



9th SMi Annual
Military Flight Training Conference
Virtual - 5 October 2021

Military Flight Simulation and Training in the 21st Century

Andy Fawkes





The Presenter

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Before



Ministry
of Defence



Now



Last time ...

Predicting the Future



8th SMi Annual
Military Flight Training Conference
London - 9/10 October 2019

Military Flight Training and Simulation in the 2020s (?)

Andy Fawkes

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

Exploiting Big Data

Big Data → Machine Learning, Neural Networks, etc. → Analysis → Human Decisions → Automation

Quantum Computing

- Artificial Intelligence
- Molecular Modeling
- Cryptography
- Financial Modelling
- Weather Forecasting

5G

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

Additional Realities – Extended Realities 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

US "Pilot Training Next"

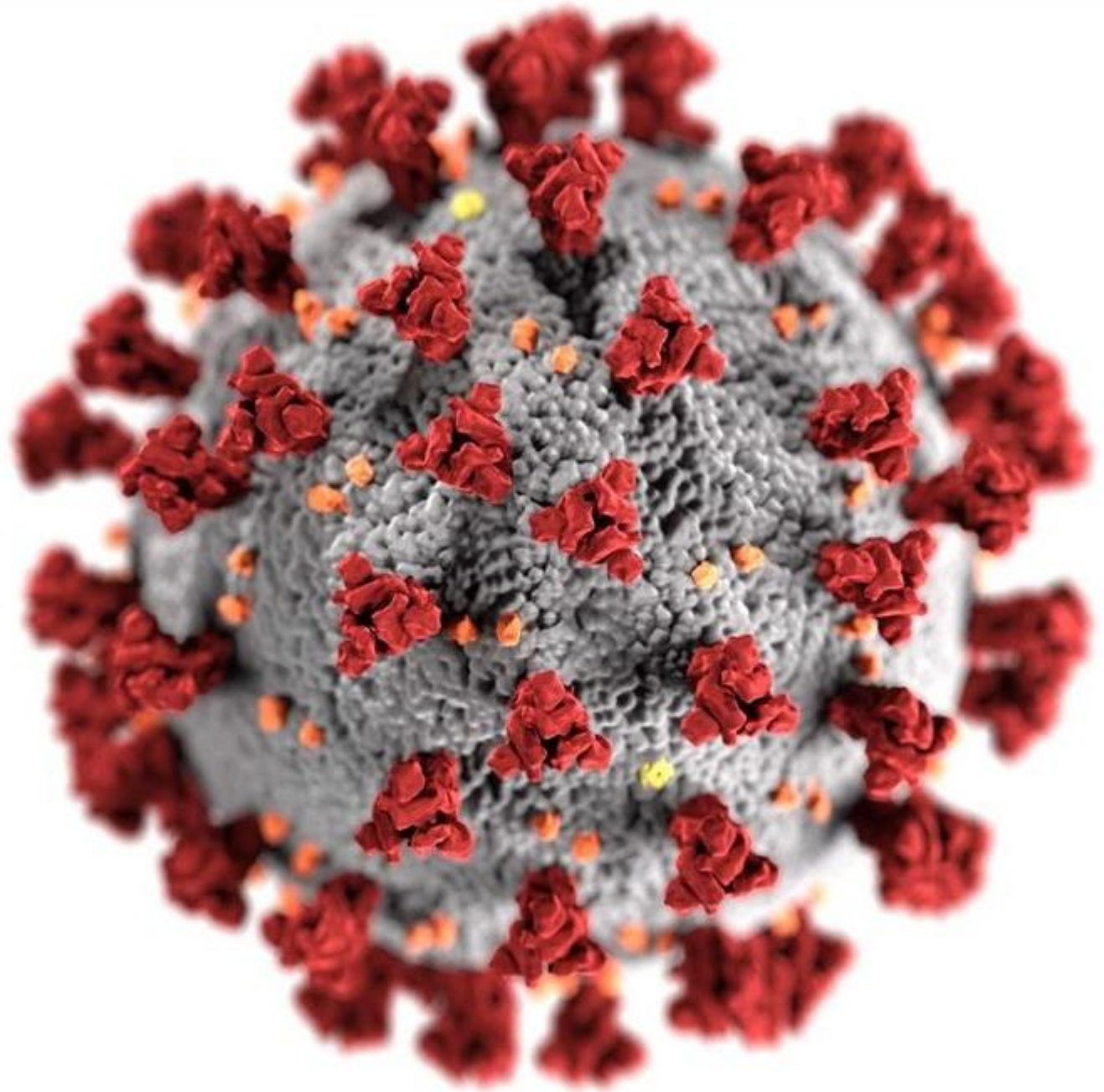
Pilot Training Next graduates 14 in learning experiment's second iteration



Outline

- Changes ...
- XR
- Gaming and the Metaverse
- The 21st Century Aviator

An Agent of Change



COVID-19 Digital Acceleration



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



Zero Carbon



WHO

THINKE

Towards Net Zero Carbon

13 Sept 21

BAE SYSTEMS

Home What we do Our Company Sustainability News & events Careers Investors

Newsroom

News releases Multi-million pound investment in synthetic training capability for Typhoon pilots

13 Sep 2021



The Ministry of Defence (MOD) has awarded BAE Systems contracts valued at more than £220m to deliver advanced synthetic training for pilots training to fly Typhoon, one of the world's leading combat aircraft.

Under the Typhoon Future Synthetic Training (TFST) contracts, BAE Systems is leading work to deliver ten high fidelity, immersive simulators, together with highly-secure state of the art training facilities at RAF Coningsby in Lincolnshire and RAF Lossiemouth in Moray.

The new training environments will be linked together providing an integrated environment for pilots to train and carry out complex combined training exercises using real world mission software and tactics.

The investment by Defence Equipment and Support, the MOD's procurement arm, reflects the Royal Air Force (RAF)'s ambition to increase its use of synthetic training, delivering cost, time and sustainability benefits over live training. This technology will also provide students with a more complex and secure training experience tailored to the individual which are often difficult to achieve in live training environments.

Richard Hamilton, Typhoon Programme Director, Europe – BAE Systems Air, said:

"We pride ourselves in delivering world-class training capability as we understand how critical it is to deliver the highest quality skills and capabilities to the front line. This contract builds on existing work to deliver synthetic training to the RAF's Typhoon Force, which will eventually enable pilots from different locations to fly virtual missions together and provide the ability to 'plug into' other assets across air, land and sea.

"The investment will deliver a number of valuable operational benefits for the RAF, alongside the positive impact that the increased use of synthetic training will make to reduce carbon emissions. With 9.6 tonnes of carbon saved by every synthetic flight, it will help reduce the current carbon footprint of live training, supporting the net zero ambitions held by our customers and ourselves."

The contract will support approximately 120 jobs in the delivery of new infrastructure at two RAF bases with a further 60 engineering jobs sustained at BAE Systems and many more with a number of specialist UK companies throughout its supply chain.

Contact

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Air sector

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Air Training

We help unlock talent giving individuals the personal skills to master different disciplines, taking students from the classroom to the frontlines.

find out more

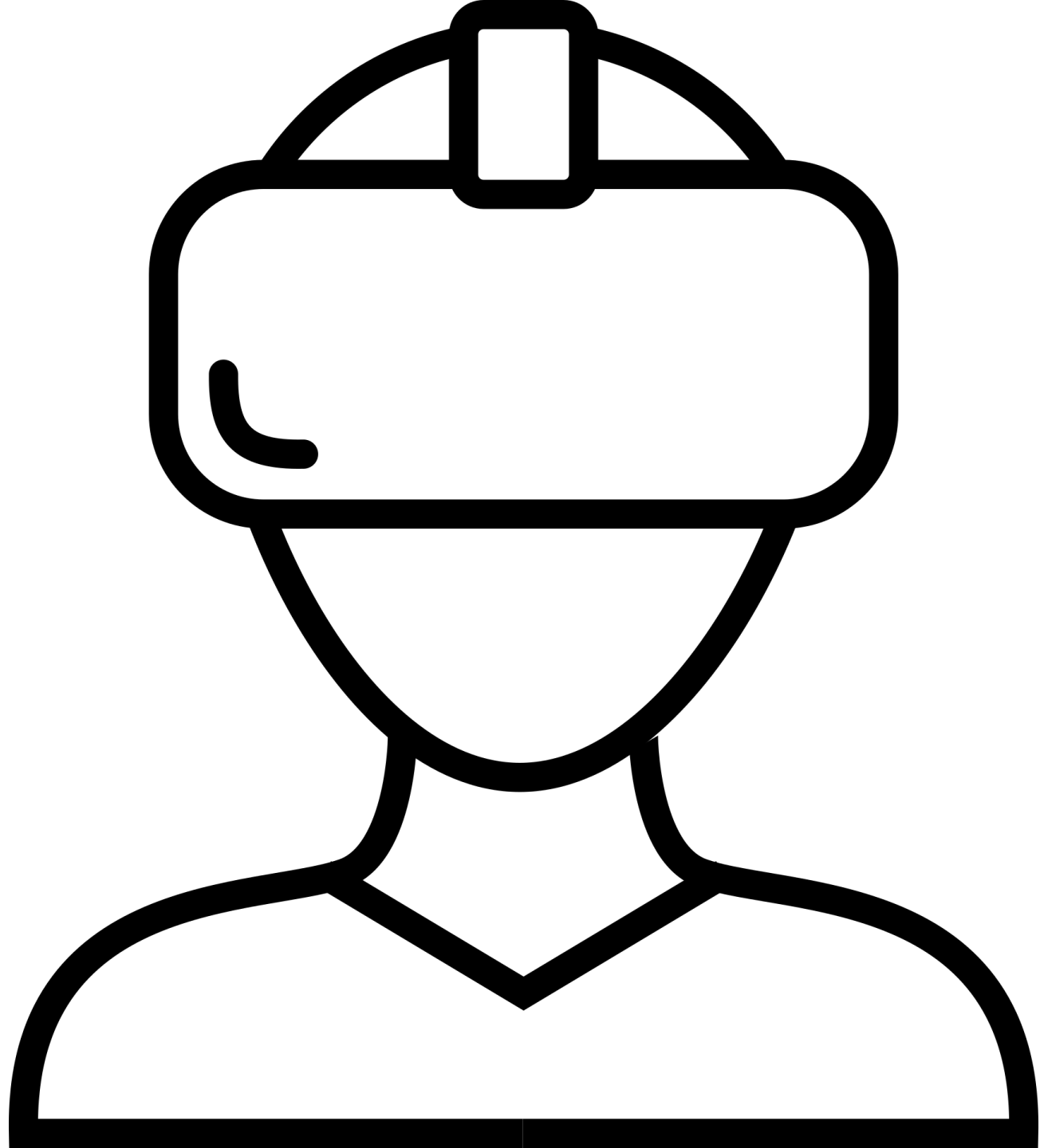
DSEI - 14-17 September 2021

Find out more about our research at the show

Visit event page

“With 9.6 tonnes of carbon saved by every synthetic flight, it will help reduce the current carbon footprint of live training, supporting the net zero ambitions held by our customers and ourselves.”

XR



Good Enough



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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.

Data



Project iDAS (immersive Data driven Airmanship Simulator)

 **HalldaleGroup**
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VRAI Wins Royal Air Force Data & Simulation Project

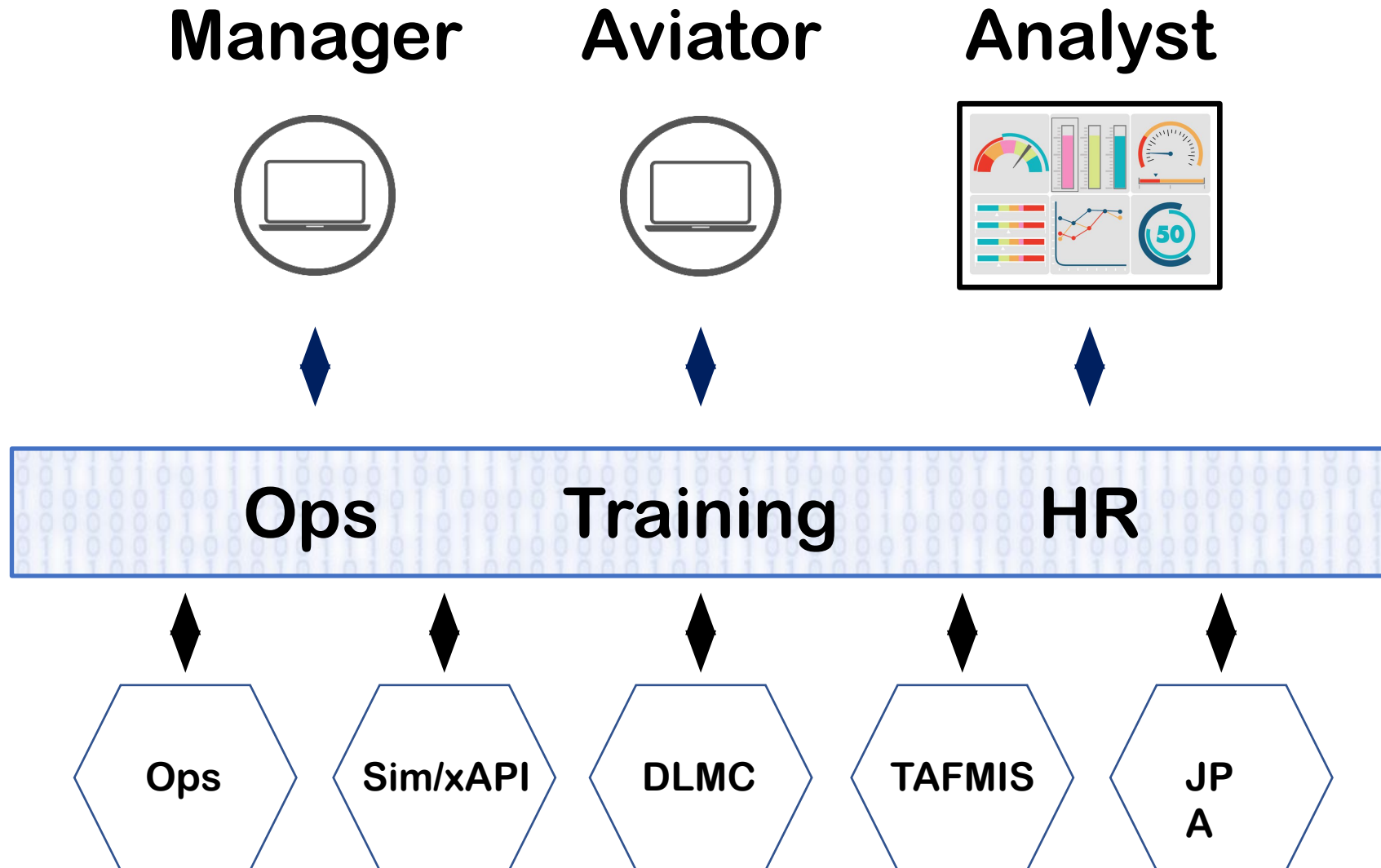


DECEMBER 10, 2020

Data driven VR simulation company VRAI has won a Defence and Security Accelerator (DASA) contract focused on improving the RAF's ability to measure and predict pilot performance using a combination of VR & data analytics technology.

The company based in Gateshead's Proto Centre, and RAF based in the local airbase RAF Leeming, was awarded the £348k funding to work with the Royal Air Force (RAF) to help codify and assess 'airmanship' in pilots. VRAI creates data driven VR simulation training for high hazard environments, with clients including leading organisations such as the IAG in Heathrow Airport, the United Nations in Somalia, and other European militaries.

Bringing Data Together



UK Air Training Capabilities - Data Stovepipes?

A400M

Apache

ASDOT

AUV

C-130

C17

DCS&S

Gladiator

(JFST)

E-3

F-35

iASTC

JFST

LTPA

MFTS

MSHTF

P-8

STARS

TFST

TyTan

WIST

Paperwork



Sept 2020



March 2021



March 2021

Highlights

- “Multi-domain integration”
- “Persistent engagement”
- “Embracing new and emerging technologies”
 - artificial intelligence, AI-enabled autonomous systems, cyber, space and directed energy weapons
- “Capability in the future will be less defined by numbers of people and platforms than by information-centric technologies, automation and a culture of innovation and experimentation.”

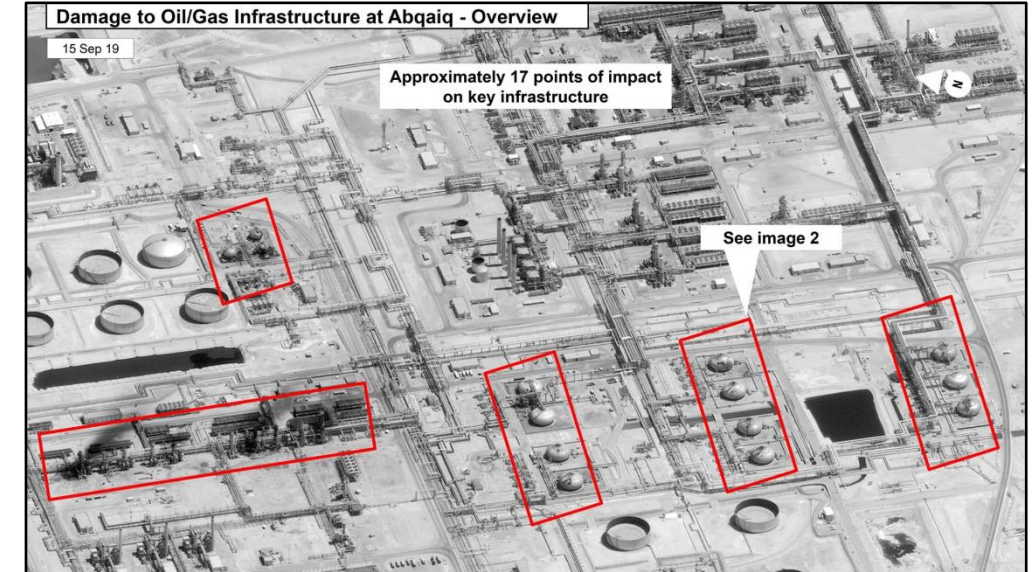
10 Jan 2019

14 Sep

2019



“Low Tech” Air Threat



CNBC MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV SEARCH QUOTES Q

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.

2021



Latest

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Magazine

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Essays

Argument

Review

/RT Afghanistan | 12 MIN READ

The Drone Unit that Helped the Taliban Win the War

The work of a drone unit, reported in detail here for the first time, shows how the Taliban were able to win the war against the U.S.-backed forces in Afghanistan



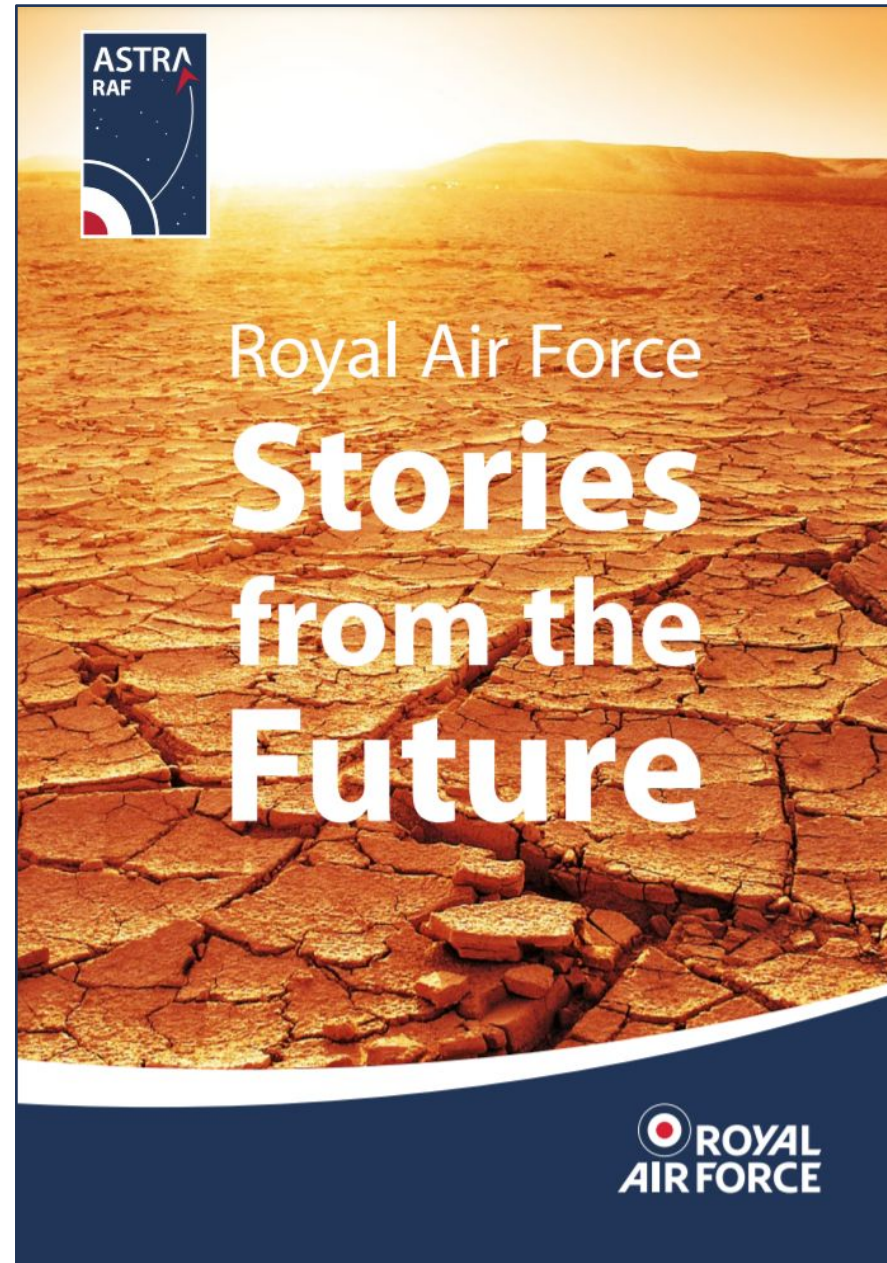
Fazelminallah Qazizai

Fazelminallah Qazizai is an Afghan journalist and co-author with Chris Sands of "Night Letters: Gulbuddin Hekmatyar and Afghan Islamists who Changed the World"

September 15, 2021

07:58 EST

Fictional Inspiration



ficint¹ [fik-in't]

(noun)

Fictional Intelligence; useful fiction, a meld of narrative and nonfiction.

(See also: *speculative fiction*)



What are We Seeking in Training?

Faster



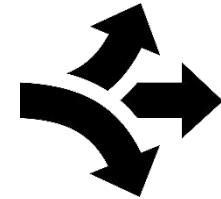
Cheaper



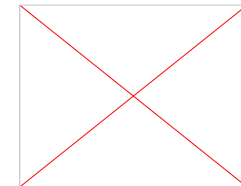
Better



Flexible



Multi-Domain



Greener



XR

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
			

AR/VR Progression over Last 10 Years (CAE)

AUGMENTED
REALITY



Google Glass



Microsoft HoloLens

HoloLens 2



2013

2016

2019

2021

VIRTUAL
REALITY



Oculus DevKit

Samsung
GearVR



HTC Vive

Oculus Rift



VARJO



Industrial optical performance threshold reached in 2019

The aim of the VRLT pilot was to identify the opportunities that Virtual Reality technology offers the Future Collective Training System

UK Virtual Reality in Land Training (VRLT) Pilot - 2019



Why VR for Team/Collective Training?

- Immersive environment creates a challenging environment
- Can rapidly rehearse and repeatedly practice in a variety of scenarios
- Flexible, scalable, deployable and cost effective





“in Virtual
Simulation
you look at
the Virtual
World,

in VR, you
are in it”



Viper Wing F-16 Cockpit Varjo XR-3 MR Headset (Prepar3D Software)

Mixed
Reality



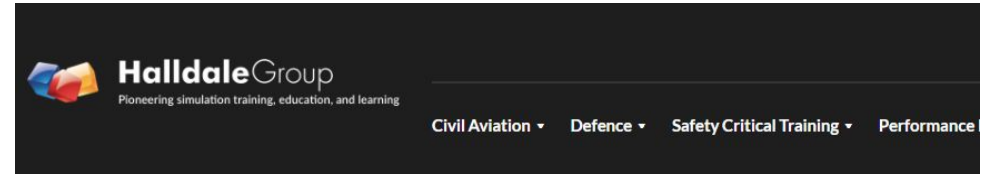
Other Crew (CAE)



Support



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.

Varjo Reality Cloud



Mixed Reality in Operations

Microsoft is supplying 120,000 HoloLens-based headsets to the US Army

The contract could be worth up to \$21.88 billion over 10 years

By Tom Warren and Sean Hollister | Mar 31, 2021, 4:11pm EDT



Image: US Army

Microsoft has won a contract to supply the US Army with HoloLens-based headsets. The contract could be worth up to \$21.88 billion over 10 years, and [CNBC reports](#) that it will involve Microsoft supplying 120,000 headsets. The software maker has been working closely with the Army since 2018, and soldiers have been testing the Integrated Visual Augmentation System (IVAS) headsets over the past two years. These devices combine high-resolution night, thermal, and soldier-borne sensors into a heads-up display.

Gaming and the Metaverse

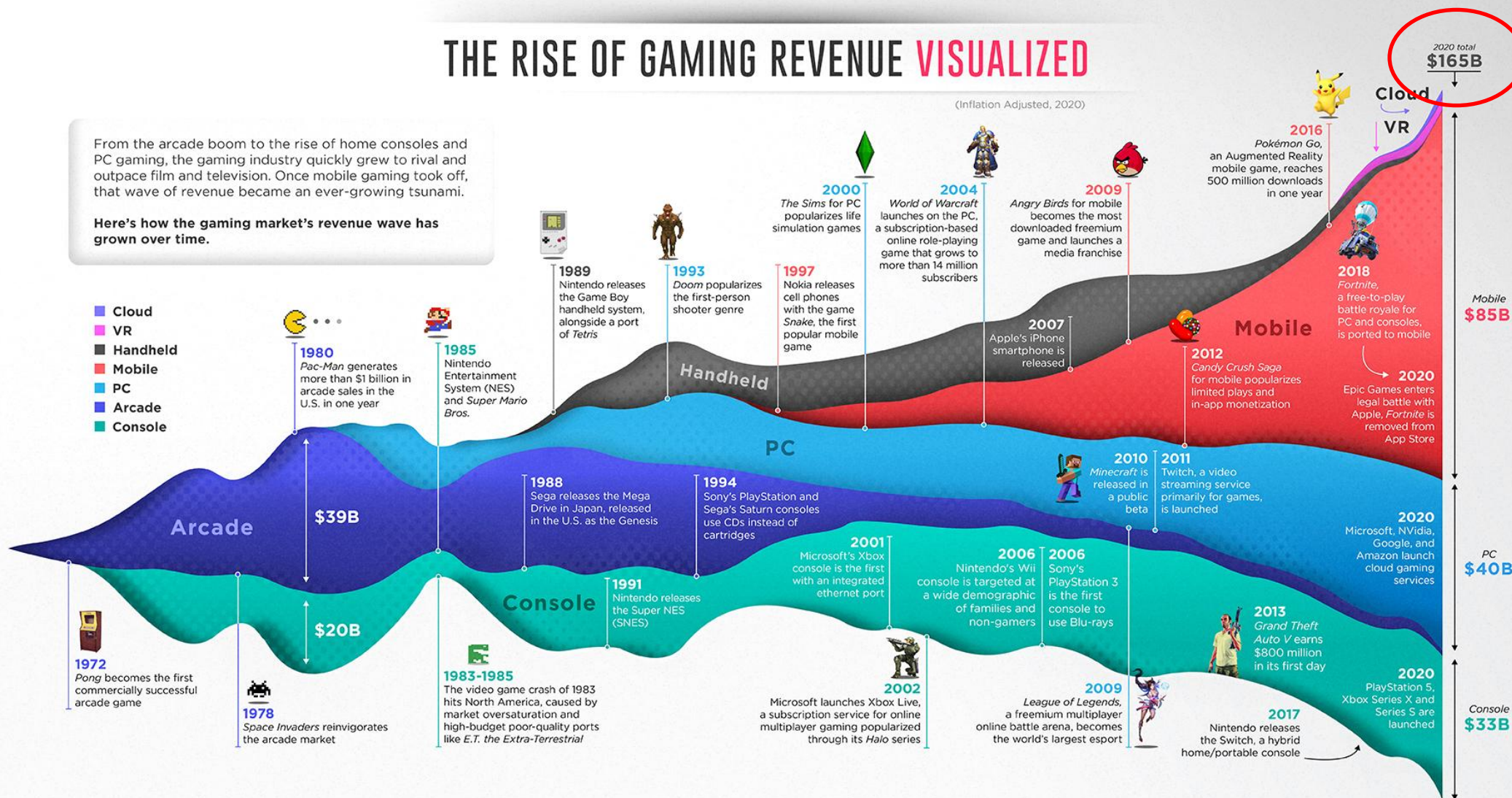
50 Years of Gaming History, by Revenue Stream (Nov 2020)

THE RISE OF GAMING REVENUE VISUALIZED

(Inflation Adjusted, 2020)

From the arcade boom to the rise of home consoles and PC gaming, the gaming industry quickly grew to rival and outpace film and television. Once mobile gaming took off, that wave of revenue became an ever-growing tsunami.

Here's how the gaming market's revenue wave has grown over time.



SOURCE: Pelham Smithers
COLLABORATORS: RESEARCH • WRITING: Omri Wallach | DESIGN • ART DIRECTION: Clayton Wadsworth

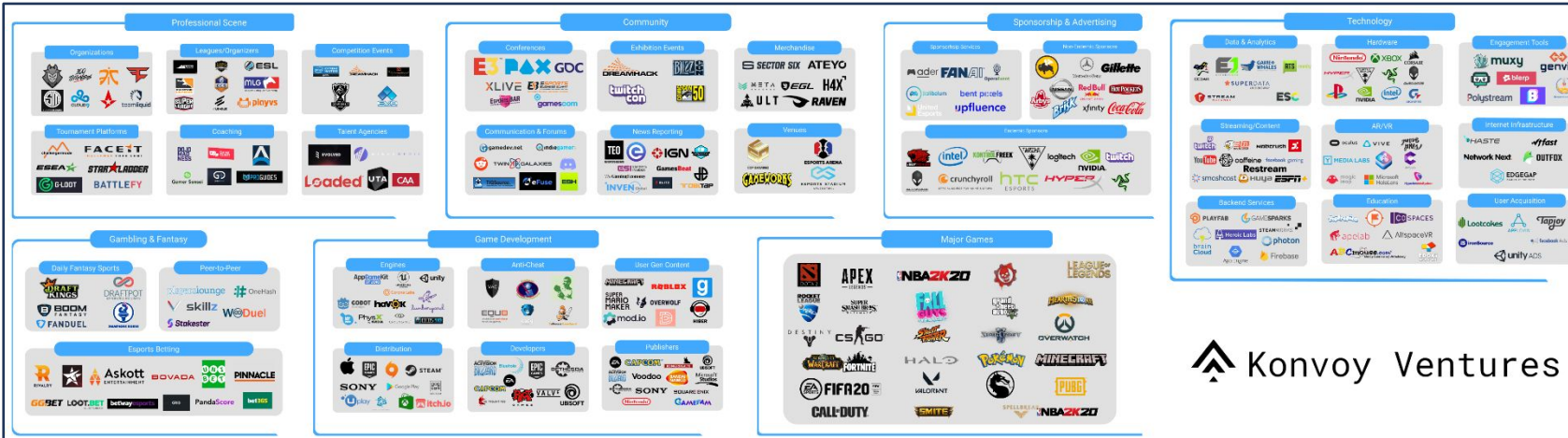
VISUAL CAPITALIST

f /visualcapitalist @visualcap visualcapitalist.com

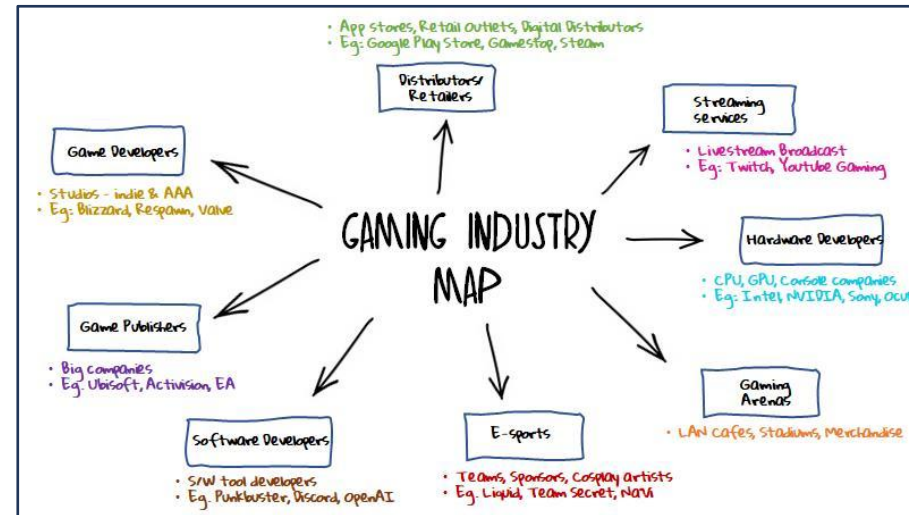
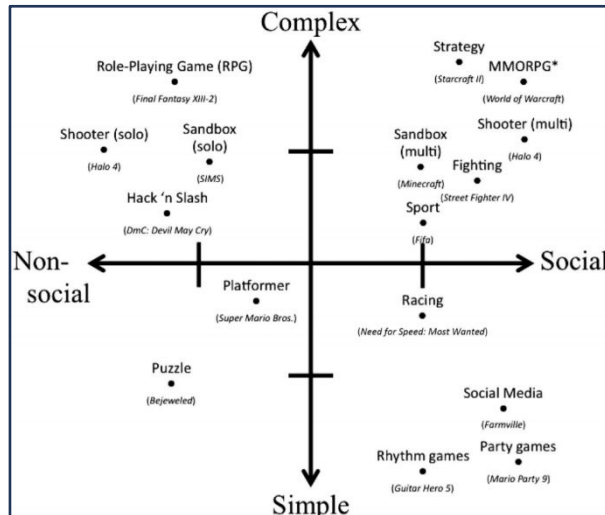
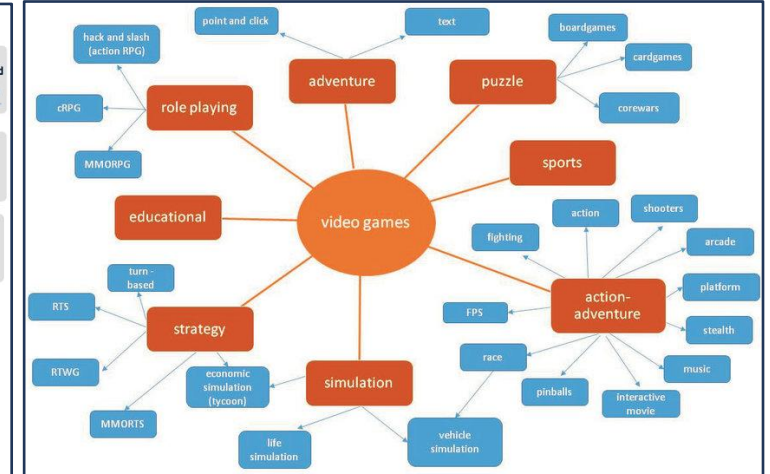
www.visualcapitalist.com

THINKE

Gaming Ecosystem(s) are Large, Complex and Evolving



Konvoy Ventures



The graphic above shows only a sampling of companies in each category. Data cumulative through March 2018

**UK Dstl
Gaming
Ecosystem
Study
(2021)**

- **Games Engines**
- **Cloud Gaming**
- **Community**
- **Data and Analytics**

Some Findings...

Game Engines

- Software such as Unity and Unreal are already being used in defence
- They are becoming ever more capable and versatile and are supported by their own ecosystems, communities, and professional services
- They have large user bases which generate open source training and knowledge
- Defence could benefit by taking a coordinated approach to procuring and deploying game engines and sharing content and best practice on their use

Cloud Gaming

- A technological reality with Amazon, Google, Microsoft, Nvidia, Sony all have services, running over domestic networks and diverse devices
- Aligns with many core Modelling and Simulation as a Service (MSaaS) characteristics
- Defence could look to cloud services such as Steam, Playfab, or Unity, and investigate emerging cloud offerings such as Polystream and Hadean
- Only be fully realised if MoD defines the appropriate network infrastructure requirement and funding for a cloud-ready network

Some Findings...

Data and Analytics

- There are many emerging technologies in unexpected parts of the gaming ecosystem which could drive new opportunities for defence M&S and defence wide individual and collective training
- Examples include, live player performance analytics in pro gaming/esports and computer vision technologies for esports training

Communities

- Connect gamers, spectators, and developers across the ecosystem, empowered by software such as Discord and sharing platforms such Twitch and YouTube
- These communities act as force multipliers, sharing knowledge, providing user-generated content, and experimenting with the technology of choice
- Defence already has bottom-up initiatives such as “Fight Club” and it could reap further community benefit with top-down support to enable M&S communities to mirror the dynamics found in the gaming ecosystem

Microsoft Flight Simulator 2020



Search





Olli43
1.46M subscribers



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 Bhirud: 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

 DodgeGt8: such a cool gamer moment!

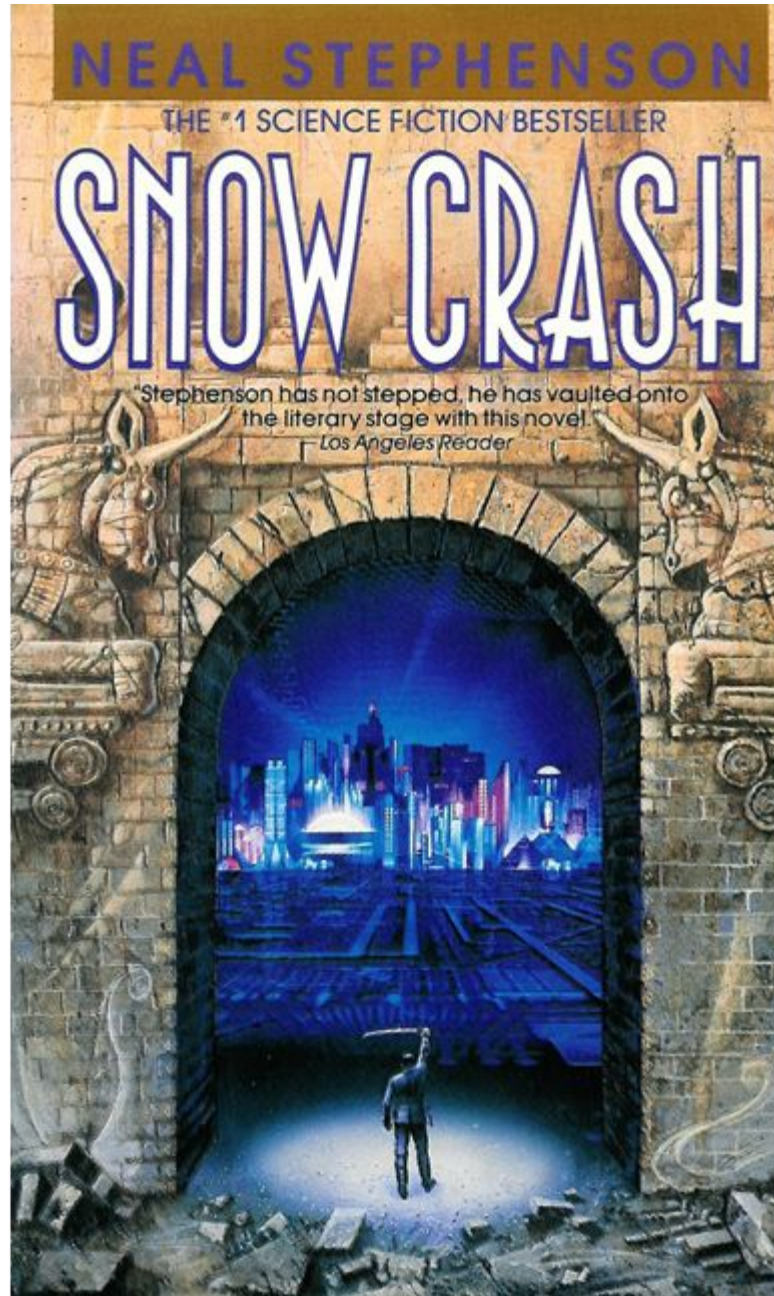
 SplIT pErSoNaLiTy: GTA 5 car meet

 TheGamingBluejay: Did he download London or is this streamed?

 Slow mode was enabled 

HIDE CHAT REPLAY

1992



- “computer-generated universe that their computers draw on their goggles and pump into their earphones ... an imaginary place known as the Metaverse”

Neal Stephenson

The Metaverse



Has the Military Been Building the Metaverse?



"Metaverse" is a portmanteau of the prefix "meta" (meaning beyond) and "universe" and is a persistent collective virtual shared space.

ANDY FAWKES

NOVEMBER 24, 2020

It seems that most tech company CEOs are mentioning the metaverse this year. What is the metaverse, why is it important and is the military already building it? MS&T Editor Andy Fawkes



Simulation Interoperability Standards Organization
"Simulation Interoperability & Reuse through Standards"

The Military's Metaverse

• *SIM-2021-Presentation-22 (SIMbrief)*



Andy Fawkes, Thinke Company, UK

2021 SIMposium

21-22 September 2021

The Metaverse in 2021



Unity



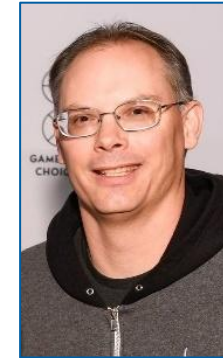
Roblox



Microsoft



Facebook



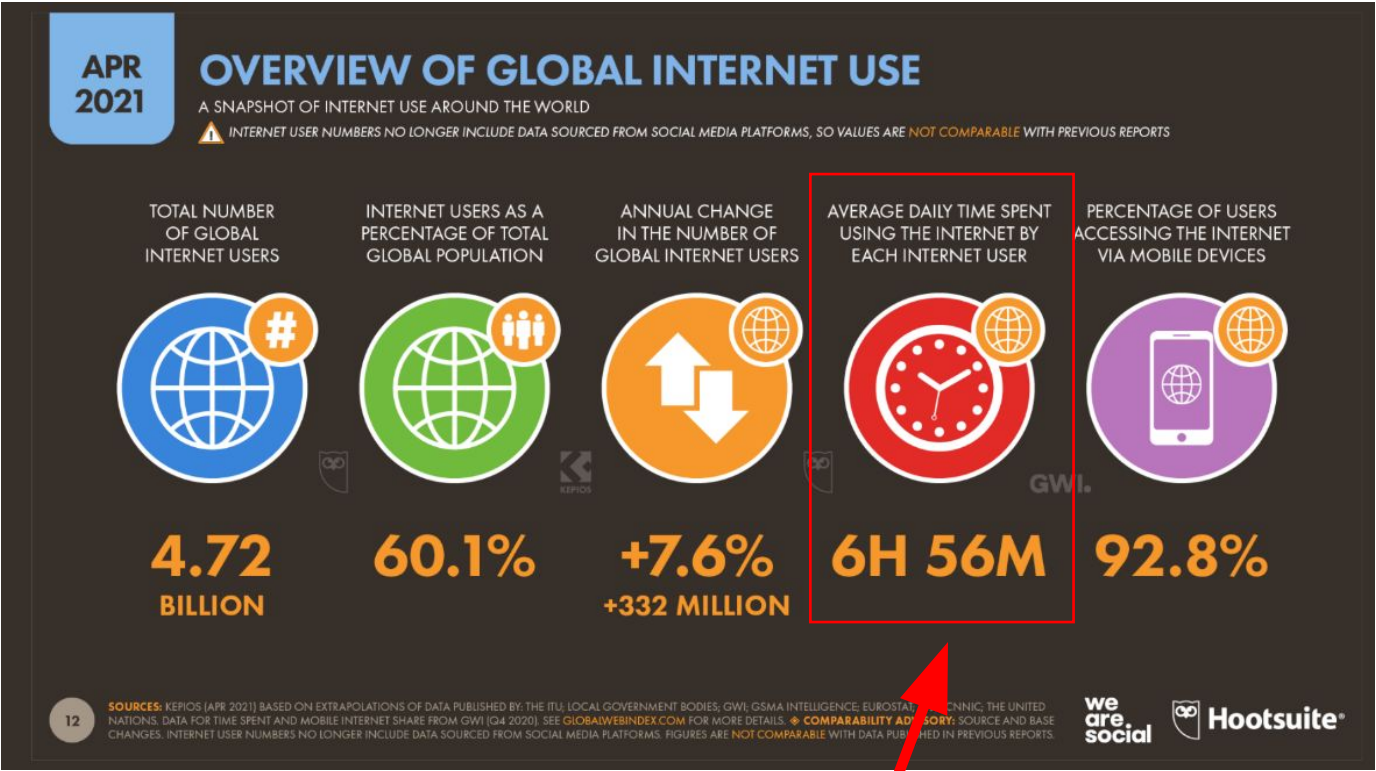
Epic Games



Nvidia

- **“A concept of a future iteration of the Internet, made up of persistent, shared, 3D virtual spaces linked into a perceived virtual universe”**
 - Wikipedia
- **“An expansive network of persistent, real-time rendered 3D worlds and simulations that support continuity of identity, objects, data, and entitlements, and can be experienced synchronously by an effectively unlimited number of users, each with an individual sense of presence”**
 - Matthew Ball, former Amazon strategist, now futurist and venture capitalist
- **An Internet that we will live in rather than look at**

The Internet & Gaming dominate our waking lives



<https://datareportal.com/reports/digital-2021-april-global-statshot>

TechRepublic

8 hours and 27 minutes. That's how long the average gamer plays each week

by Veronica Combs in Innovation on March 10, 2021, 6:04 AM PST

Binge gaming is up 13% over last year with some age groups playing six hours at a stretch, a worldwide survey finds.



Image: iStockphoto/gorodenkoff

Metaverse Convergence



Technology Convergence

- Computing
- Software
- AI and automation
- Data and Analytics
- Networking
- XR
- Sensors & Haptics
- Digital Twins
- Blockchains
- Gaming
- Standards

Microsoft

“A convergence of the physical and digital worlds creating a new world of opportunity and transformative solutions ...”

Microsoft metaverse technology stack

Microsoft Mesh & HoloLens

Enable anyone across the planet to collaborate in mixed reality environments.

Microsoft Power Platform

Empower anyone within your organization to interact with and act on the data flowing through your environment. Build applications, dashboards, and intelligent chatbots that modernize workflows.

Azure AI & Autonomous Systems

Azure AI delivers breakthrough insights into all your data. Microsoft Project Bonsai provides a low-code approach to machine teaching and creating intelligent autonomous systems that learn and improve over time.

Azure Synapse Analytics

A comprehensive set of data services that work together to provide predictive analytics, the ability to analyze data across systems, and the ability to track the historical state of your environment.

Azure Maps

The location of things. Indoor private maps enable you to apply location and routing services to people and things in your private environment while keeping data locked down to your enterprise.

Azure Digital Twins

Simplify the creation of detailed, comprehensive digital models. Support for the Digital Twin Definition Language enables modeling of complex relationships between things and systems in your environment.

Azure IoT

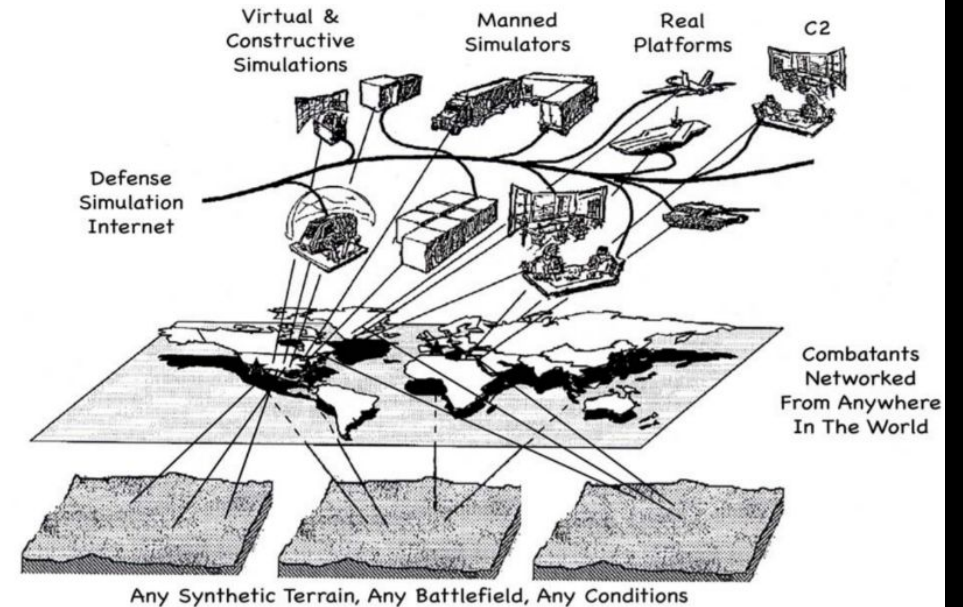
Connect physical assets and run cloud intelligence directly on premises. Sense and monitor anything in your physical environment seamlessly and securely.

The physical world

A Military Metaverse?

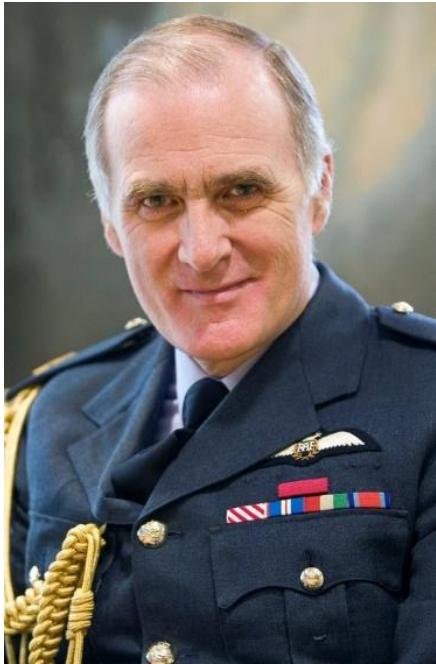
“Persistent secure networked interoperable live, virtual and constructive simulations, synchronized with operational systems and enterprise-wide digital twins of equipments, platforms, infrastructure and personnel and the wider human and natural world.”

Fawkes



*SIMNET's 1980s Vision
Jack Thorpe PhD*

Top Cover for the Military Metaverse



UK Chief of Defence
Staff
Sir Jock Stirrup
2007

... and we can see emerging the fusing of synthetic and real world environments such that it would make increasingly difficult to distinguish between training carried out in simulation and the real thing



US Army
MG Maria Gervais
2020

... our goal is to establish a common synthetic environment, where live, virtual and constructive training can be converged through common standards, common data, common terrain and an open architecture

Future 21st Century Defence Simulation Infrastructure?

- **Persistent**
- **Integrated**
- **Multi-domain**
- **Networked**
- **At the Point of Need**
- **Seamless across Real and Virtual Worlds**
- **Across Operational Cycle**
- **Across Procurement Cycle**
- **Through Career**

The 21st Century Aviator

RAF Age Distribution - 2019



38% of the RAF is ≤ 29
and 74% ≤ 39

UK Armed Forces Biannual Diversity Statistics: 1 April 2019

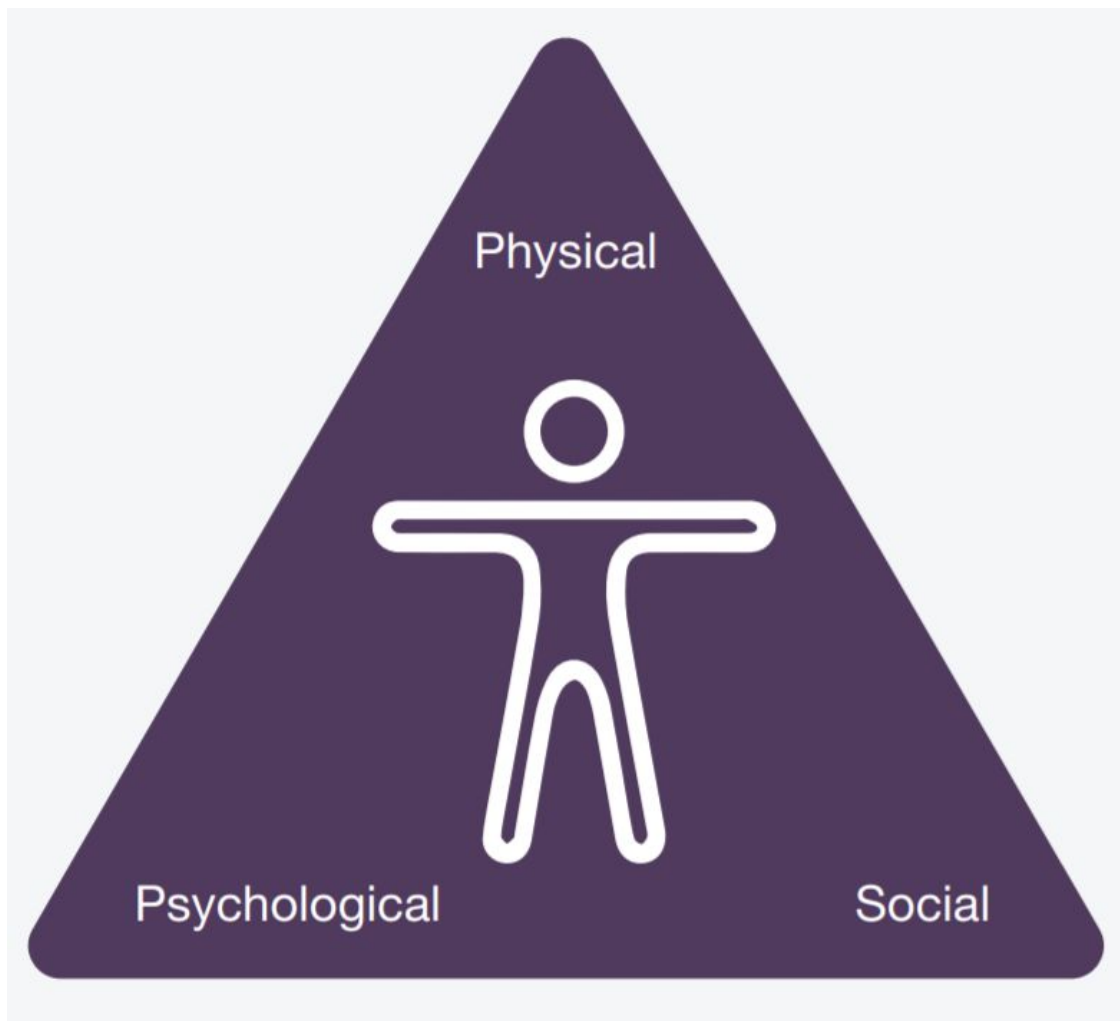
Royal Air Force		32 860
Under 18		200
Female	20	8.9
Male	180	91.1
18 - 19		910
Female	100	11.2
Male	810	88.8
20 - 24		4 790
Female	660	13.9
Male	4 130	86.1
25 - 29		6 470
Female	980	15.2
Male	5 490	84.8
30 - 34		6 100
Female	1 040	17.0
Male	5 070	83.0
35 - 39		5 800
Female	940	16.2
Male	4 860	83.8
40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

Human Augmentation (May 2021)



“Future wars will be won, not by those with the most advanced technology, but by those who can most effectively integrate the unique capabilities of both people and machines.”

The Human as a Platform



Human augmentation possible benefits for Service personnel



Physical performance

- Increased strength, speed and endurance
- Enhanced sensory functions and range

Psychological performance

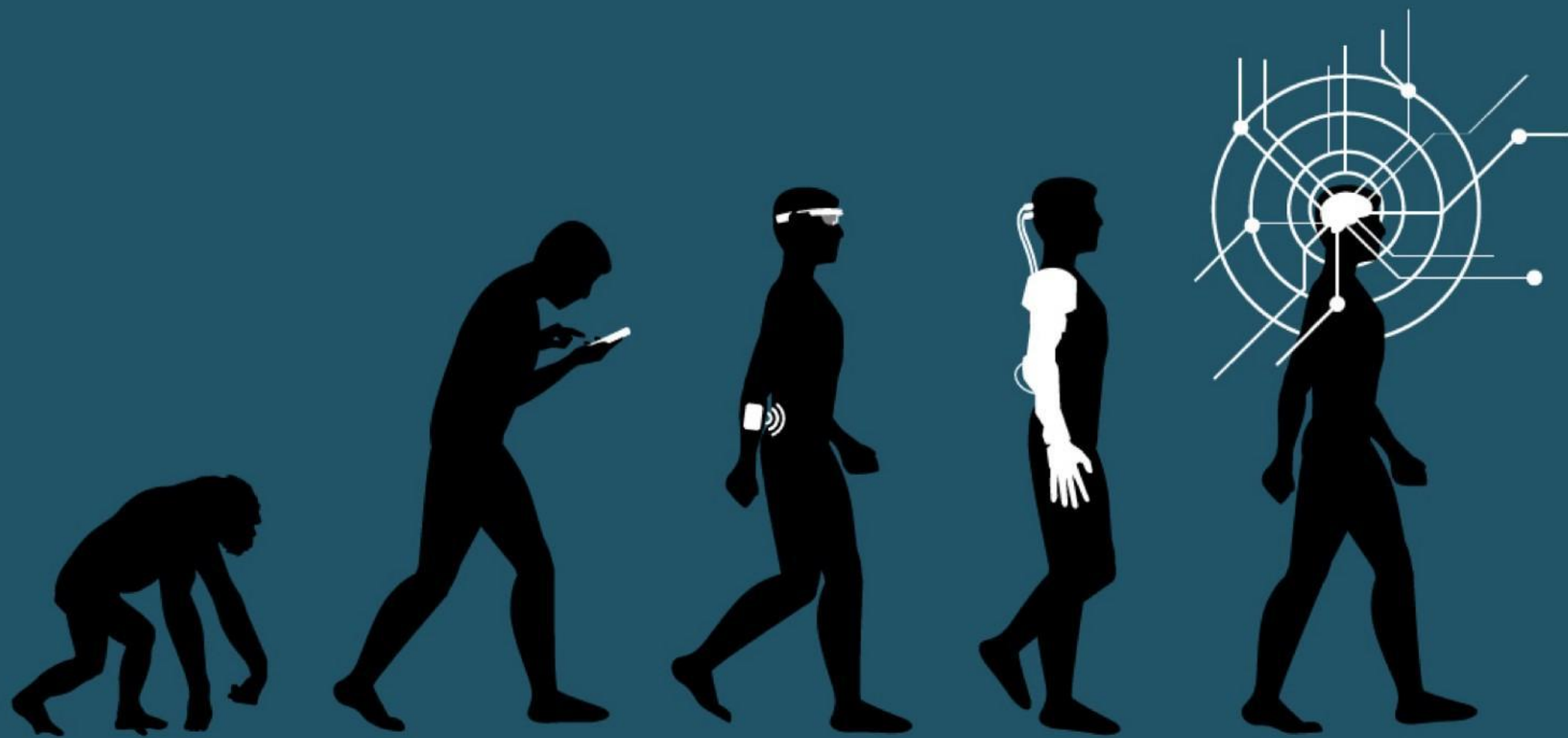
- Improved attention, vigilance and memory
- Increased perception and situational awareness
- Enhanced decision-making
- More efficient learning

Social performance

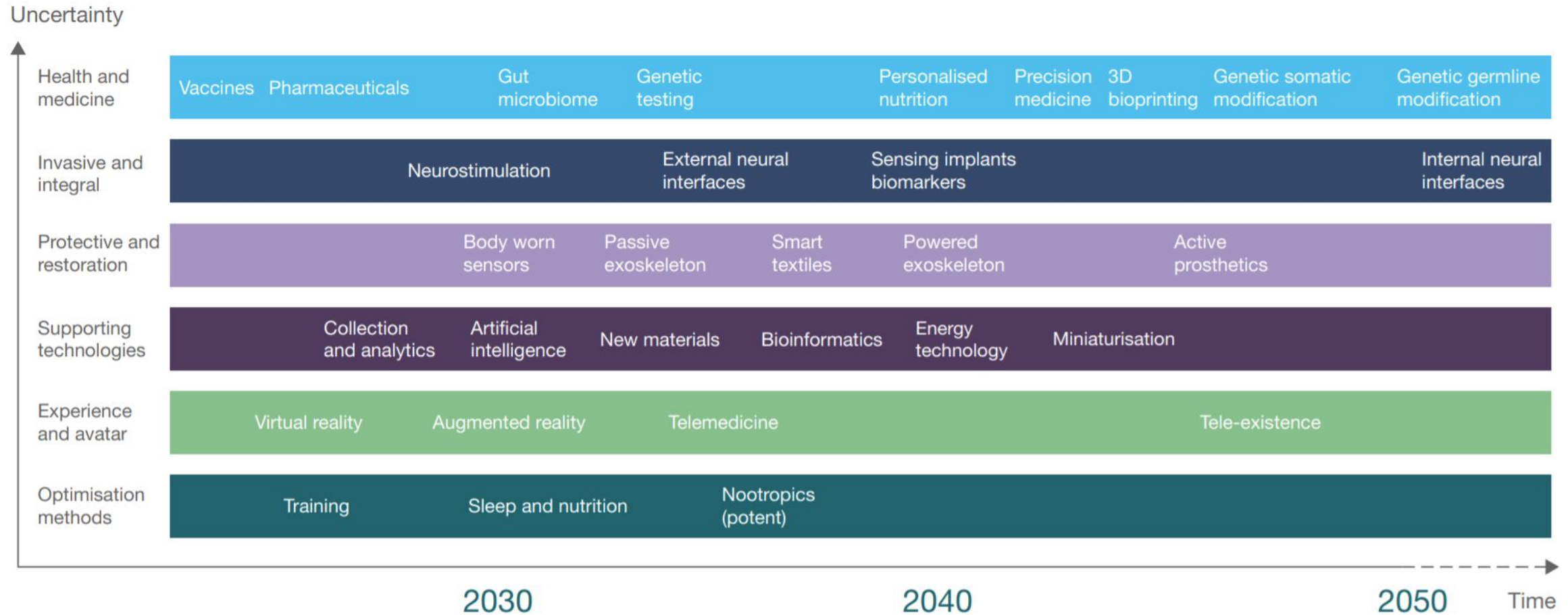
- Improved communication
- Better group cohesion – stronger units

Health and combat readiness

- Improved health and well-being
- Fast recovery from injuries and wounds
- Enhanced resilience and perseverance



Realisation of Human Augmentation Timeline



Human Augmentation – The Dawn of a New Paradigm (May 2021)

Wearables

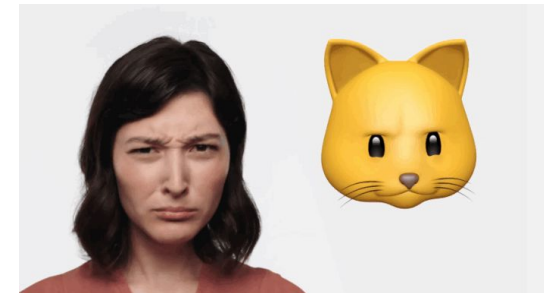
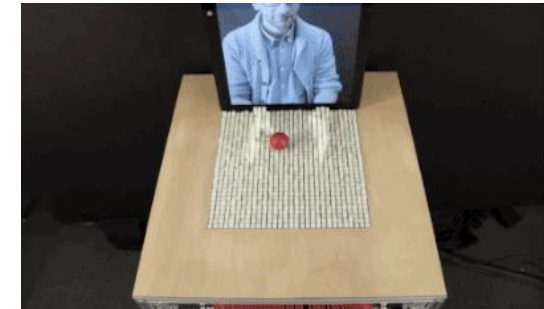


Eye Tracking



Next-Generation User Interfaces

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



Just Art?



SIGGRAPH 2021

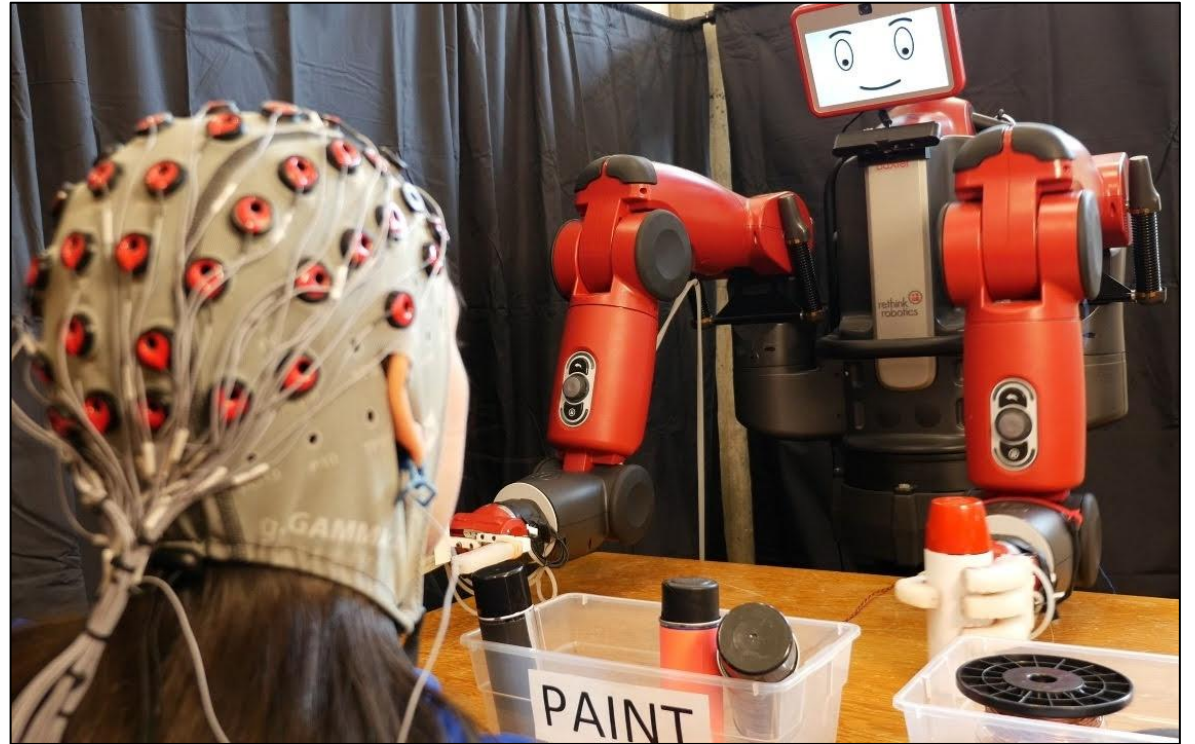
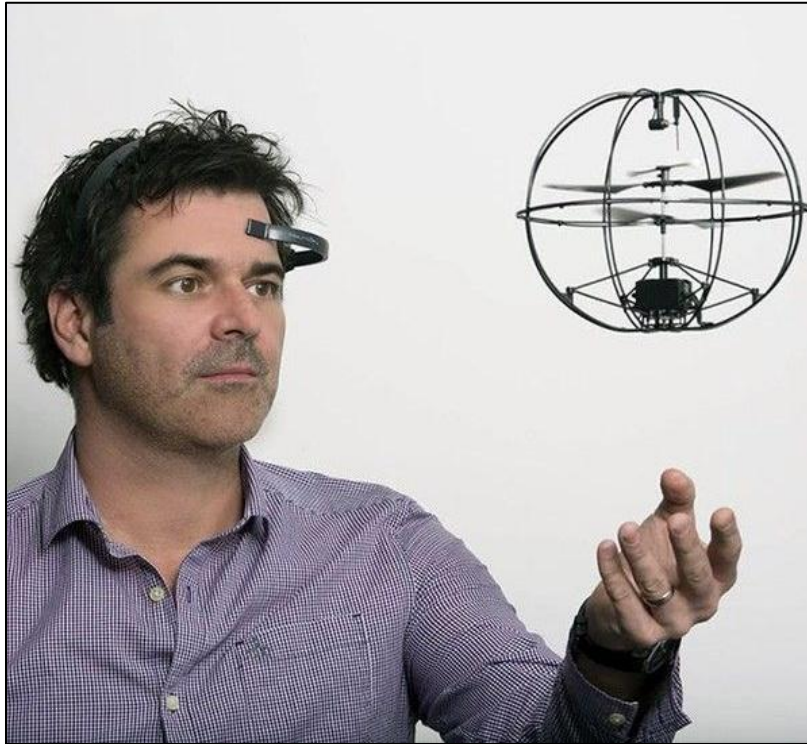
Skoltech
Skolkovo Institute of Science and Technology

DronePaint: Swarm Light Painting with DNN-based Gesture Recognition

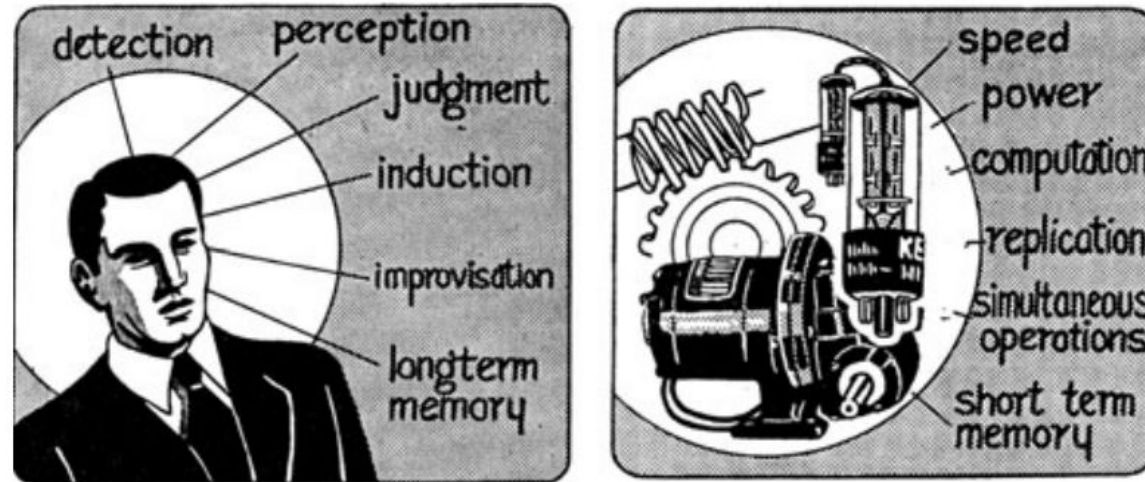
Valerii Serpiva, Ekaterina Karmanova, Aleksey Fedoseev,
Stepan Perminov, Dzmitry Tsetserukou
Skolkovo Institute of Science and Technology
Moscow, Russia.

- Authors: V. Serpiva, E. Karmanova, A. Fedoseev, S. Perminov, D Tsetserukou
- Laboratory: Intelligent Space Robotics and VR/AR Lab.
- University: Skolkovo Institute of Science and Technology, Russia
- Conference: ACM Siggraph 2021, Emerging Technologies

Brain Interface



Human-Machine Teaming



“great caution be exercised in assuming that humans can successfully monitor complex automatic machines and take over if the machines break down”

Paul M Fitts (1951)

Human Engineering for an Effective Air Navigation and Traffic Control System

Questions?

