



Maritime Information Warfare – The Human Dimension

Andy Fawkes



Human Factors and Training Always Last?

Technology and Humans...



It's Serious...



100% Information?

USS Fitzgerald



USS John S. McCain

~~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.



100% Information?

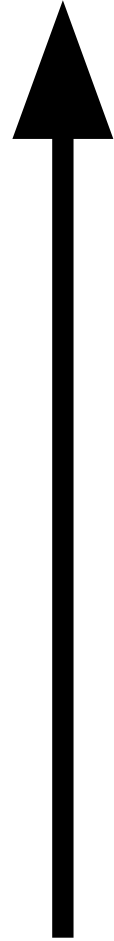
The Push and Pull of Intelligence. As the use of web based systems to post intelligence to be sought and 'pulled' by users becomes the norm, we will have to train our people accordingly. There is a real danger of missing important information amongst the mass available, because 'we don't know how much 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.

“Submarine: Steel Boats - Iron Men” (1989)



THINKE

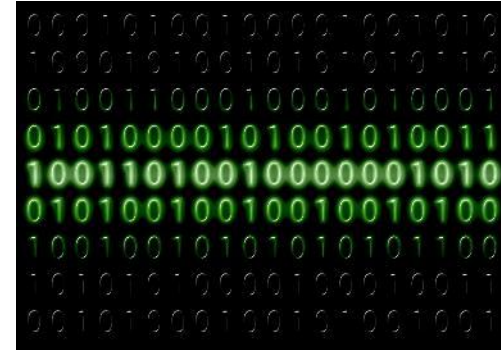
Adaptability



People



Digital



Metal



UK Royal Navy Training



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

Sailors of the Future?



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

Leveraging Human Information



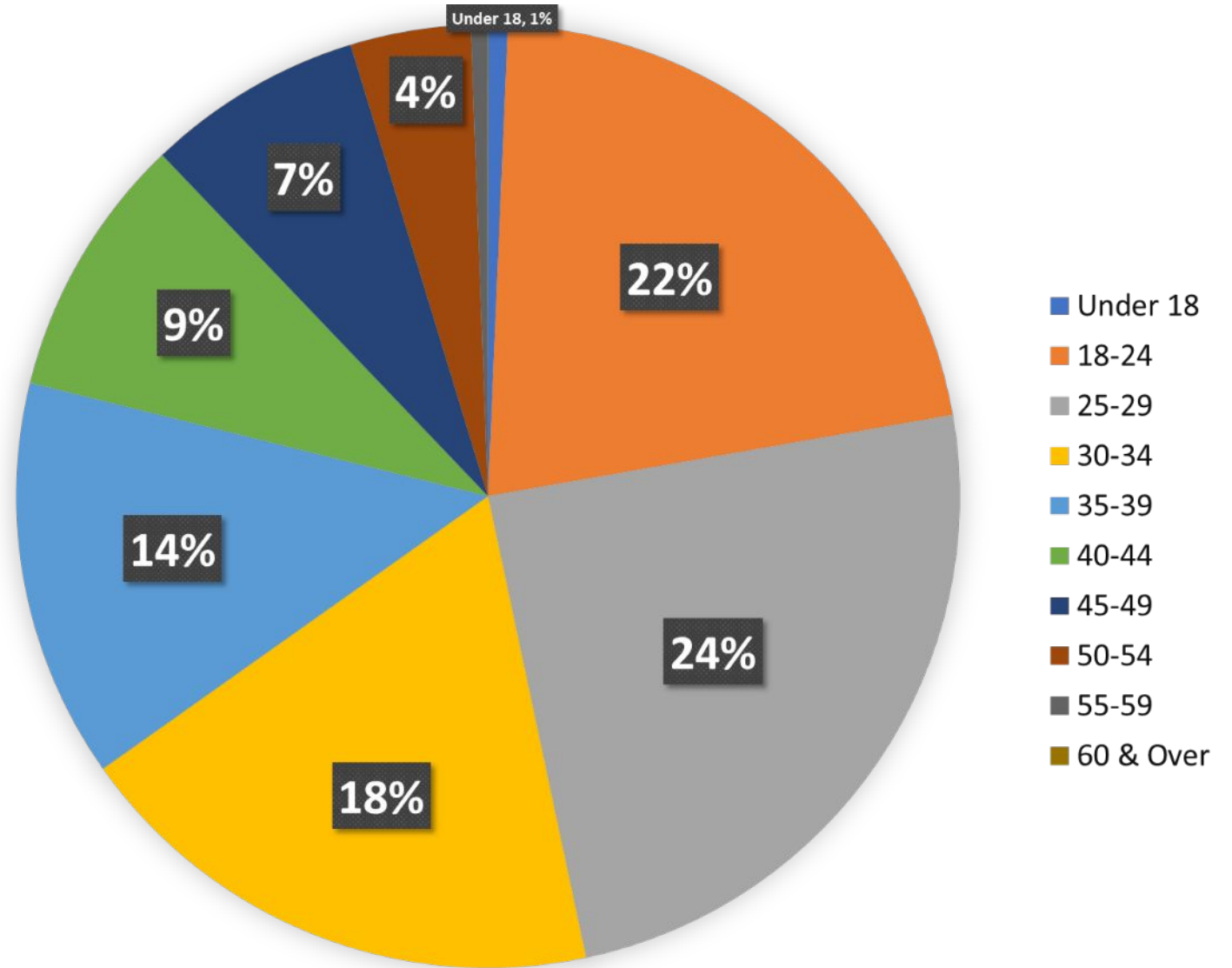
Presentation Overview

- The Modern Sailor
- Training System Developments
- Training Data
- Do we need Humans? Simulation and AI
- Simulation – C2 Convergence
- Organisational Realities

The Modern Sailor

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

World's first text message sent 25 years ago today



Jimmy Nsubuga for Metro.co.uk Sunday 3 Dec 2017 12:15 pm



1.8k



METRO.co.uk

It's the text message's 25th anniversary (Picture: Metro.co.uk)

We don't want to make you feel old but it has been 25 years since the first text message was sent.

Globally, nearly a billion SMS text messages are sent every hour

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

Royal Air Force

RAF urged to recruit video game players to operate Reaper drones

Former drone commander in Syria says air force should try signing up operators 'straight out of PlayStation bedroom'

This article is 12 months old

2993

Patrick Wintour
Diplomatic editor

Friday 9 December 2016
17.23 GMT



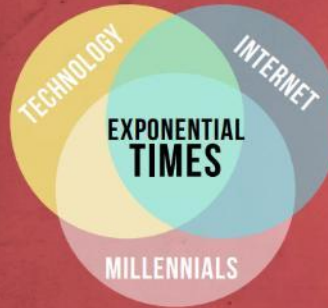
A Reaper drone operator inside a control cabin at RAF Waddington in Lincolnshire. Photograph: David Sillitoe for the Guardian

Video Games...



Ryan Jenkins

EXAMPLES

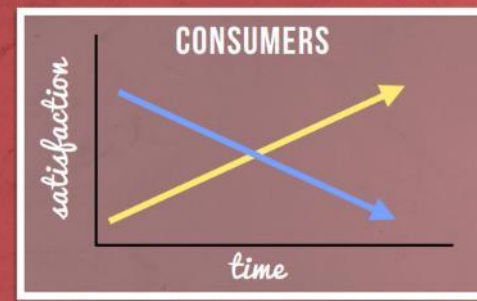


**Not anomalies...
but the preview.*

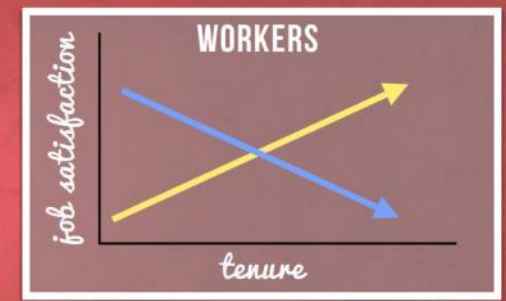
- UBER > FORD'S WORTH = ~\$60 BILLION / FOUNDED IN 1903
UBER'S WORTH = ~\$70 BILLION / FOUNDED IN 2009
-  > 1ST MONTH = 130 MILLION DOWNLOADS
1ST 90 DAYS = \$600 MILLION IN REVENUE
-  > MARRIOTT = 1 MILLION ROOMS SINCE 1927
AIRBNB = 2 MILLION ROOMS SINCE 2008
-  > 8/24/15 = 1 BILLION USERS IN 1 DAY
TODAY = 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.

THE GENERATIONS	AGE	GLOBAL ADULT POP.
GENERATION Z	< 19	n/a
MILLENNIALS	20-36	31%
GENERATION X	37-52	27%
BABY BOOMERS	53-71	29%
BUILDERS	72-89	11%
G.I. GENERATION	90+	2%

Young People Now Have More Knowledge?



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Royal Navy

Is this your company?

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[192 Reviews](#)
[107 Jobs](#)
[259 Salaries](#)
[19 Interviews](#)
[51 Benefits](#)
[5 Photos](#)

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Royal Navy Overview

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

Website	www.royalnavy.mod.uk	Headquarters	Holywood, 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**

What's Next?



Digital Native



AI Native?

Training System Developments

Digital Media Consumption



E-Learning



THINKE

Live Simulation

-

People in
Instrumented
Real World



Virtual Simulation

-

People in a
Virtual World

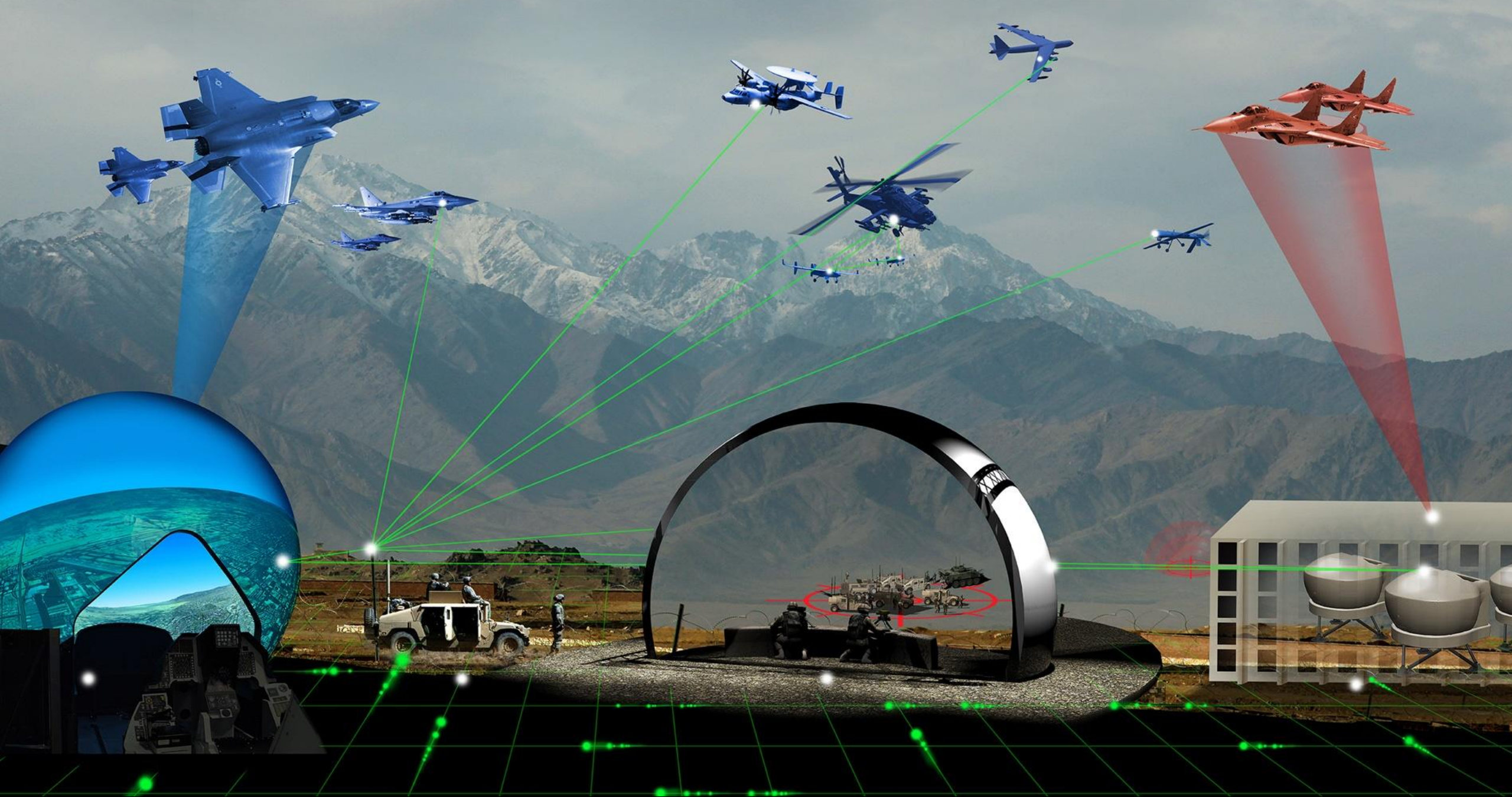


Constructive Simulation

-

Simulated
People & World





Live-Virtual-Constructive Infrastructure

THINKE

Latest Simulation Technology

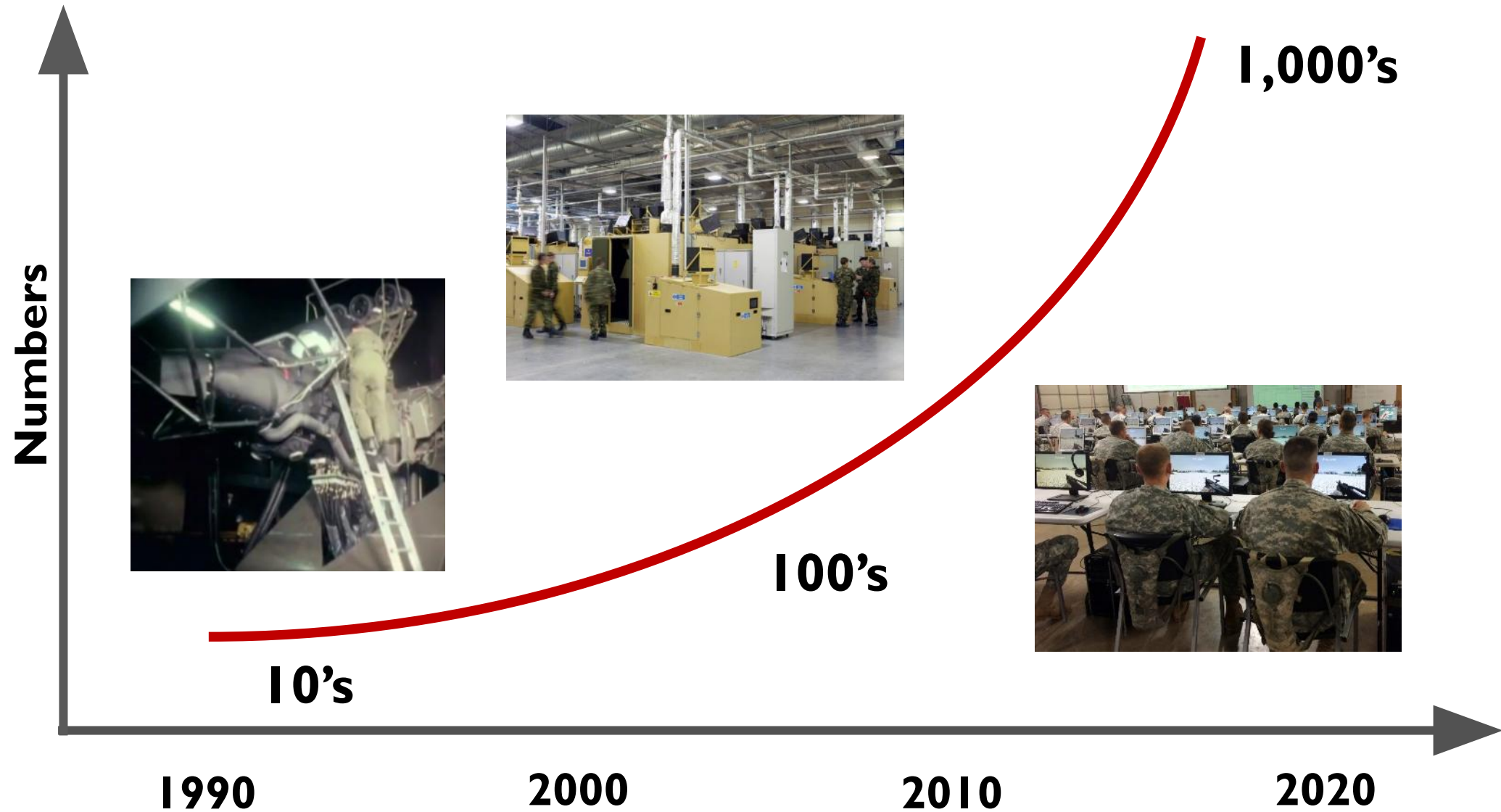


Consumer Technology



Bohemia
Interactive

Military Access to Simulation



Maritime Operations Room Training





THINKE

Virtual Reality

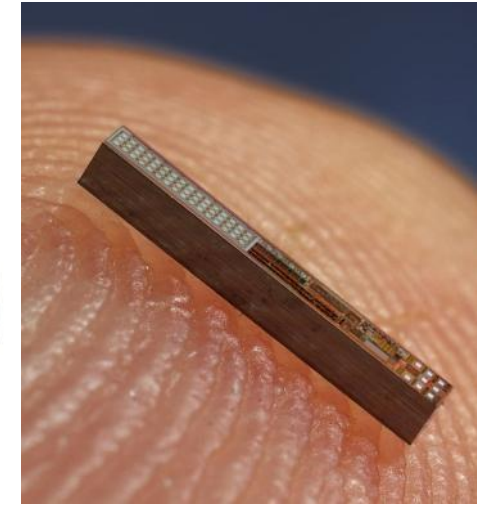
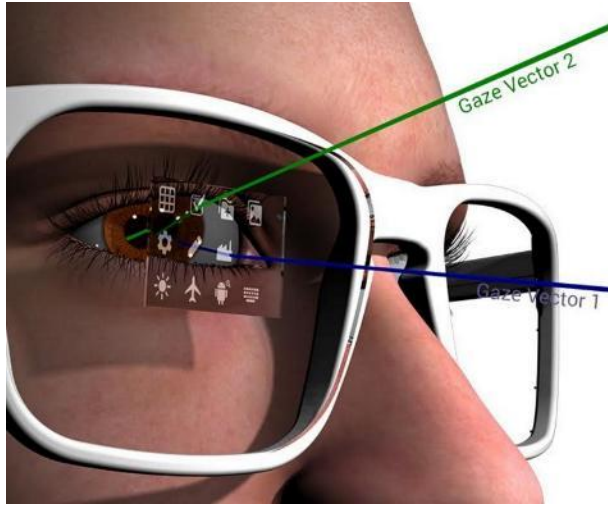




Augmented Reality



Quantified Human



Train and Retain the Trainer?



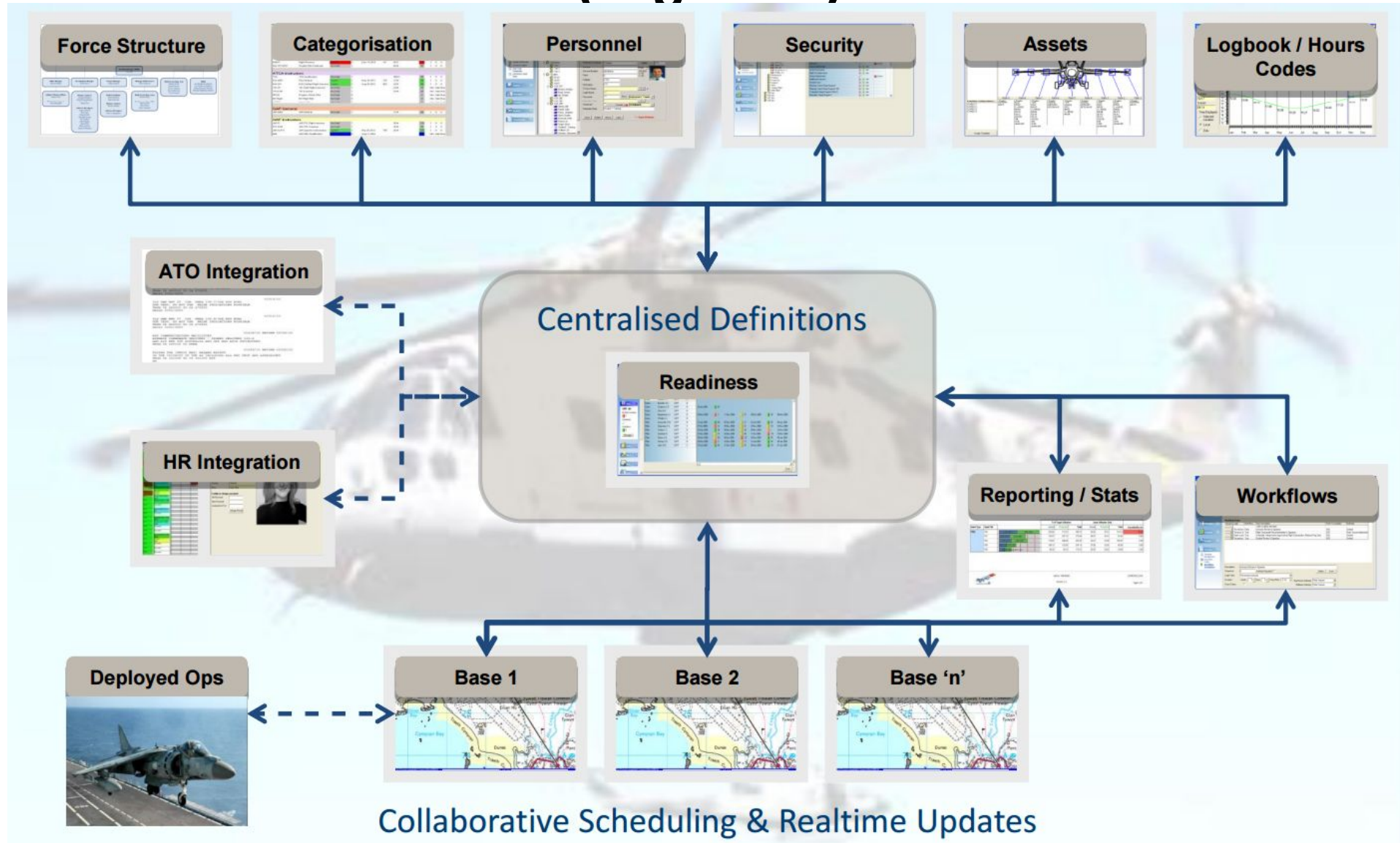
Training Data

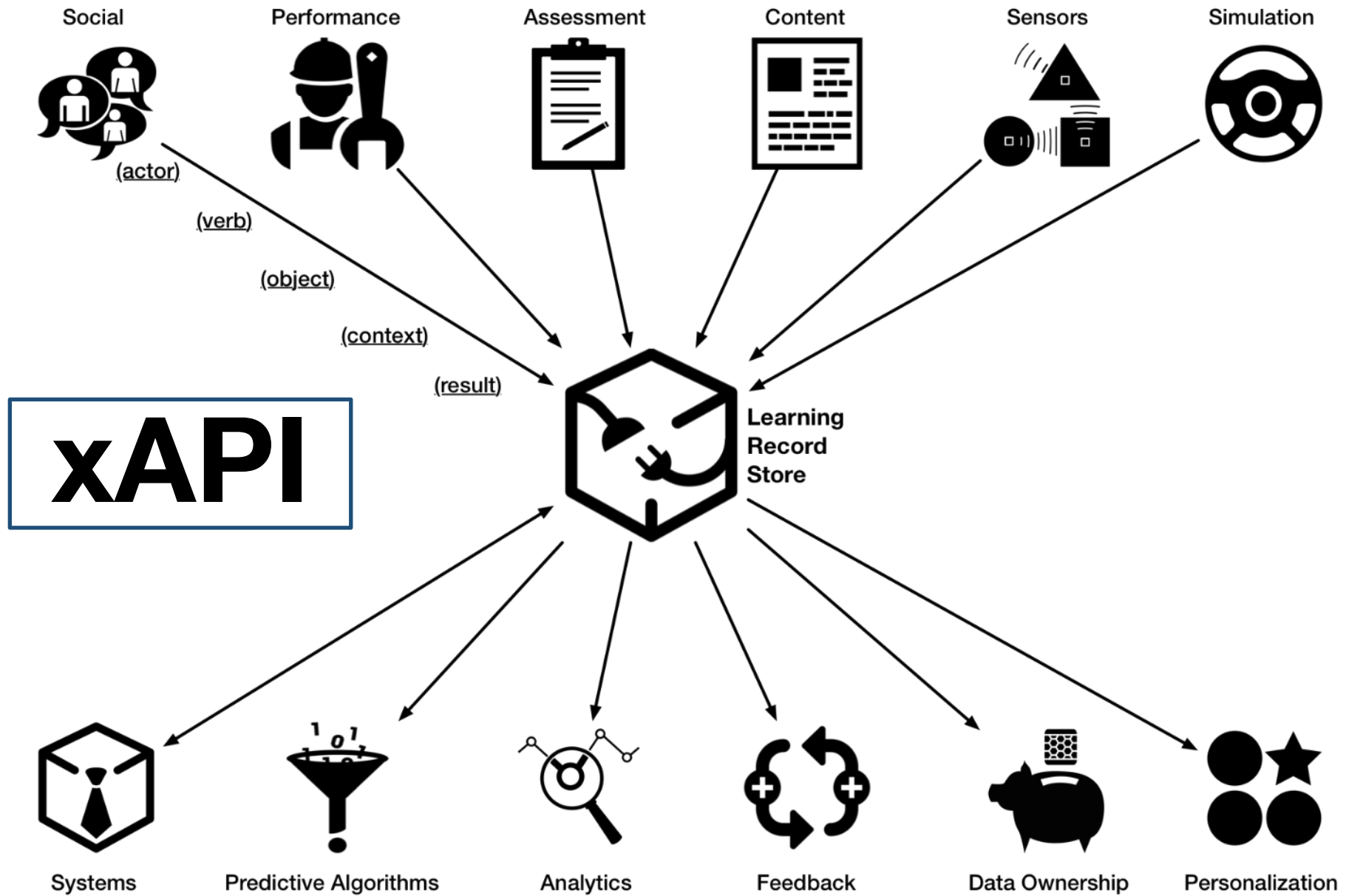
UK Thursday War

Weekly war-fighting
and damage control
exercises



Training & Operations Management Software (FlightPro)



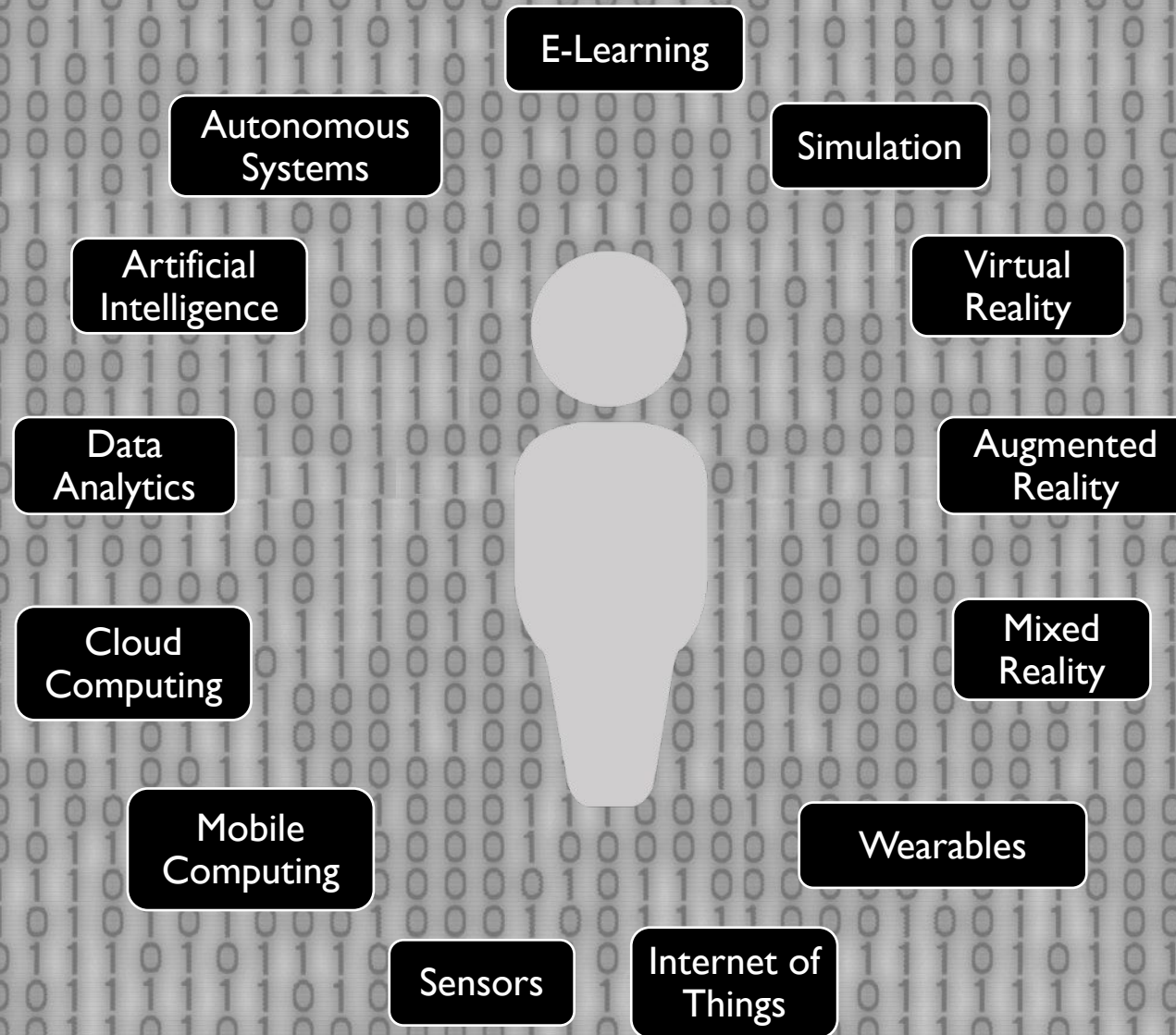


Dstl Funded Research - What can we Learn from Massively Multiplayer Online Games? (MMOGs) in a Defence Context?



- MMOGs offer a new way of thinking about persistency of training and simulation data and user community support.
- A defence MMOG approach would bring benefits to trainees, trainers, analysts and the enterprise, driving cost effectiveness and improving flexibility. Key MMOG features:
 - Persistency of Player/Simulation Data
 - Community Support

Digitisation of Training



A Fourth Revolution - Training 4.0 (?)



1st

2nd

3rd

4th

Paper,
Chalk

Paper,
Electro-Mecha
nical

Digital
Media

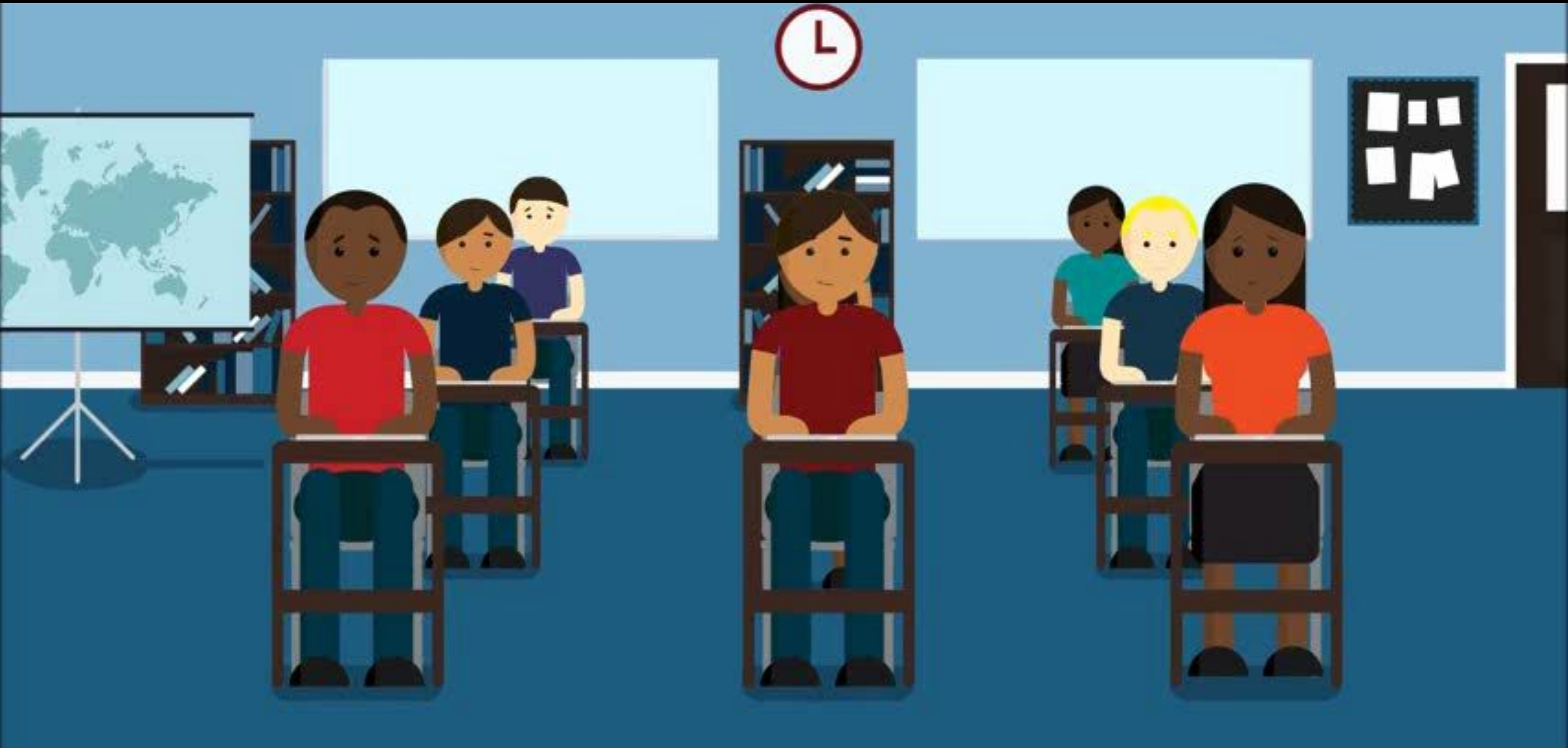
Digitisation of
Training

People Analytics

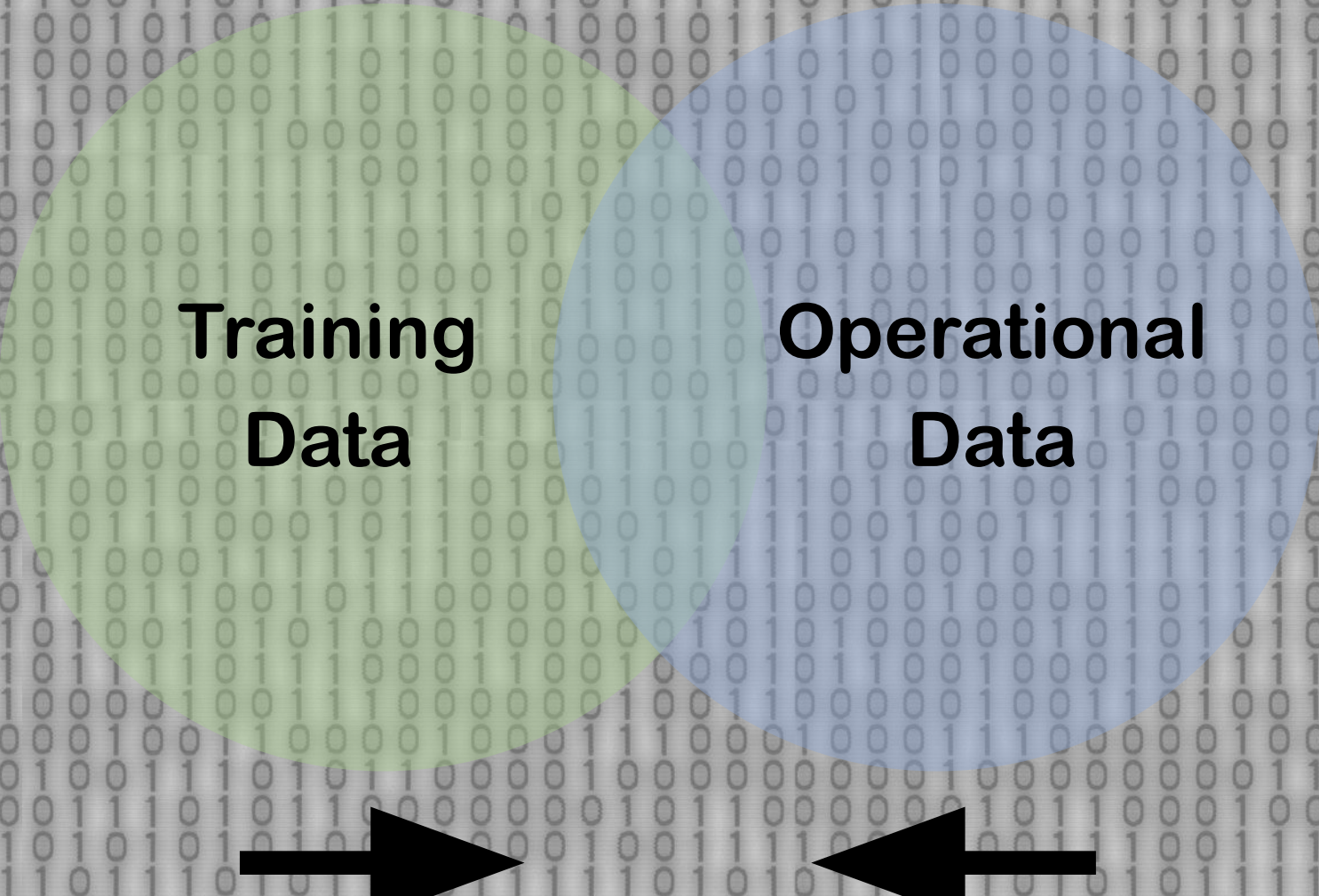
- Driven by the widespread adoption of cloud HR systems, companies are investing heavily in programs to use data for all aspects of workforce planning, talent management, and operational improvement.
- People analytics, a discipline that started as a small technical group that analysed engagement and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

Personalised Data-Driven Learning



Linking?



The diagram features two overlapping circles on a background of binary code. The left circle is green and labeled 'Training Data'. The right circle is blue and labeled 'Operational Data'. Below the circles, a black arrow points from the Training Data circle towards the Operational Data circle, and another black arrow points from the Operational Data circle towards the Training Data circle, indicating a bidirectional relationship or 'linking' between the two data sets.

**Training
Data**

**Operational
Data**

Do we need Humans?

Simulation and AI

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

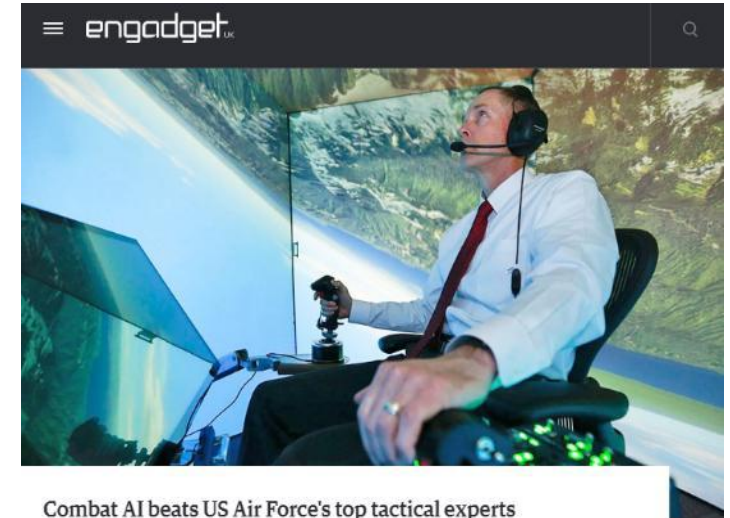


**US Navy
X-47B**



**US Army
Manned-Unmanned
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, @dolftown
06.28.16 in Robots



**US Navy
Autonomous
Craft**

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?



AI Learning in Games (2015)

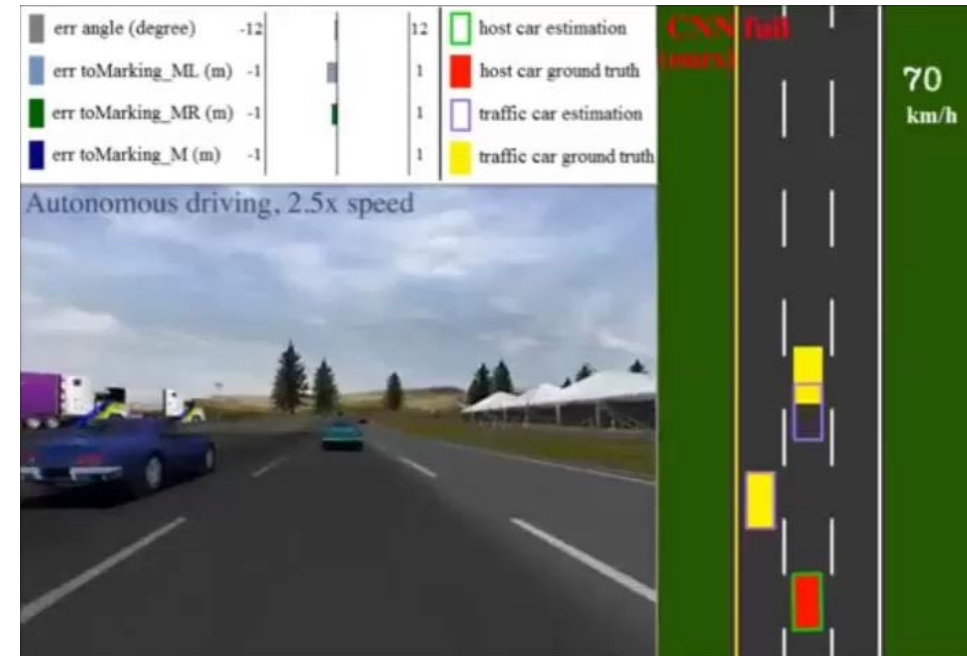
Google DeepMind's Deep Q-learning

The algorithm will play Atari breakout.

The most important thing to know is that all the agent is given is sensory input (what you see on the screen) and it was ordered to maximize the score on the screen.

No domain knowledge is involved! This means that the algorithm doesn't know the concept of a ball or what the controls exactly do.

Google DeepMind (Atari Breakout)



Princeton University (TORCS Racing Simulator)

Nvidia's Isaac Robot Training (May 2017)

ROBOTS



Creators: Sergey Chernov, Kostas Mouskas,
Marvin Zhang, Sergey Levine

Berkeley University

Unity Blogs

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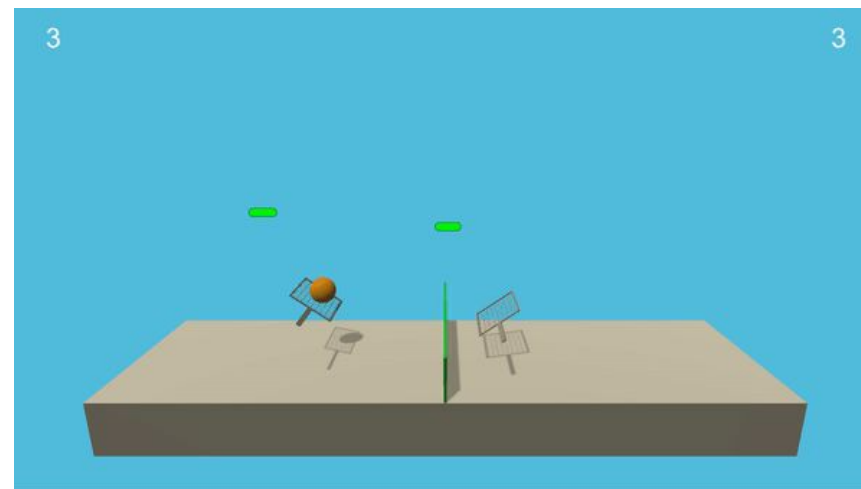
Machine Learning Agents



Introducing: Unity Machine Learning Agents

Arthur Juliani, September 19, 2017

Unity Games Engine Machine Learning Agents (Sep 2017)



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 | @jvincent | 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)

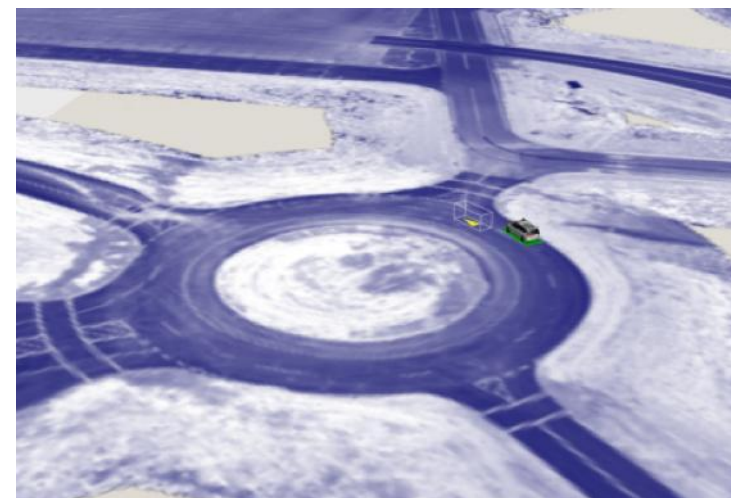
Starcraft

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

Alphabet (Google) Waymo



3 Million Real Miles (2016)



2.5 Billion Simulated Miles (2016)

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?

The Ethical Dimension of Artificial Intelligence

German Government Autonomous Car Design Principles (2017)

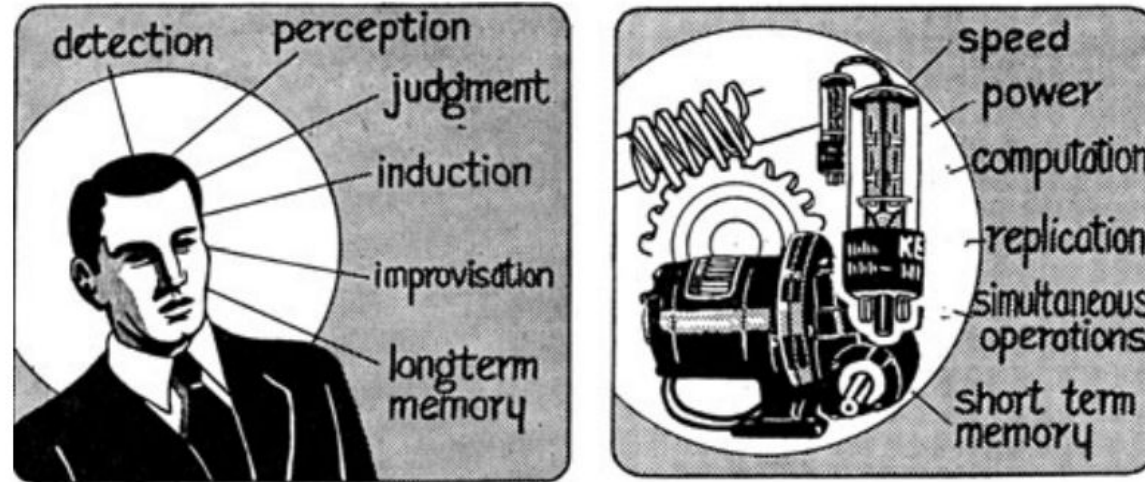
1. Automated/networked driving is ethically necessary if the systems cause fewer accidents than human drivers
2. In the event of danger, the protection of human life always has top priority
3. For unavoidable accidents, any qualification of people according to personal characteristics (eg. age) is not permitted
4. At all times the system must state who is responsible: the human or the computer
5. Anyone who drives must be documented
6. The driver must be able to decide themselves about the use of their vehicle data

UK Ministry of Defence (2017):

“It’s absolutely right that our weapons are operated by real people capable of making incredibly important decisions, and we are guaranteeing that vital oversight”

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.

Still Some Way to Go



Tom Clancy's Rainbow Six: Vegas
2

Google Street View



Humans might get even better...

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UK edition ▾

theguardian

website of the year

home

UK

world

politics

sport

football

opinion

culture

business

lifestyle

fashion

environment

tech

travel

home > science

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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e

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3,346

329



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

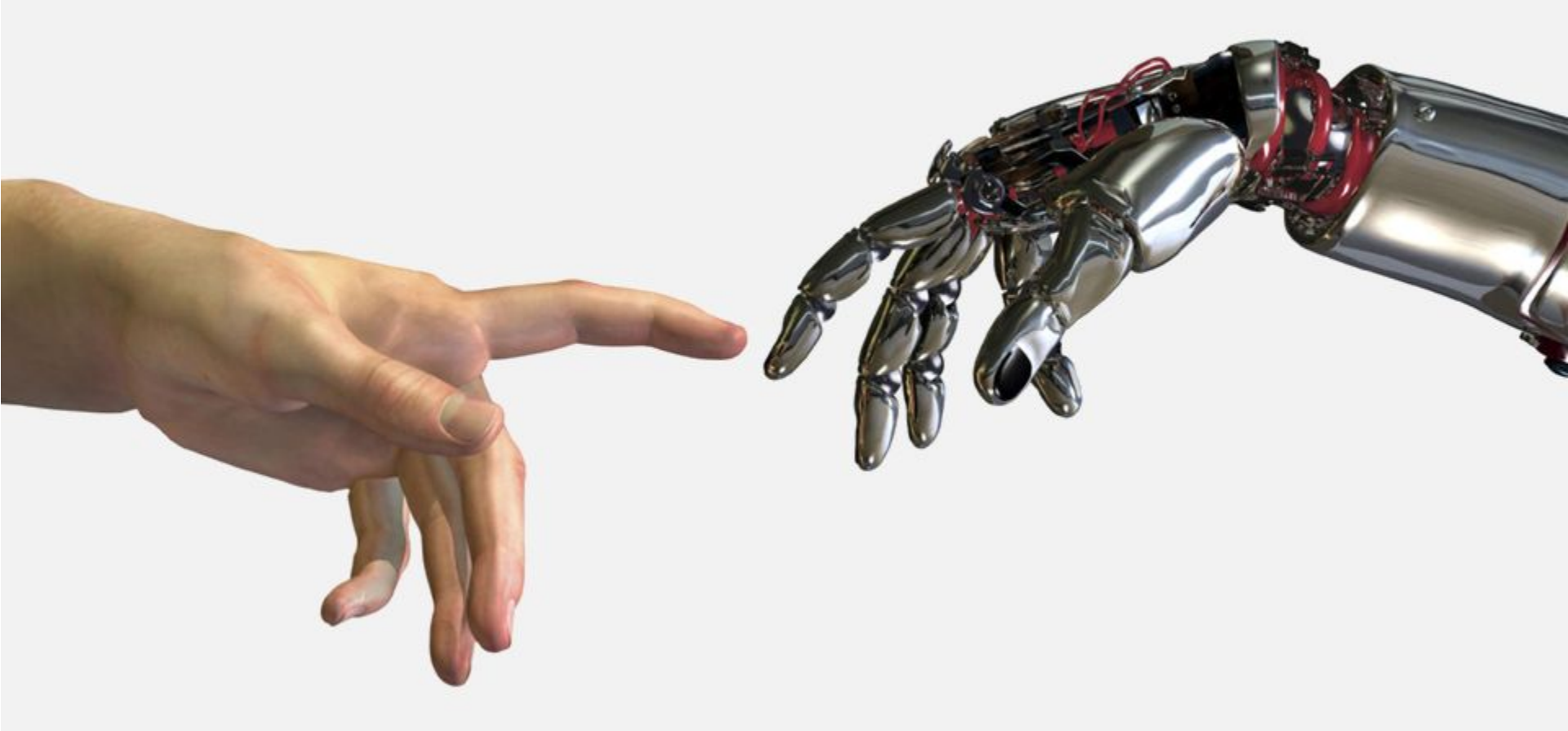
US military scientists have used electrical brain stimulators to enhance mental skills of staff, in research that aims to boost the performance of air crews, drone operators and others in the armed forces' most demanding roles.

The Guardian – 7 Nov 2016

THINKE

The Optimum Human/Machine Blend

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



Simulation – C2 Convergence

Ender's Game - 1985



HDWallpapersImages.com

THINKE

Ender's Game Film - 2013



THINKE

Ender's Game



Leadership



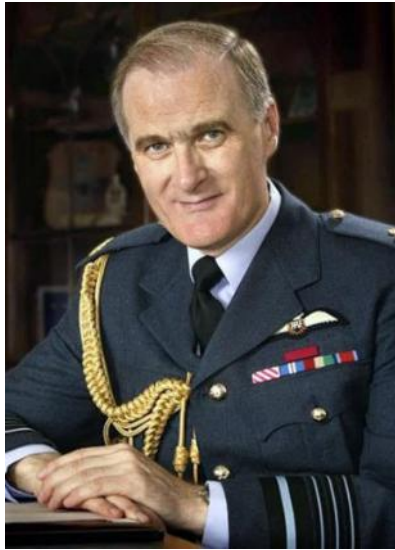
Intuitive Interfaces



Remotely-Operated/Autonomous Agents

Sir Jock Stirrup Chief of Defence Staff

2007 RAeS Edwin Link Lecture



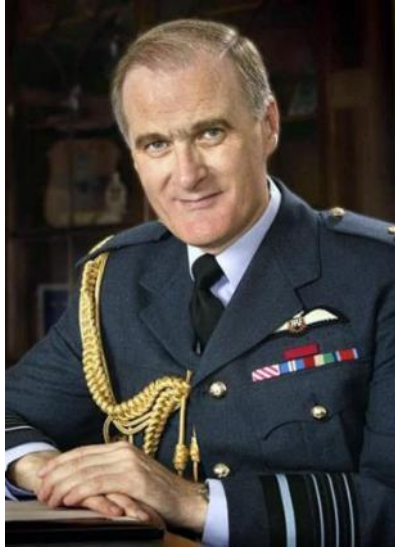
“Lets imagine for a moment a possible future scenario. A commander sits above a battle space with a Gods eye view. He is not actually there he is in a synthetic environment fused from the inputs of multiple and diverse sensors.

By a gesture or a word he can suddenly expand any part of the scene... by word or gesture he can designate targets which are automatically engaged perhaps by unmanned combat vehicles... He sees the results in real time and reacts accordingly... presented also in real time to another commander...

And the scenario that I have described has at its heart the networking of sensors, decision makers and weapons systems... and it fuses synthetic and real world environments in a way that makes it increasingly difficult to distinguish between the two.

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2007 RAeS Edwin Link Lecture



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The Problem - Different Stages to Perform On...

Training



Mission Preparation



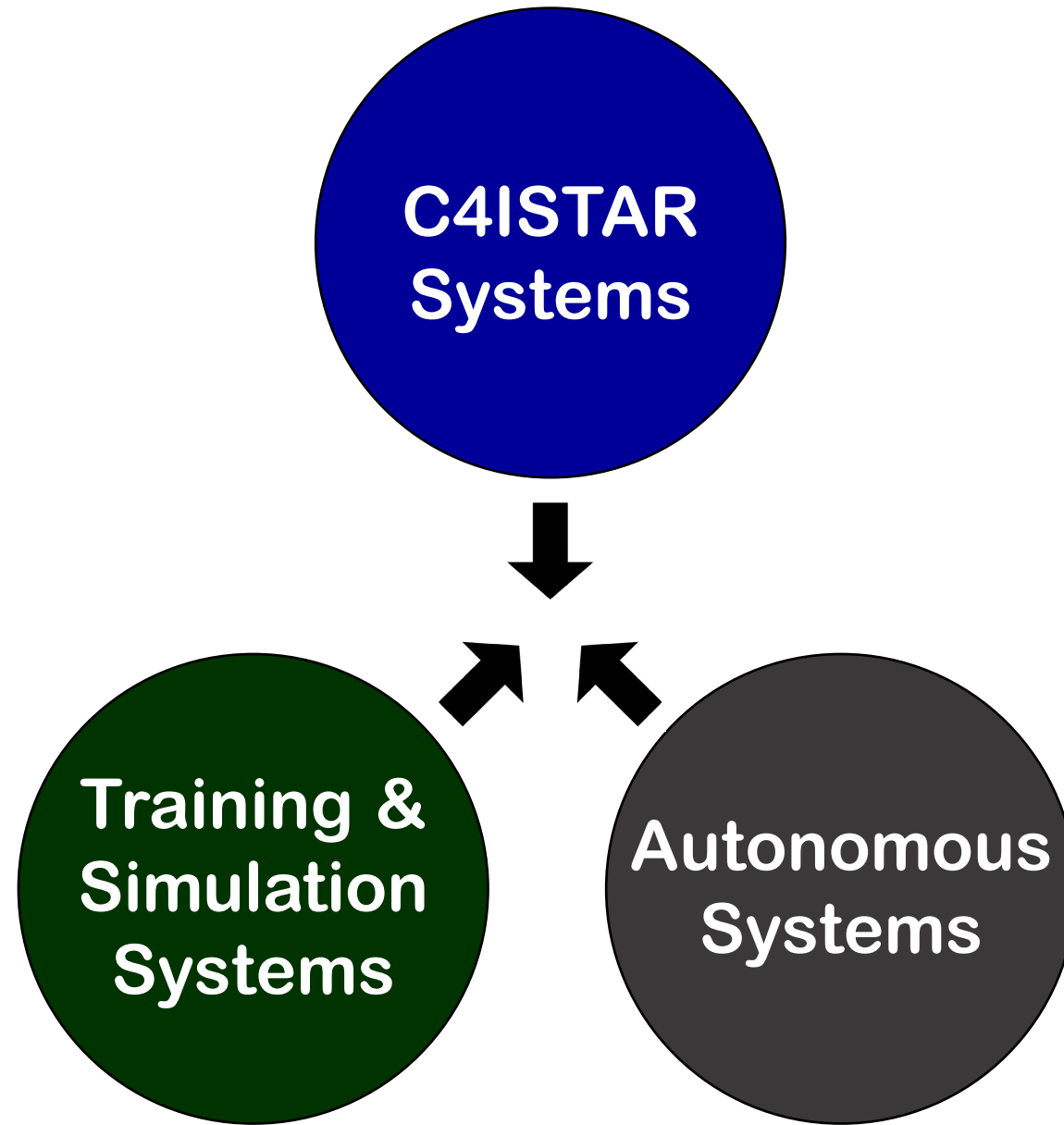
Analysis



Operations

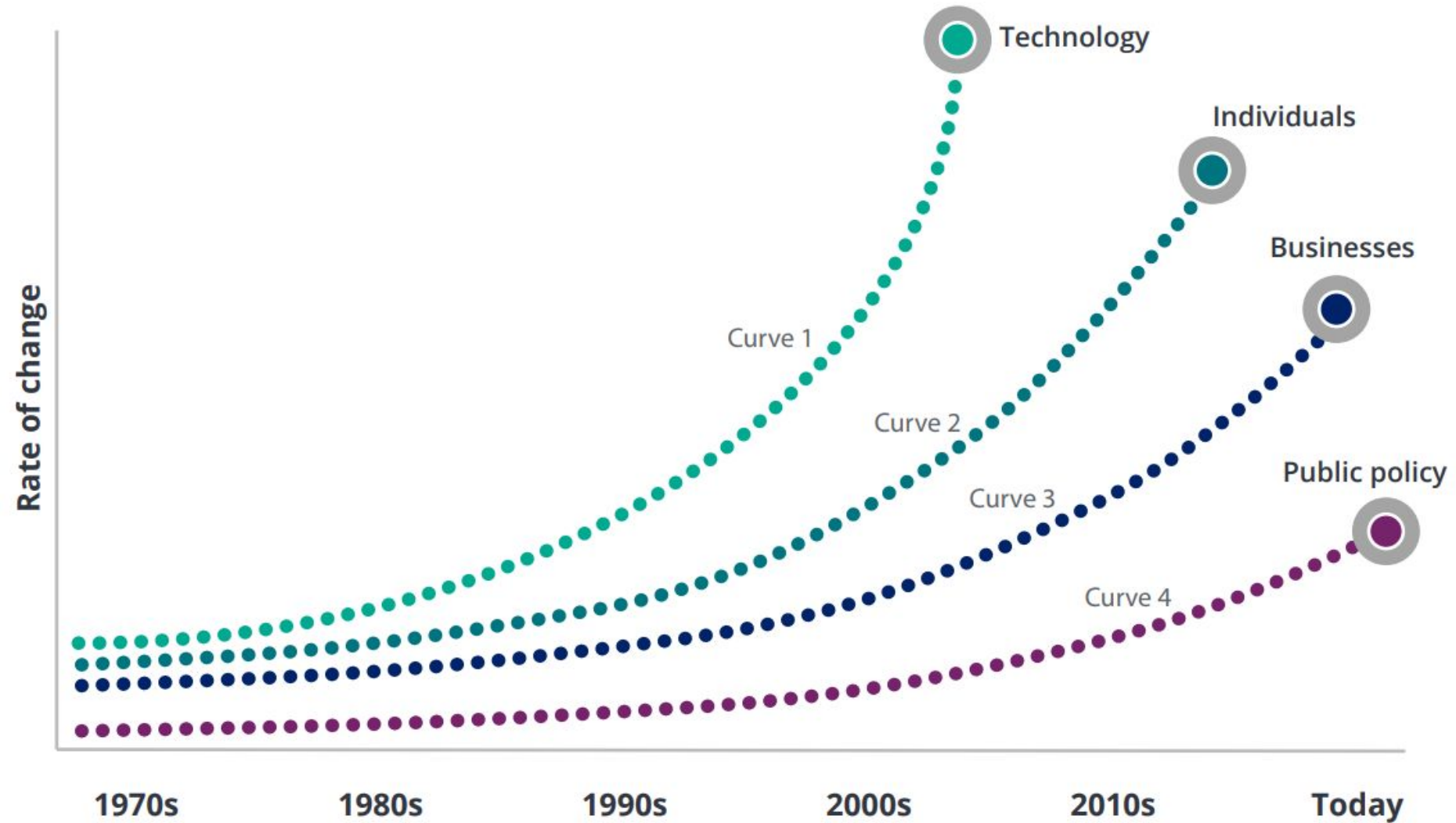


Ambition



Organisational Realities

Technological Change



The Organisation of the Future

Old rules	New rules
Organized for efficiency and effectiveness	Organized for learning, innovation, and customer impact
Company viewed as a hierarchy, with hierarchical decision rights, structure, and leadership progression	Company viewed as an agile network, empowered by team leaders and fueled by collaboration and knowledge-sharing
Structure based on business function with functional leaders and global functional groups	Structure based on work and projects, with teams focused on products, customers, and services
Advancement through promotion upward with many levels to progress through	Advancement through many assignments, diverse experiences, and multifunctional leadership assignments
People “become leaders” through promotion	People “create followers” to grow in influence and authority
Lead by direction	Lead by orchestration
Culture ruled by fear of failure and perceptions of others	Culture of safety, abundance, and importance of risk-taking and innovation
Rules-based	Playbook-based
Roles and job titles clearly defined	Teams and responsibilities clearly defined, but roles and job titles change regularly
Process-based	Project-based

Technology



Procurement



Stovepipes of Data



Training Providers - Innovation v Stability?

- Adaptability
- Responsiveness
- Technology Exploitation



- Investment
- Stability of Supply
- Stability for Trainers

Striving for Training System Interoperability

Challenges

- Project Priorities v Enterprise Priorities
- Different Vendors
- Different Timescales
- Different Technology

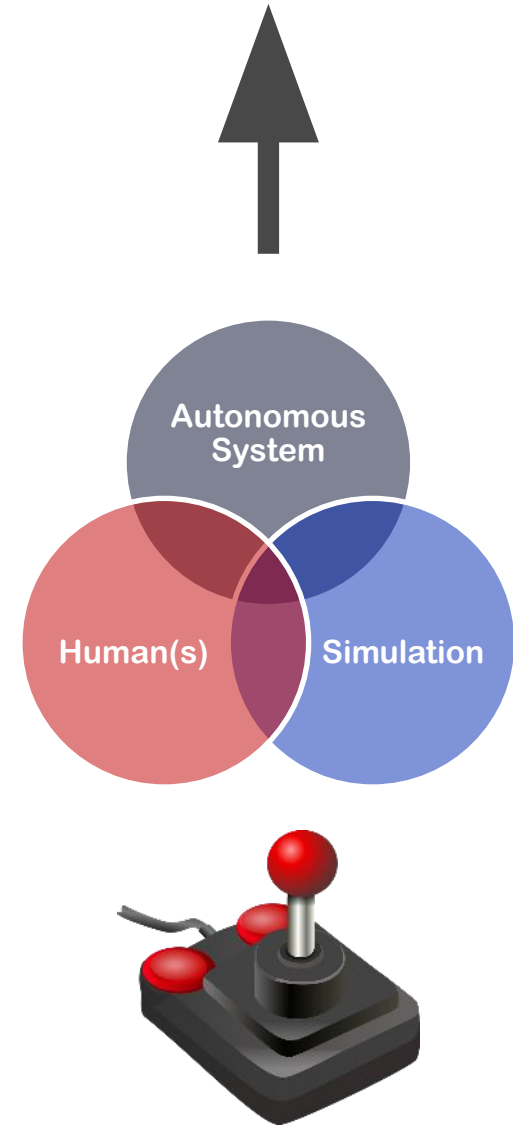
Response

- Standards Bodies
 - Simulation Interoperability Standards Organization
 - NATO Modeling & Simulation Group
- Rationalise Software



3 Final Thoughts

- Human factors become more important as automation increases
- Simulation can play a key role in testing and training humans and autonomous systems both separately and together
- Can we learn more from the gaming industry?



Questions?



THINKE

~~SECRET UK EYES ONLY~~

D/CDS 3/6/1

16 May 2007

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100% Information?

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People are the Most Adaptable Component of Military Capability



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

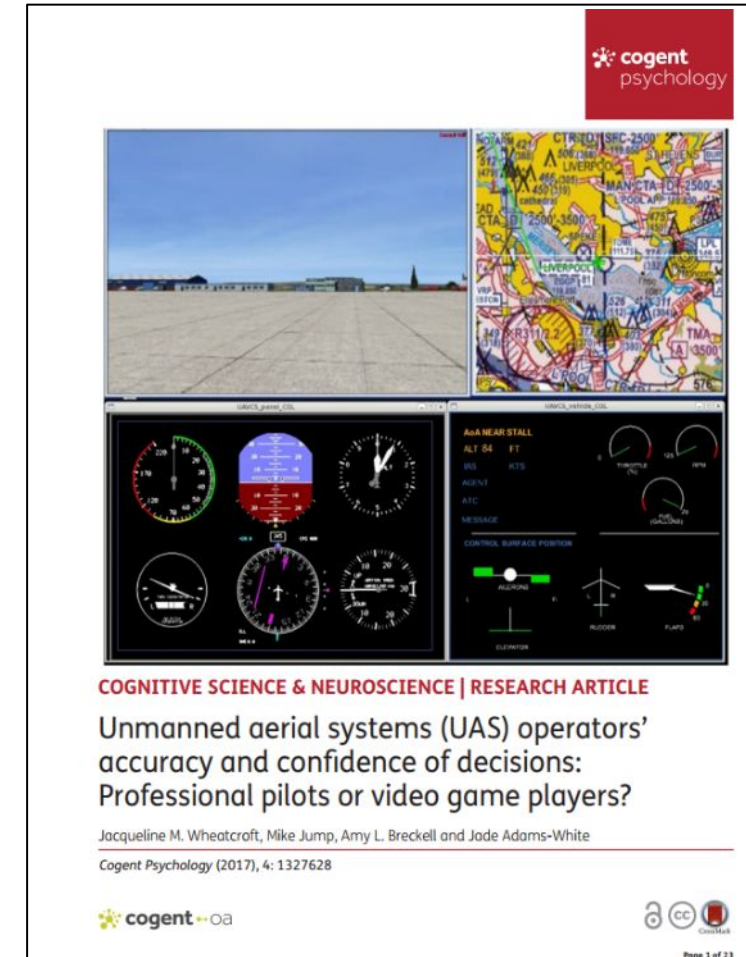
US Army Synthetic Training Environment (STE)

- 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)

Video Game Players and Remote Operation



- Three potential UAS operator groups were explored for suitability:
 - Video game players (VGP)
 - Professional pilots
 - Private pilots
- “Findings support the idea that VGPs could be considered a resource in UAS operation”

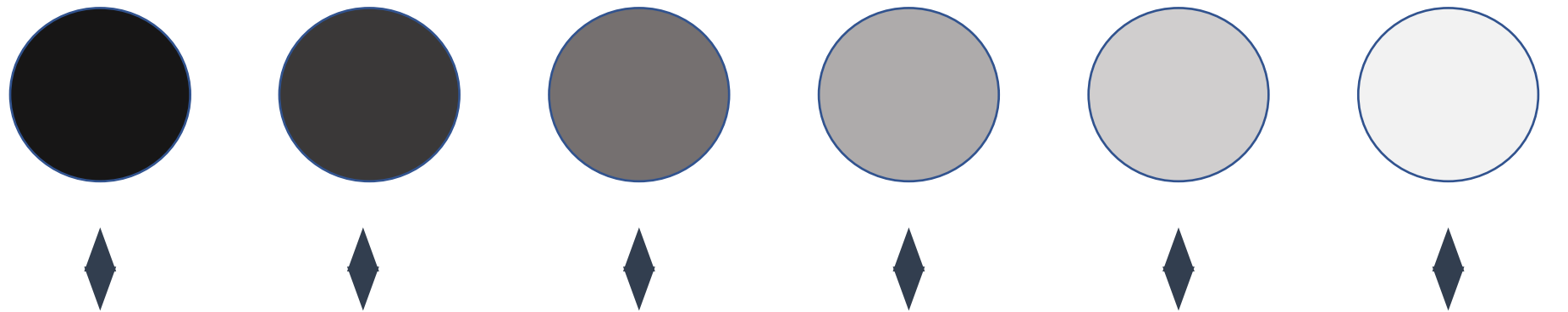




Islands of Data

THINKE

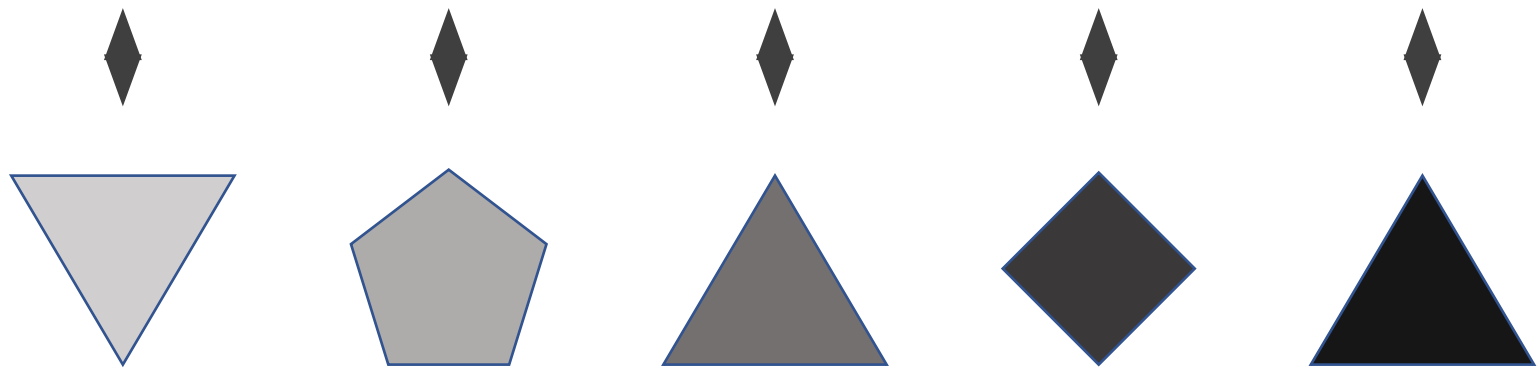
MoD Customers



Pooled Data



Service Providers



So What?

Computers are being
programmed to learn how
to play games, not how
to play games

Land/Air Integration



MBDA/MLM RAIDS
(Rangeless Airborne Instrumented Debriefing System)



Cubic Individual Combat Aircrew Display System
(ICADS®)



Forward Air Controller



Cubic Area Weapons Effects
Simulator (AWES)

BML & C-BML (now C2-Sim)

- Battle Management Language (BML) (2001) and Coalition Battle Management Language (C-BML) (2004)
- Link between C2 and Simulation Systems
- Standard digitized representation of a commander's intent to be used for real troops, for simulated troops, and for robotic and automated forces

Some Benefits of a Data-Driven Approach

Trainee

- Trainees have a training and education environment that measures and records their performance and provides official goals to be attained
- Through career, training content and other trainees are easy to discover and share knowledge with

Training Analyst

- Training and human factor analysts can collect centrally held training data and can conduct analysis on:
 - human performance and training systems effectiveness, and
 - methodologies/pedagogies

Trainer

- Trainers have access to a training and education environment that is available 24/7 and is maintained and updated centrally
- Training scenarios are easy to access, develop and share
- Training and exercise events are easy to schedule and set up, locally and across the defence enterprise

Enterprise

- Software and data are maintained and upgraded centrally reducing costs and responding better to changing operational needs

Challenges

- Data ≠ Knowledge
- People Business
- Cyber



Where to Invest?



More e-Learning
for all?

A more expensive
Simulator for a few?

Value for Money? - US GAO Aug 2016 Report

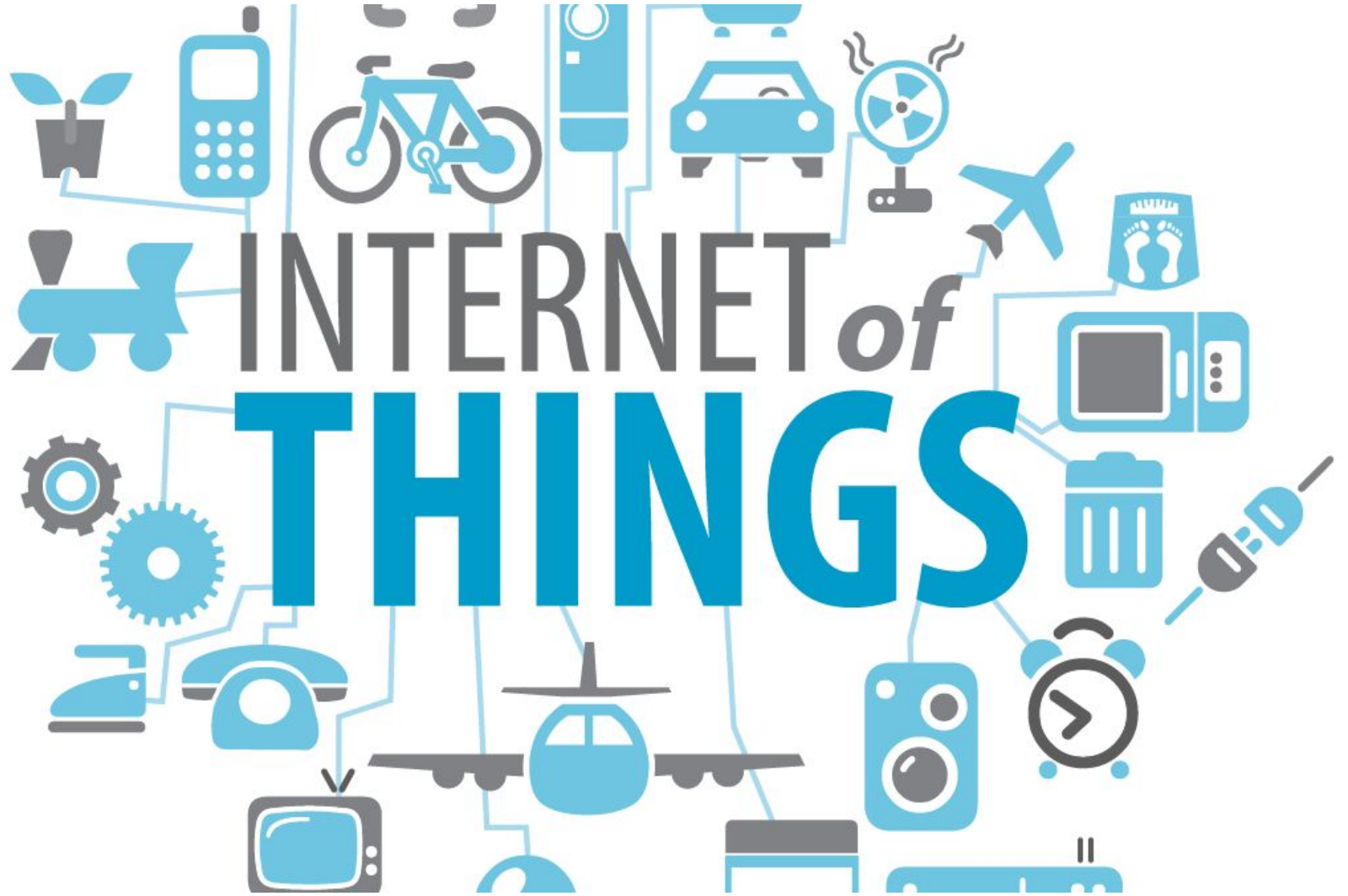
- Seven (US Army) virtual training devices are used on average for 21% of their total availability
- Four of the low-use systems cost more than \$70 million to procure and \$15 million to operate in FY2015

	Utilisation
Engagement Skills Trainer II (EST II)	38%
Call for Fire Trainer II	37.8%
Games for Training VBS coming	30.8%
Dismounted Soldier Training System (DSTS)	15.4%
Stryker Mobile Gun System Advanced Gunnery Training System (MGS AGTS)	8.6%
Intelligence and EW Tactical Proficiency Trainer (IEWTPT)	8.4%
Common Driver Trainer (CDT) Mine Resistant Ambush Protected (MRAP) vehicle device	1.3%

- Gaps in Governance:
 - Front-end analysis
 - Effectiveness analysis
 - Linkage with training strategies

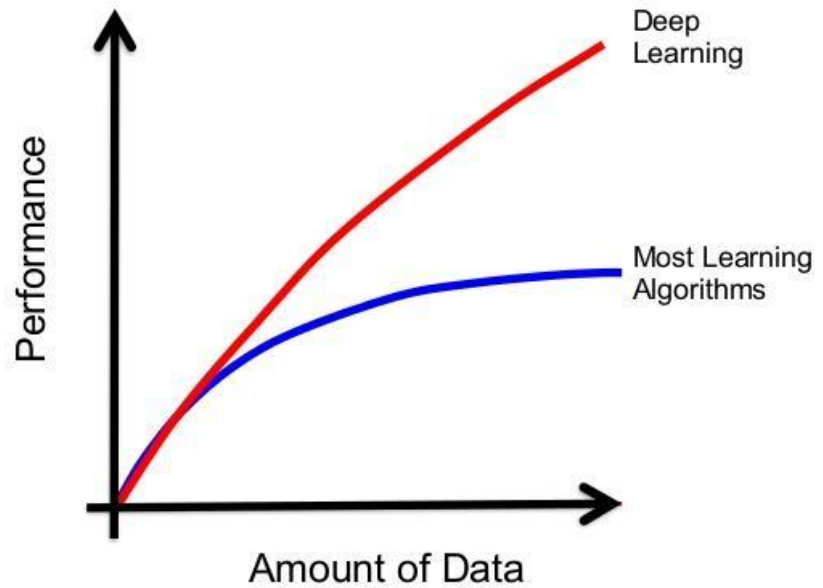
Why is Data of Interest?

Sensors Everywhere

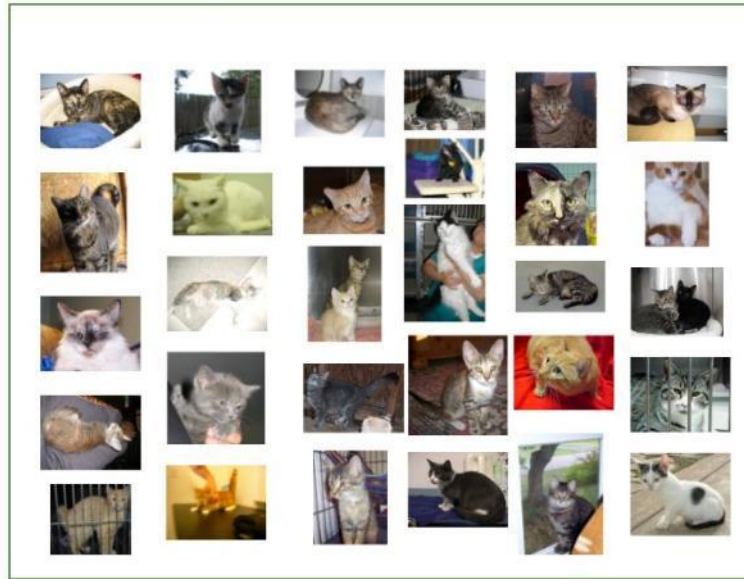


AI and Data

BIG DATA & DEEP LEARNING



Cats



Dogs



Sample of cats & dogs images from Kaggle Dataset

How do they all fit together?





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Training Can be Dangerous



Training Can be Expensive

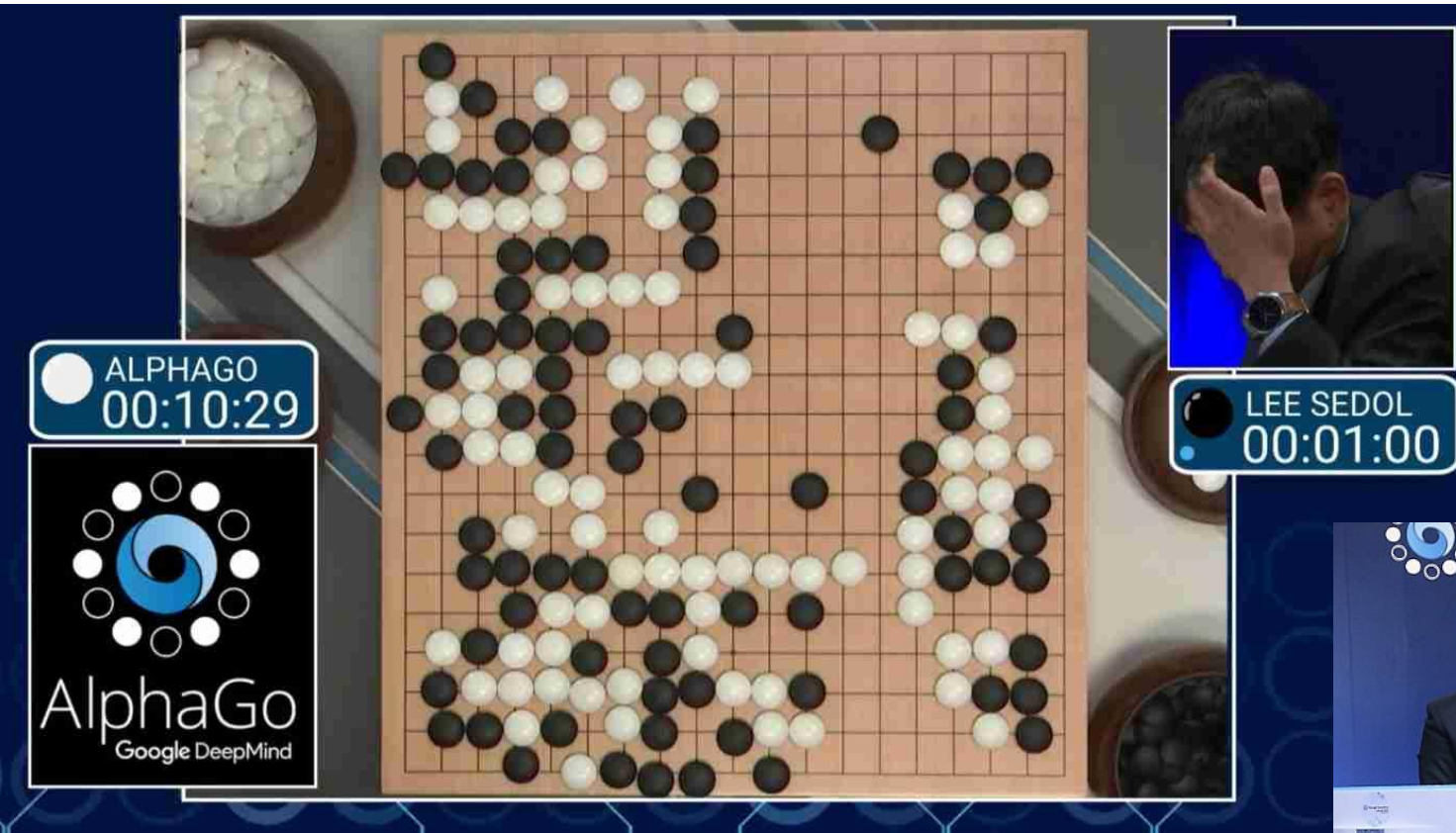


and...

- Affected by Weather
- Affects the Environment
- Aircraft Required



Board Games and AI



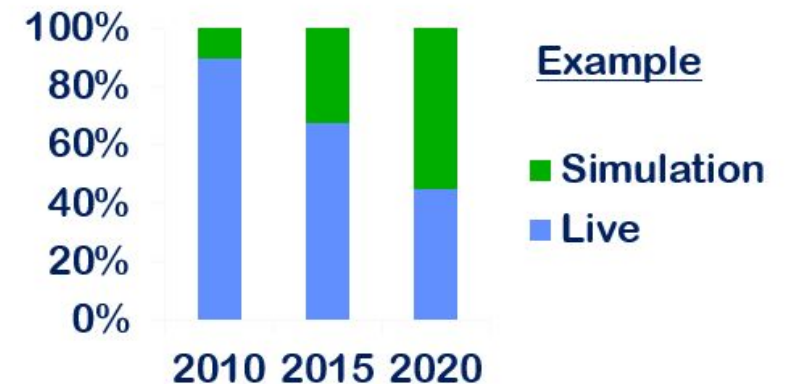
AlphaGo (2016)



Quantitative Evidence?

2010 – UK MoD SDSR Simulation Targets

- Step Change in Exploitation of Simulation for More Cost Effective Training
- 25% Transfer Current Live Training to Simulation by 2015
- Further 25% Current Live Training to Simulation by 2020



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Organisational/Project Boundaries

Apache

ASDOT

F-35

MSHTF

LTPA

A400M

TyTan

DOTC(A)

STARS

DCS&S

C-130

DSALT2

WIST

iASTC

CI7

MAA

P-8

AUV

MFTS

TFST

E-3

How does it all fit together?

