



A View on the Future of Maritime Training and Simulation

Andy Fawkes



Presentation Overview

- The Future Operational Context
- The Future Sailor
- Simulation and Training System Developments
- Technology Trends of Interest

The Future Operational Context

The Current Global Security Context

- The world in a process of rapid & fundamental change
- Long-term shifts in the balance of global economic & military power
- Emergence of powerful non-state actors
- Predictable and unpredictable threats
- Rapid civil technology developments & escalating cyber threat
- Increasingly congested and complex world

UK MoD “Modernising Defence Programme” 2018

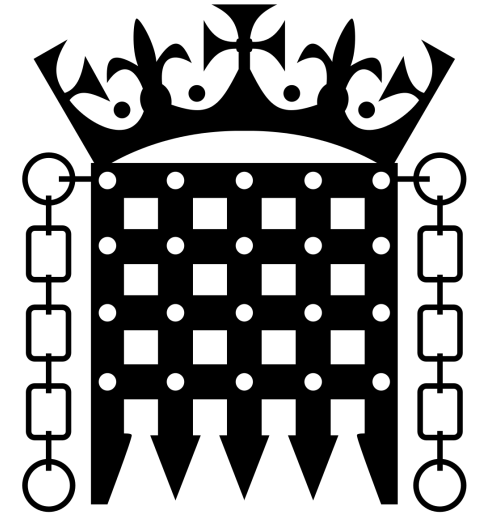
As we identified in 2015, this requires the **Joint Force** we are building to be versatile and agile.

It will need to be capable of operating in all **five domains** (land, sea, air, space and cyber).

It will need to be **international** by design, **routinely exercising** and operating with allies and partners.

It will need to be credible and capable of operating against state and non-state threats, **normally not alone but** with allies, such as NATO, and our partners, but always having the ability to **act on our own** if and when that is required.

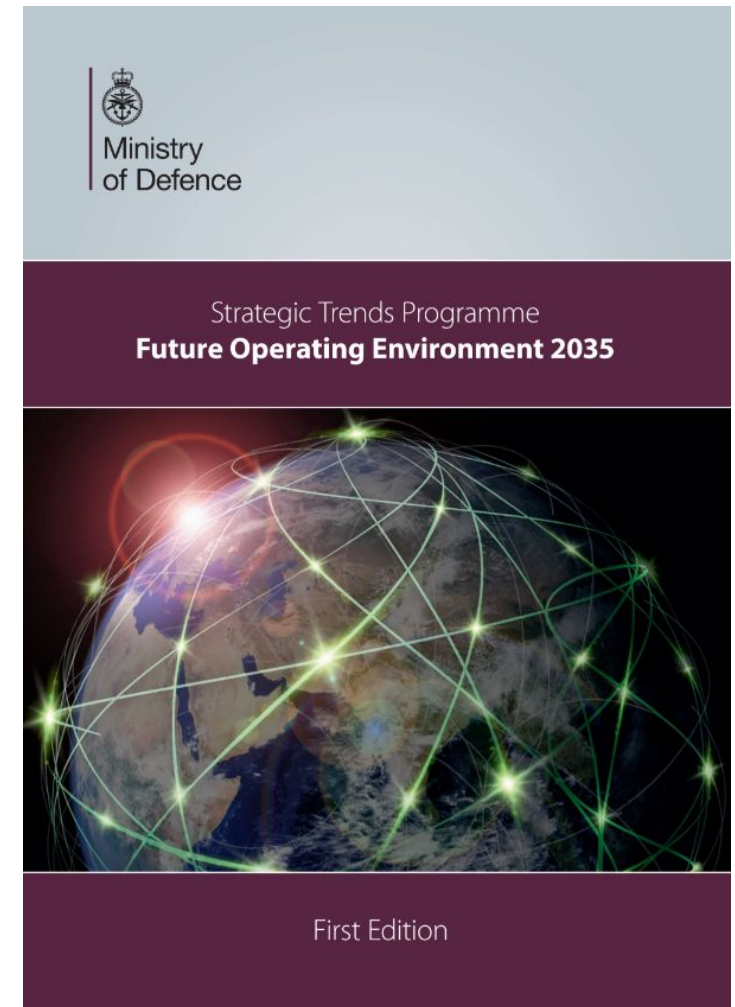
And it must be able to contribute to our **national security at home**, working with the police, and other national security organisations.



UK MoD Future Operating Environment 2035

“the future operating environment will be more **complex and ambiguous**, from physical to electronic to human aspects.

...we will habitually be working in an even more combined, **joint, inter-agency, intra-governmental and multinational** context to contend with the challenges.”



US Air Force Air Superiority 2030 Flight Plan (May 2016)



- Threat capabilities are likely to advance along two major vectors
 - A levelling of capabilities
 - Advanced fighter aircraft, sensors, and weapons are becoming more accessible to more countries which spreads these threats across a wide range of locations and scenarios
 - Increased threat capabilities
 - Increased quantity and sophistication of cyberspace threats and air threats including hypersonic weapons, low-observable cruise missiles, and sophisticated conventional ballistic missile systems.

The Nature of Warfare



- **War is chaotic**
- **No battle plan withstands contact with the enemy**



*** Need to be Skilled**

*** Need to Work Together**

*** Need to be Adaptable**

UK Royal Navy Training

- “are we ready to fight tonight?”
- “are we prepared to fight tomorrow?”



The Future Sailor

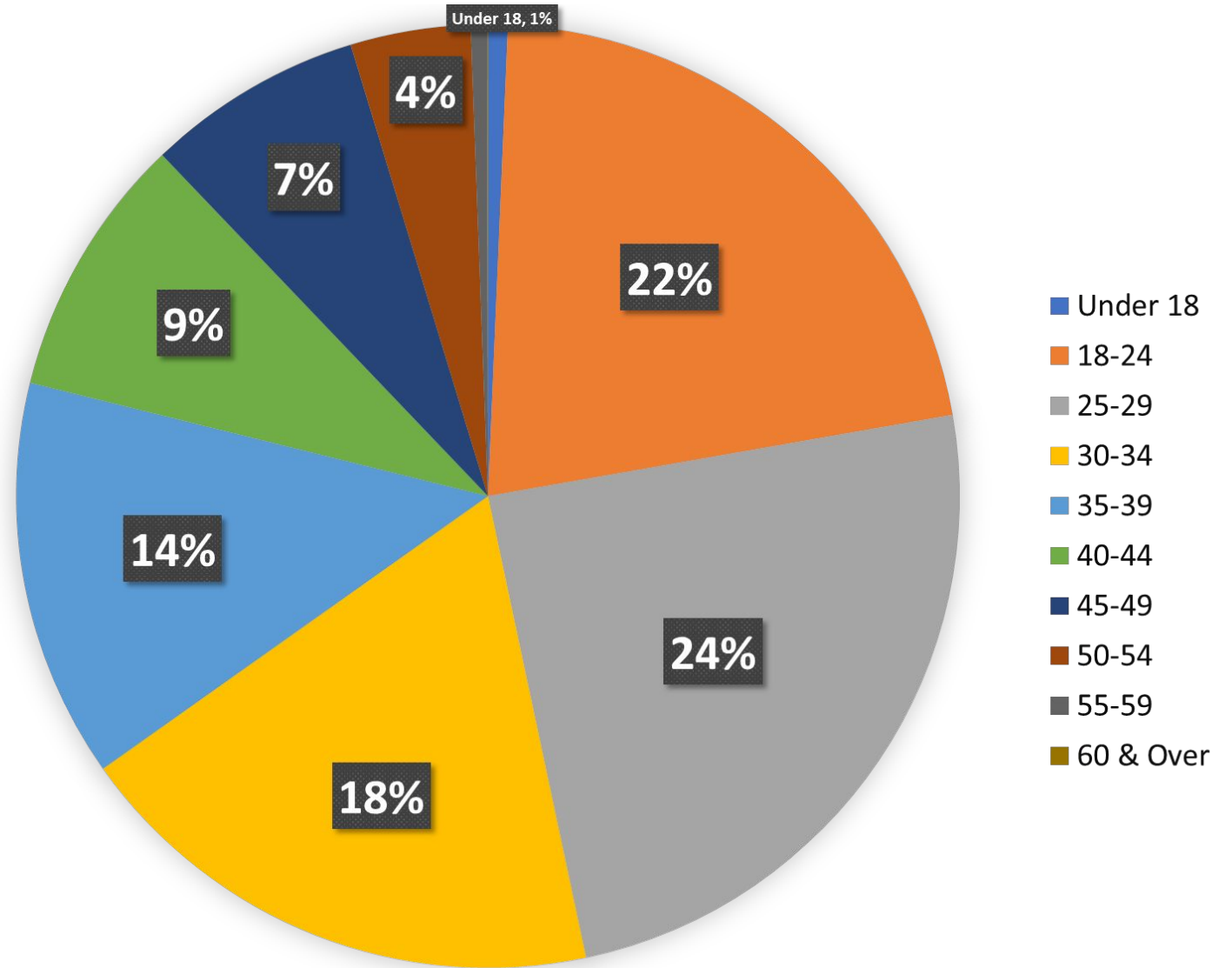
Sailors of the Future?



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

2017 RN Age Distribution

47% of the
Royal Navy is
29 or Less
and **79%** 39
or Less





“Digital Native”

a person born or brought up during the age of digital technology and so familiar with computers and the Internet from an early age

Broadly, 50% of the Royal Navy now are Digital Natives and 80% by 2030

What's Next?



Digital Native



AI Native?

Television Shortcuts

A dying habit: why the average BBC1 viewer is 61



709

Simon Usborne

Wednesday 29 March
2017 17.38 BST



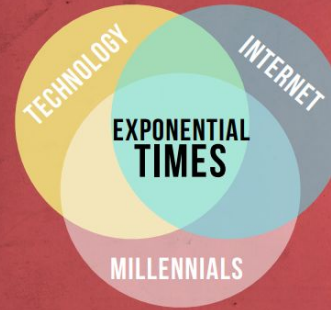
 Old medium ... has TV lost its appeal to young people? Photograph: simonkr/Getty Images/iStockphoto

Changing Demographics



Ryan Jenkins

EXAMPLES

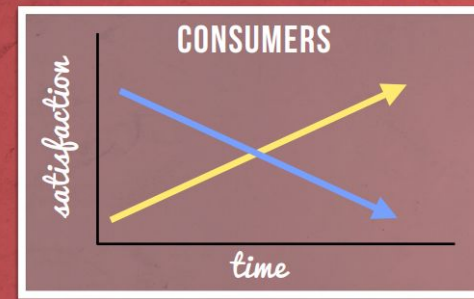


**Not anomalies...
but the preview.*

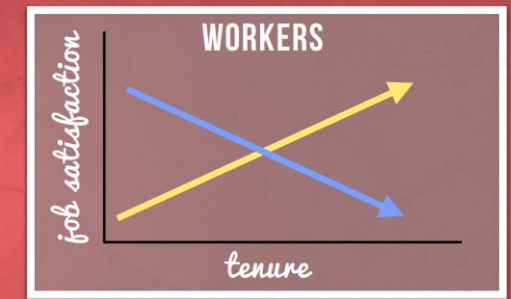
- UBER > FORD'S WORTH = ~\$60 BILLION / FOUNDED IN 1903
UBER'S WORTH = ~\$70 BILLION / FOUNDED IN 2009
-  > 1ST MONTH = 130 MILLION DOWNLOADS
1ST 90 DAYS = \$600 MILLION IN REVENUE
-  > MARRIOTT = 1 MILLION ROOMS SINCE 1927
AIRBNB = 2 MILLION ROOMS SINCE 2008
-  > 8/24/15 = 1 BILLION USERS IN 1 DAY
TODAY = 2 BILLION MONTHLY USERS
- DSC > GILLETTE = 72% MARKETSHARE IN 2012 [DSC FOUNDED]
DSC = 51% MARKETSHARE IN 2015
-  > 100,000X SMALLER & 7,000,000,000X MORE POWERFUL
THAN A COMPUTER IN THE EARLY 1970S
- Casper > 2014 = \$1 MILLION IN SALES - 1ST MONTH
2016 = \$200+ MILLION IN REVENUE

WORK

the goal of employee experience



— MATERIAL PURCHASES
— EXPERIENTIAL PURCHASES



=

GOAL: SHIFT MILLENNIALS RELATIONSHIP WITH WORK FROM FEELING
LIKE A MATERIAL PURCHASE TO AN EXPERIENTIAL PURCHASE.

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Royal Navy

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[51 Benefits](#)
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Royal Navy Overview

[Work Here? Start responding to reviews](#)

Website	www.royalnavy.mod.uk	Headquarters	Hollywood, Northern Ireland
Size	5001 to 10000 employees	Founded	Unknown
Type	Government	Industry	National Agencies
Revenue	\$10 to \$25 million (USD) per year	Competitors	Unknown

In times of conflict or peace, the Royal Navy is key to the prosperity of Britain and the stability of the high seas. Our 30,000 highly skilled men and women work across multiple disciplines to protect our nation's interests.

We are a highly ... [Read more](#)

Work in HR/Personnel or Marketing?

[Get a free employer account](#)

Royal Navy Locations

- Glasgow, Scotland 3.7 ★
- Helensburgh, Scotland 3.3 ★
- London, England 2.8 ★
- Plymouth, England 3.4 ★
- Portsmouth, South East England, England 3.6 ★

[Show More](#)

Royal Navy Reviews

3.6 ★★★★★ [Rating Trends](#)

63%

Recommend to a friend

72%

Approve of CEO



Sir Jonathon Band
70 Ratings

29 Nov 2017



"Ex leading air engineering technician"

★★★★★ Former Employee - Anonymous Employee

Jobs You May Like

- 

Full Stack Ruby Developer
toucanBox - London, England
- 

Human Resources Manager (Maternity Leave Coverage)
DBRS - London, England

Employee Power?

ratings and reviews of over
600,000 companies worldwide

BEST PLACES *to work* **2017 Employees' Choice**

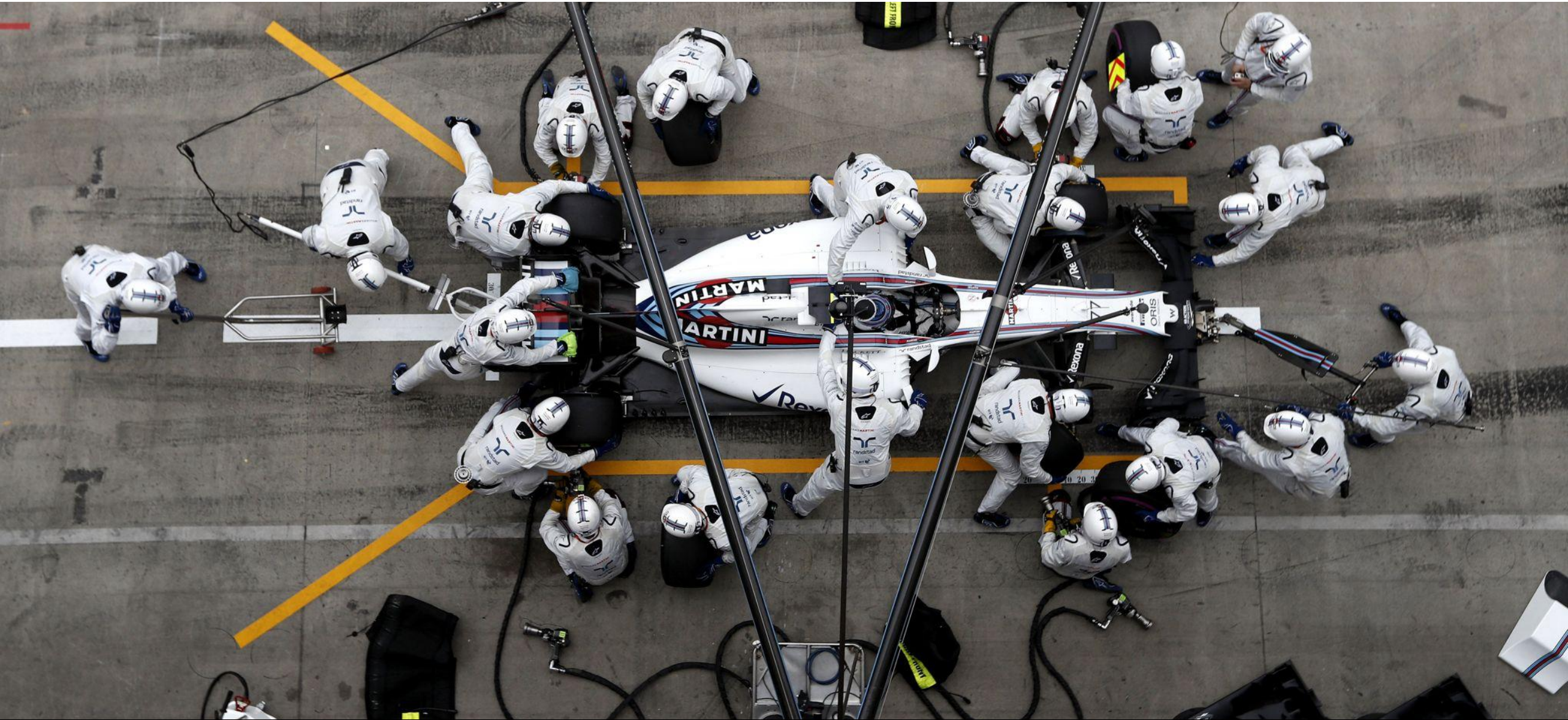


* It's a Digital Age

* Recruits with New Educational Experiences

* Draw on the Experiences of all Age Groups

Don't Forget Teamwork & Practice - 1.92 Seconds



Simulation and Training System Developments

Nations Train Differently

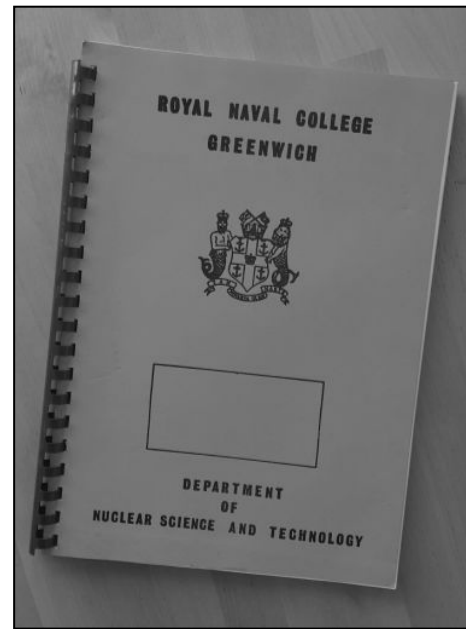
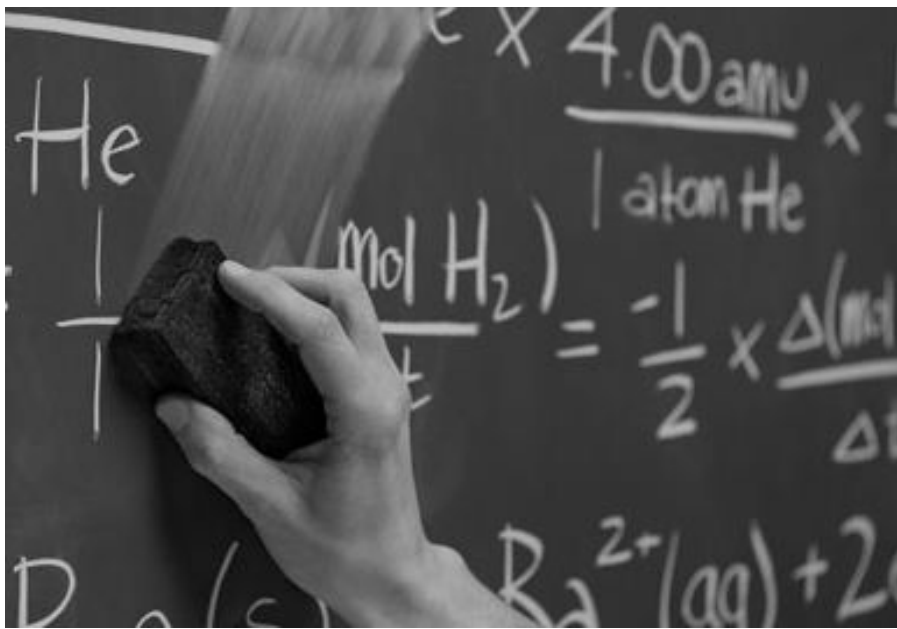


- National and Military Culture
- Appetite for Risk
- Operational Tempo
- Equipment
- Training Methodology and Technology
- Resources
- Allies and Enemies

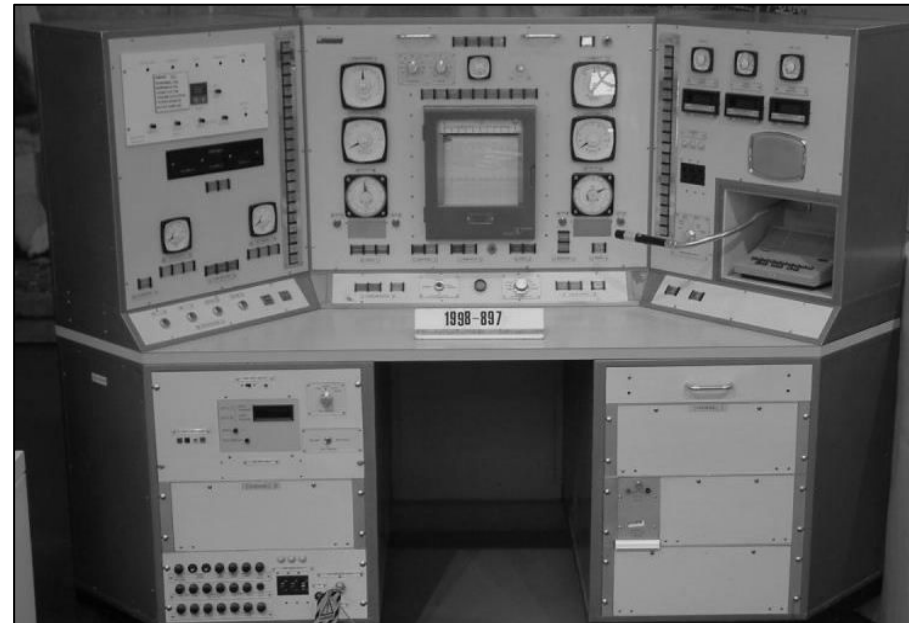
Military Training & Education Expenditure - %Total

~20%

- Manpower
- Platforms and Equipment
- Fuel and Maintenance
- Training Estate and Establishments
- Training Systems and Simulators



My 1990s Teaching Aids



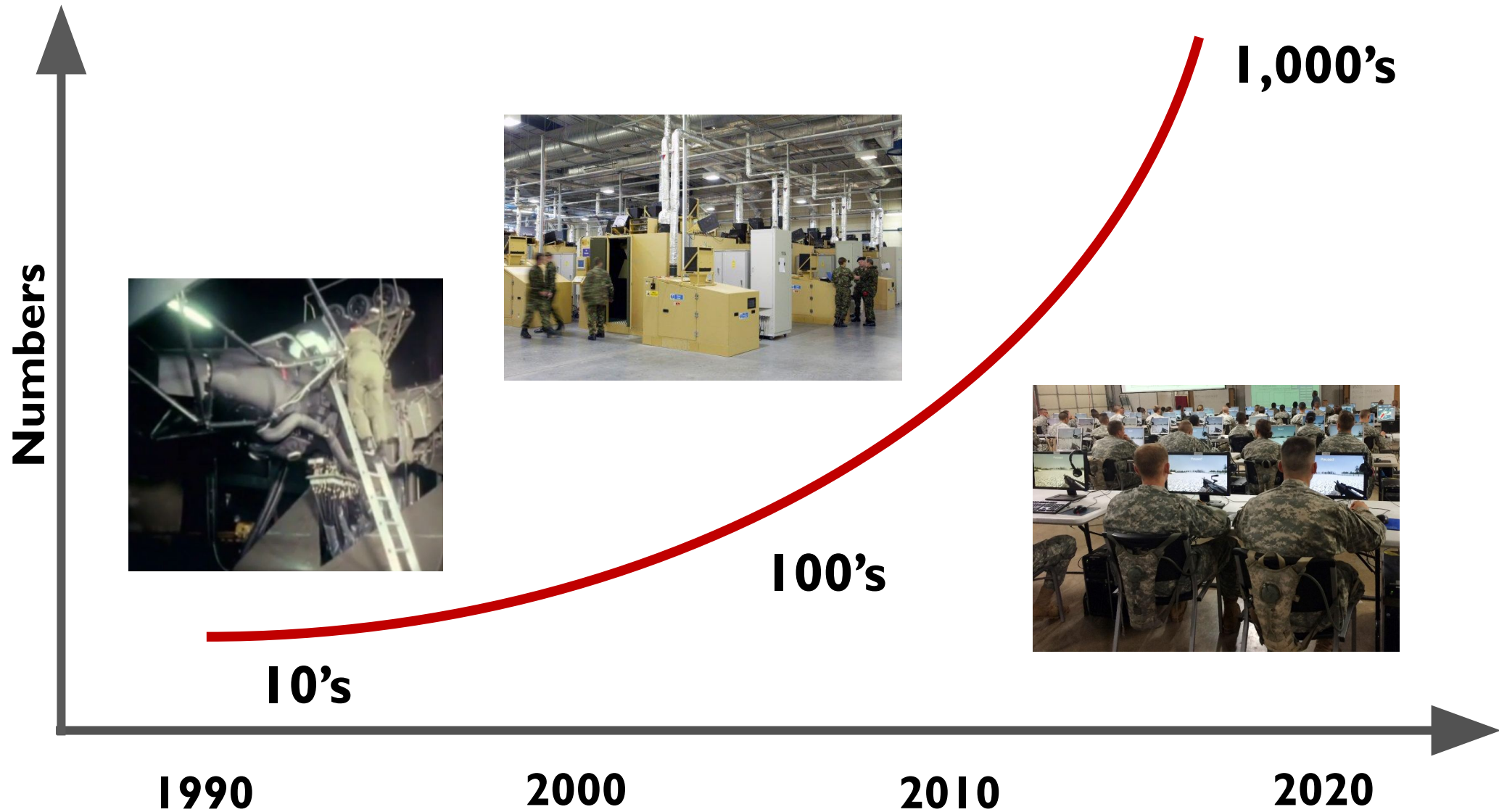
Digital Media Consumption Now



Games-Based Simulation Now - Land, Sea, Air, Anywhere



Military Access to Simulation



Latest Simulation Technology



Consumer Technology

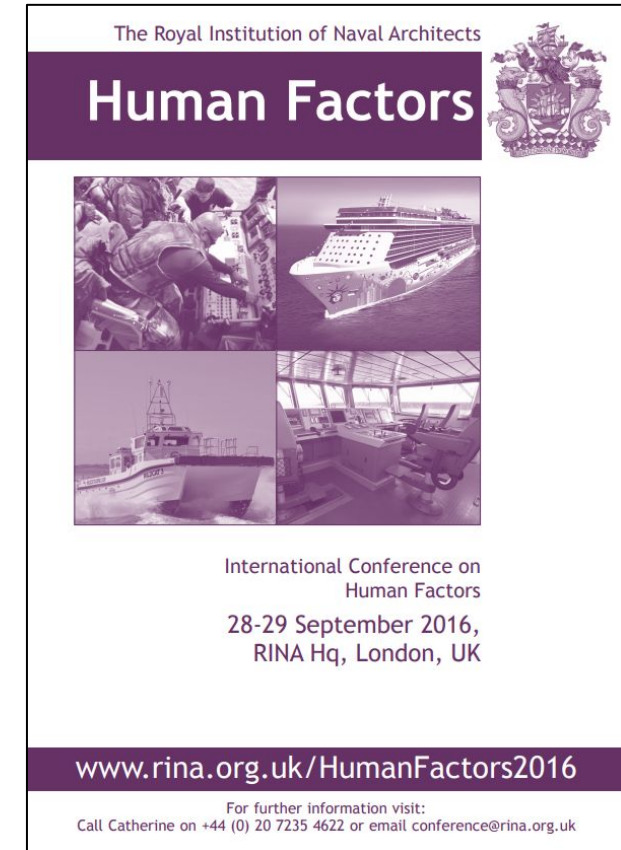


A man with a beard, wearing a black polo shirt, is seated at a desk in a dimly lit room. He is looking at a large computer monitor displaying a 3D simulation of a mechanical assembly. On the desk, there is a laptop with a red keyboard, a large black motion capture camera, a keyboard, and a specialized joystick or controller mounted on a base. The man's shirt has a logo on the left sleeve that reads "Bohemia Interactive".

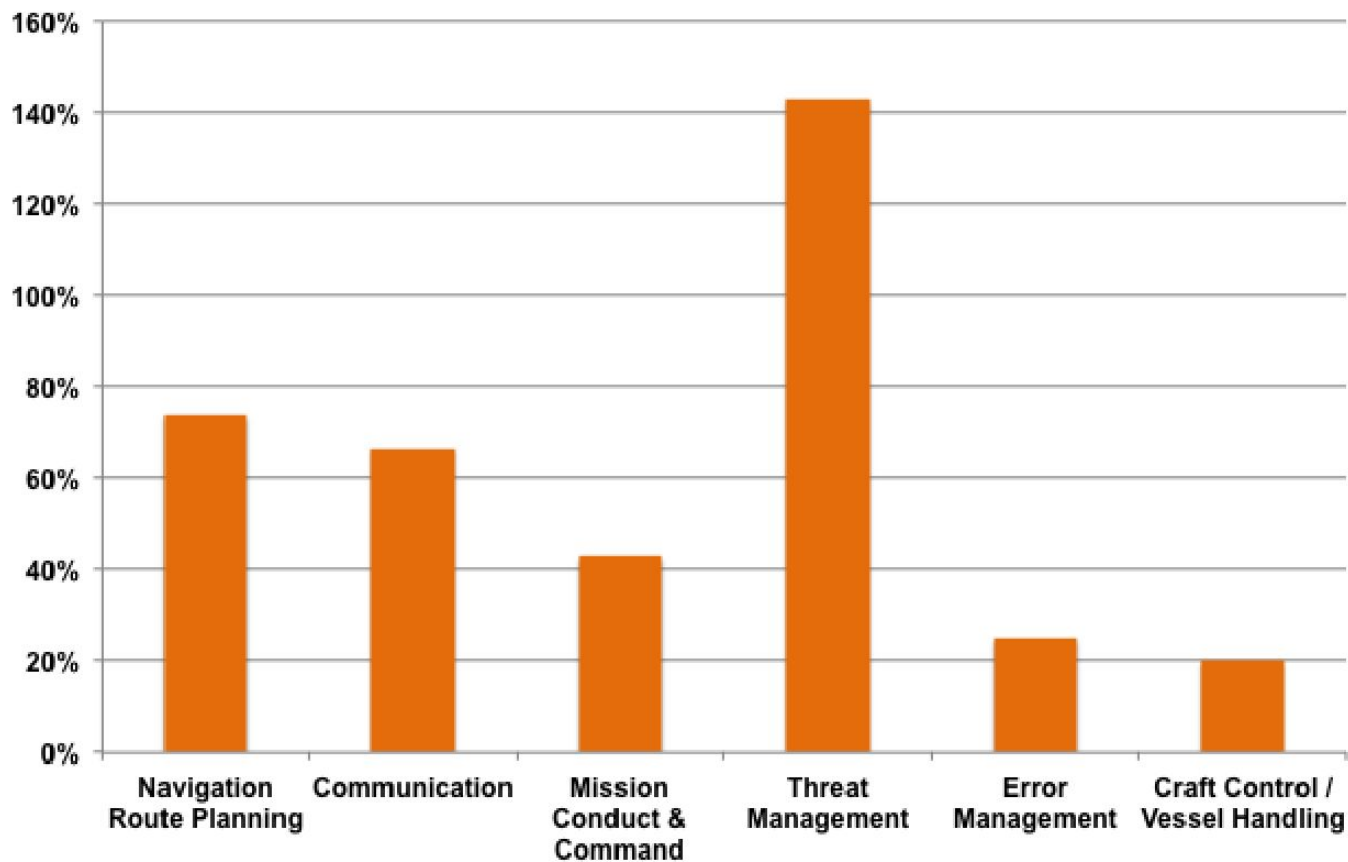
Bohemia
Interactive

Does Simulation Work?

- The Training System: Developing Crew Competence Within The Virtual and Real Worlds,
 - J Hill; Trident Marine, UK, T Brand; StrongWake, Canada, T Dobbins; STRResearch, UK
- “Simulation, correctly integrated into a training syllabus, is a valuable tool in the education progression of developing individual and team competence and proficiency.
- Simulation can also put the crews into increasingly more dangerous scenarios, gaining experience that is not available in real life without extreme dangers to life or craft.”



DOES SIMULATION WORK ?



SIMULATION
ENHANCEMENT



NON-SIMULATIO
N BENCHMARK

Ref: Hill, Brand & Dobbins (2016) Conf. Proceedings; RINA Human Factors.

DOES SIMULATION WORK ?

- **Threat Management** (143%) – the crew can learn faster in a simulation environment where they can crash and learn from their mistakes.
- **Communication** (67%) – they can repeatedly practice the standard DYNNAV communication protocol.
- **Navigation Route Planning** (74%) – allowed crews to practice route planning learned in the classroom.

Ref: Hill, Brand & Dobbins (2016) Conf. Proceedings; RINA Human Factors.

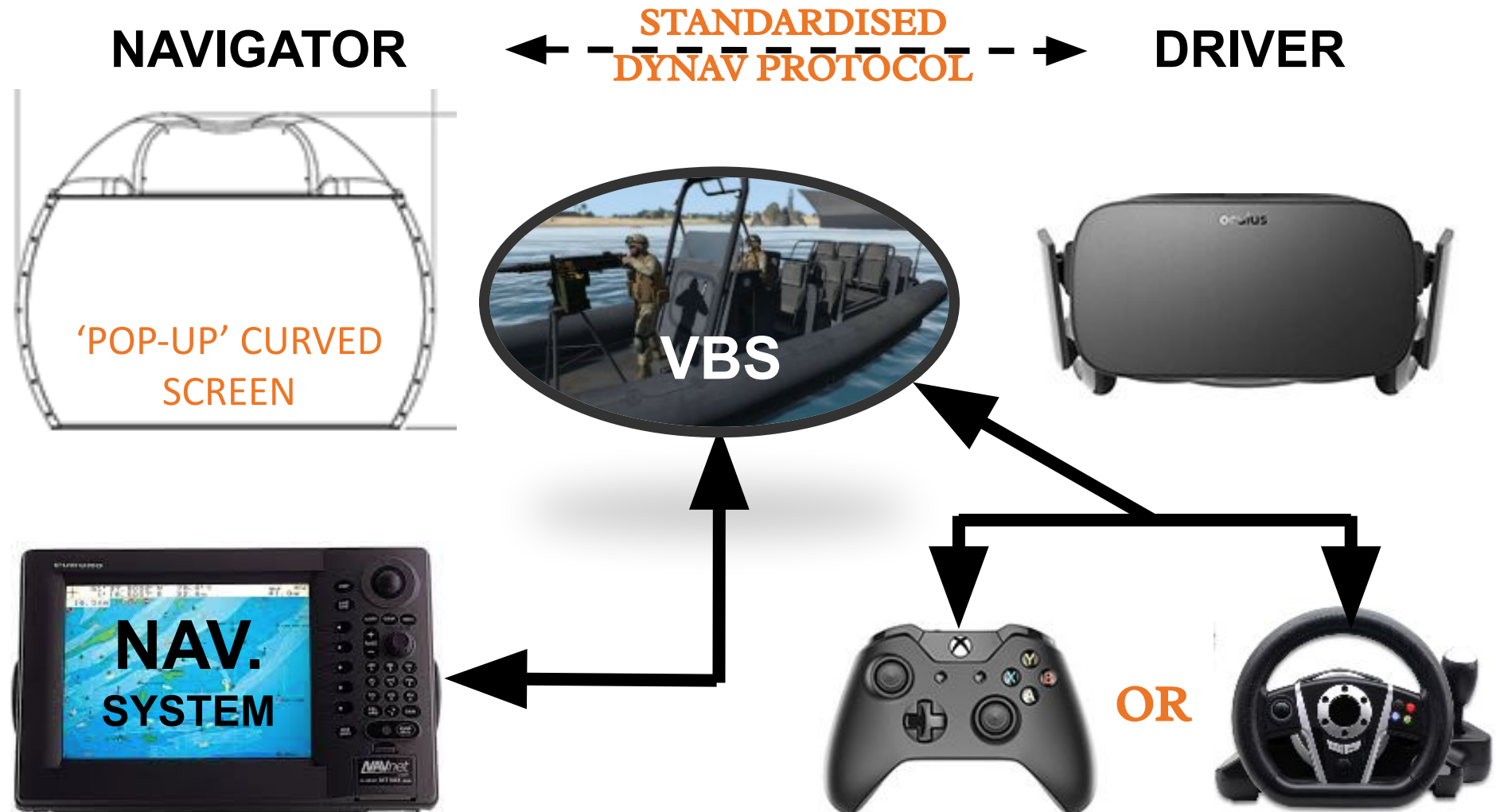
DOES SIMULATION WORK ?

- **Mission Command & Control** (43%) – they can practice working together.
- **Error Management** (25%) – they can see the results of their and system errors and have a better understanding of how to manage them.
- **Craft Control / Handling** (20%) – this is principally a practical task so no enhancement was expected.

Ref: Hill, Brand & Dobbins (2016) Conf. Proceedings; RINA Human Factors.

Example Team Trainer Concept

20KTS+



Example Team Trainer Concept

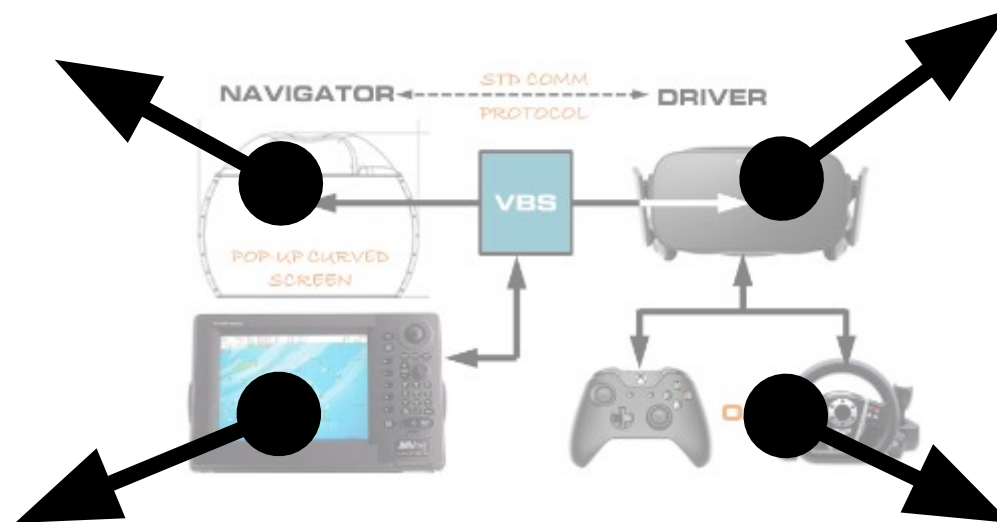


Navigator - External View

- Simple curved screen
- Large flat screen

Driver - External View

- Oculus Rift / Vive etc.



Navigation Display

- Real hardware in the loop
- Generic or manufacturer specific
- Radar emulation

Driver - Controls

- Steering
- Throttle / speed

Live/Simulation Balance



- **Live Training**
- **Fear**
- **Friction**
- **Fog of War**
- **Real Comms**
- **Build Muscle Memory**
- **Real Weather & Terrain Effects**



Simulation-Based Training

- Flexible and Deployable
- Repeatable
- Safe
- Fully Instrumented
- Less Cost and Equipment
- Less Environmental Impact

Live Simulation

-

People in
Instrumented
Real World



Virtual Simulation

-

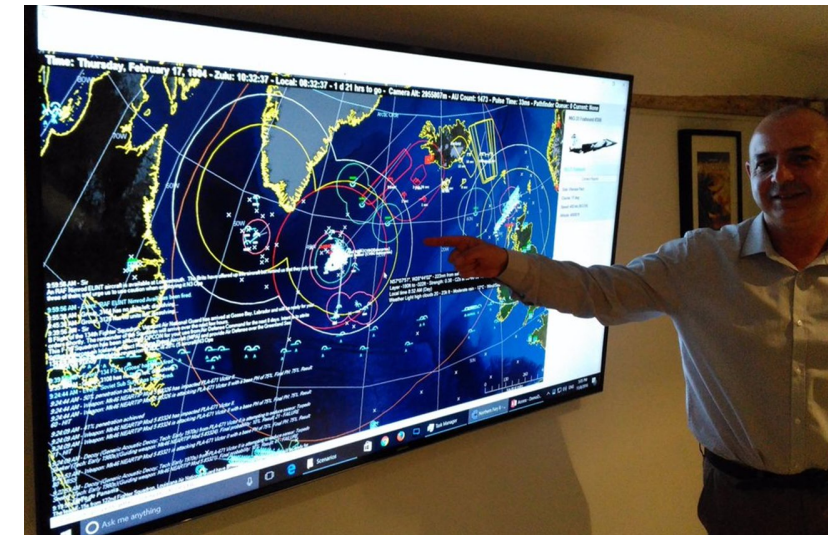
People in a
Virtual World

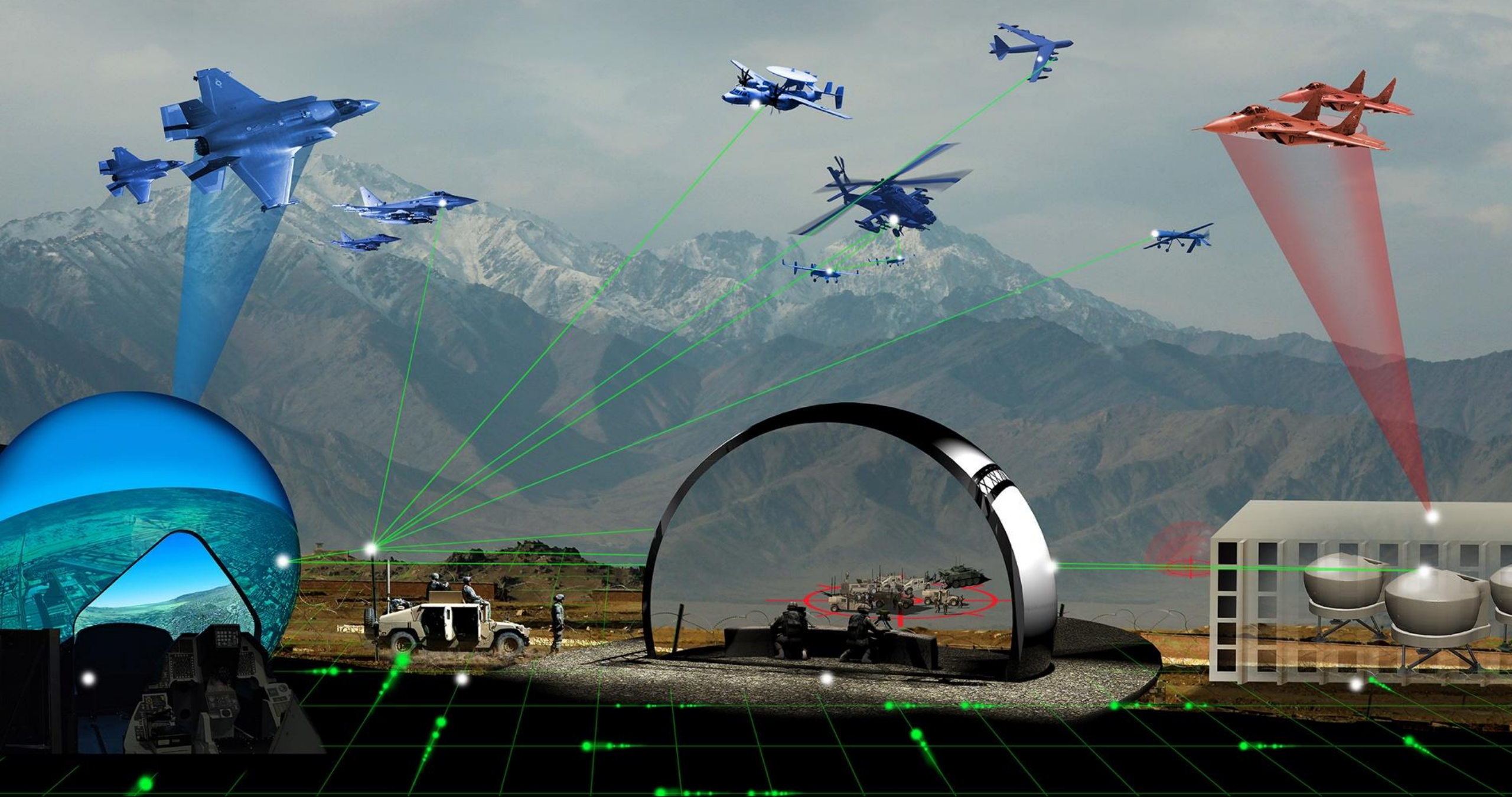


Constructive Simulation

-

Simulated
People & World

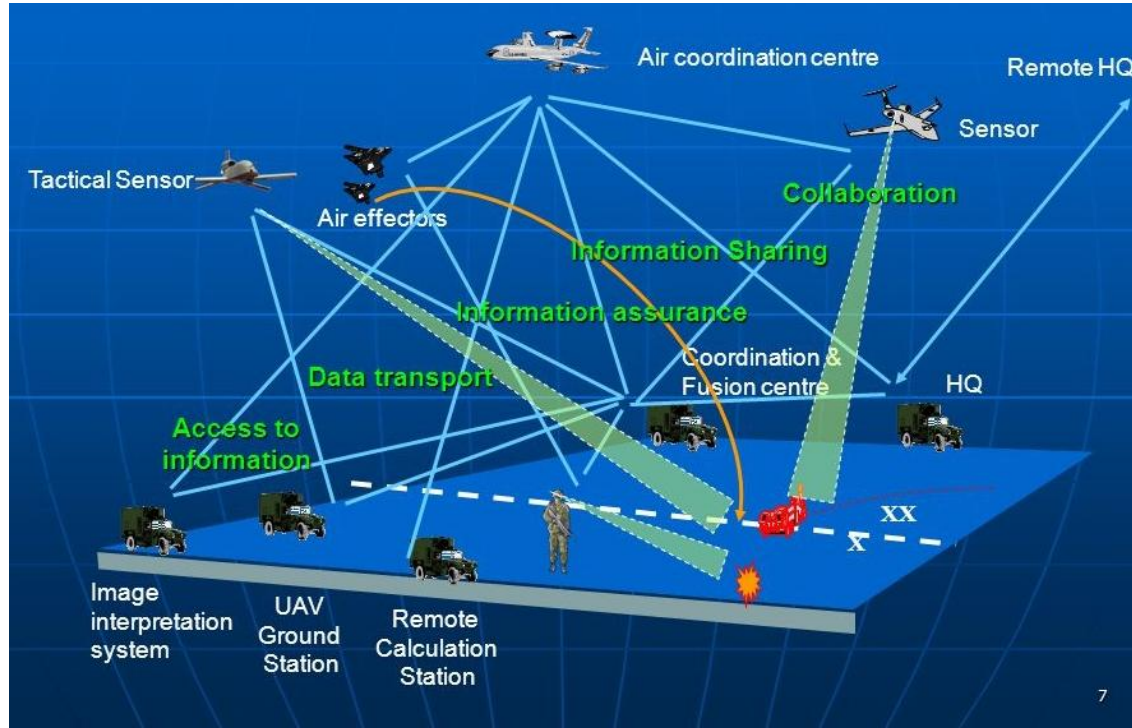




Live-Virtual-Constructive Infrastructure

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Parallels...



Networked Combat Systems

LVC - Live Virtual Constructive Simulation



UK Thursday War

Weekly war-fighting and
damage control
exercises

Routine LVC?



Maritime Operations Room Training





HMS Queen Elizabeth Flight Deck Training

RNAS Culdrose



HMS Queen Elizabeth F-35 Lightning Training



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Train and Retain the Trainer?





*Training Still Requires Significant Human Input

Technology Trends of Interest

SISO/US Army – ENGTAM Group

(Exploration of Next Generation Technology Applications to Modeling and Simulation)

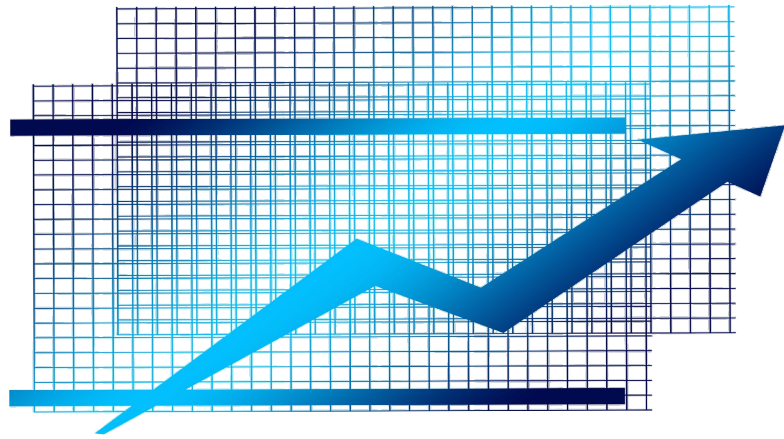
- Gaming Technology
- Virtual Reality
- Augmented Reality.
- Cloud and Streaming
- Wearables/IoT
- Big Data and Data Analytics
- Artificial Intelligence

US Army Synthetic Training Environment (STE)

- One synthetic environment for training
- Incorporate the US Army's one-world terrain project which maps the entire globe, both geographically and socio-politically.
- Realistic Simulation to accurately represent current and future weapon systems
- Interoperation with Mission Command Information Systems (MCIS)
- Delivery of Training to the Point of Need (PoN)
- Integration with services / applications outside the gaming engine
- After Action Review (AAR) Tools
- Immersive Training via Virtual interfaces
- Scalability (40,000 to 2,000,000 entities)

Technology Trends of Interest

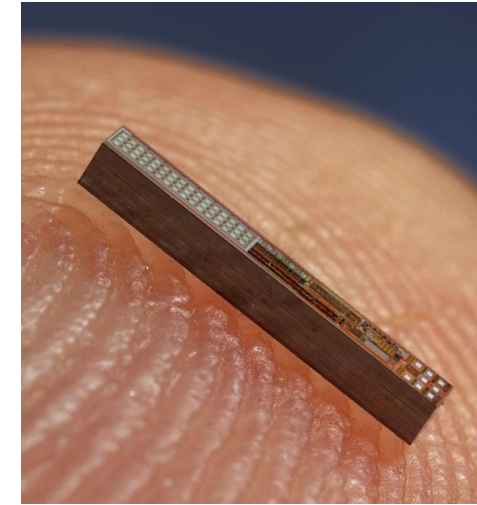
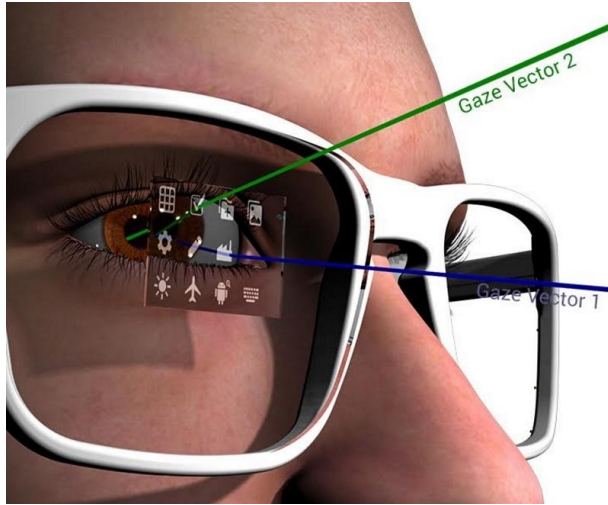
- Measurement & Evaluation
 - Quantified Human
 - Big Data and Analytics
 - Digitisation of Training
- Training at the Point of Need
- Artificial Intelligence



Technology Trends...

Measurement & Evaluation

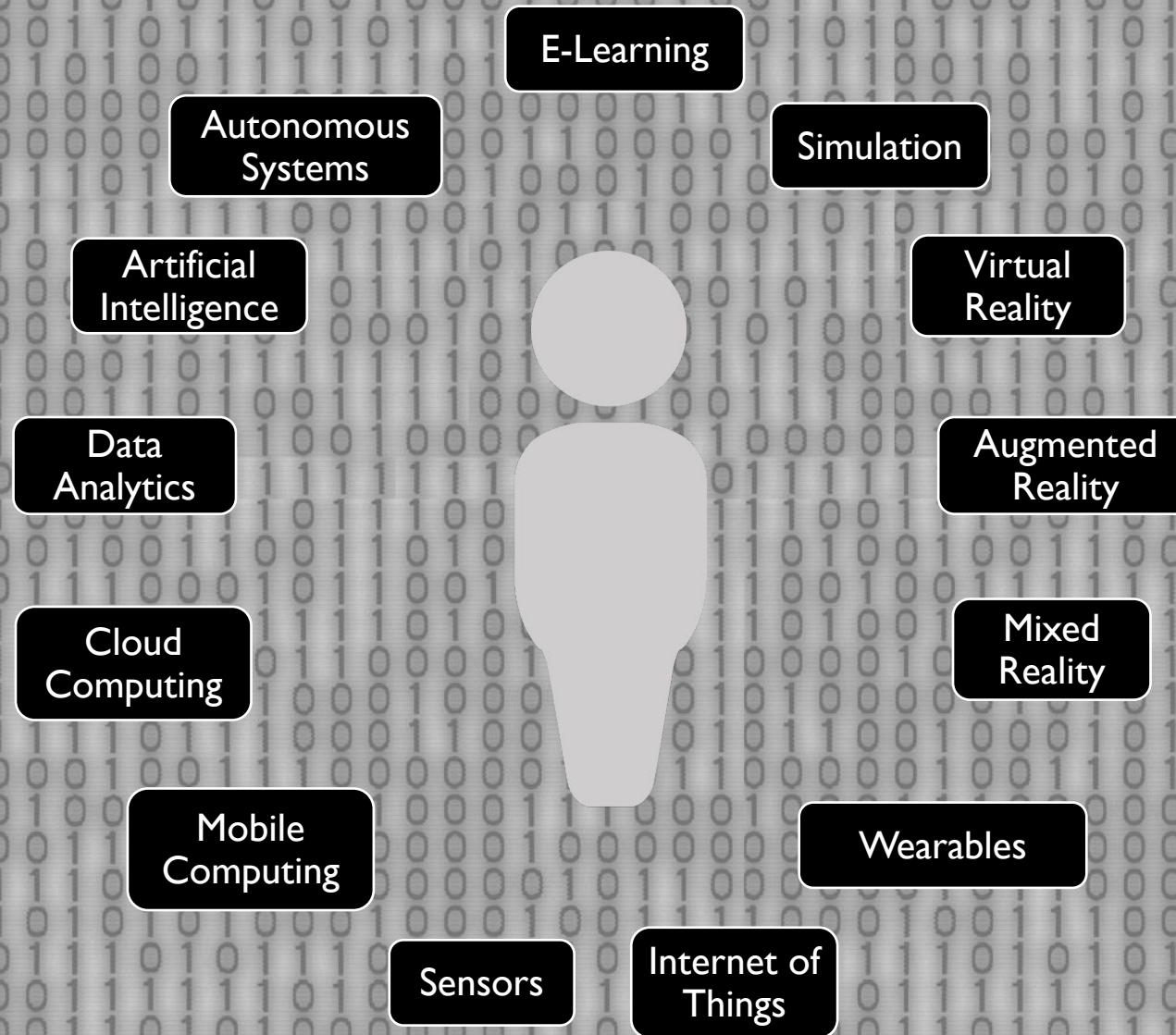
Quantified Human



Quantified Humans



Digitisation of Training

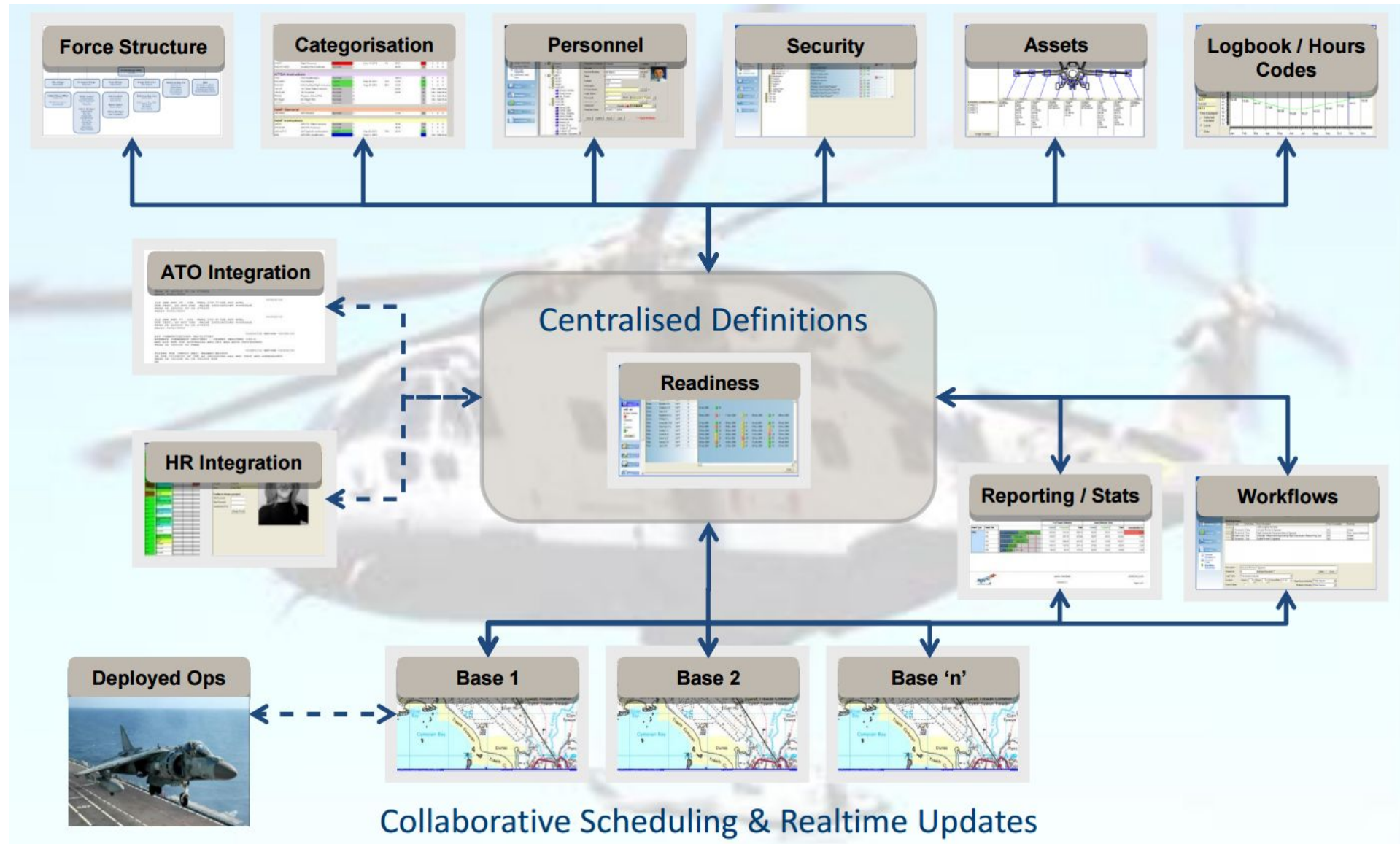


People Analytics

- Driven by the widespread adoption of cloud HR systems, companies are investing heavily in programs to use data for all aspects of workforce planning, talent management, and operational improvement.
- People analytics, a discipline that started as a small technical group that analysed engagement and retention, has now gone mainstream.

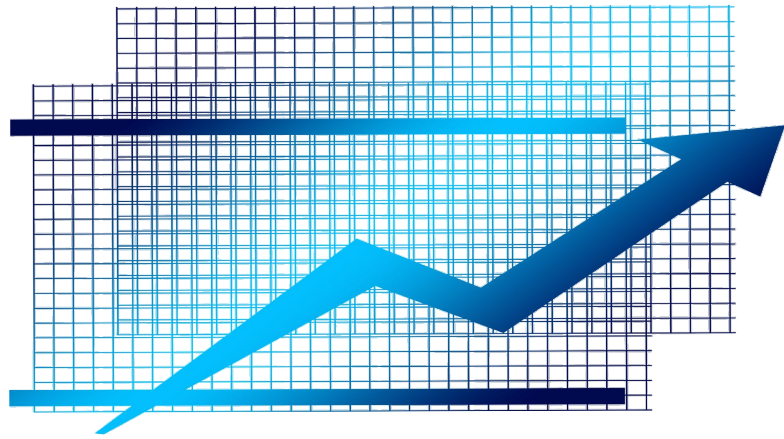
Old rules	New rules
People analytics is viewed as an HR team focused on advanced analytics within HR	People analytics is viewed as a business analytics team that works across the business to drive business results
Analytics focuses on HR topics such as retention, engagement, learning, and recruitment metrics	Analytics focuses on business problems such as sales productivity, workforce effectiveness, high-potential retention, fraud, accident patterns, and other operational needs
The organization makes a business case for better data integration, quality, and tools	The organization has already committed to accurate and integrated data, and has tools and processes to ensure quality and ease of analysis
The people analytics team has a strong understanding of HR data	The people analytics team understands HR data, financial data, and customer data, and it has relationships with all the other analytics groups in the company
The people analytics team lives in HR operations and reports to HR technology, or in functional areas	The people analytics team operates at a senior level, reports to the CHRO, and serves business leaders across the company
The people analytics team is a small set of technical experts with data management and statistical skills	The people analytics team is a multidisciplinary team, with a focus on business consulting, visual communications, and problem solving
People analytics is staffed by PhD statisticians whose primary focus is the development of models and data warehouses	People analytics is a consulting function that helps business leaders solve problems
People analytics focuses on employees	People analytics focuses on the entire workforce, including employees and contingent labor
The people analytics team focuses heavily on engagement survey data and employee happiness and culture	The people analytics team moves beyond engagement to understand the detailed drivers of engagement and builds culture models to understand what drives the workforce

Training & Operations Management Software (FlightPro)



Personalised Data-Driven Learning





Technology Trends...

Training at the Point of Need

E-Learning



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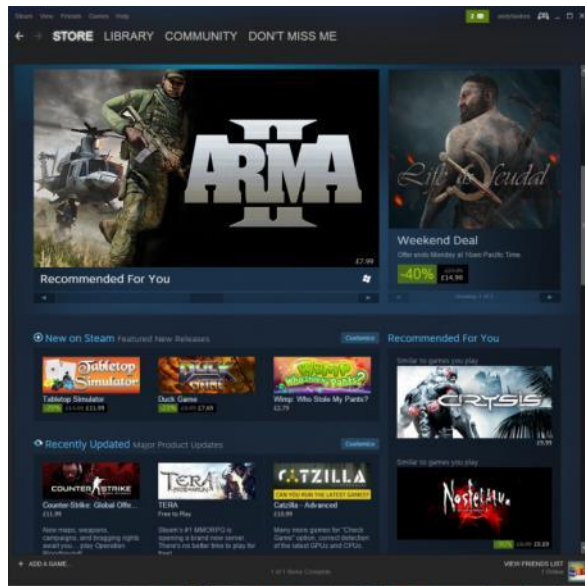
Cloud Gaming



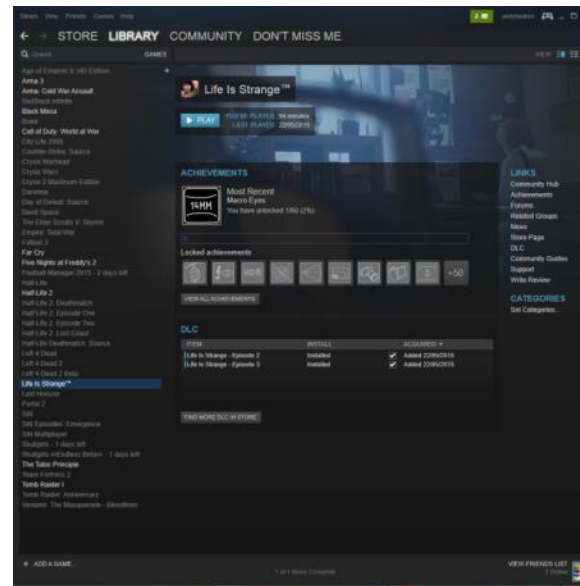
Fujitsu/VBS3 DSEI 2015



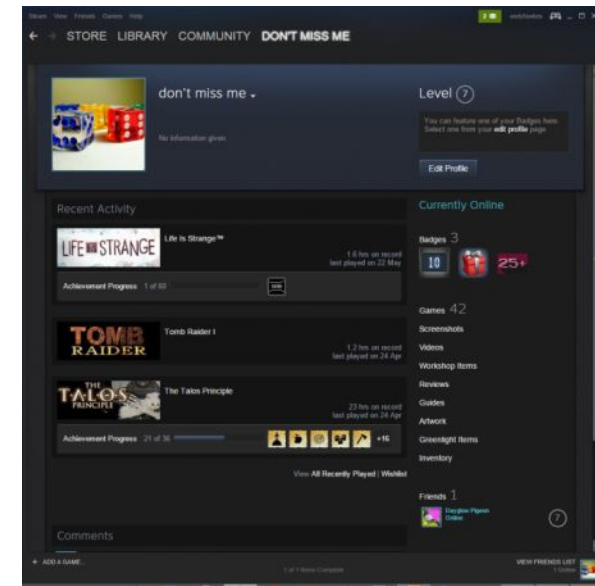
Your Cloud Gaming Profile



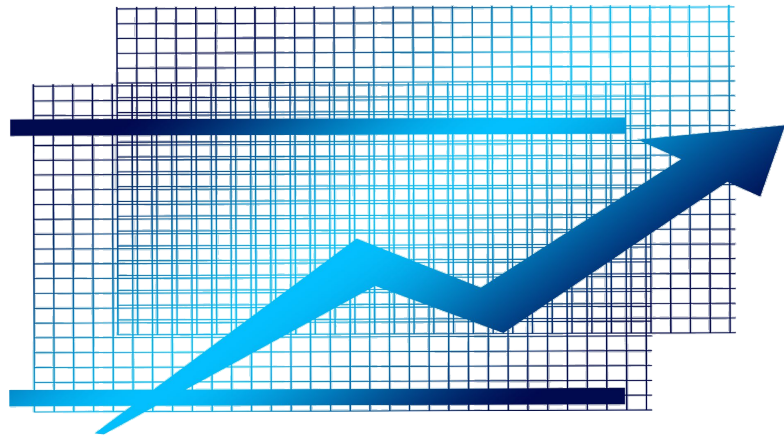
New
Games



My
Games



My
Profile



Technology Trends...

Artificial Intelligence

Queen Bee Drone – 1930s/40s



nearly 400 built

Nothing New in the World?



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



Radio Controlled "Queen Bee" (1936)

Military Autonomous Systems

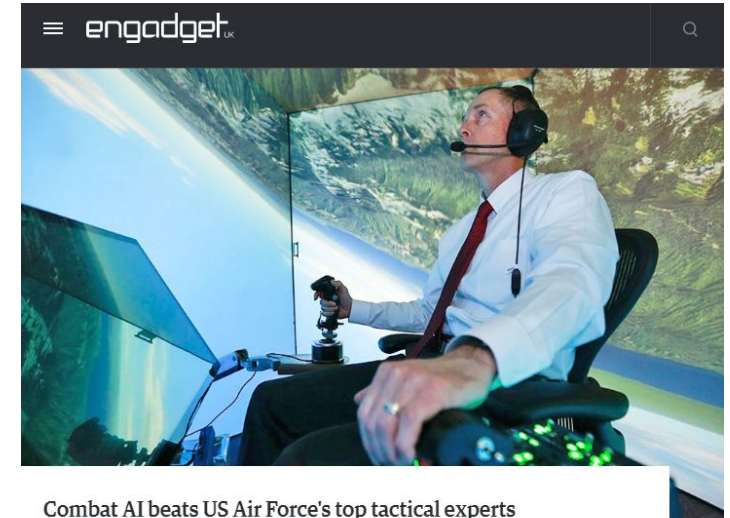


US Navy
X-47B



US Army
Manned-Unma
nned Teaming
(MUM-T)

US AFRL
“ALPHA”



Combat AI beats US Air Force's top tactical experts

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



Andrew Dalton , @doltown
06.28.16 in Robots



Driving Factors in Artificial Intelligence

1. Hardware

- Faster Processors hosted locally or in the cloud
- Synergies of AI programming (eg. solving matrices) and graphics cards

2. Data

- Explosion of data, online and real time, to train AI programs

3. Algorithms

- Algorithms such as deep learning are a major force driving AI

DeepMind and Go (Oct 2017)

- Latest DeepMind incarnation is “AlphaGo Zero”, with new neural net design
- Trained in 3 days, no human intervention except Go rules
- Result:
 - “AlphaGo Zero” beats “AlphaGo” – 100 to 0
- Singularity?



DeepMind and Blizzard release new tools to train AI using Starcraft

What can computers learn from playing video games? Quite a lot actually

by James Vincent | @jjvincent | Aug 9, 2017, 1:00pm EDT

f SHARE t TWEET in LINKEDIN



A screenshot of Starcraft II, a real-time strategy game where players control human or alien armies. | Image: Blizzard

AI and Strategy Games (2017)

Starcraft

1. A multi-agent problem
2. Imperfect information
3. Large & diverse action space
4. Early decisions influence the game later

Artificial Intelligence Technology Challenges

- Large volumes of data are required, especially for modern neural net AI approaches
 - *Favours the large Tech companies?*
- AI programs typically can only do one task
 - *"there is no neural network in the world, and no method right now that can be trained to identify objects and images, play Space Invaders, and listen to music"* (DeepMind)
- AI programs can be difficult to understand and verify after programming
 - *DARPA's Explainable Artificial Intelligence (XAI)*
- Cyber Security?

Still Some Way to Go



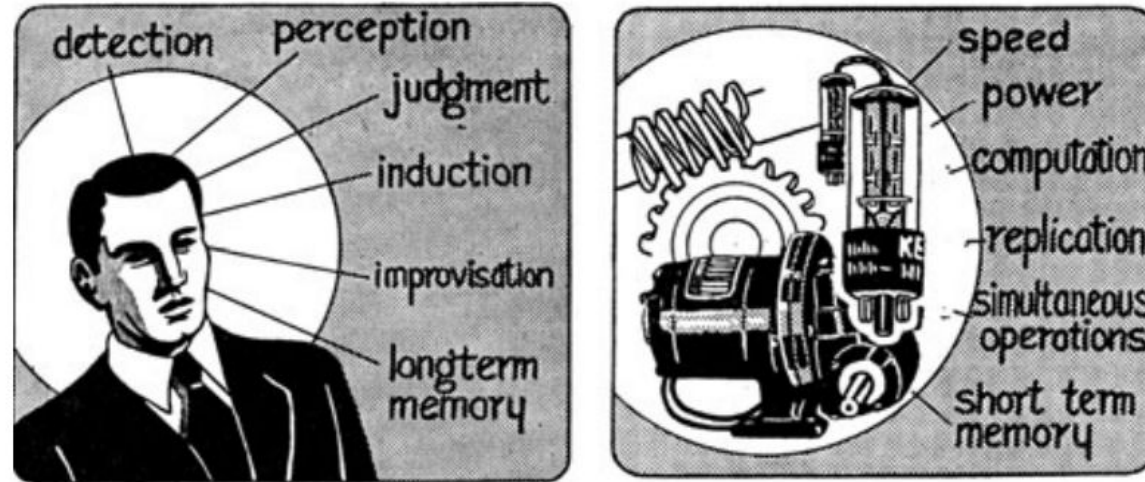
Tom Clancy's Rainbow Six:Vegas 2

Google Street View



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.

Humans might get even better...

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Neuroscience

US military successfully tests electrical brain stimulation to enhance staff skills

Study paves way for personnel such as drone operators to have electrical pulses sent into their brains to improve effectiveness in high pressure situations

Ian Sample Science editor

@iansample

Monday 7 November 2016 17:48 GMT

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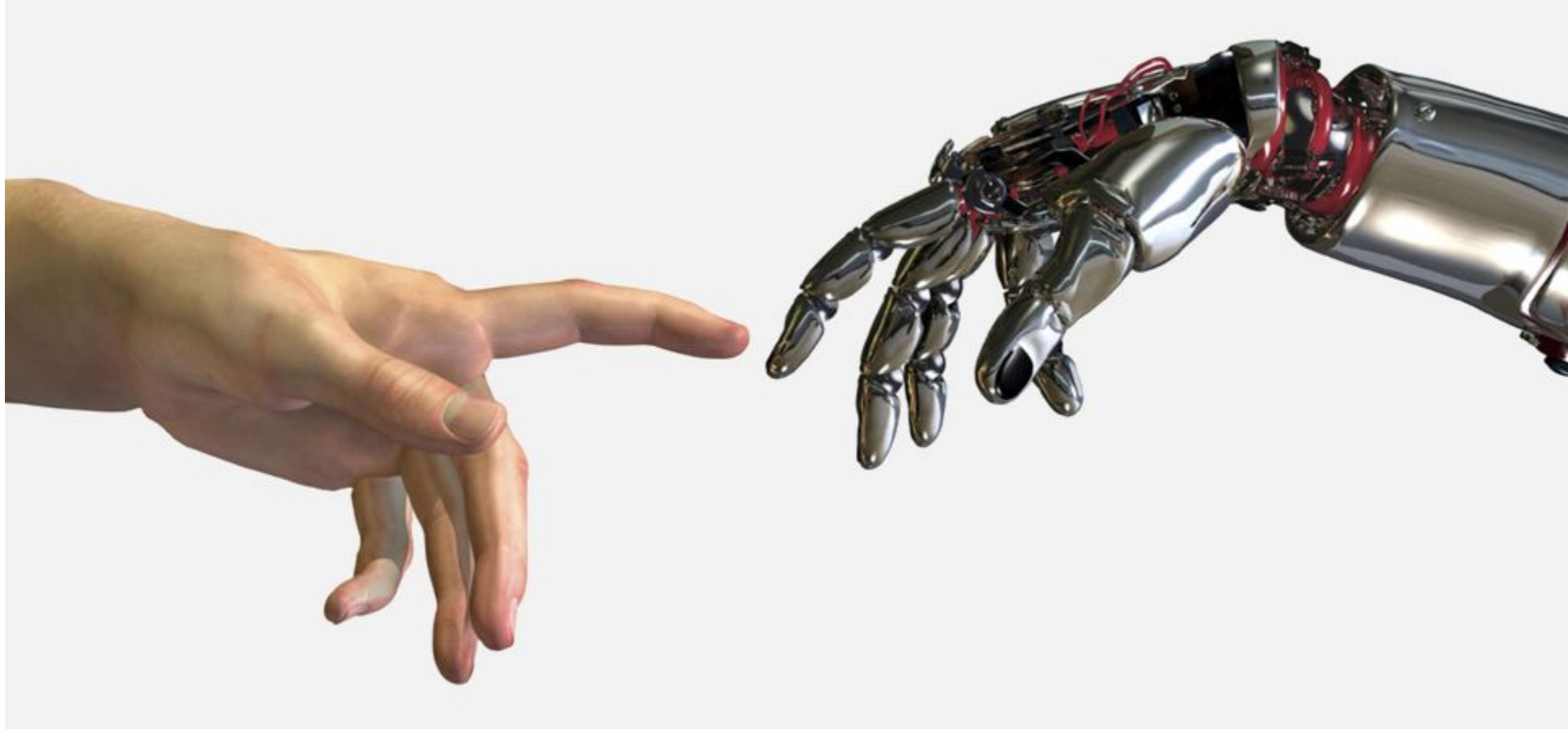


Performance of military personnel can slump if the demands of the job become too intense. The study found that electrical brain stimulation can stave off the drop in performance. Photograph: Christian Science Monitor/Getty

US military scientists have used electrical brain stimulators to enhance mental skills of staff, in research that aims to boost the performance of air crews, drone operators and others in the armed forces' most demanding roles.

The Optimum Human/Machine Blend

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





* Where and When Training is Delivered Can be More Flexible

* Work Towards the Optimum Human/Machine Blend



Human Factors and Training Always Last?

Technology



Procurement



Questions?



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