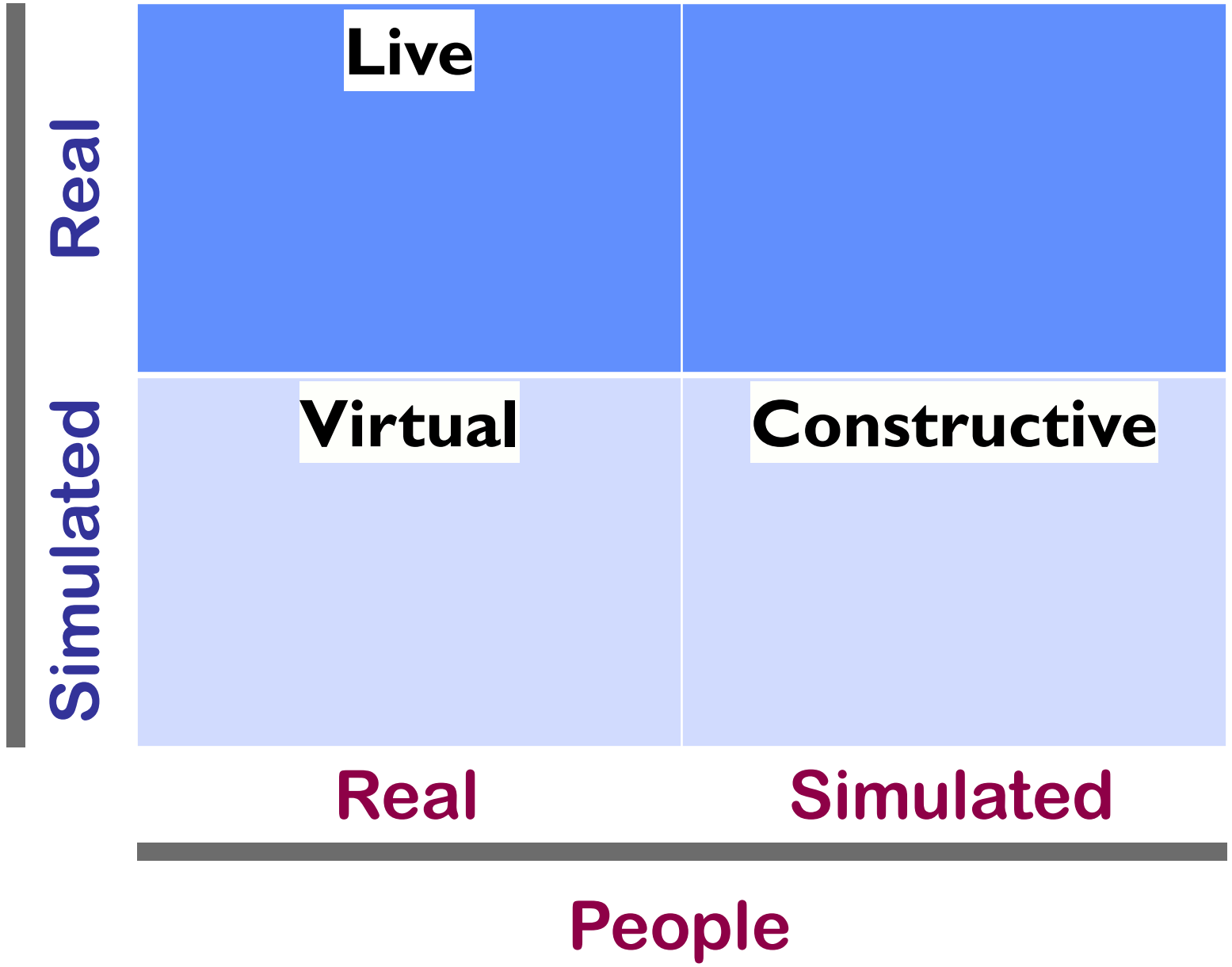
# Simulation Categories (LVC)



# Simulation Now - Land, Sea, Air, Anywhere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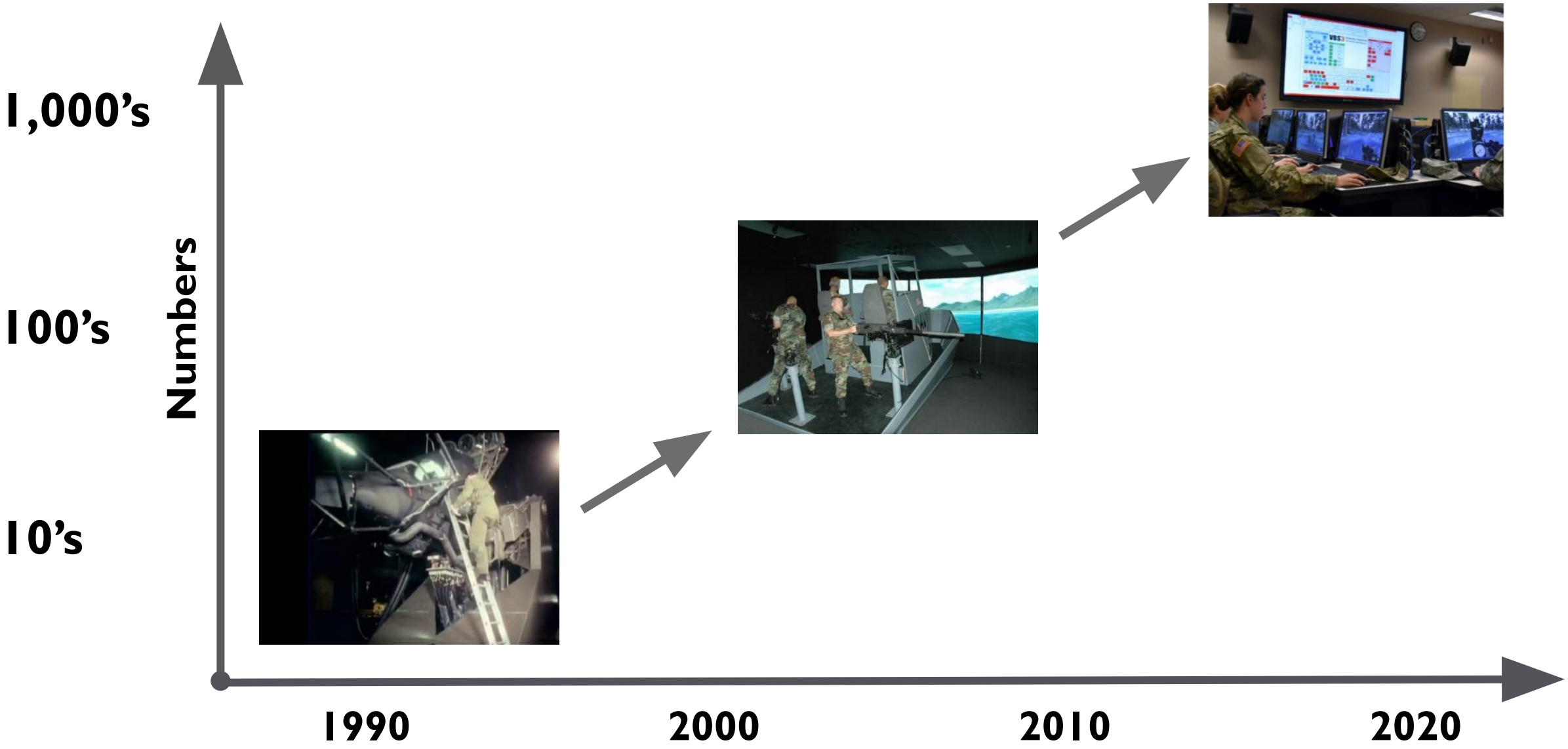
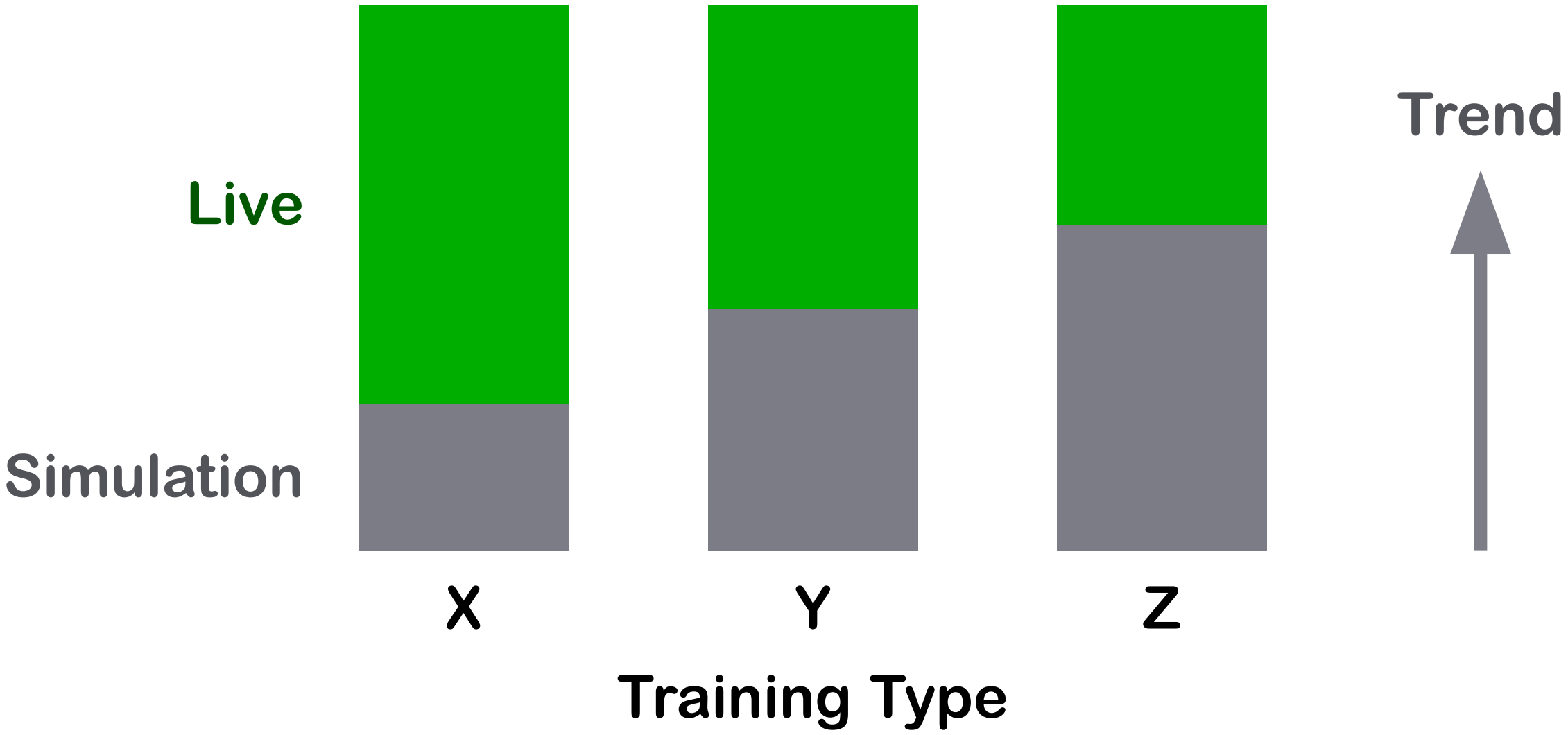
VBS

# Military Access to Simulation



# Live & Simulation Based Training



# Maritime Composite Training System

THINK

BAE Systems

# VR RHIB Simulator

- **RN working with Novatech, the University of Portsmouth, and Bohemia Interactive Simulations**

- 3-DoF simulator chair
- Replica control console
- Gaming style steering wheel
- Oculus Rift headset
- VBS3 Software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# HMS Queen Elizabeth Flight Deck Training

## RNAS Culdrose


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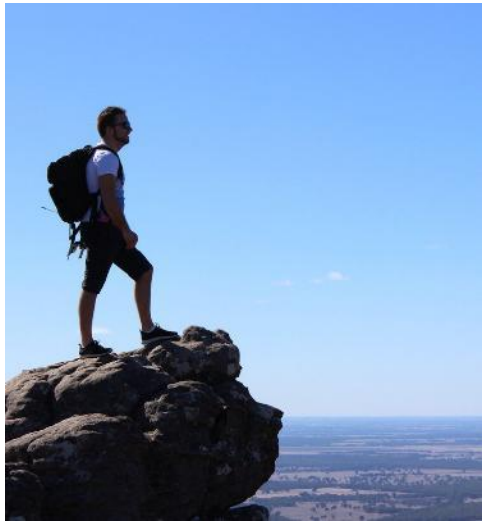
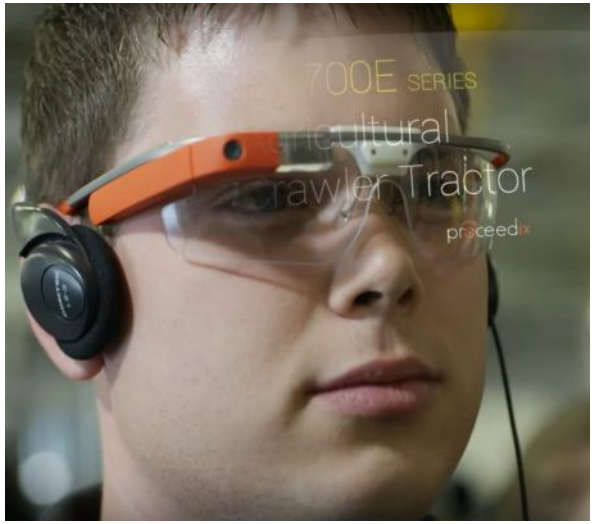
# Some Technologies of Interest for Training

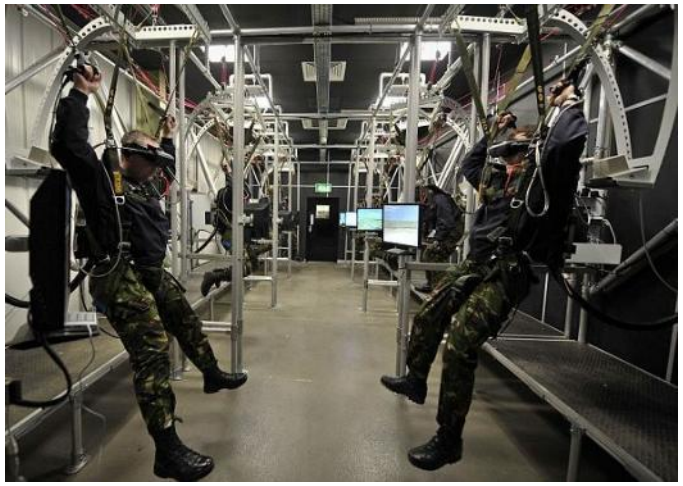
# Extended Reality - XR

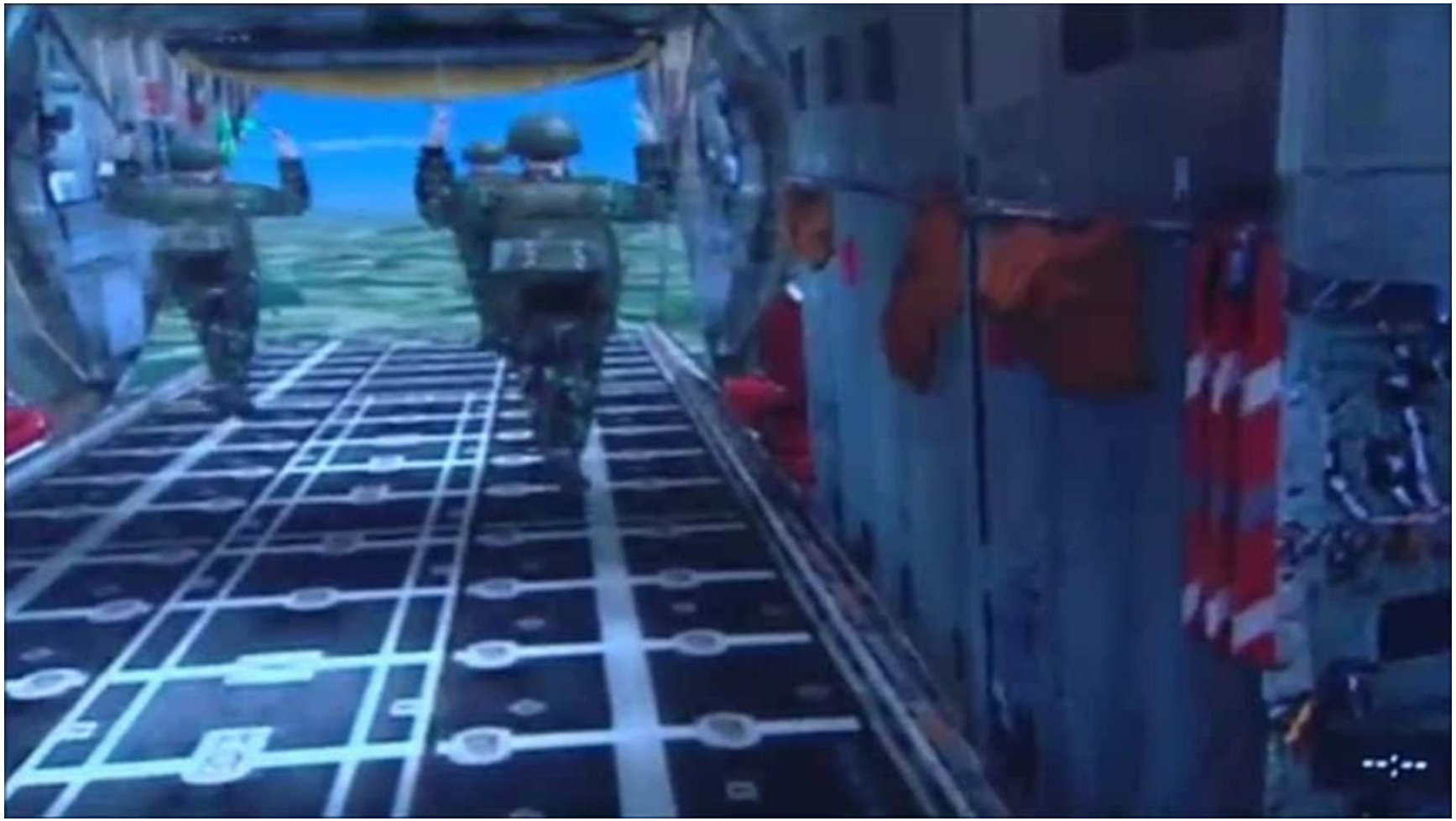
| Reality | Augmented Reality | Mixed Reality | Virtual Reality |
|---|---|---|---|
| The real world | Information layered over vision | Blend of real & digital information to enhance reality | Fully virtual world |






# UK Parachute Training - VR in Use (RAF Brize Norton - 2011)





Pennant/Forces TV

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# US “Rotary Wing Next”

- Redesigned course using VR cut 28 week programme by 6 weeks, with aim to reduce to 14 weeks
  - 38 Hours VR Training (+38 Hrs)
  - 20 Hours Simulator Training
  - 67 Hours Live Flying (-18 Hrs)

- Emphasis on training crew communications, checklists and start-up procedures before getting in the cockpit



STARS AND STRIPES



By JAMES BOLINGER | STARS AND STRIPES

Published: October 17, 2019

## Virtual reality-heavy course speeds up Air Force helicopter pilot training by six weeks

Air Force officers pose with a TH-1H helicopter at Fort Rucker, Ala., Oct. 10, 2019, after graduating from a pilot training program that tested virtual reality simulators and a new, shorter curriculum. They are, from left, 2nd Lt. Trent Badger, 2nd Lt. J. Karl Bossard, 1st Lt. Matthew Gulotta, 2nd Lt. John Thrash, Capt. Josh Park and 2nd Lt. Richard Songster. BRIAN BRADEN/U.S. AIR FORCE

# Virtual Reality in Land Training Pilot Q1 2019

- The aim was to identify how Virtual Reality technology might support future Army Team/Collective Training
- 30+ Trainees in VR
- Direct military involvement in the Pilot

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# The “Training Audience”

Commander
Driver
Gunner

Infantry

| | |
|---|---|
| Warrior 1 | 3 + 6 |
| Warrior 2 | 3 + 6 |
| Warrior 3 | 3 + 6 |
| Challenger 2 Tank | 4 (Loader) + |

31 +
IF

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# Teamwork Effectiveness Training

- Leadership – character, knowledge and action that inspires
- Situation Awareness – shared mental model of team situation
- Decision Making – team collectively makes a choice
- Communication – right information, right people, right time
- Co-operation – team goals over individual's

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in Virtual Simulation you look at the Virtual World,

in VR, you are in it


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# VR-Based Training at Scale

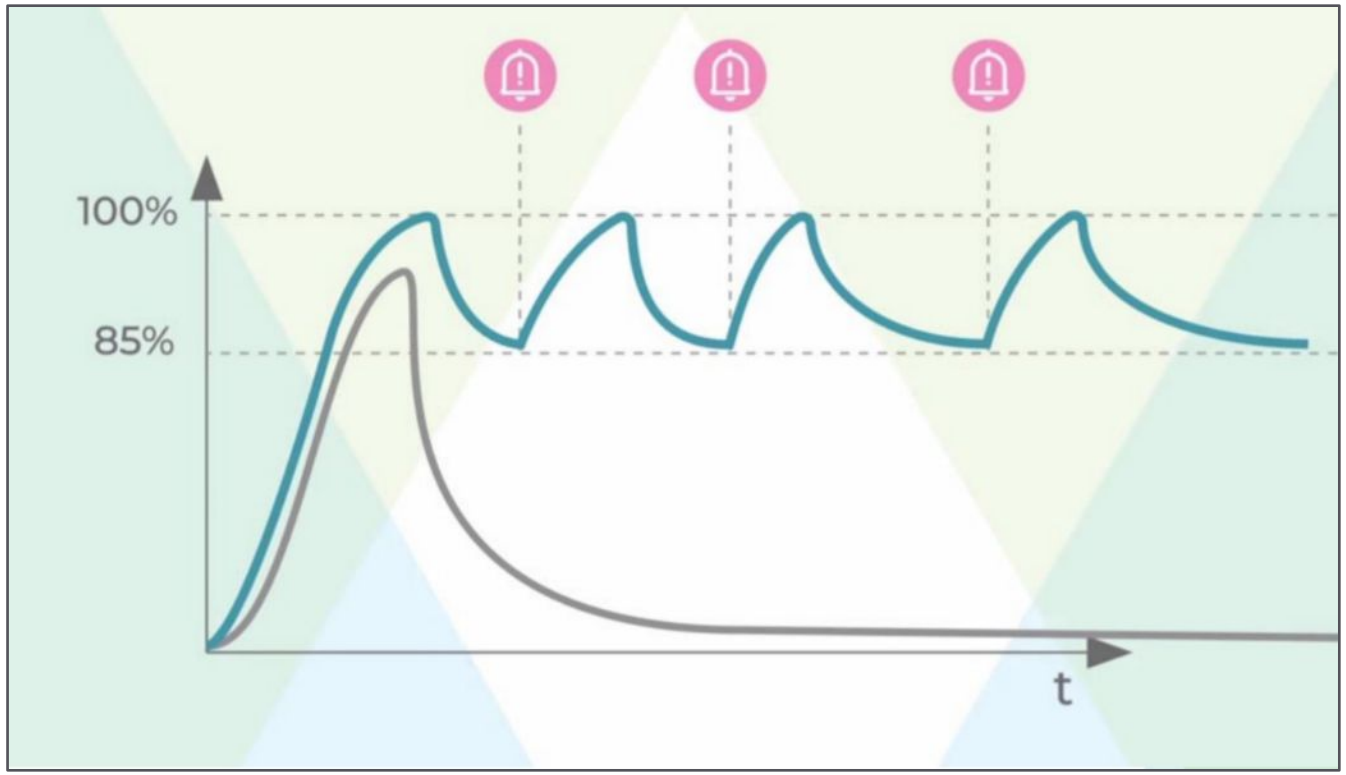

- 18,500 Lufthansa cabin crew practice safety-related training required by the authorities in 18 VR cabins located in Frankfurt and Munich

- Trainees receive a short introduction from the digital assistant, and during the entire exercise a single panel operator can monitor multiple cabins

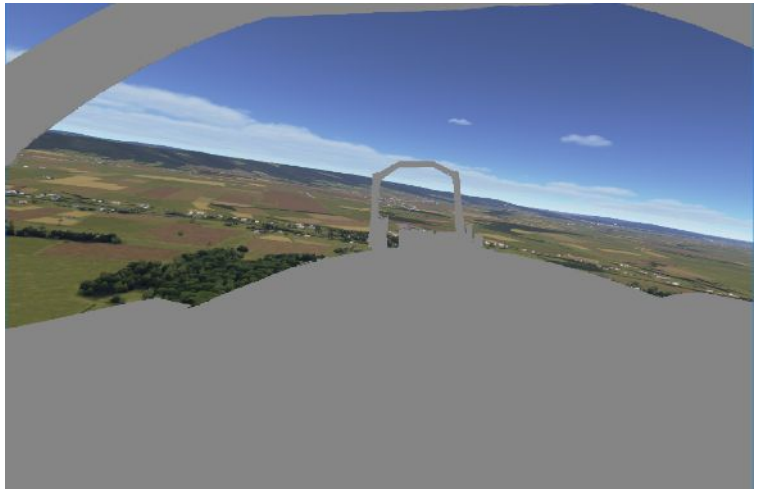

- From 2020, Scandinavian Airlines will use VR systems to enhance its cabin crew emergency landing procedure training

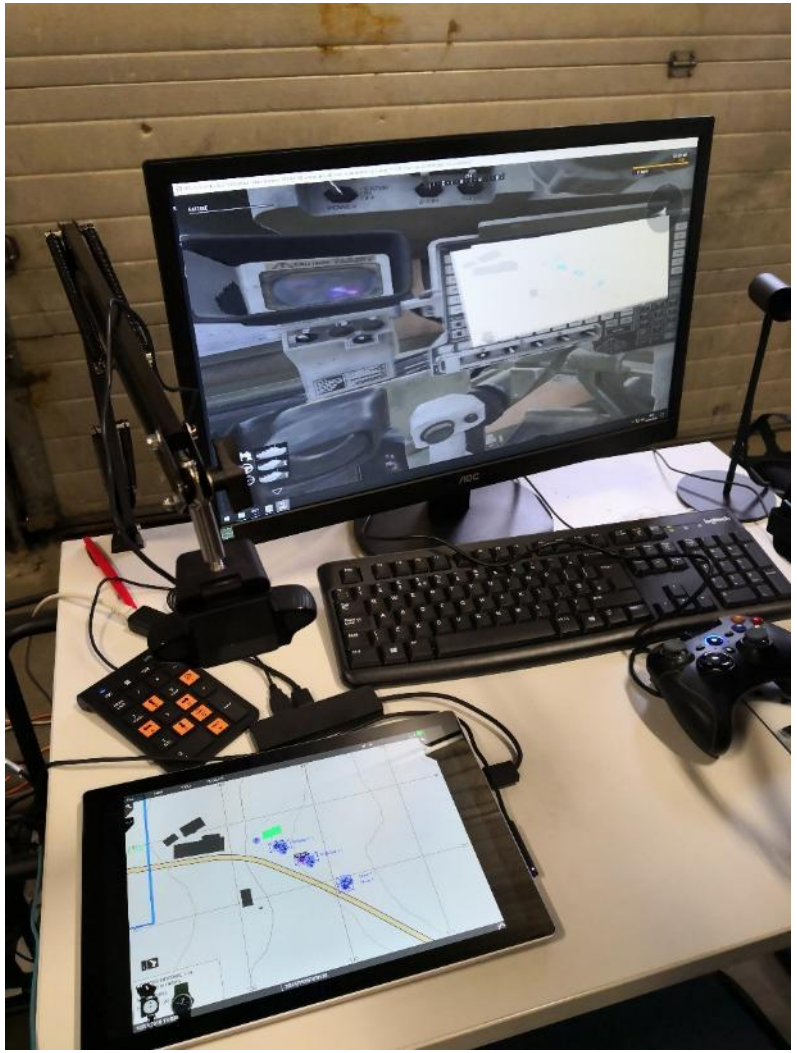
- VR will be introduced in all training courses for door opening, arming, disarming including slide, raft and SOPs

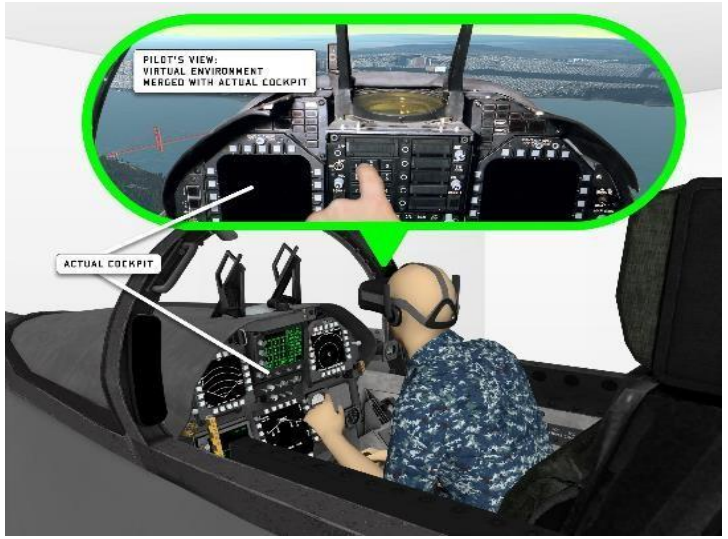
# Maintaining Proficiency/Reducing Skillfade




# Mixed Reality Visual Systems






# Close Air Solutions (UK)
# Real + Virtual - Hyper Real Immersion – 2018

# Microsoft Minecraft Earth (2019)

## AR + Motion Capture


Microsoft


Apple

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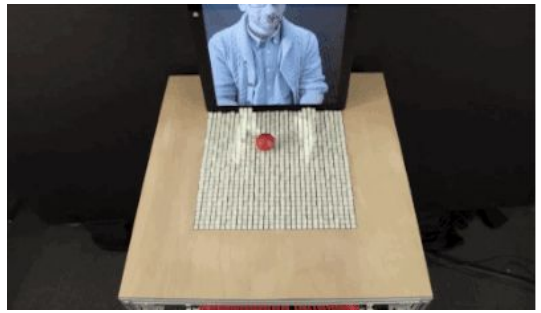
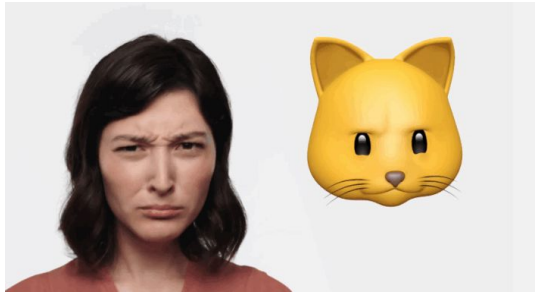
# Next-Generation User Interfaces

- Gesture Interfaces


- Tangible User Interface



- Emotion Sensing



- Brain-Computer Interface

# Eye Tracking



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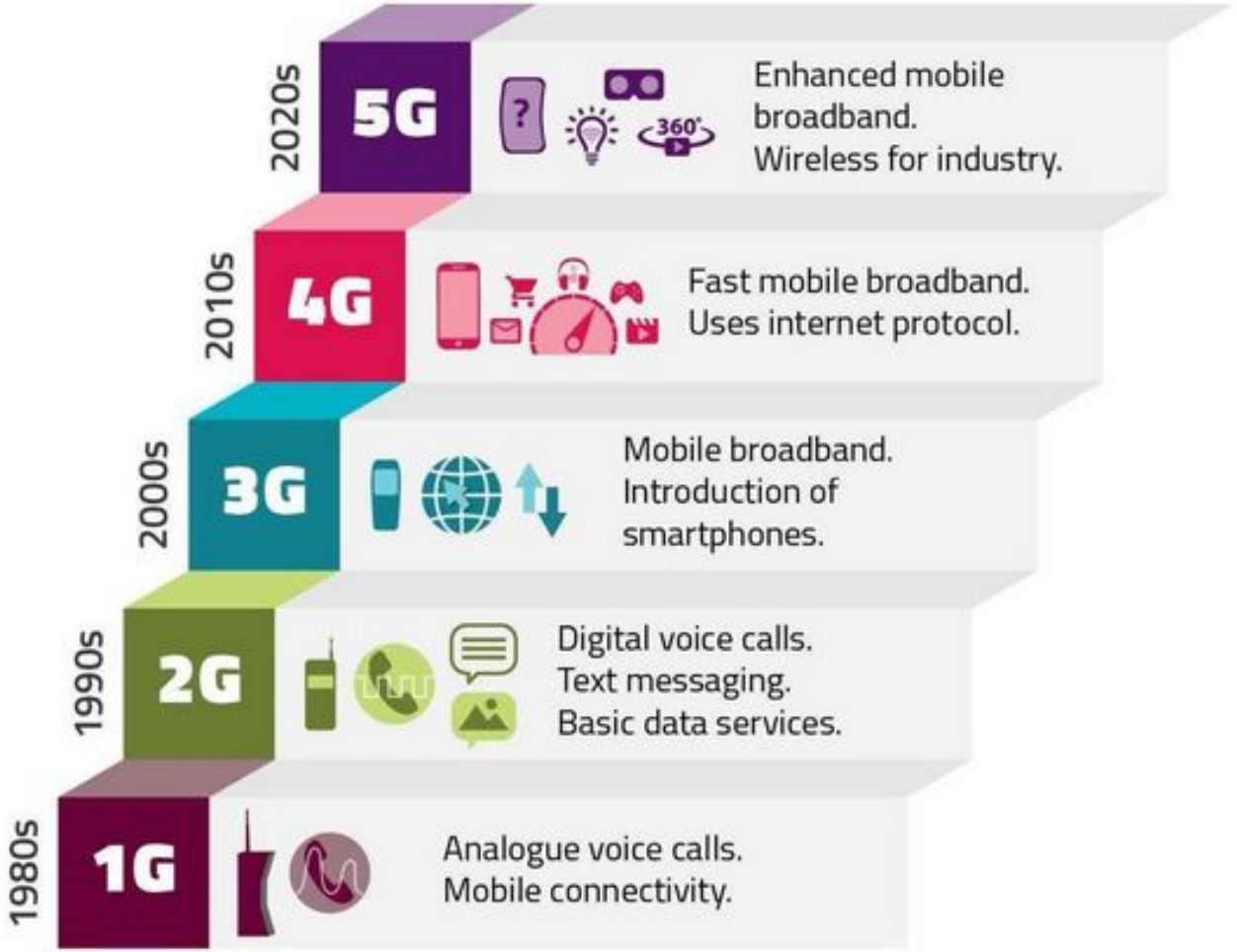
# Wearables



# Edge Computing

- Data is processed locally rather than being transmitted to a data centre (the Cloud)
- Reducing latency/ improving response times and saving bandwidth
- Enables smart applications and devices to respond to data almost instantaneously
- Potential to improve distributed training latency and security

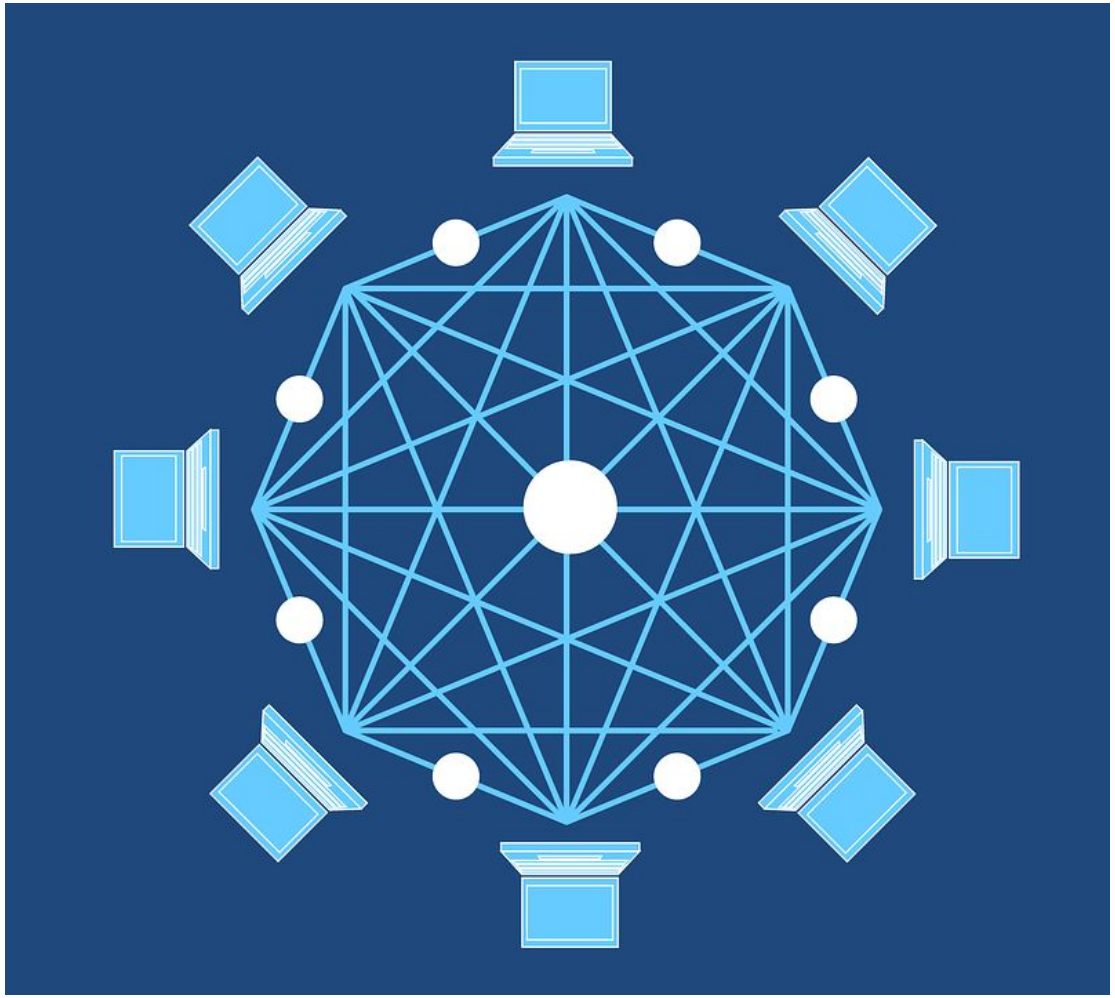
# 5G



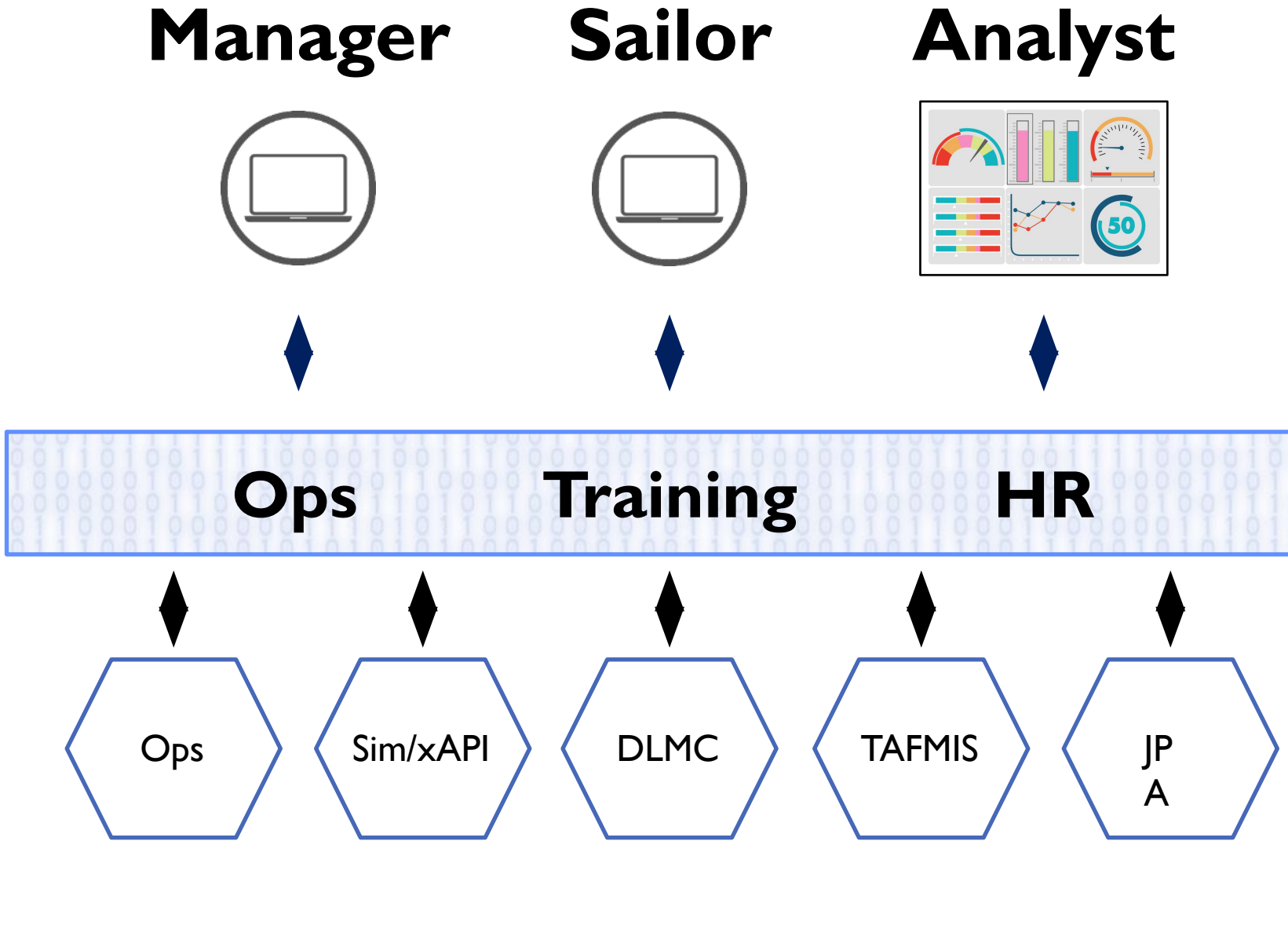

- Faster, reduced latency
- Greater Exploitation of the Cloud
- Enhanced Capability for VR/AR, Reducing Local Headset/ Processor Burden

# Blockchain

- A growing list of records, called blocks, that are linked using cryptography
- Many potential applications beyond Bitcoin
- Could host an individual's "Knowledge Score" through their life, capturing both in-house and external training and education



# Bringing People Data Together



# Stovepipes of Data

# What about “Digital Twins”?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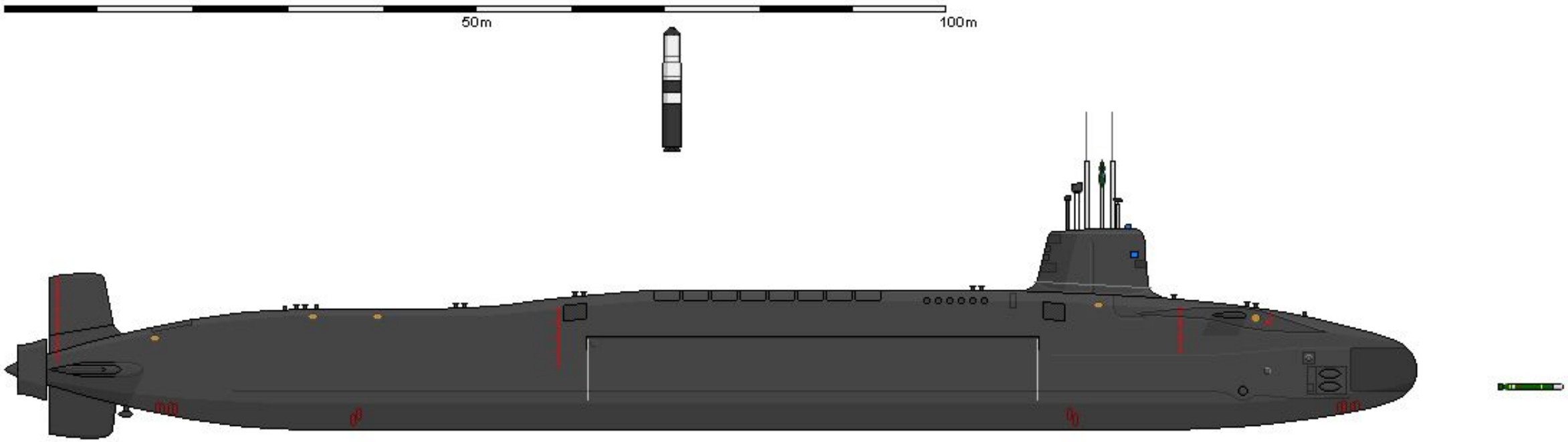
# UK Vanguard Class SSBN – A “Perspex Twin”




**1980s - 1/5th Scale Perspex Model Supported the Design & Build and Later, Refits**

# Exploring Autonomous Concepts in Simulation (VBS3)

# It's all about Sharing Data & Information in Acquisition

- Within Projects
- Across Projects
- Over Time

# Stovepipes of Data

# The Price of Data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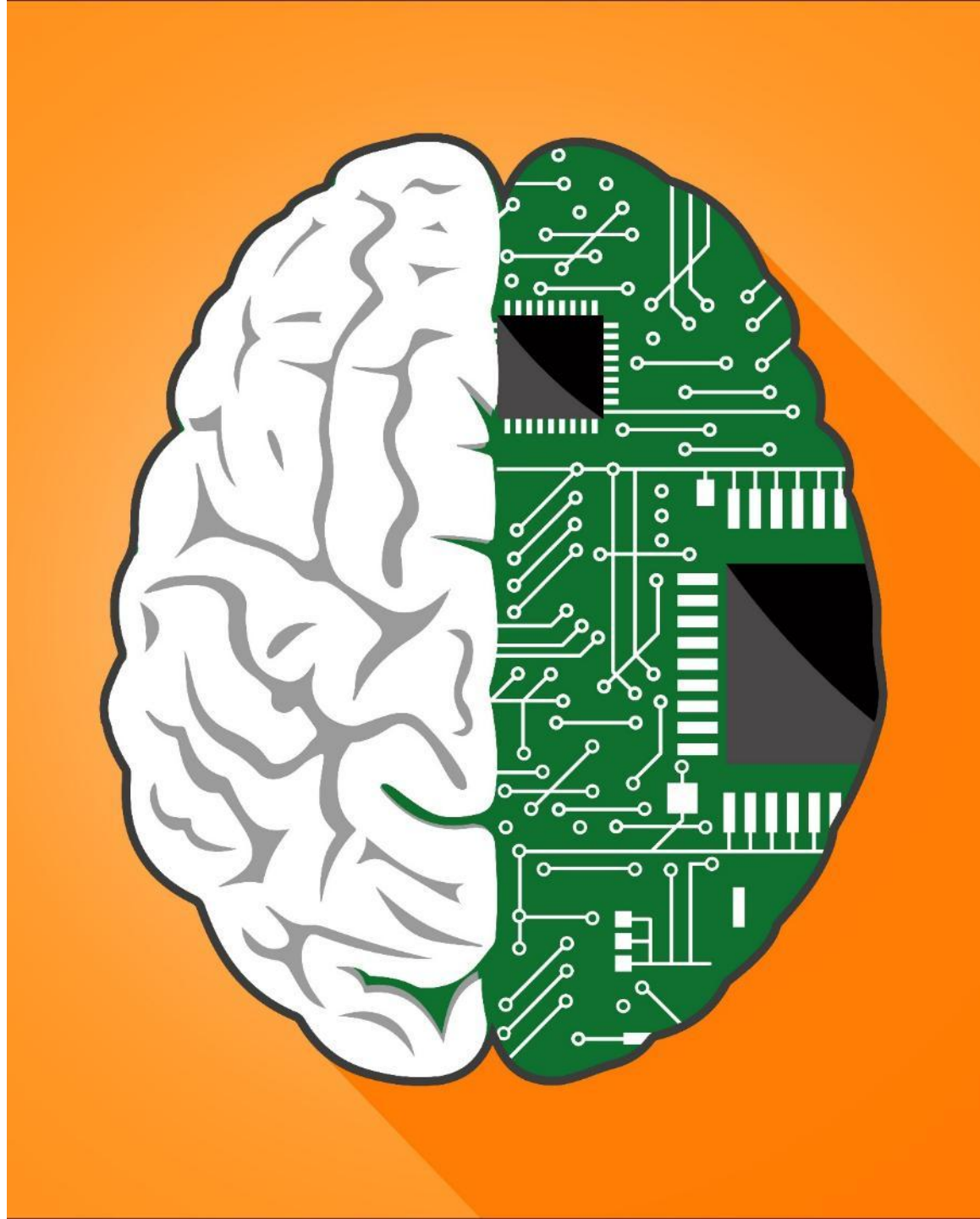
# AI

- Personalizing the learning experience
- Virtual mentoring/tutor
- Advanced analytics
- Creating digital training content

- Training that automatically changes to fit the skill level of the player
- More cost effective, faster simulation design & production
- Improved simulation AI-driven characters & effects

- Reduce the need for training

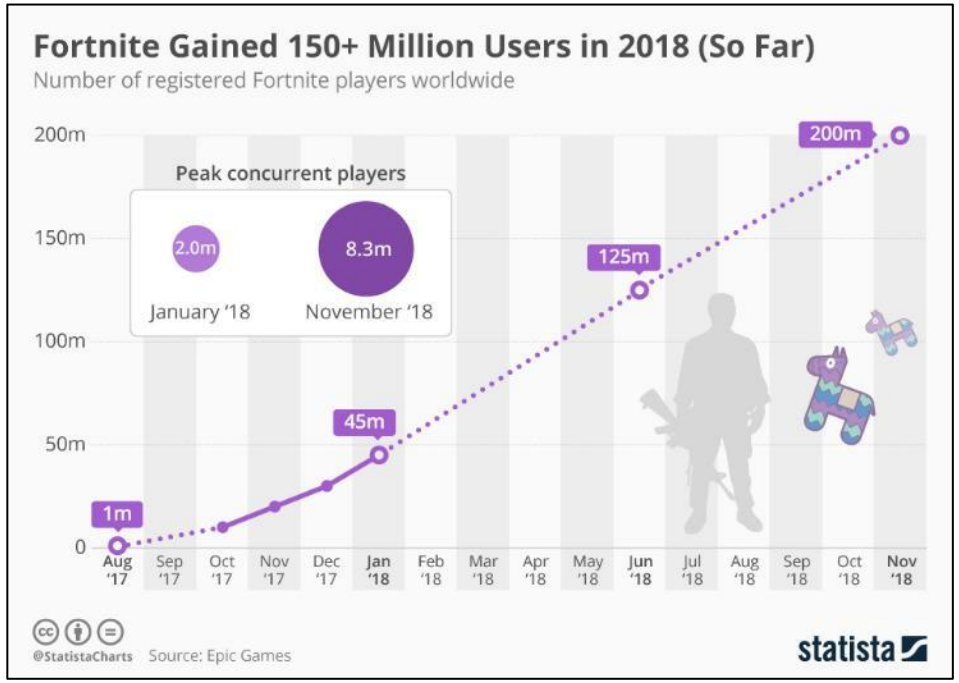


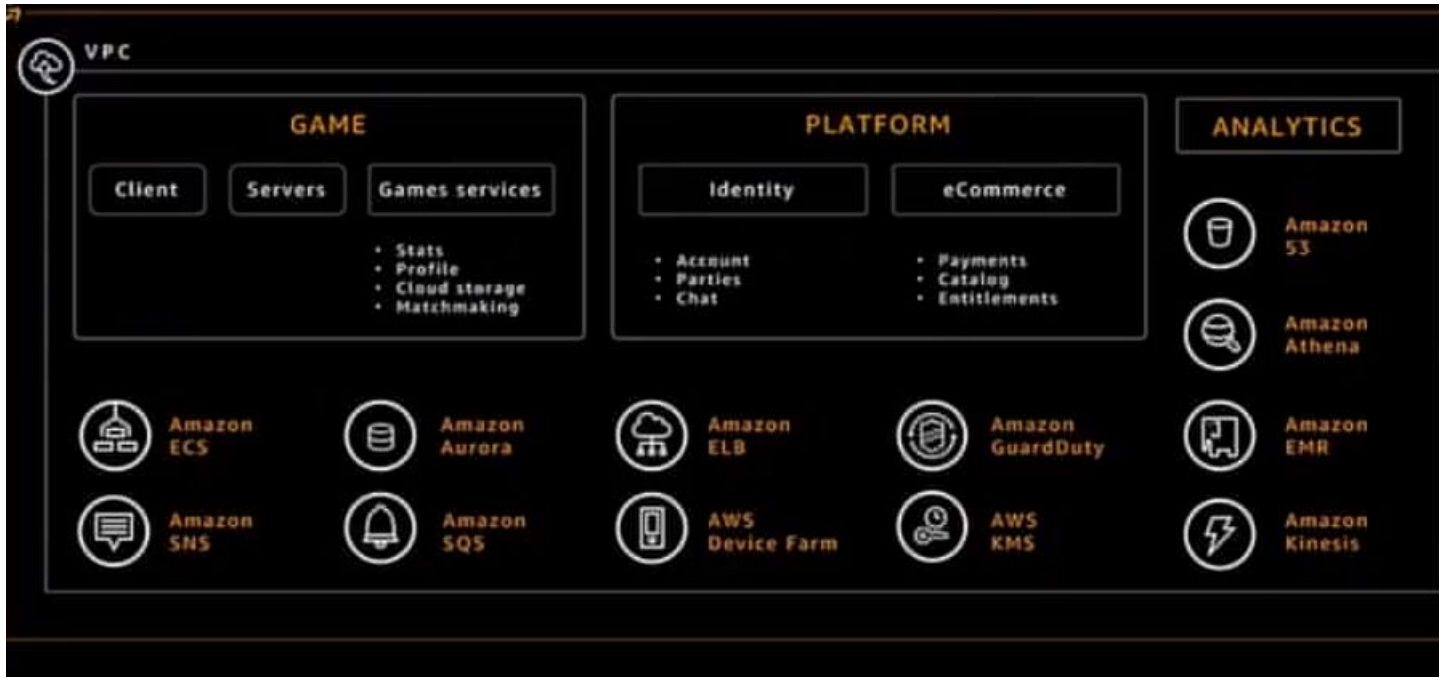
# Some Insights from the Latest Online Games


# Fortnite Battle Royale

# Fortnite Hosting

- Epic Games exploits Amazon Web Services (AWS)
- Fortnite servers around the world to reduce latency
- Each month Epic collects two petabytes of data
- From 0 to 250 Million Players in 24 Months



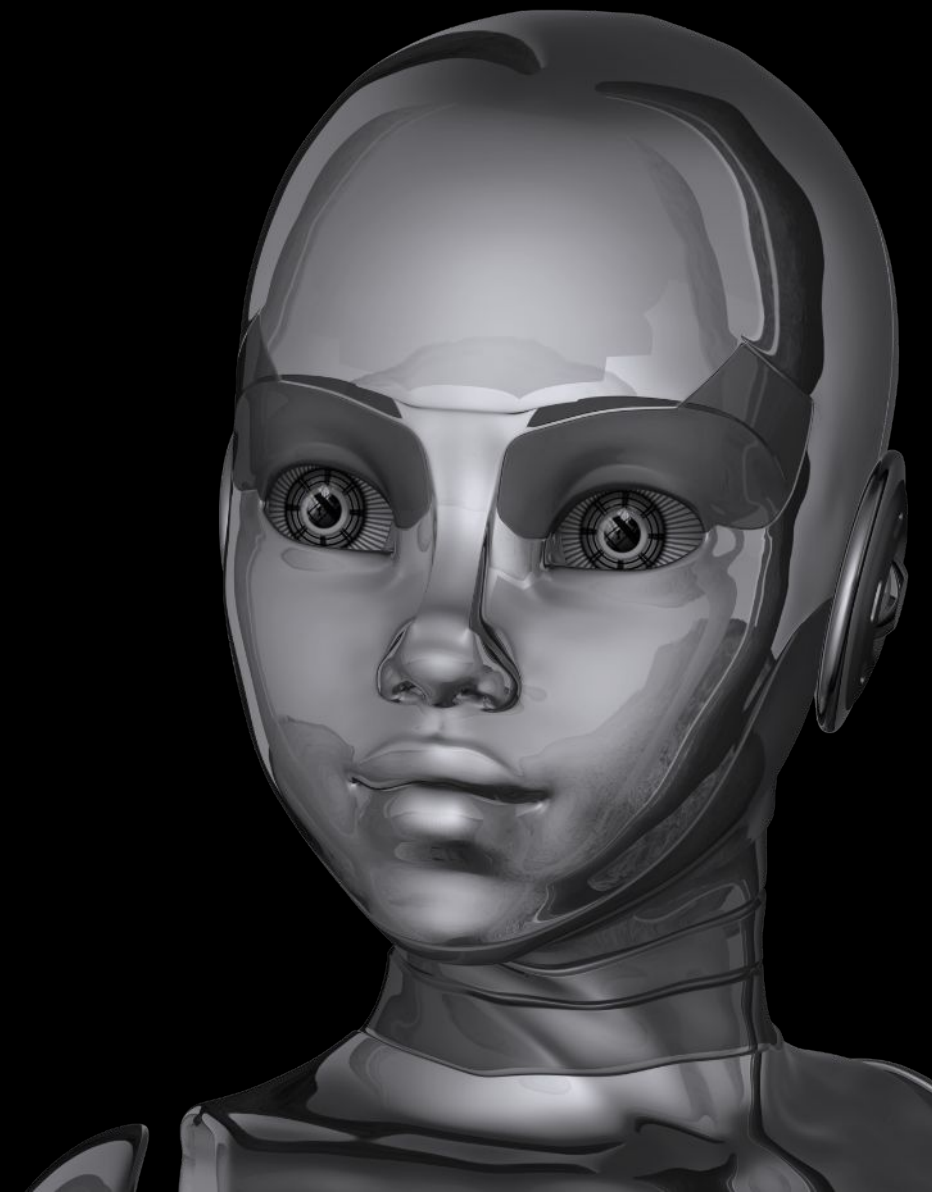
# Apex Legends (Team-Based Battle Royale)

- 50 Million Players joined in one month (Feb 19)
- Earning $92 million in revenue across all platforms
- A novel ping system allows teammates to mark supplies, locations, and enemies


# Cross-Platform Play

An online video game that allows players using different game hardware such as Consoles, PCs, Mobiles etc to play with each other simultaneously

# A More Autonomous Future?



# Nothing New in the World?

RN High Angle Control System Fire Control Computer (1930s/40s)


Radio Controlled “Queen Bee” (1936)

Gaumont British Newsreel (Reuters) - Wikipedia

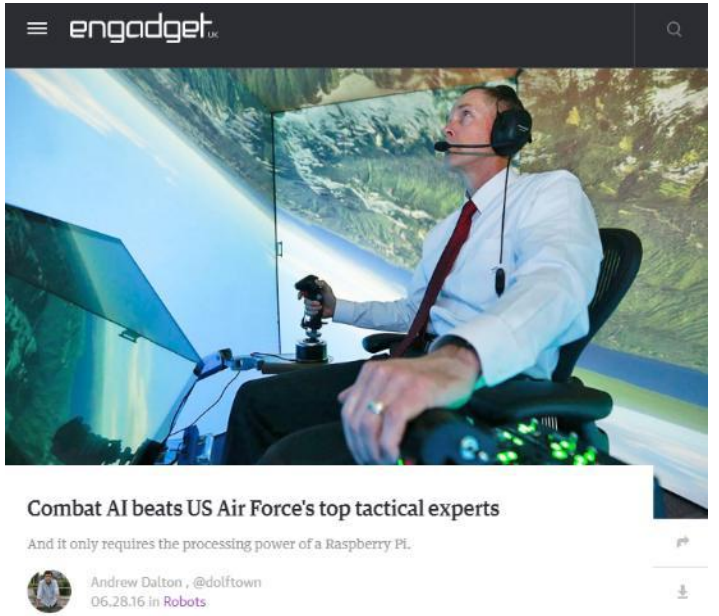
# Queen Bee Drone – 1930s/40s


**nearly 400 built**

# Military Autonomous Systems

US Navy
X-47B

US AFRL
“ALPHA”




US Army
Manned-Unmanned
Teaming
(MUM-T)

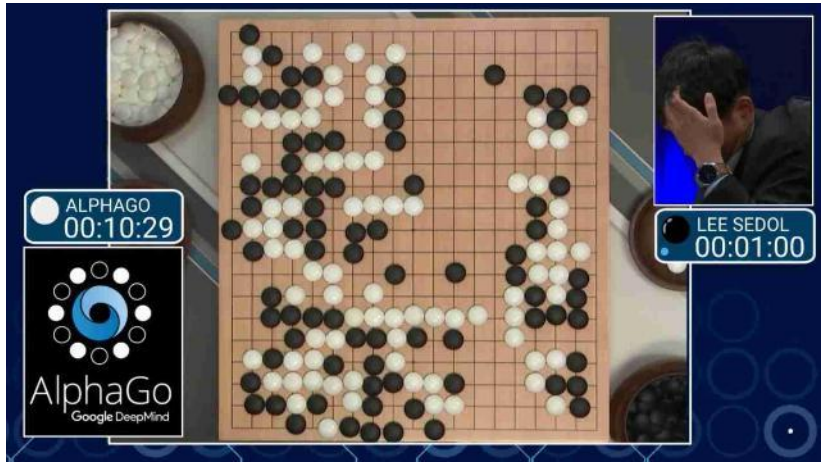
US Navy
Autonomous
Craft

THINK

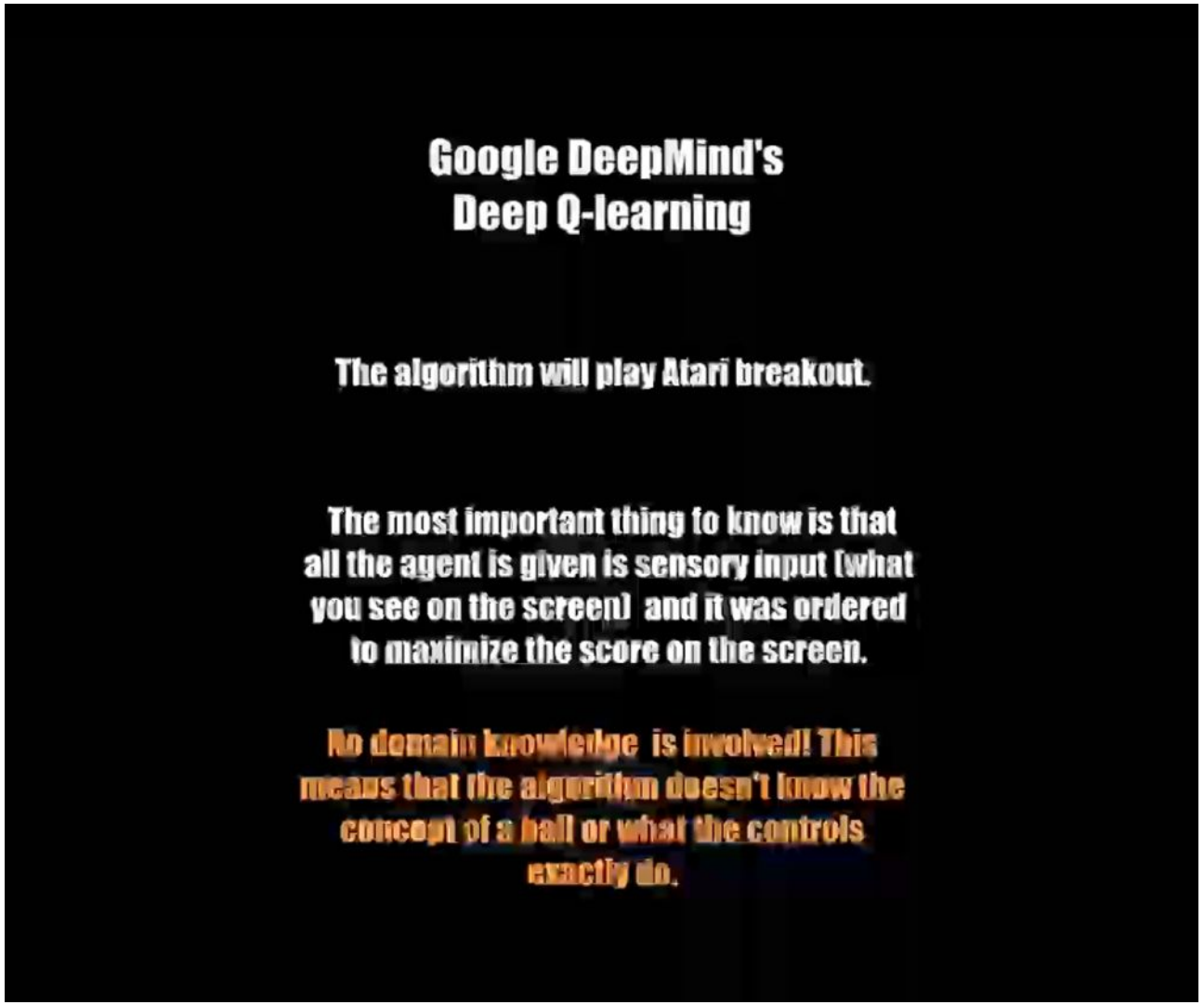
# “AlphaGo” (2016) & “AlphaGo Zero” (Oct 2017)

- AlphaGo beats top Human Go Player

- The next incarnation was “AlphaGo Zero”, with a new neural net design
  - Trained in 3 days, no human intervention except Go rules
  - AlphaGo Zero beats AlphaGo – 100 to 0

# AI Learning in Games/Simulation




Google DeepMind
(Atari Breakout) - 2015

# Google DeepMind AlphaStar (2019)

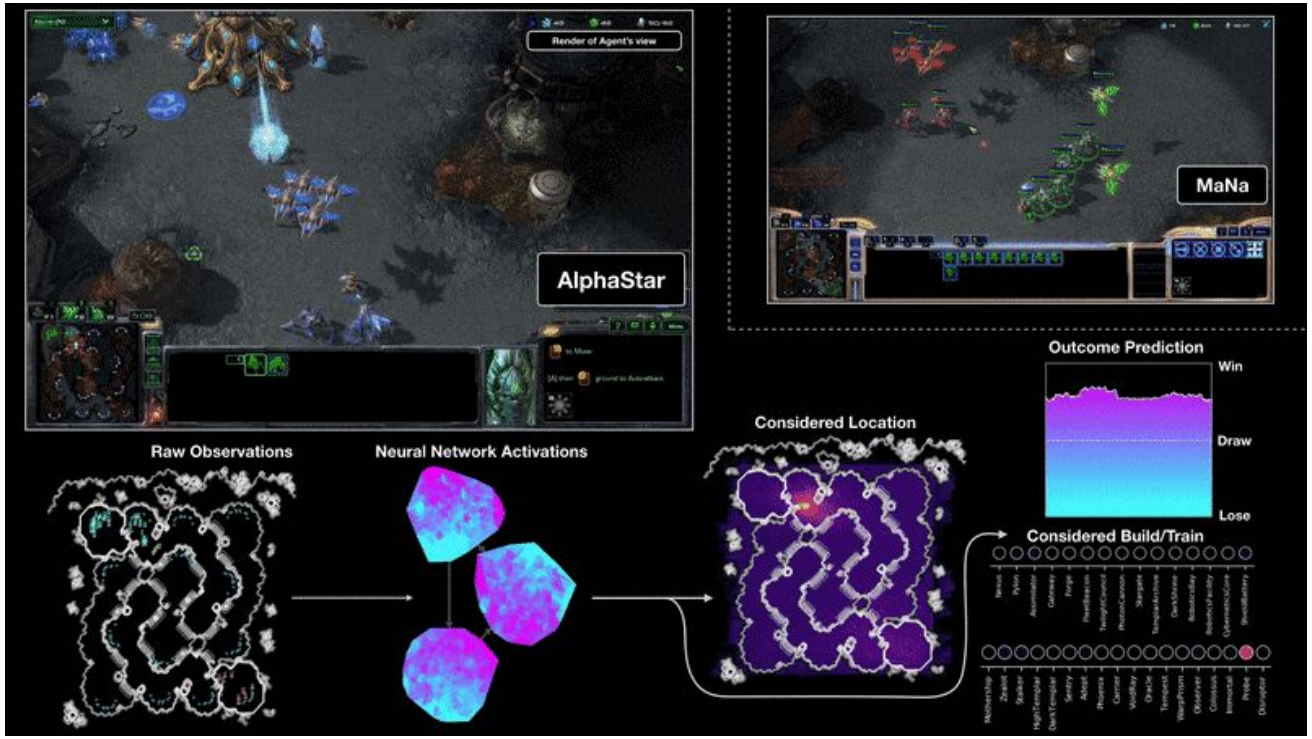
THE VERGE TECH REVIEWS SCIENCE CREATORS ENTERTAINMENT VIDEO MORE

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

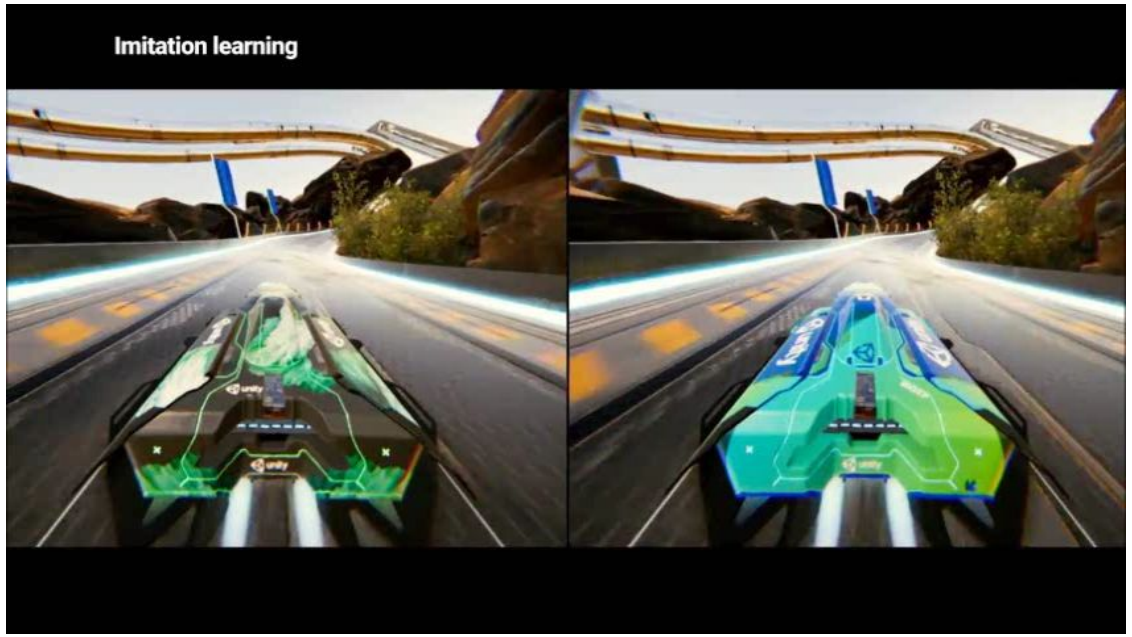



"The game's complexity is much greater than chess, because players control hundreds of units;

more complex than Go, because there are 10^26 possible choices for every move;

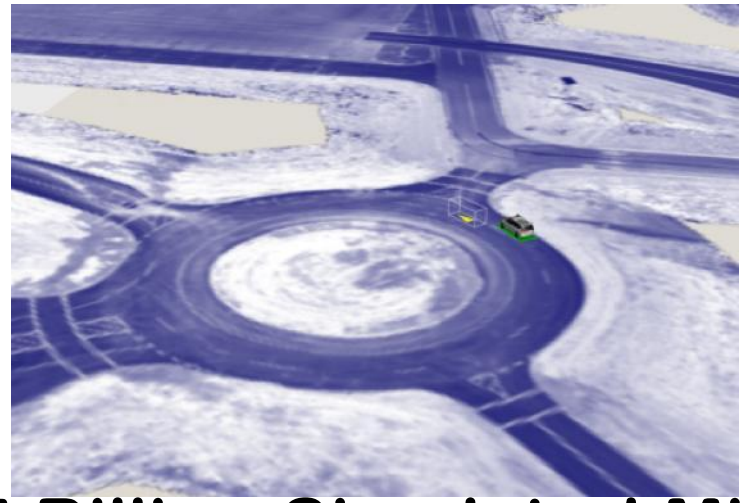
and players have less information about their opponents than in poker."


# Unity Games Engine
# Machine Learning Agents
# *AI Training*

# Alphabet (Google) Waymo


3 Million Real Miles (2016)



2.5 Billion Simulated Miles (2016)

# Data Misjudgements

Google Street View

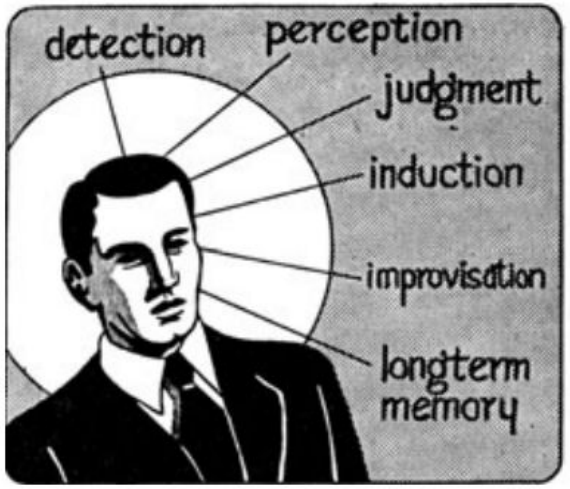
# Still Some Way to Go

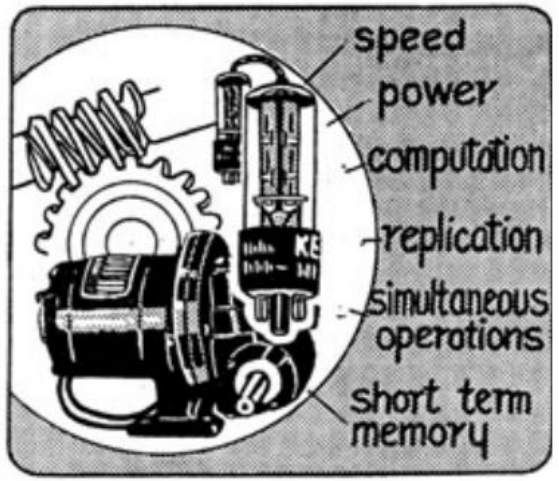

Tom Clancy's Rainbow Six: Vegas
2

# Humans & Automation

# Paul M Fitts (ed) (1951)

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



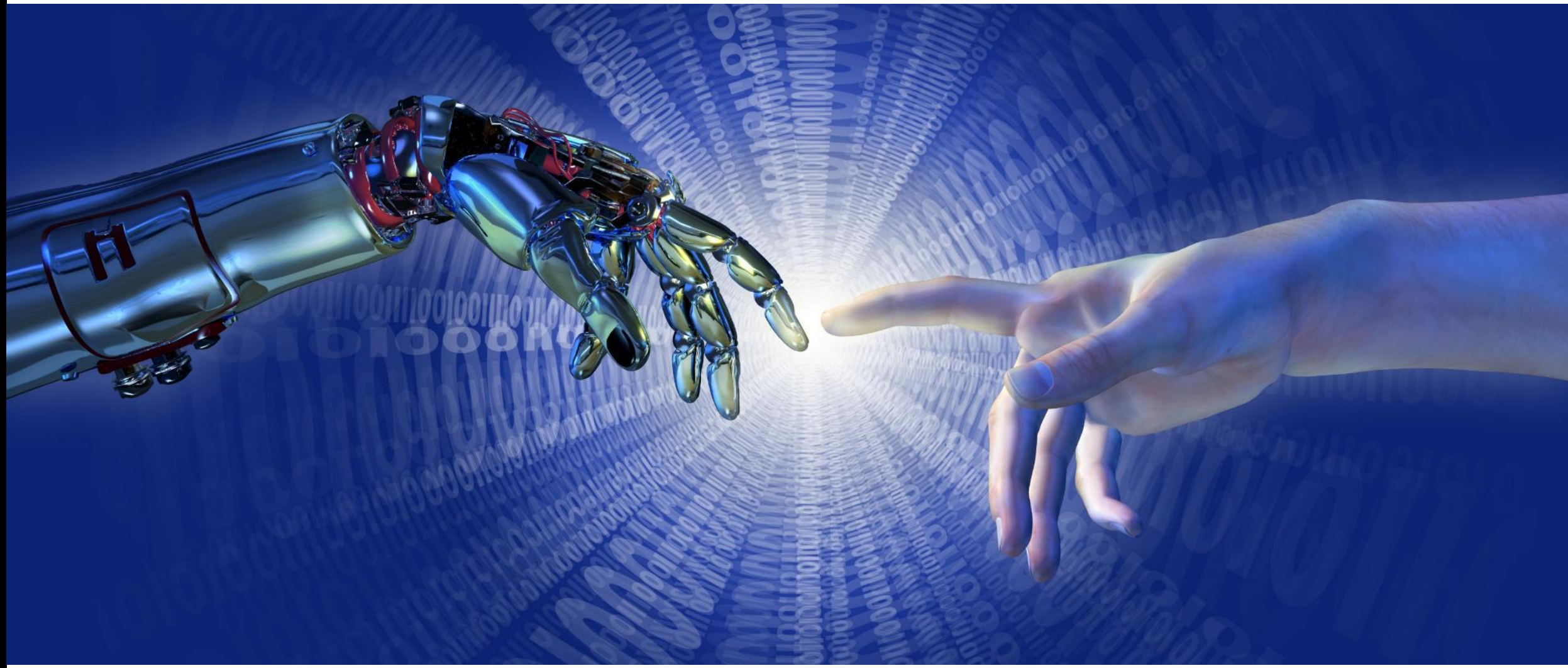




- We suggest that great caution be exercised in assuming that men can successfully monitor complex automatic machines and take over if the machines break down.
- Engineers should seriously consider systems in which machines would monitor men and prevent them from making dangerous mistakes.

# Boeing 737 MAX

- "Without speculating on the results of the investigations....
- Where the response of the pilot/driver is time-critical, as in the case of an aircraft flying at low level shortly after take-off, the safety argument either has to dictate a very high integrity system not subject to single point failures or a human factor design that gives the pilot/driver unequivocal advice on the nature of the fault condition and the correct remedial action.
- The human factor design and training system is part of the safety assessment.
- Where the human performance (e.g. reaction time, sustained close monitoring) cannot meet the safety target, the system has to be designed to safety critical standards.
- The introduction of new functionality into an existing type and released as a new variant needs to be well documented and provided to the operators, complemented with training for operators.
- Training should always look at the new or changed functionality and include failure scenarios such as loss of or degradation of the new functionality as a minimum, and trained for in simulation.

# Seek the Optimum Human/Machine Blend



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

# Innovation

THINKe

# VRLT Timeline

**Dec 18**

**Contract Award**

**Jan 19**

**Sprint 1**

18 Soldiers in VR

Oculus Rift, Vive, DVS/VBS3

**Feb 19**

**Mar 19**

**Sprint 2**

36 Soldiers in VR

Oculus Rift, Haptics, Polystream Cloud, Training Data Cloud Capture, Unity, DVS/VBS3

**April 19**

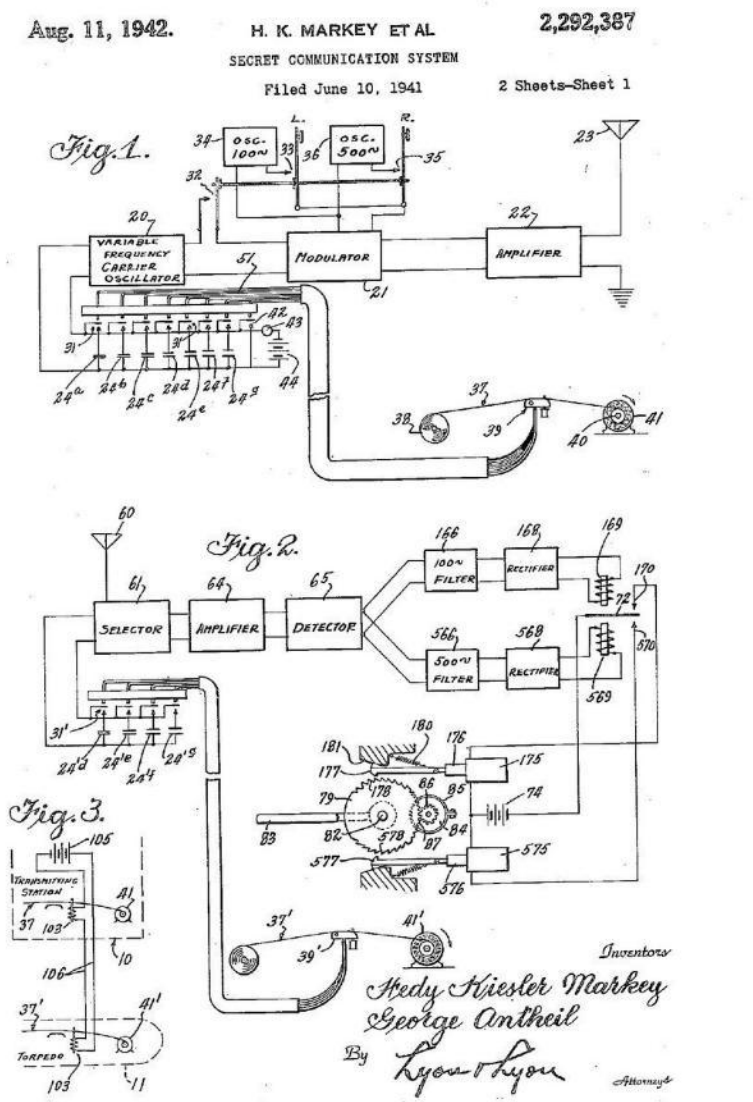
**Sprint 3**

36 Soldiers in VR

OR, Vive, Mixed Reality, 105mm Gun Integration, Haptics, Unity, Polystream Cloud, Training Data Machine Learning, DVS/VBS3

# US Army Synthetic Training Environment (STE)
## MG Maria R. Gervais, Association of the United States Army (March 18)

THINK



Aug. 11, 1942. H. K. MARKEY ET AL 2,292,387

SECRET COMMUNICATION SYSTEM

Filed June 10, 1941 2 Sheets-Sheet 1

Fig. 1.



Fig. 2.



Fig. 3.



Inventors
Hedy Kiesler Markey
George Antheil
By Lyon & Lyon
Attorneys

# Innovation from Unexpected Quarters

- Frequency-Hopping Radio-Controlled Torpedoes
- Hedy Lamarr & George Antheil Patent 1942

# Questions?

THINK