



**2nd SMi Maritime Information Warfare  
Conference - London  
27 November 2018**

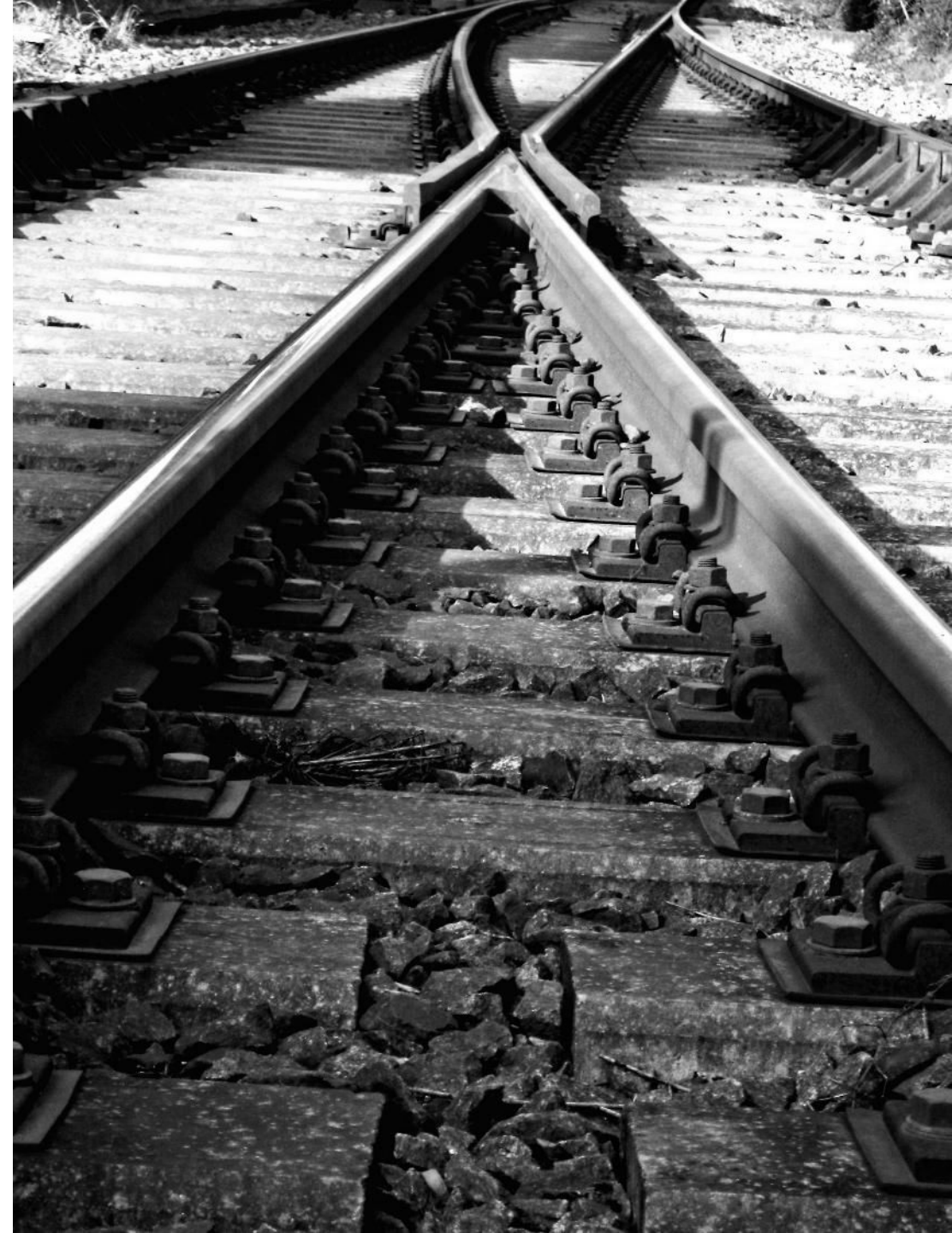
**A Training & Simulation  
Perspective on  
Maritime Information &  
Automation**

**Andy Fawkes**



**Human Factors  
and Training  
Always Last?**

**Operations &  
Training  
-  
Parallels &  
Convergences**



**or  
Parallel  
Universes?**



# Information Warfare 100 years ago...



- **Velocity** - 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
- **Volume** - 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

# Importance of Human Factors



**USS Fitzgerald  
(2017)**



**USS John S. McCain  
(2017)**

# Importance of Human Factors



~~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.

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



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The Hoffman Collection

# Sailors of the Future?



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

- **The Modern Sailor**
- **Training & Simulation**
  - **Developments**
  - **Data**
  - **Digital Twins/Siblings**
- **What about Gaming?**
- **A More Autonomous Future?**

## **Presentation Overview**

# The Modern Sailor

# RN Age Distribution - 2018



46% of the RN is  $\leq 29$   
and 79%  $\leq 39$

## UK REGULAR FORCES BY AGE

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

|                    | Army<br>Service | Naval<br>Service | RAF<br>Service | All<br>services |
|--------------------|-----------------|------------------|----------------|-----------------|
| <b>Under 18-24</b> | <b>21,720</b>   | <b>7,440</b>     | <b>5,530</b>   | <b>34,710</b>   |
| Under 18           | 1,630           | 230              | 160            | 2,030           |
| 18-24              | 20,090          | 7,210            | 5,370          | 32,680          |
| <b>25-34</b>       | <b>34,770</b>   | <b>13,550</b>    | <b>13,220</b>  | <b>61,530</b>   |
| 25-29              | 19,250          | 7,540            | 6,830          | 33,610          |
| 30-34              | 15,520          | 6,010            | 6,390          | 27,920          |
| <b>35-44</b>       | <b>19,640</b>   | <b>7,490</b>     | <b>9,330</b>   | <b>36,470</b>   |
| 35-39              | 12,760          | 4,650            | 5,790          | 23,210          |
| 40-44              | 6,880           | 2,840            | 3,540          | 13,260          |
| <b>45 and over</b> | <b>4,970</b>    | <b>4,010</b>     | <b>4,860</b>   | <b>13,850</b>   |
| 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              |



# “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<sup>rd</sup>s of the RN now are Digital Natives and 90% by 2030**

**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”

MailOnline

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



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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.



# What's Next?



**Digital Native**



**AI Native?**

 Sign In



Overview

254 Reviews

114 Jobs

376 Salaries

21 Interviews

64 Benefits

5 Photos

[View Jobs at Royal Navy](#)

### Royal Navy Overview

[Work here? Get a FREE Employer Account](#)

|              |                                                                |
|--------------|----------------------------------------------------------------|
| Website      | <a href="http://www.royalnavy.mod.uk">www.royalnavy.mod.uk</a> |
| Headquarters | Holywood, Northern Ireland                                     |
| Size         | 5001 to 10000 employees                                        |
| Founded      | Unknown                                                        |
| Type         | Government                                                     |
| Industry     | National Agencies                                              |
| Revenue      | £10 to £25 million (GBP) 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.

### Royal Navy Reviews

3.7



[Rating Trends](#)

70%

Recommend to a friend

80%

Approve of CEO



Sir Jonathon Band  
89 Ratings

# Employee Power?

ratings and reviews of  
over 600,000 companies  
worldwide

# Training & Simulation Developments

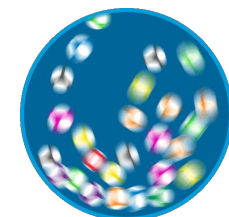
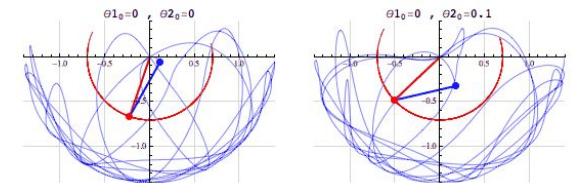
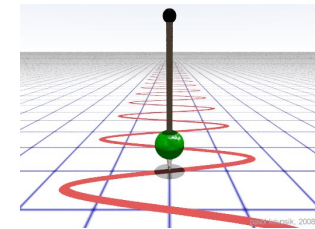
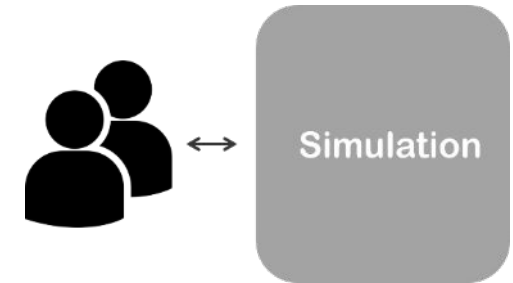


# Digital Classroom



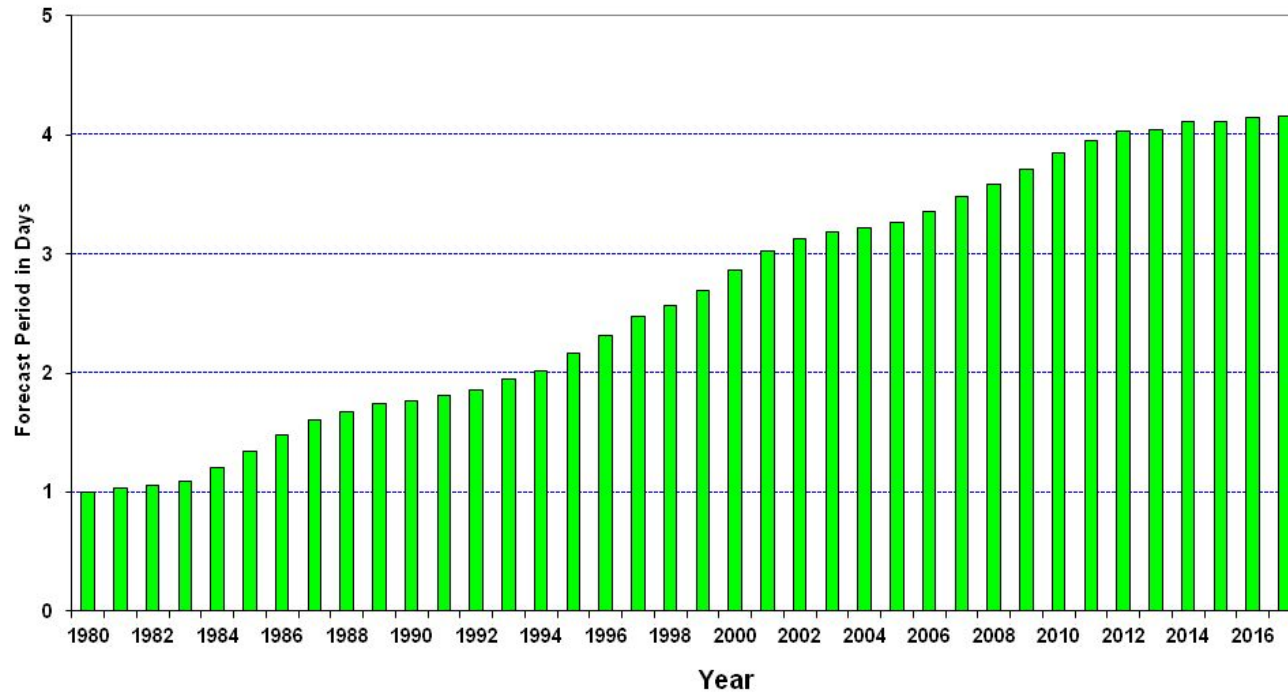
# What is Simulation?

- 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 (2017)

Accuracy of PMSL forecast (in days) compared to baseline of 1-day forecast in 1980





**War is chaotic**

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

**“All but war is  
simulation”**

# Black Swan

**Pre-1697**



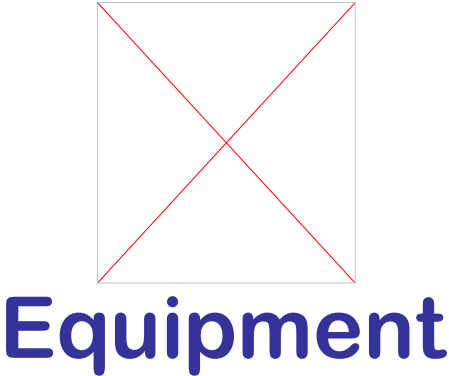
**Post-1697**



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



# Simulation Categories (LVC)



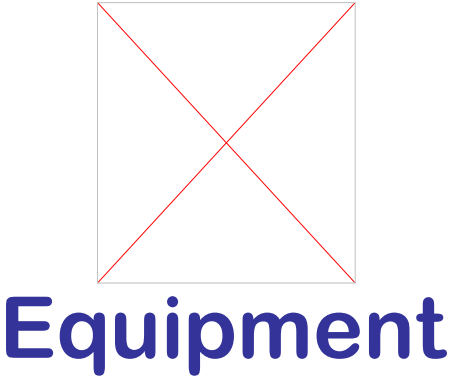
Real  
Simulated

|           |                |                     |  |
|-----------|----------------|---------------------|--|
| Real      |                | <b>Live</b>         |  |
| Simulated | <b>Virtual</b> | <b>Constructive</b> |  |

Real                      Simulated



# Simulation Categories (LVC-A)



Real

Simulated

|  |         |              |  |
|--|---------|--------------|--|
|  |         | Real         |  |
|  | Live    | Autonomous   |  |
|  | Virtual | Constructive |  |
|  |         | Simulated    |  |

Real

Simulated



People

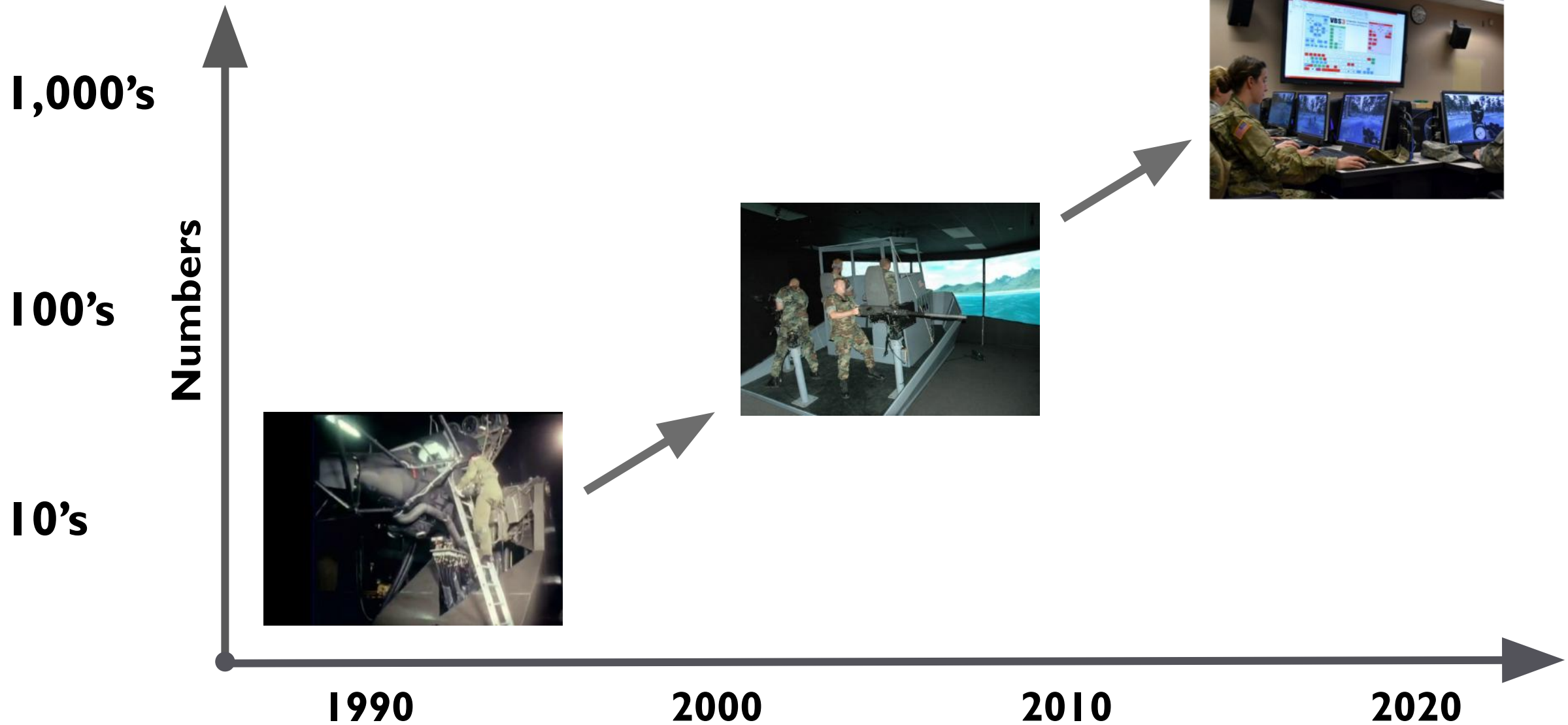
# Simulation Now - Land, Sea, Air, Anywhere



THINKE



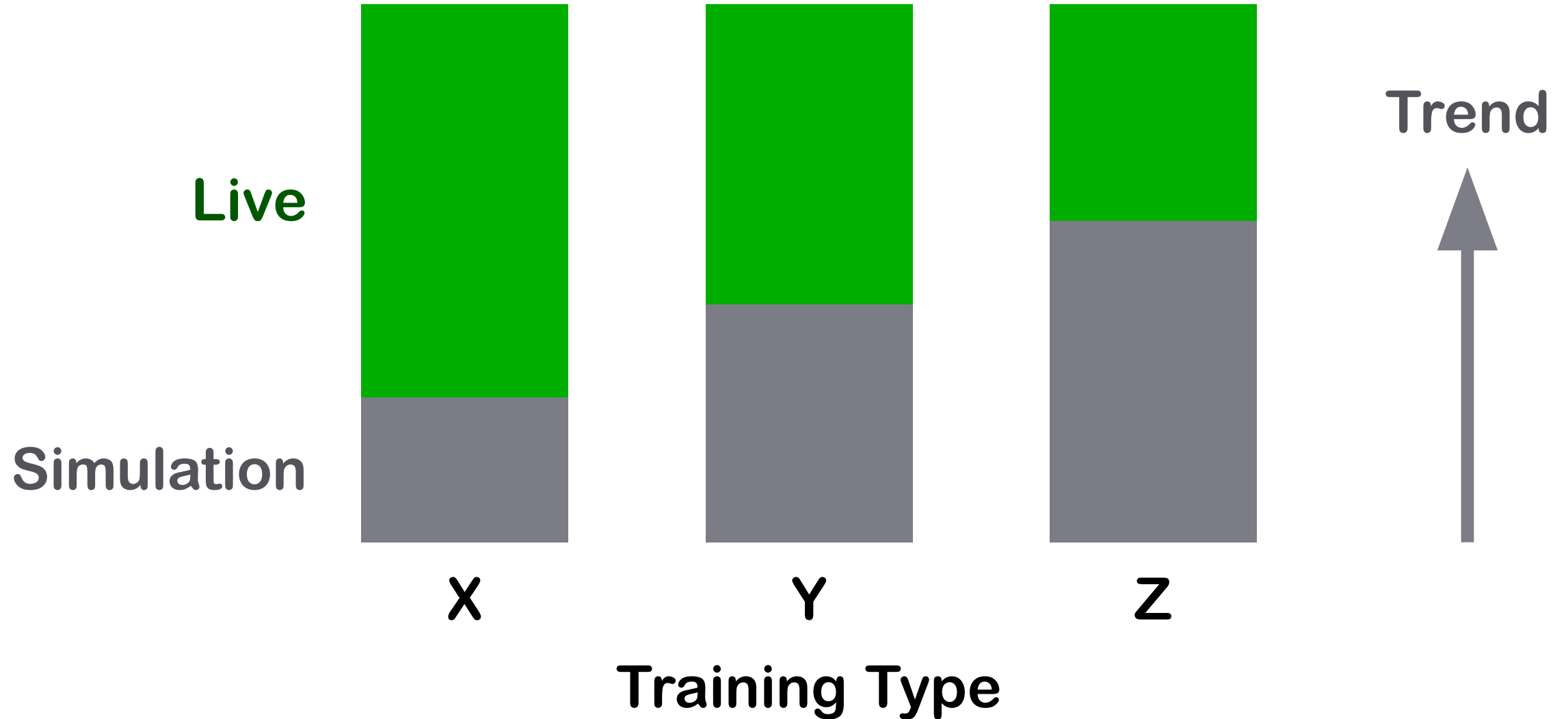
# Military Access to Simulation



# Why Training Simulation?



# Live & Simulation Based Training



# HMS Queen Elizabeth F-35 Lightning Training



# HMS Queen Elizabeth Flight Deck Training

## RNAS Culdrose



# Additional Realities

**Reality**

**The real world**



**Augmented Reality**

**Information layered over vision**



**Mixed Reality**

**Blend of real & digital information to enhance reality**



**Virtual Reality**

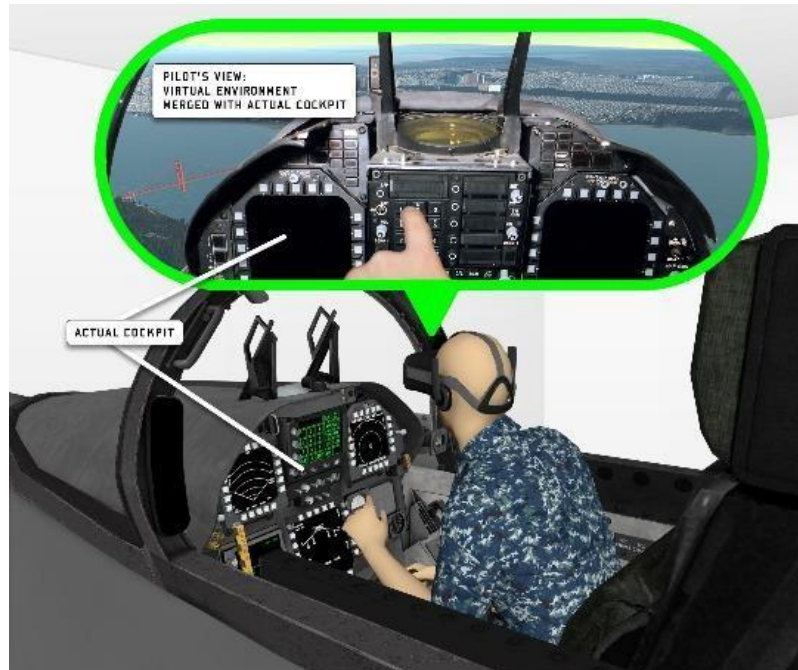
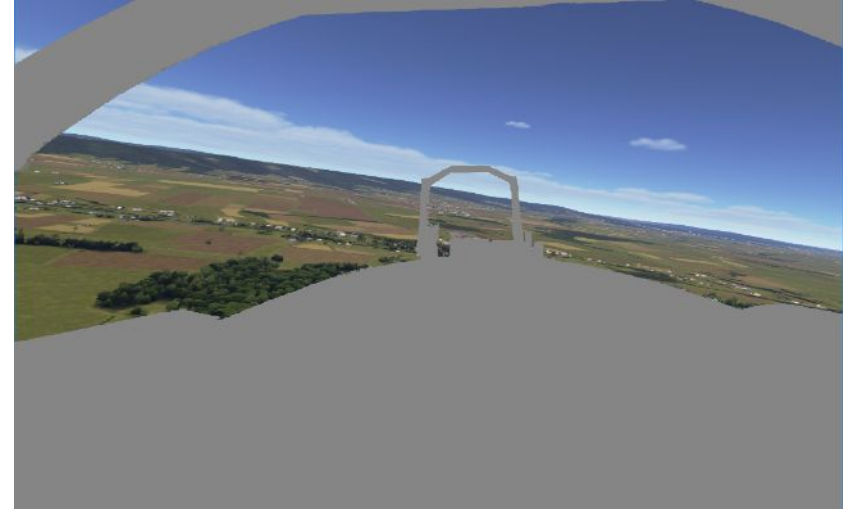
**Fully virtual world**



# VR + Virtual Cockpit Interaction



# Mixed Reality Visual System (MRVS)



# US Army Troops to Test Augmented Reality in 2019

Global1 News Network (2 Apr 2018)



UNI

# 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)

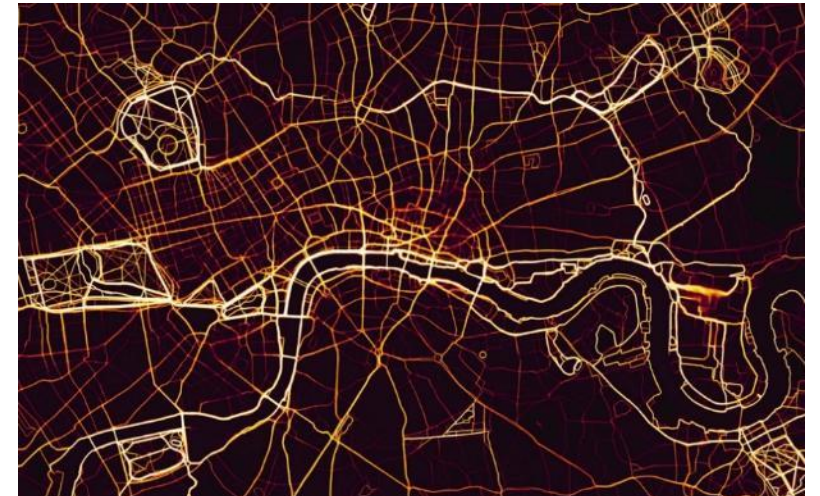
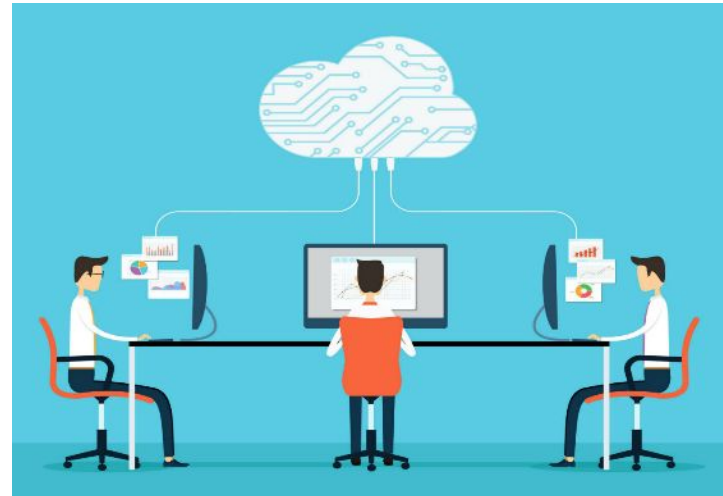
US Army Synthetic Training Environment (STE)  
MG Maria R. Gervais, Association of the United States Army (March 18)



THINKE

Data

# Training Data Generators



# 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

# Personalised Data-Driven Learning



# Stovepipes of Data



# The Price of Data

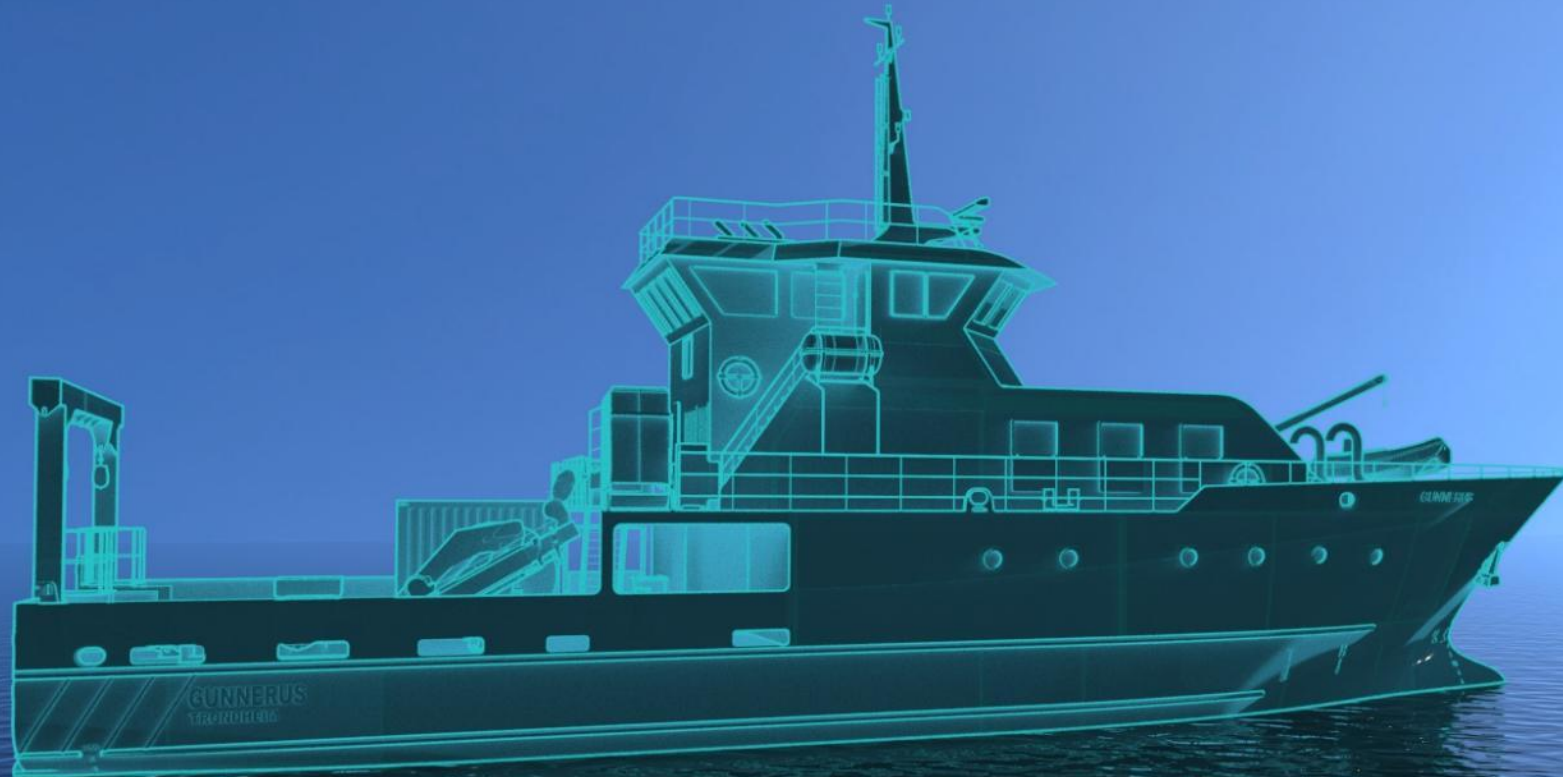


# UK Thursday War

Weekly  
warfighting &  
damage control  
exercises



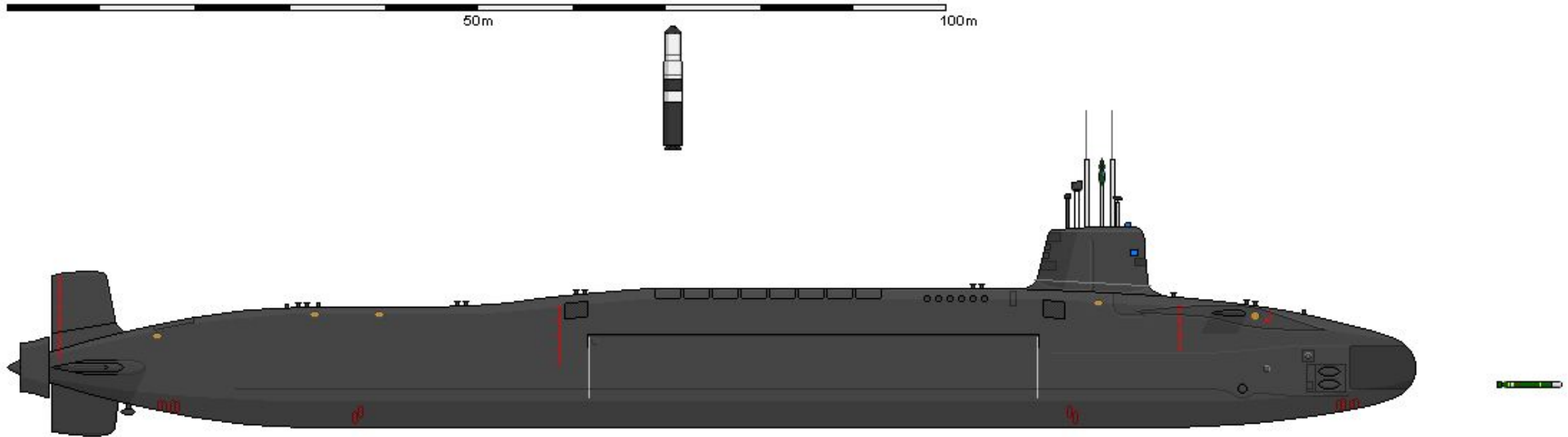
# What about “Digital Twins”?



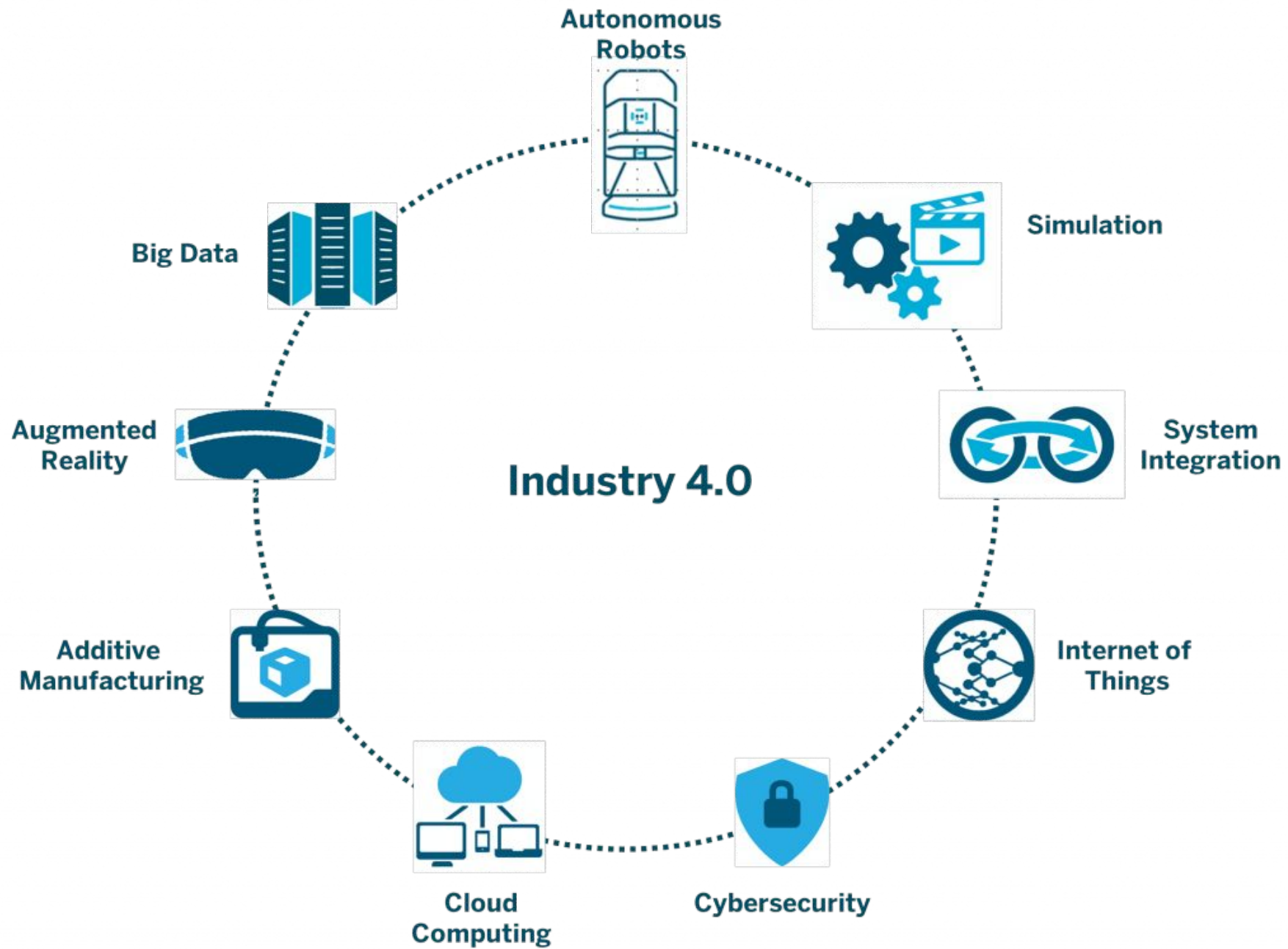
# **“Digital Twins” or “Digital Threads” or “Digital Siblings” or Simulation Based Acquisition...**



# UK Vanguard Class SSBN – A “Perspex Twin”



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



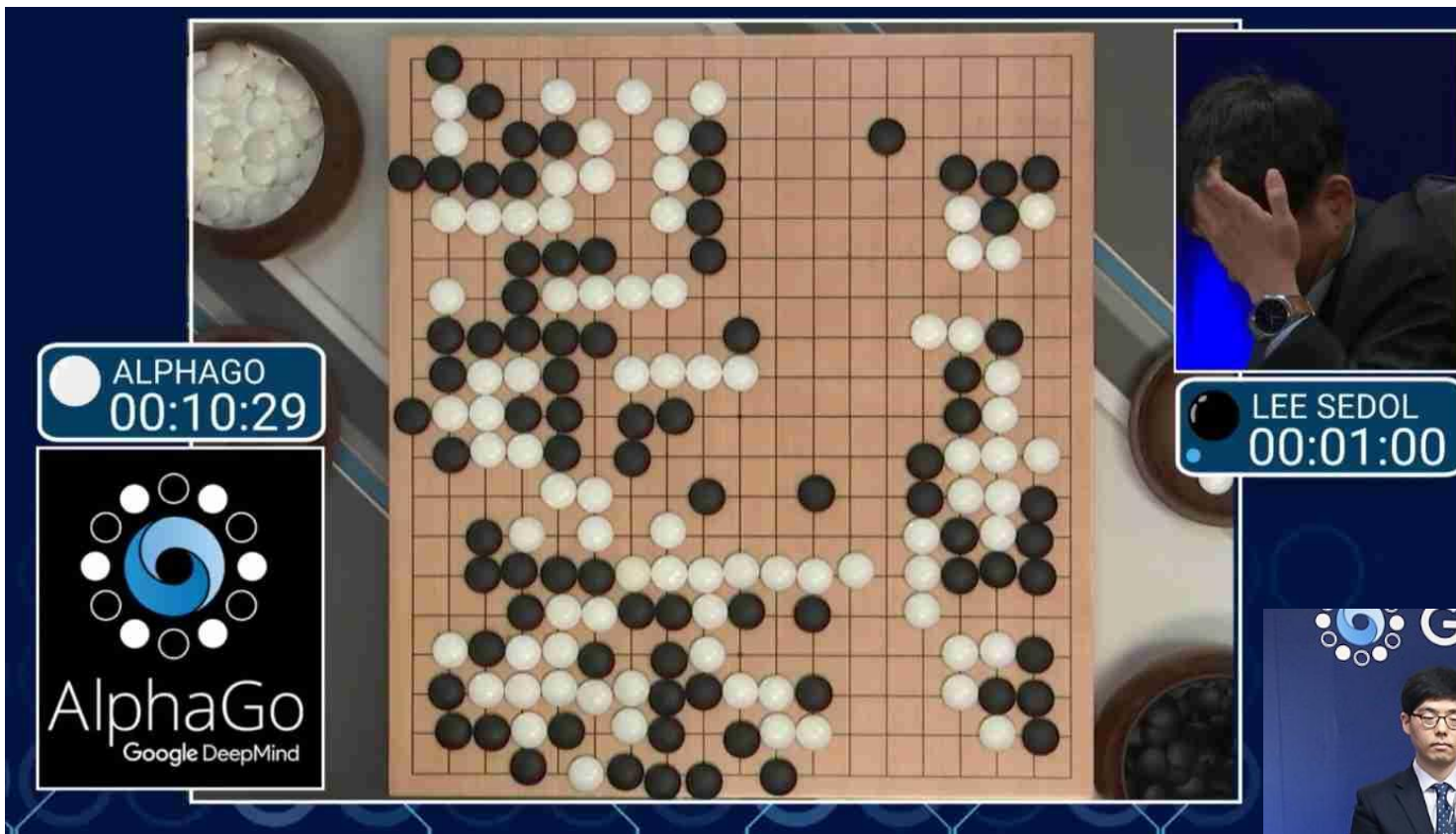
# It's all about Sharing Data & Information in Acquisition

- **Within Projects**
- **Across Projects**
- **Over Time**



**What about Gaming?**

# Board Games and AI



AlphaGo (2016)



# “AlphaGo Zero” (Oct 2017)

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



# AI Learning in Games/Simulation

## Google DeepMind's Deep Q-learning

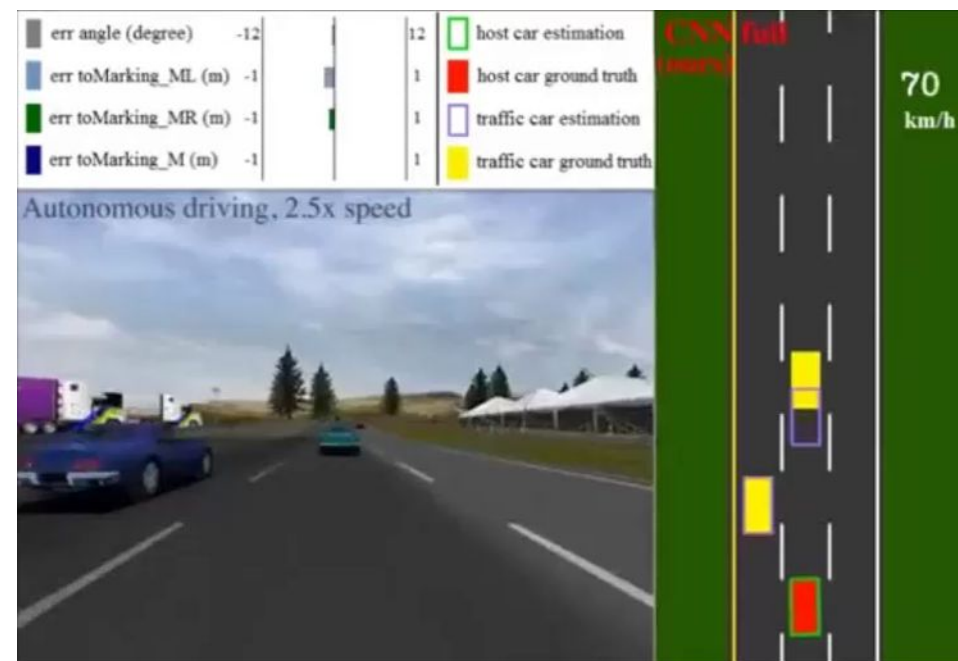
The algorithm will play Atari breakout.

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)



# 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



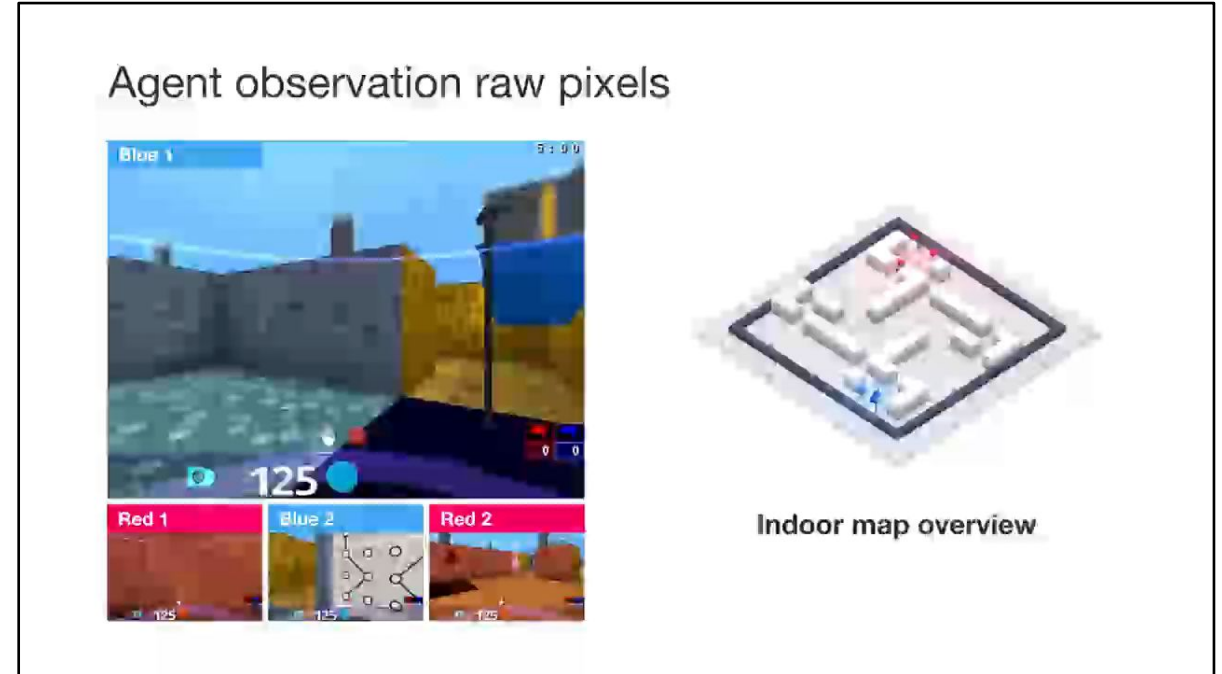
A screenshot of Starcraft II, a real-time strategy game where players control human or alien armies. | Image: Blizzard

# 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

# Quake III Arena's Capture the Flag and Deepmind's AI (2018)



- In a tournament randomly mixing AI agents with 40 human players, the agents quickly learned to exceed the win rate of human counterparts
- Human players rated the agents as more collaborative teammates than other humans





## Machine Learning Agents



# Unity Games Engine Machine Learning Agents *AI Training*



## Machine Learning Agents

Simultaneous Training Demo

Imitation learning



# AI & Games Hardware Technology Synergies

Tom's Guide / Tom's Hardware / Laptop Mag / TopTenReviews / AnandTech / shopsavvy

tom's **HARDWARE** PRODUCT REVIEWS BUYING GUIDES HOW TO DEALS NEWS FORUM LOGIN

GRAPHICS > FEATURE

## Nvidia's Turing Architecture Explored: Inside the GeForce RTX 2080

25 COMMENTS

by Chris Angelini September 14, 2018 at 6:00 AM

Page 14: Ray Tracing And AI: Betting It All on Black

### Ray Tracing And AI: Betting It All on Black

Nvidia could have poured *all* of its efforts into features that make Turing faster than the Pascal architecture in today's games, rather than splitting attention between immediate speed-ups and investments in the future. But the company saw an opportunity to drive innovation and took a calculated risk. And why not? Its performance and efficiency lead over AMD's Vega RX series creates a comfortable margin to push next-gen technology more than we've seen in years.



# Fortnite Battle Royale



- Online video game released Mar 17
- As of July 2018, the game had seen over 125 million players and estimated to have earned more than US\$1 billion in microtransactions
- The goal is to be the last player alive out of 100 by eliminating or avoiding other players
- Nearly all objects in the game can be harvested for materials (e.g. wood), to build fortifications, such as walls and ramps, which can be used for protection, to help move, or slow down progression of other players
- In Fortnite, players have the option to spend money on in-game currency, called “V bucks,” which can be used to make in-game purchases. The currency is used to purchase cosmetic skins, dances, and pre-released game modes for their characters, which range from 200 to 2,000 V-bucks (\$2 to \$20) (but which do not affect game play). Average spend \$84.67 each player.
- Game refreshed through “Seasons” (now no 7)

# Fortnite Battle Royale



# Fortnite Cloud Hosting



- Epic Games exploits Amazon Web Services (AWS)
- Fortnite servers around the world to reduce ping
- 8.3m Concurrent Players
- Each month Epic deals with two petabytes of data

## Analytics pipeline stats

### REAL-TIME INGESTION

92M events/minute

~54B events/day

40GB/minute of data at peak

5,000 Kinesis shards

### DATA WAREHOUSE

14 petabytes

~2PB monthly growth rate

### MANAGED CLUSTERS

~8.3K batch ETL jobs/day

22 EMR clusters in prod

4K EC2 analytics instances



# Fortnite Battle Royale – “Cross Platform Play”

- The ability of an online video game to allow players using different video game hardware to play with each other simultaneously
- Games typically designed to be deployed on different platforms and gaming network protocols considered



# Still Some Way to Go



Tom Clancy's Rainbow Six: Vegas

# A More Autonomous Future?

# Queen Bee Drone – 1930s/40s



nearly 400 built

# Nothing New in the World?



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



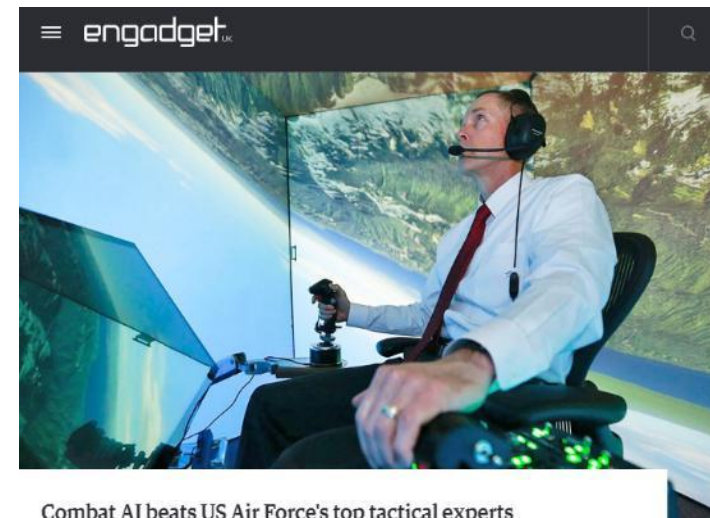
**Radio Controlled "Queen Bee"  
(1936)**

# Military Autonomous Systems



**US Navy  
X-47B**

**US 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 Army  
Manned-Un  
manned  
Teaming  
(MUM-T)**

**US Navy  
Autonomous  
Craft**



# Military AI

## IT and Networks

### DARPA's new \$2 billion initiative for next-level AI

By: Mike Gruss September 9



DARPA leaders hope a new initiative focus on artificial intelligence could help improve day-to-day processes within the Department of Defense. (U.S. Air Force photo by Staff Sgt. Alexander Riedel)

ACQUISITION, CONGRESS, INTEL & CYBER, STRATEGY & POLICY

### Joint Artificial Intelligence Center Created Under DoD CIO

"The major challenge for the US is China," CNA analyst Larry Lewis said. "They are approaching the use of AI just like the US approached going to the moon in the sixties."

By SYDNEY J. FREEDBERG JR.

on June 29, 2018 at 1:37 PM

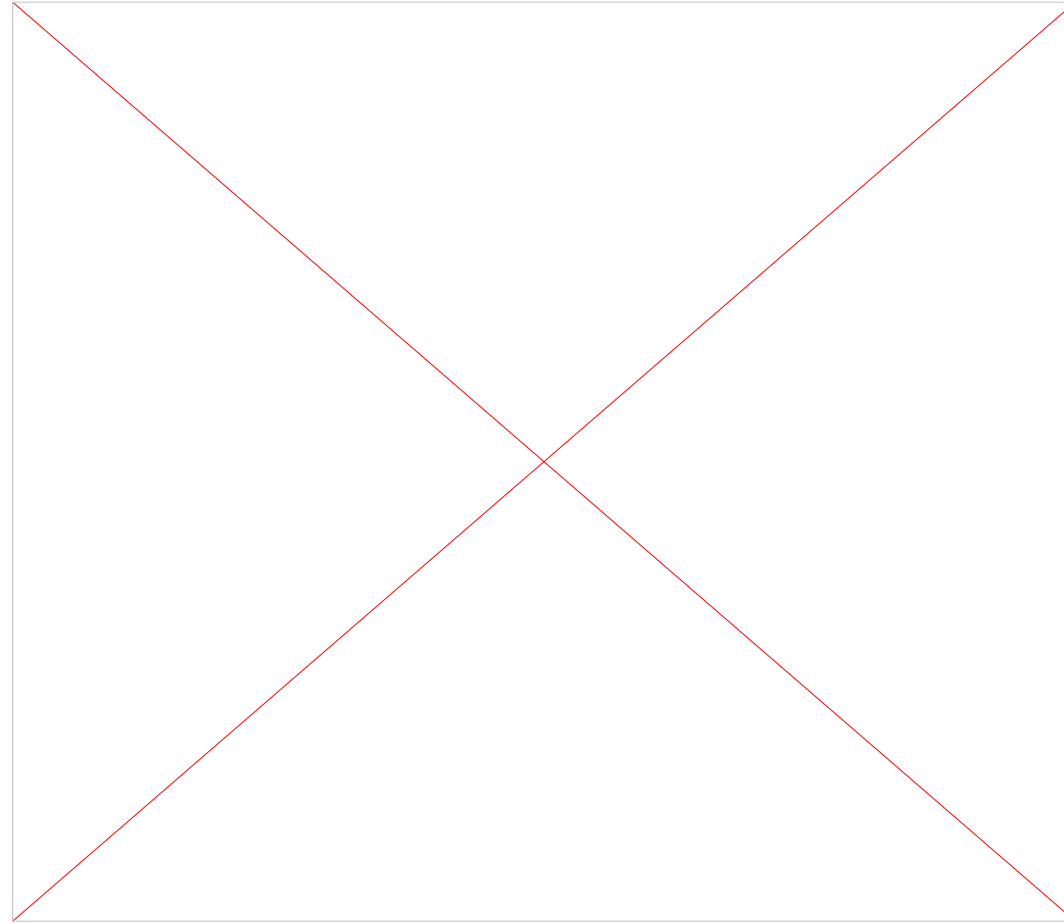
17 Comments

115  
SHARES



# Current AI R&D Investment

Military

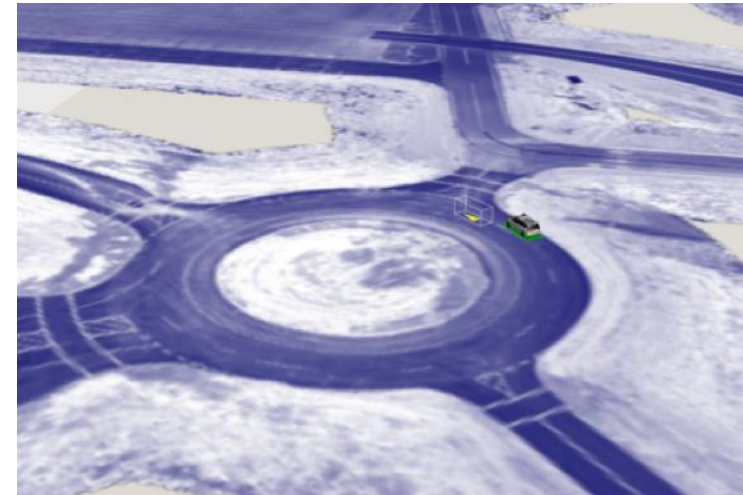


Civilian

# 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 and some Nations?*
- 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 and Privacy
- Ethical Considerations

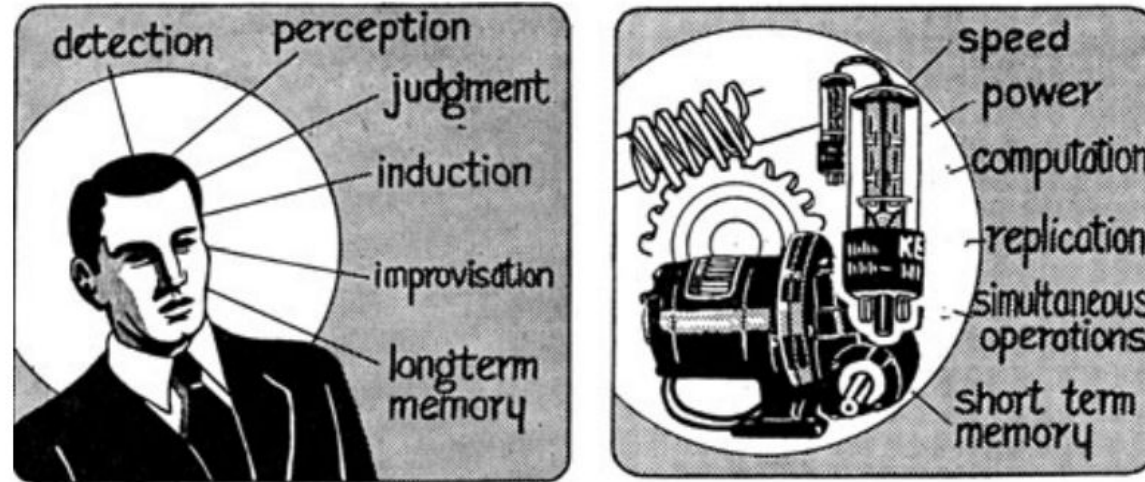
# Data Misjudgements



Google Street View

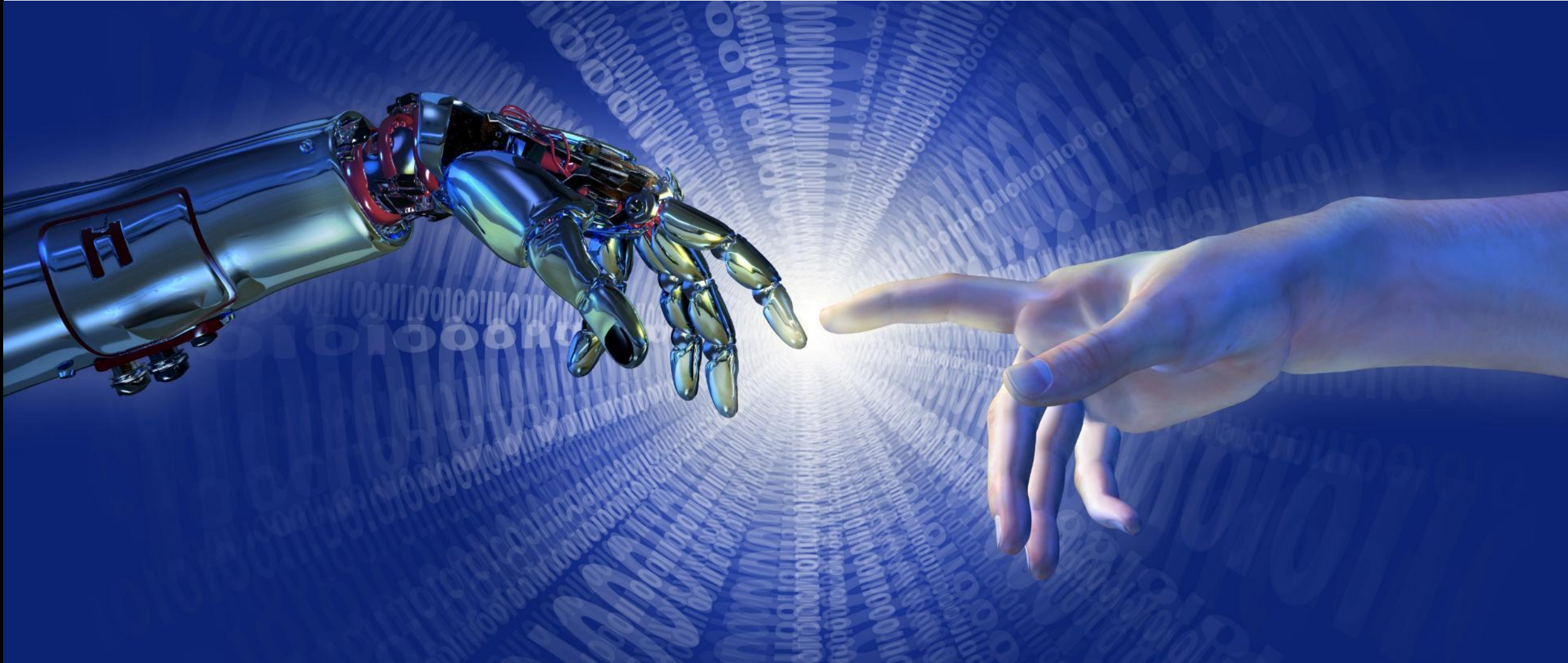
# Paul M Fitts (ed) (1951)

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



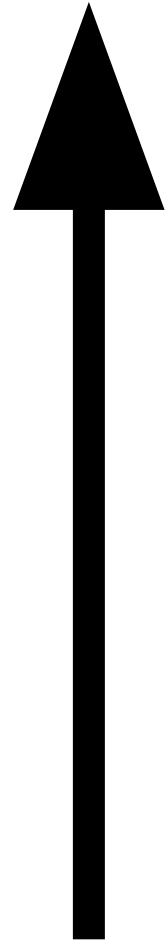
- **We suggest that great caution be exercised in assuming that men can successfully monitor complex automatic machines and take over if the machines break down.**
- **Engineers should seriously consider systems in which machines would monitor men and prevent them from making dangerous mistakes.**

# Seek the Optimum Human/Machine Blend



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

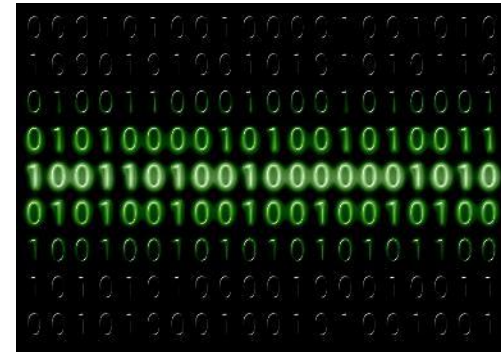
# Operational Adaptability



**People**



**Digital**



**Metal**

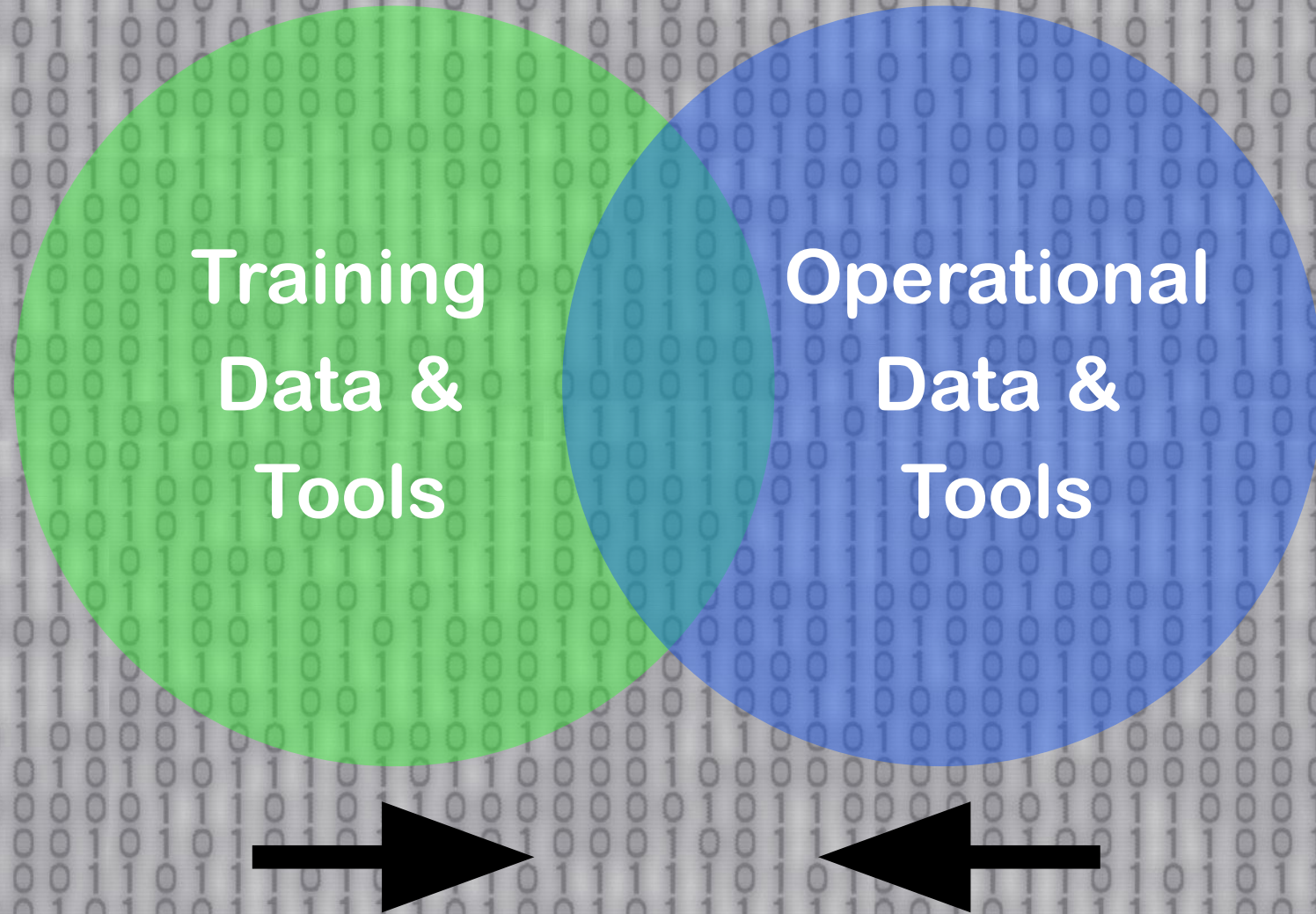


**The Human Component  
of Warfare may change,  
but it will always be  
there, and we need to  
provide relevant, timely  
and cost effective  
training and education**



**Logic, Adaptability  
& Imagination**

# Convergence...



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Questions?