

# Ready and Adaptable

## Training and Simulation for Submarines and Submersibles

Andy Fawkes

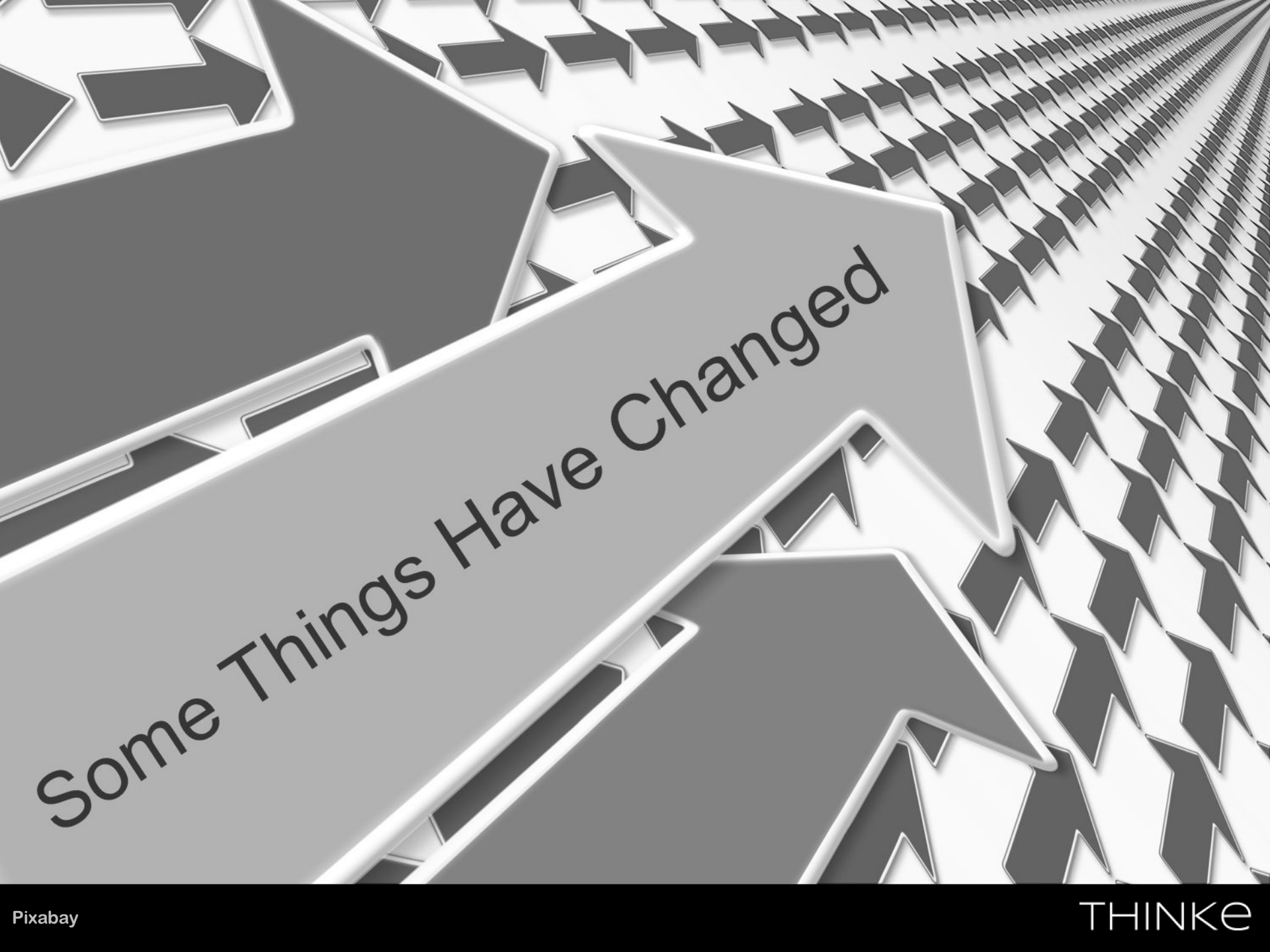
# My Background

**Submarines**

**Simulation**

**Ministry of Defence**

**Industry**



Some Things Have Changed



# Submarines in the News

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Tuesday, Apr 25th 2017 1PM 8°C  4PM 8°C  5-Day Forecast

# MailOnline

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## Russia to send the world's largest submarine to the Baltic: Monster sub armed with 20 nuclear missiles to sail into NATO's 'swimming pool' as Putin flexes his muscles

- Massive Typhoon-class sub Dmitry Donskoy is to leave the White Sea and travel around Norway and Denmark
- Measuring an enormous 574-foot in length the Russian vessel it is one of the most feared of the Cold War era
- The beast set to serve as a chilling reminder to the rest of the world about Russia's growing nuclear prowess
- Submarine can stay submerged for 120 days with a crew of 160 on board and is fitted with six torpedo tubes

By [GARETH DAVIES FOR MAILONLINE](#)

**PUBLISHED:** 16:28, 6 April 2017 | **UPDATED:** 18:19, 6 April 2017



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# Submarines in the News

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## Is Kim Jong-un planning to use submarines to launch nuclear attack? How 50 North Korean subs 'went missing' sparking panic in Seoul and Tokyo

- Fears Kim Jong-un is adapting fleet of subs so they can launch nuclear missiles
- It comes two years after 50 North Korean submarines 'went off the radar'
- Pyongyang is marking biggest national day called 'Day of the Sun' on Saturday

By [JULIAN ROBINSON FOR MAILONLINE](#)

**PUBLISHED:** 10:51, 13 April 2017 | **UPDATED:** 11:57, 13 April 2017



# Submarines in the News



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## China is building the world's largest nuclear submarine facility

It can build four subs at a time.

By Jeffrey Lin and P.W. Singer April 19, 2017



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# Protracted Procurement...

## The Telegraph

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### BAE hands new nuclear submarine to the Royal Navy – four years late

When the Navy gets its hands on the first new class of submarine launched for 17 years, it is sure to be a quiet affair.

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By Amy Wilson

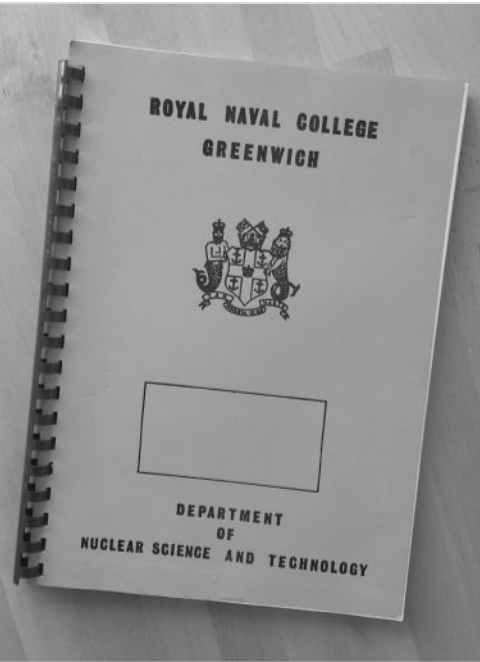
11:33PM GMT 15 Nov 2009

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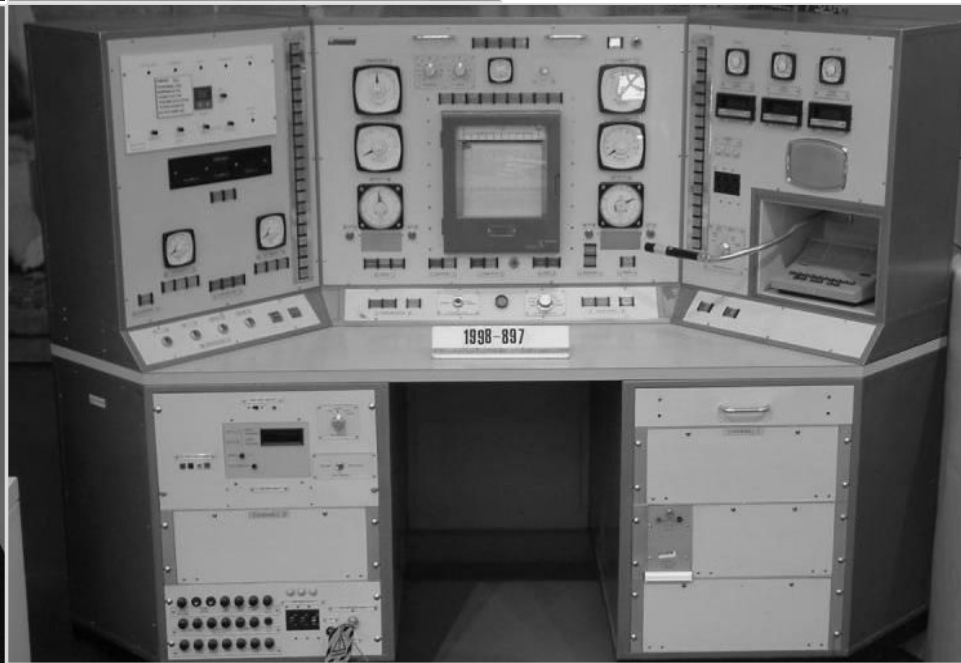


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# 1990s Teaching Aids



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# 30 Years of Game Graphics



News story

# Female submariners make history

From: [Ministry of Defence](#) and [The Rt Hon Philip Hammond MP](#)

First published: 5 May 2014

Three women have become the first females to serve in the Royal Navy Submarine Service.



Left to right: Lieutenants Maxine Stiles, Alex Olsson and Penny Thackray

Pioneering lieutenants Maxine Stiles, Alex Olsson and Penny Thackray have become the first women to serve on a submarine in the 110 years of the 'Silent Service'.

Following months of specialised training, the 3 women have each earned their 'dolphins' badge; the hard-won and much-prized symbol of a submariner.

Defence Secretary Philip Hammond said:

“ I am delighted to be able to congratulate our first ever female submariners and wish them all the best in their future careers.



# Changing Demographics

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Television  
Shortcuts

## A dying habit: why the average BBC1 viewer is 61

Broadcasters may be desperate for younger audiences but older telly-watchers dominate - the average ITV fan is 60, 55 if they prefer Channel 4. How worried should programme-makers be?



476 709

Simon Osborne

Wednesday 29 March 2017 17:38 BST



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

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# Humans not Required?

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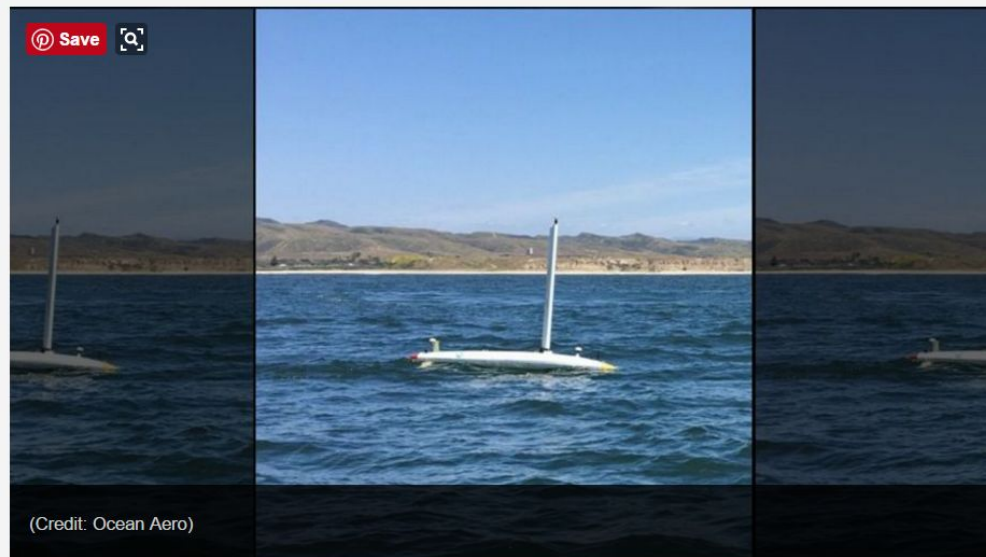
TECH HOME COMPUTERS GOOGLE VIDEO GAMES MILITARY TECH WAR GAMES SLIDESHOWS

US ARMY

## Drone sailboat transforms into spy sub

By Allison Barrie · Published April 21, 2017 · FoxNews.com

f t g e p



Robots

# Robots to replace 1 in 3 UK jobs over next 20 years, warns IPPR

Study calls for billions to fund retraining after pinpointing hospitality, retail, transport and manufacturing sectors and poorest parts of UK as most at risk



Automated production at the Jaguar Land Rover factory in Solihull, England. Photograph: Leon Neal/Getty Images

A leading thinktank has urged the government to spend billions of pounds helping poorly skilled workers in the less prosperous parts of the UK cope with the threat of the looming robot revolution.

The left-leaning Institute for Public Policy Research (IPPR) said in a new report that those most at risk from automation were concentrated in low-skill sectors of



1,614 1,011

Larry Elliott

Saturday 15 April 2017 08.01 BST



Some Things  
Remain the  
Same

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





# all in the same boat



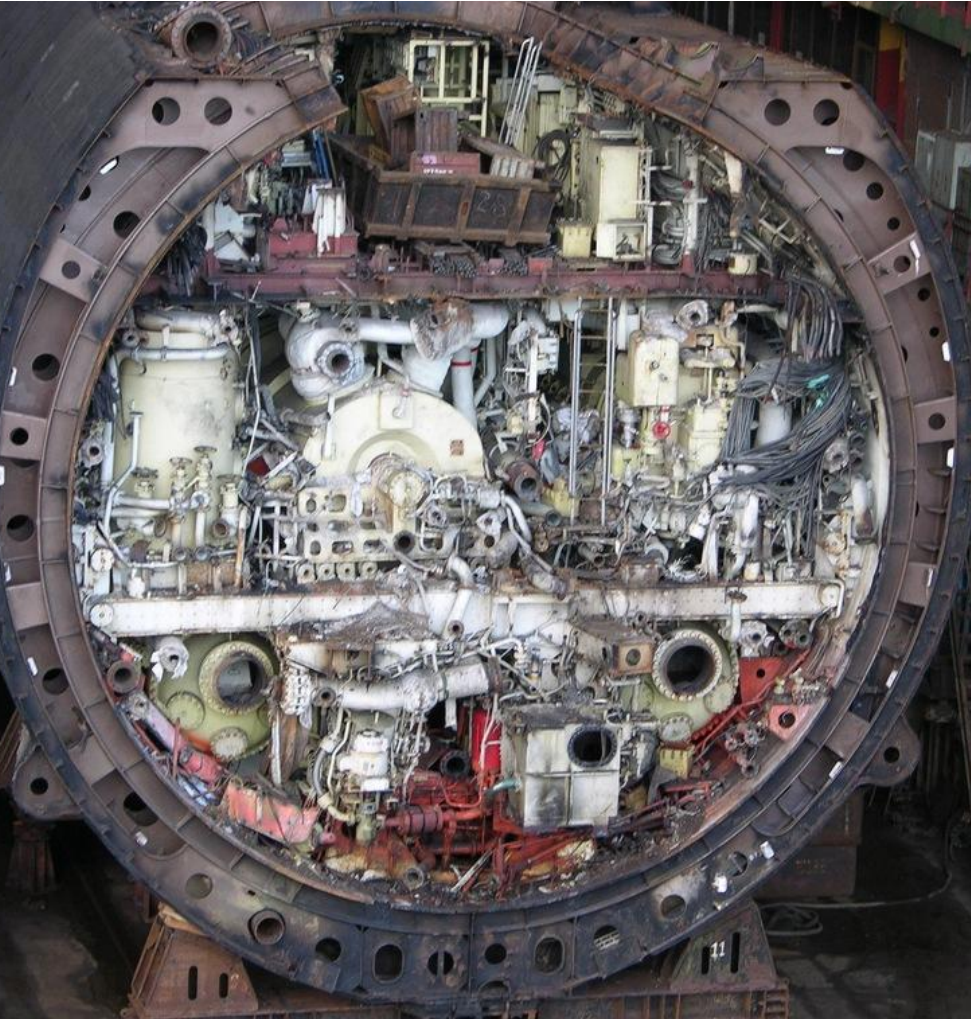


# Team Working





# Fixed



# Flexible





# Unresolved Issues...





# Human Factors/Training Last in the Queue in Defence Procurement?



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# Talk Outline



# Will Consider...

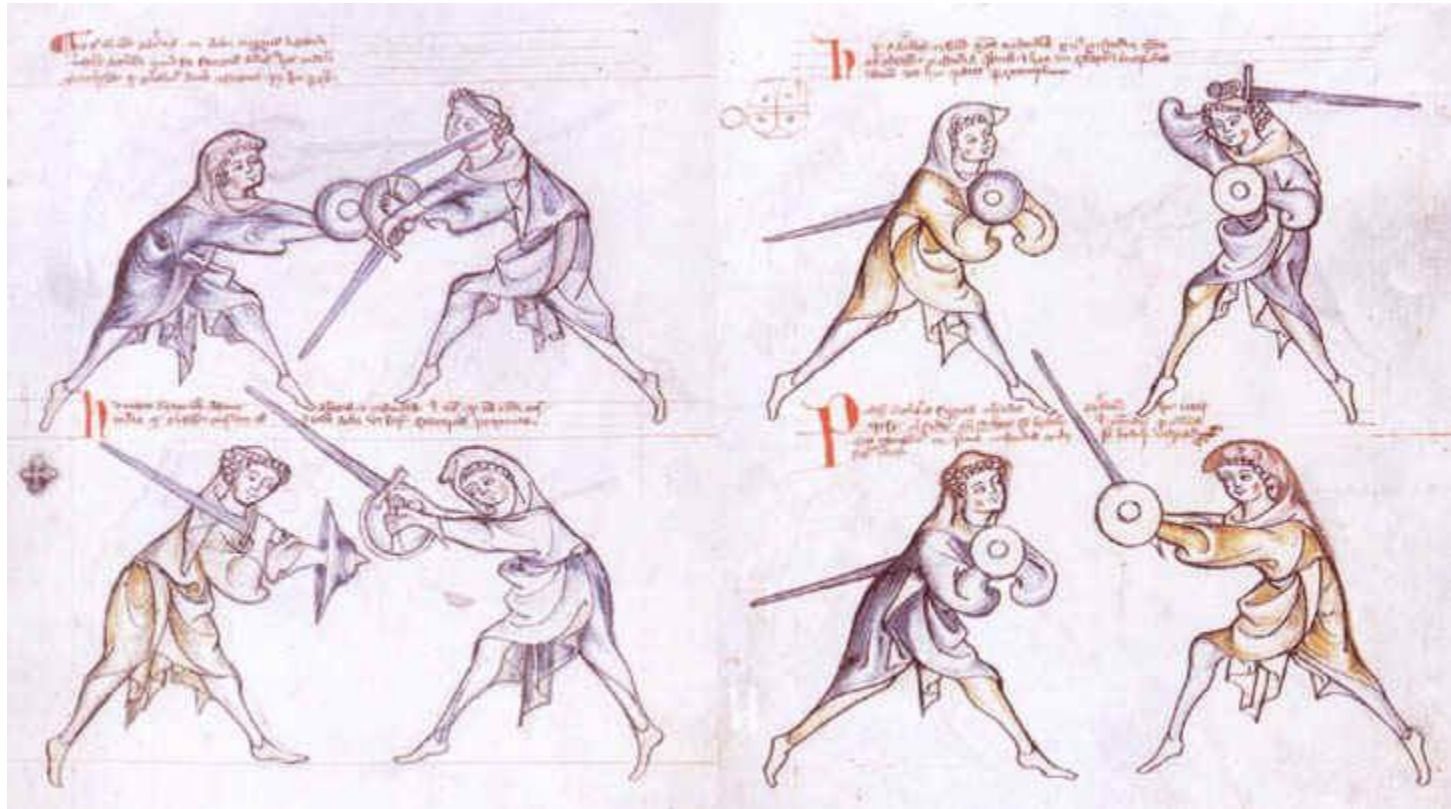
- **A Little History**
- **Simulation for Submarines?**
- **Other Training Technologies**
- **Will Humans be Redundant?**
- **Training and Procurement**

# A Little History



# Oldest Surviving Training Media

## 13th Century German Sword & Buckler Manual



# 1904 – Royal Navy Portsmouth



A MEETING OF THE PORTSMOUTH NAVAL WAR GAME SOCIETY IN THE NELSON ROOM AT THE "GEORGE," PORTSMOUTH.

*The Naval War Game and How it is Played.*

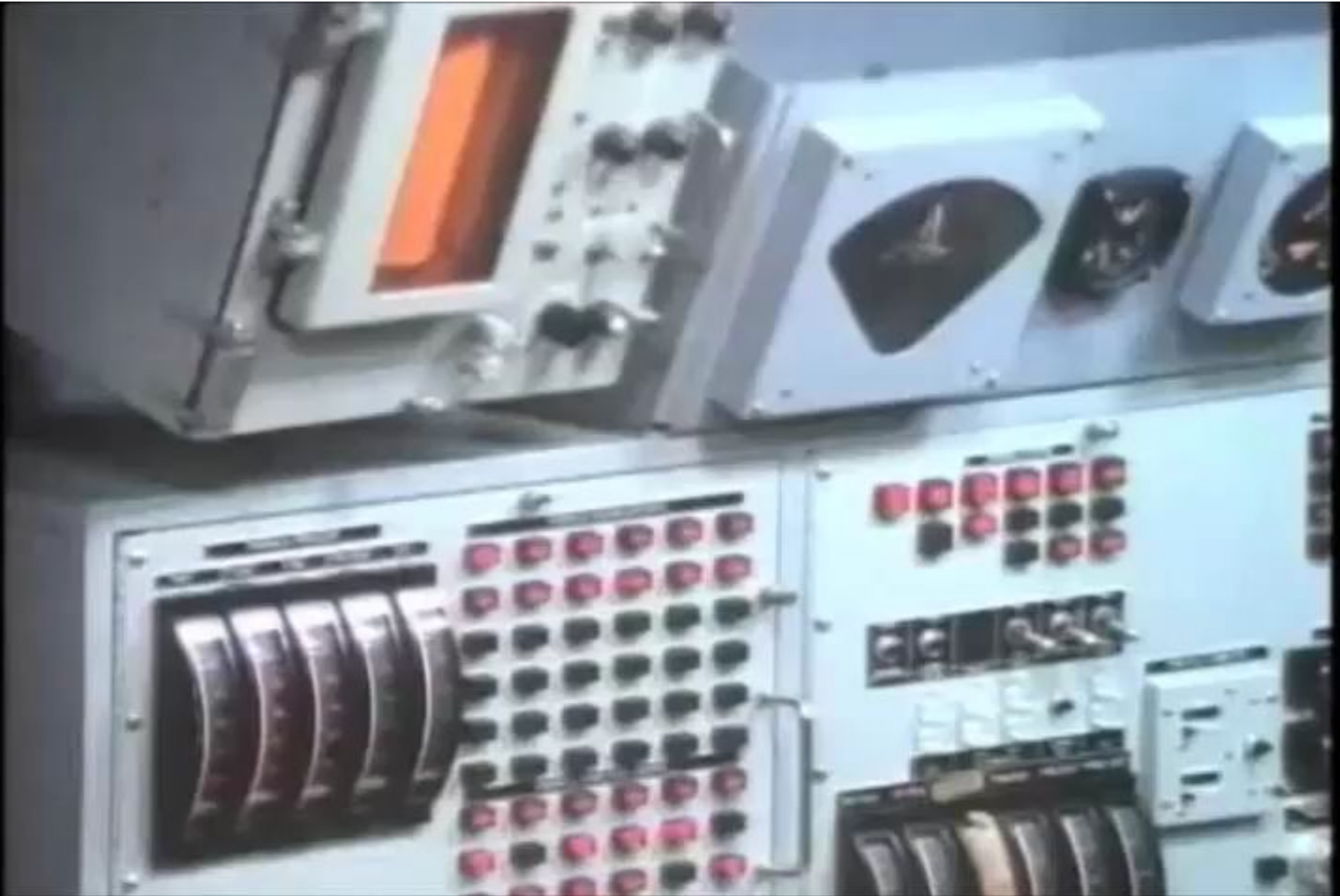




# Naval Flight Simulation (1970s)



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



# Key Points

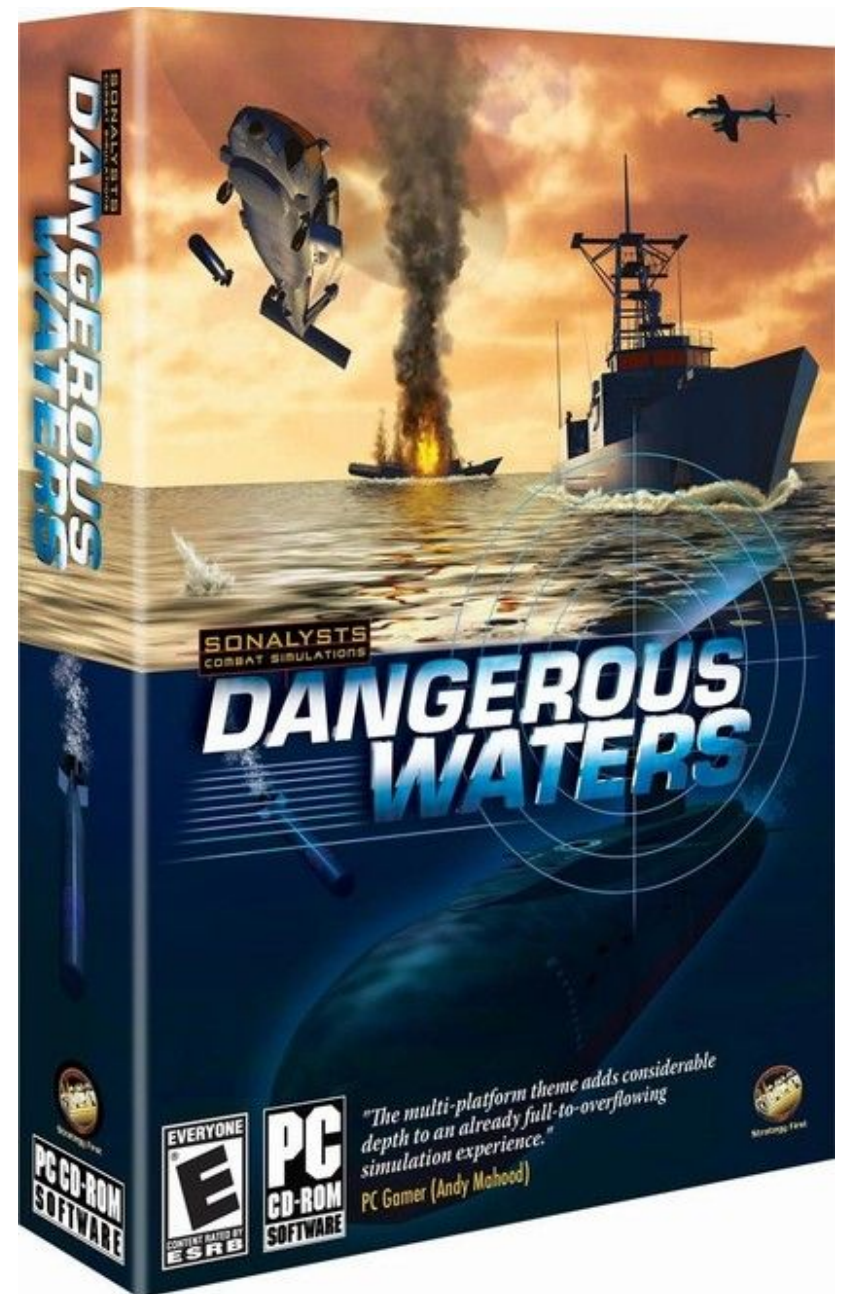
- **Central Role of Instructor**
- **Clear Training Objectives**
- **Physical Fidelity of Simulator**
- **Importance of Simulator Motion(?)**



# 1990 - US Navy Battle Force In-Port Training (BFIT)



# Computer Games! (2005)



# Computer Games in Training - 2008





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## Royal Navy use PlayStations to train sailors

The Royal Navy has begun a programme to issue hand-held PlayStation computer consoles to sailors so they can study for tests in confined quarters.



Marine warfare engineering technicians were the first to receive the devices, and if proved useful they will be distributed around other personnel. Photo: GETTY

7:16AM GMT 27 Nov 2009

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**In Politics**

# Digital Media Consumption



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# Maritime & Beyond - Simulation Now





# UK Type 45 Destroyer High-Detail Model (300 Compartments)



# Command: Modern Air/Naval Operations



# Simulation for Submarines?



# Training Requirement

**Better**



**Faster**



**Cheaper**



# loose definitions

- **Simulation**
  - Live – People in Instrumented Real World
  - Virtual – People in a Virtual World
  - Constructive – Simulated People and World
- **Virtual Reality**
  - immersive multimedia through a computer-simulated environment
- **Augmented Reality**
  - real-world augmented by computer-generated sensory input
- **Mixed Reality**
  - merging of real and virtual worlds

# Live Simulation

## People in Instrumented Real World





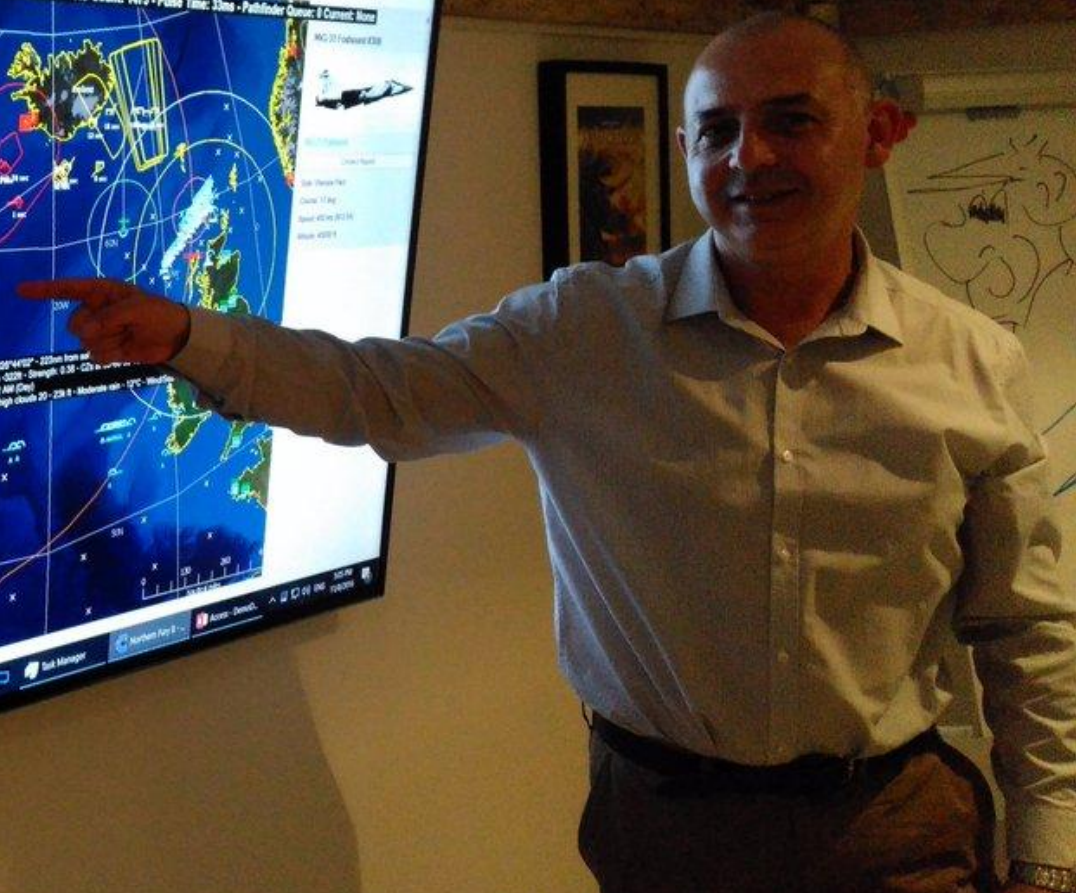
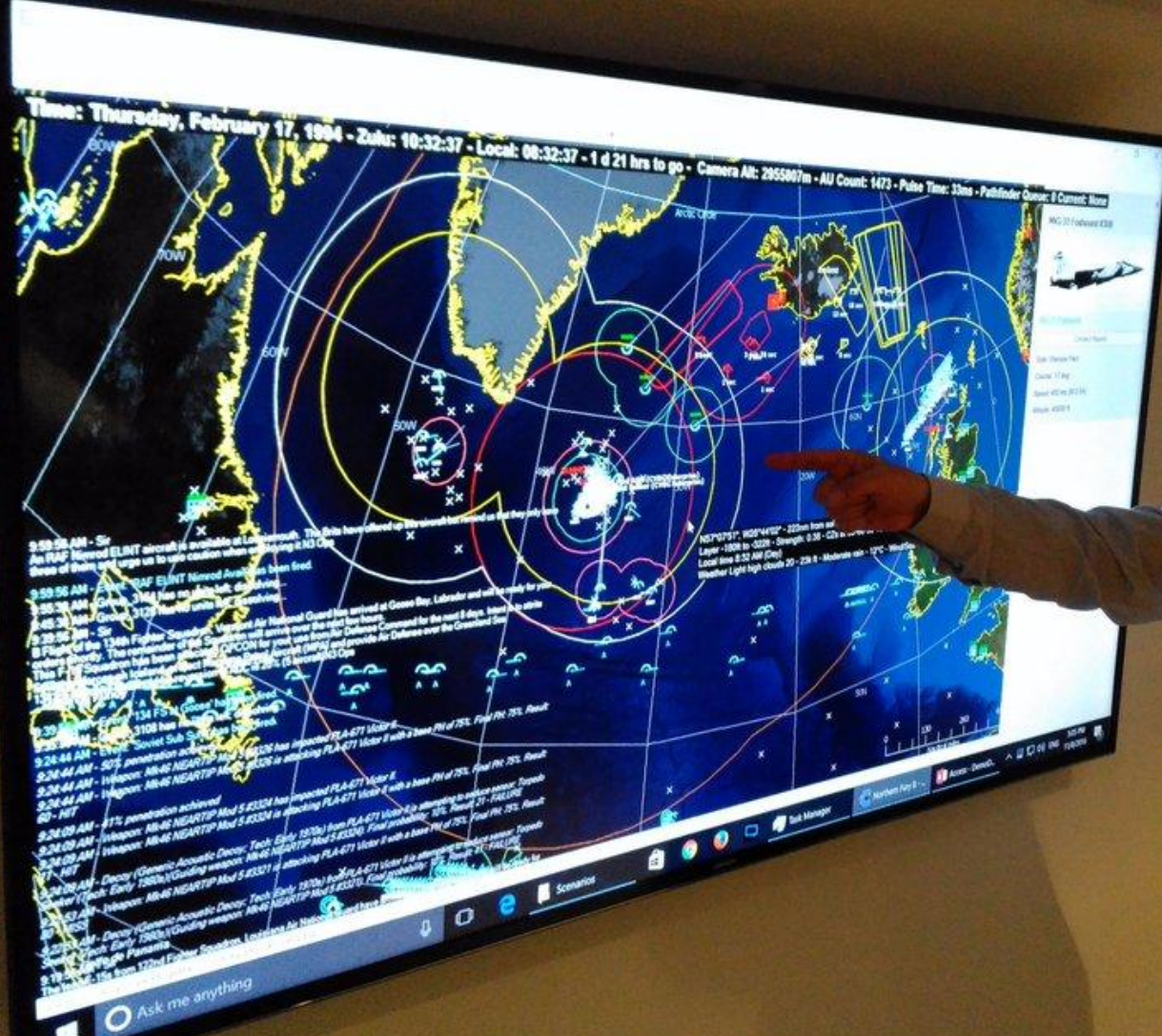
# Virtual Simulation

## People in a Virtual World





# Constructive Simulation Simulated People and World





# Live-Virtual-Constructive Simulation





# Simulation is Safer



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# Saves Money





# and...

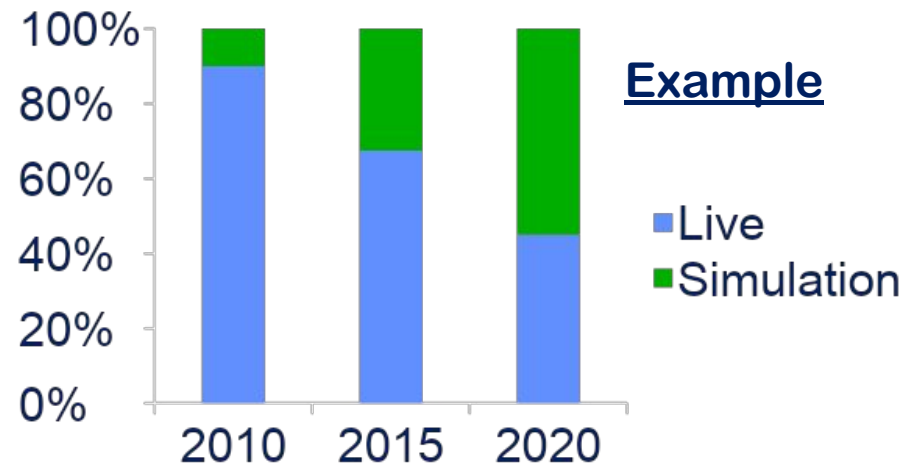
- **Not affected by the Weather**
- **Less effect on the Environment**
- **Real Systems not Required**





# 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



# RN Maritime Composite Training System



# RN Maritime Composite Training System

## *An Alternative View*

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## High and dry: Cost-cutting Royal Navy forced to train new recruits on VIRTUAL ships

- Veterans and existing staff to be 'deployed' in front of monitors at two new bases which cost £108million
- Simulators open after Navy is left with aircraft carriers but no aircraft
- 1,000 people per year to be trained in 'replica operations room' which features banks of LCD screens

By [ROB COOPER](#)

UPDATED: 13:33, 6 December 2011



# Submarines are Different?

**Training - Ashore v At Sea?**





# Sir Jock Stirrup

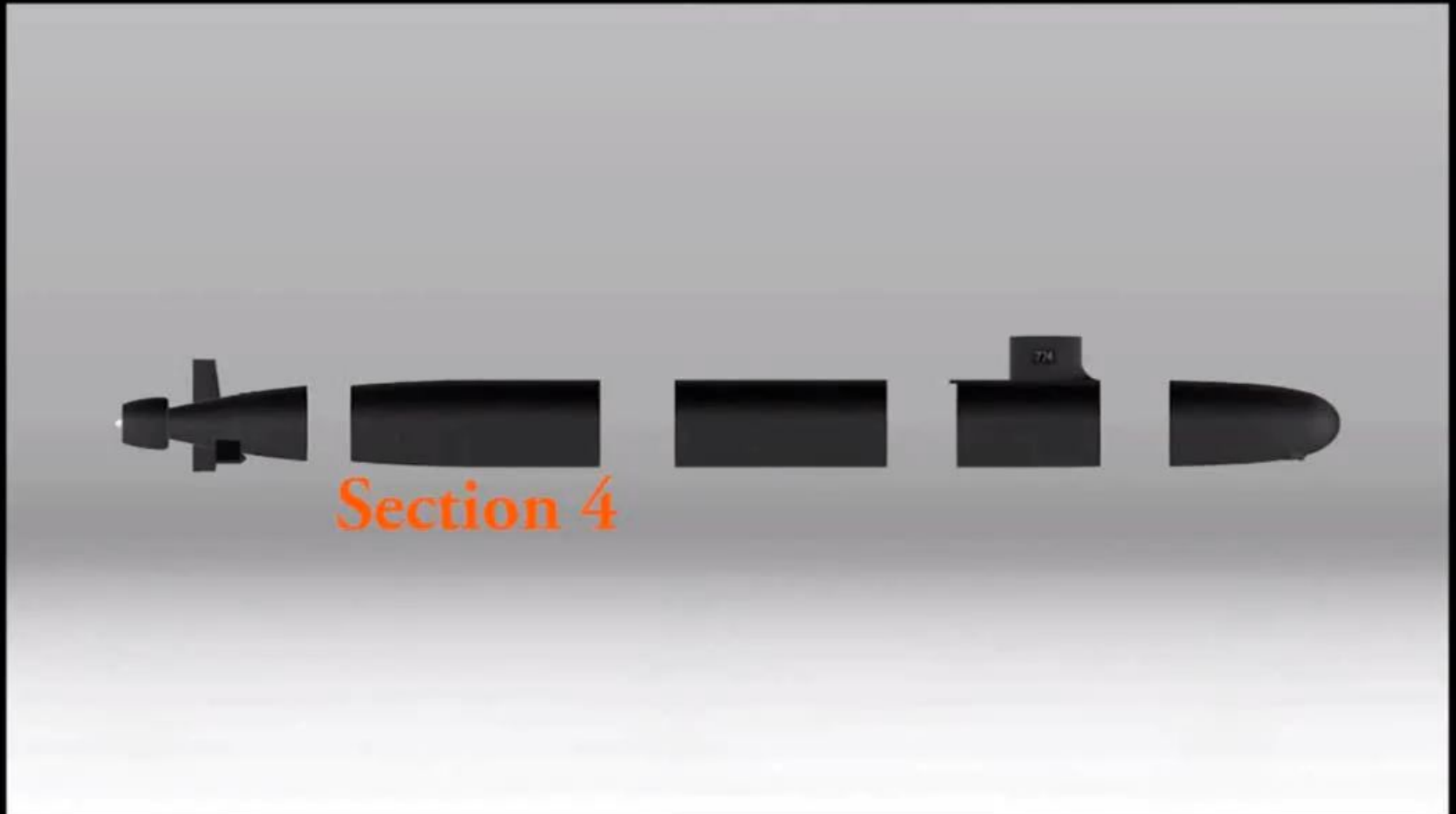
## Chief of Defence Staff

2007 RAeS Edwin Link Lecture

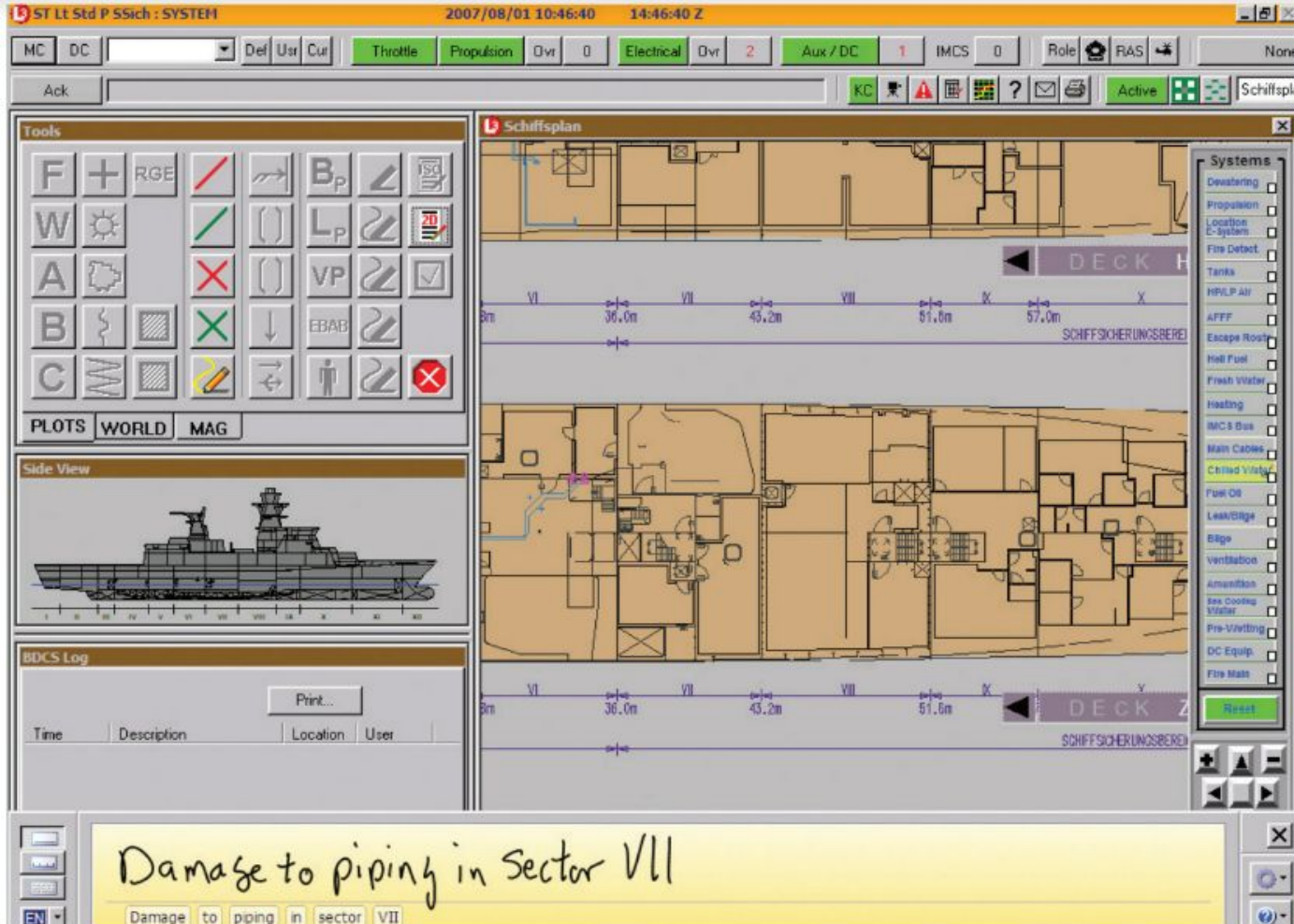
- “...the crew of a submarine when it is submerged in many ways are already operating in a virtual environment...”
- “...we can see emerging *the fuzing of* synthetic and real world environments *such* that would be it would it make increasingly difficult to distinguish between training carried out in simulation and the real thing.”



# US Navy Virginia Class Submarine Walkthrough







# Mixing New & Old

## INTERACTIVE KILL CARDS

As Royal Navy manpower levels continue to drop and ships are becoming bigger yet more lean-manned, personnel can often be expected to operate in unfamiliar

'Alerts', which the user must accept in order to progress to the data screen.

Using the green keyhole icon, the compartment schematic can be seen which will offer personnel a clear visual representation of the hazards they are

hoses required, hydrant positions, nearest EDBA set, pumping arrangements and fixed Fire Fighting systems. This can be further applied to allow for a whole ship approach enabling command and control elements to deal with incidents on a

# Virtual Simulation – Submarine Use Cases(?)

- Submarine 3D walkthroughs and procedural training
- Submarine System Visualisation
- Bridge and Periscope Navigation training
- Recognition trainer
- UUV/UAV/USV operations
- ASW/ASuW Tactics Visualisation
- Special forces deployment

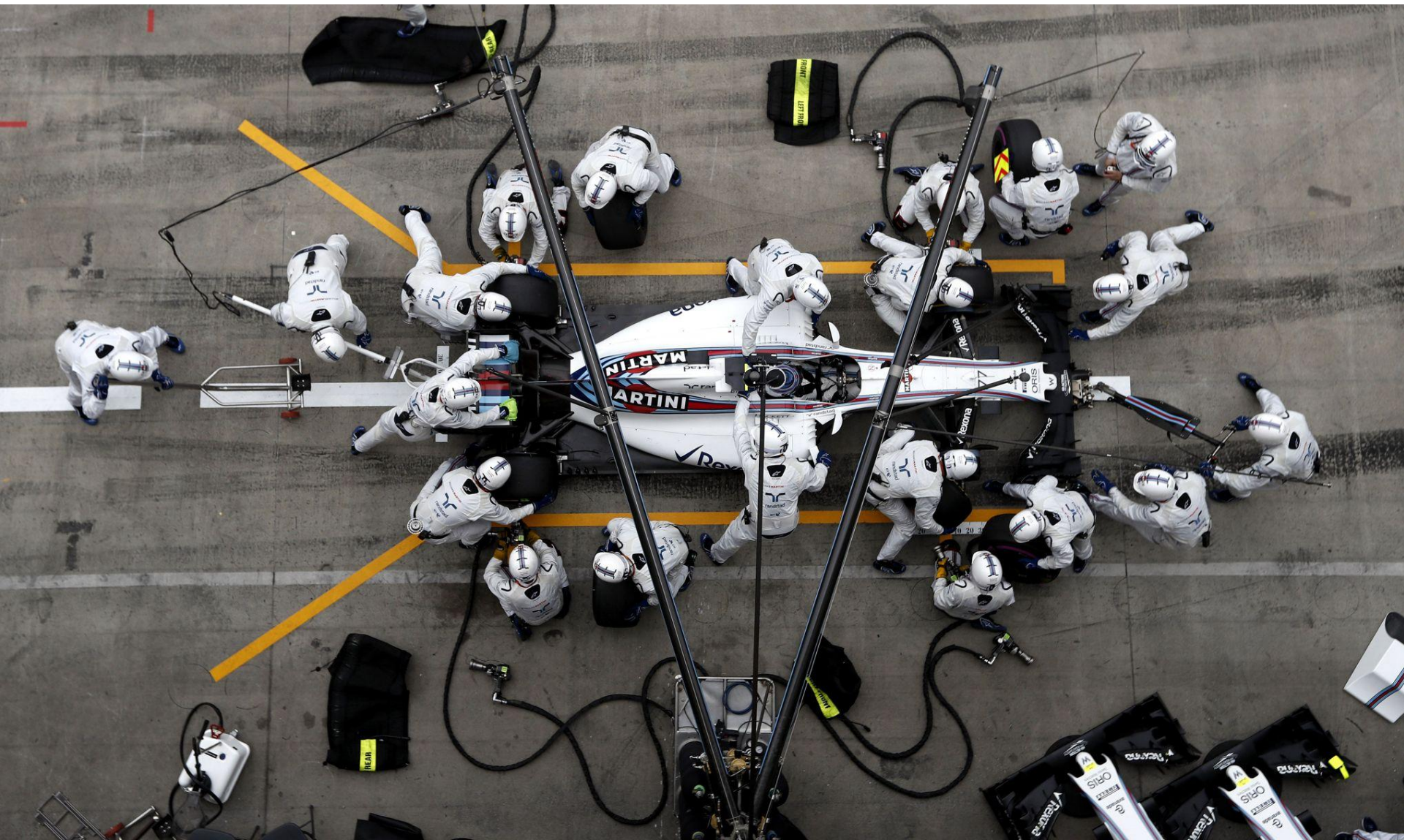
# Simulation in Submarine Procurement





# Other Training Technologies

# 1.92 Seconds



# Williams 2016





# Fire Fighting Simulator



# HOW TO DOWN 4 BEERS



# IN LESS THAN 12 SECONDS

# Seen It?

- If No...
  - humans can be convinced of seeing things they have not
- If Yes...
  - humans sometimes only need to see something once to learn

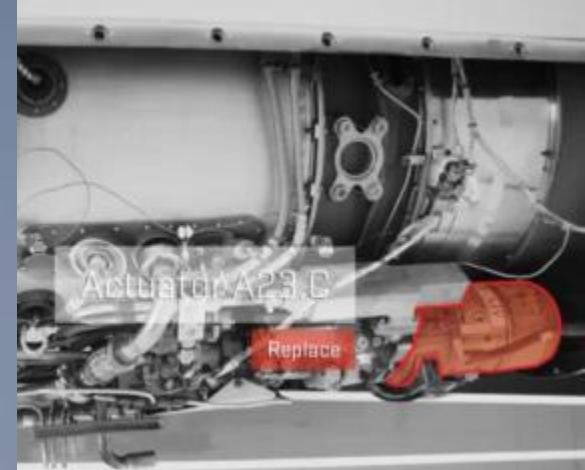


# Virtual Reality





Daqri Helmet



# Augmented Reality in the Workplace



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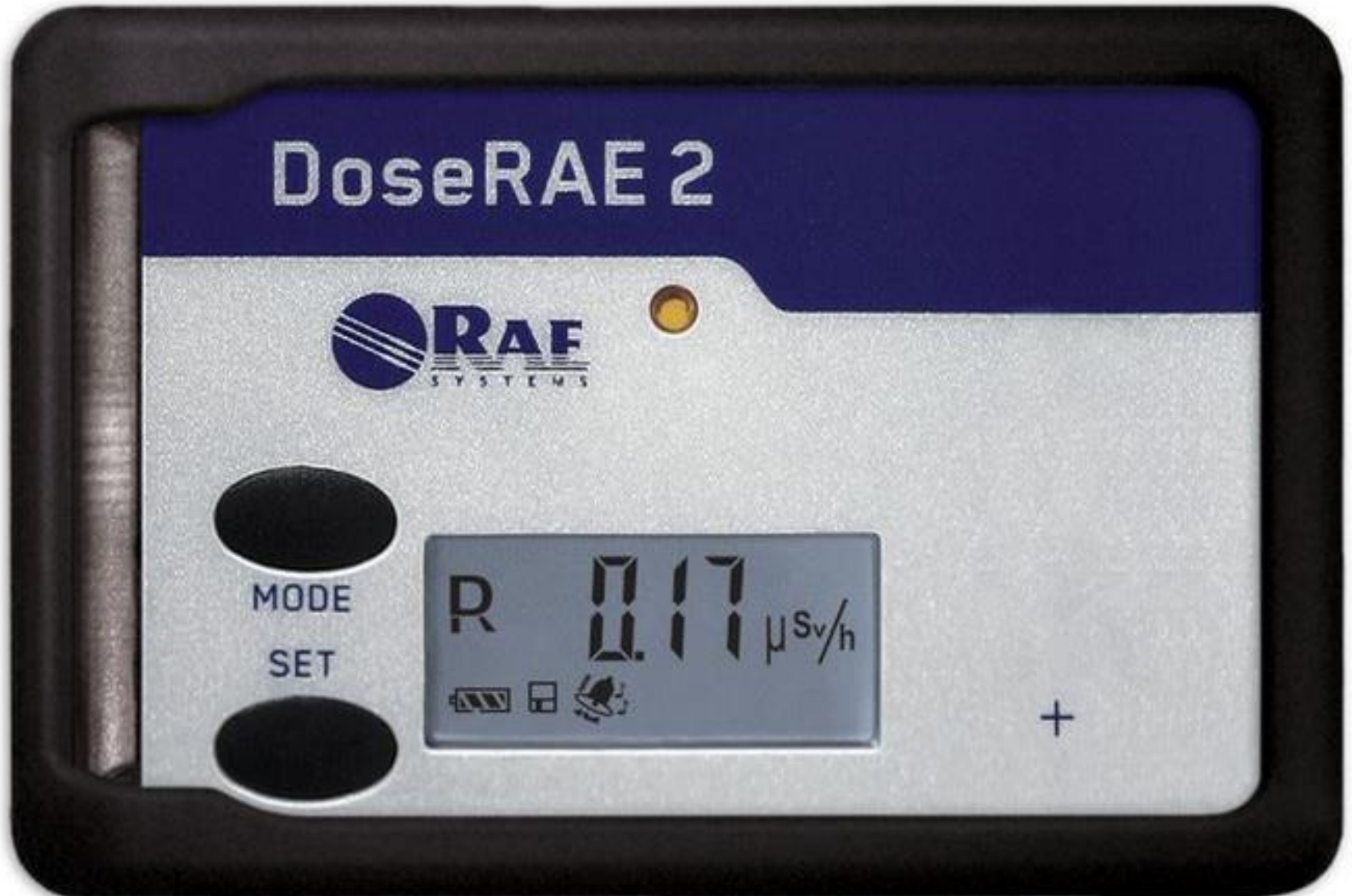
# Wearables



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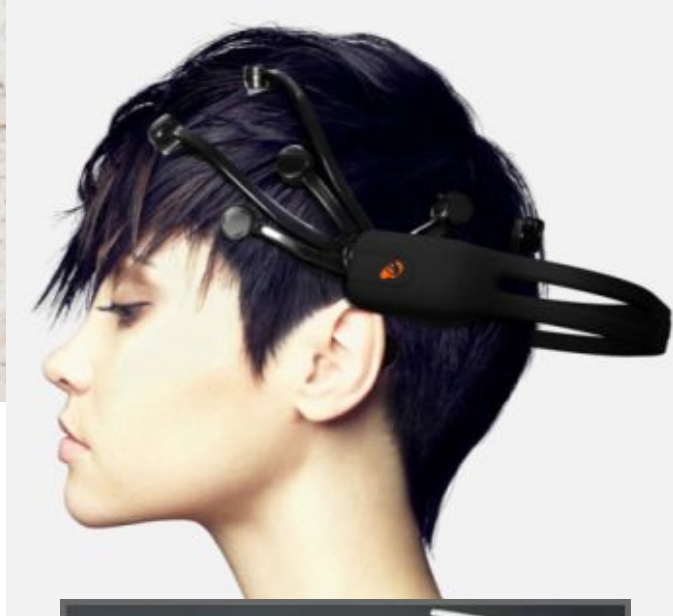


Not New



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# Quantified Human



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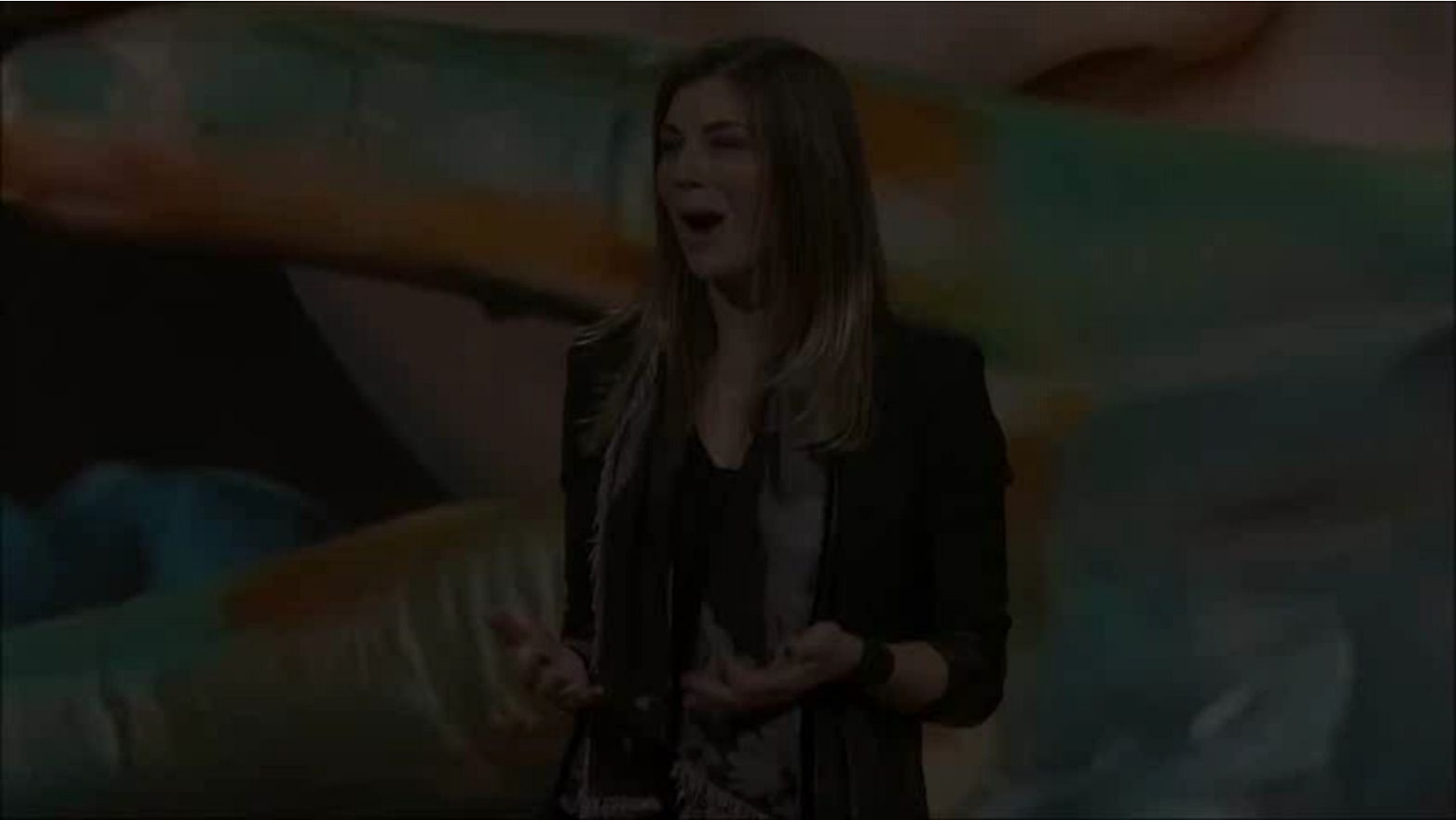
# Learning Focused - Analytics Drawing on Both Live and Simulated Training



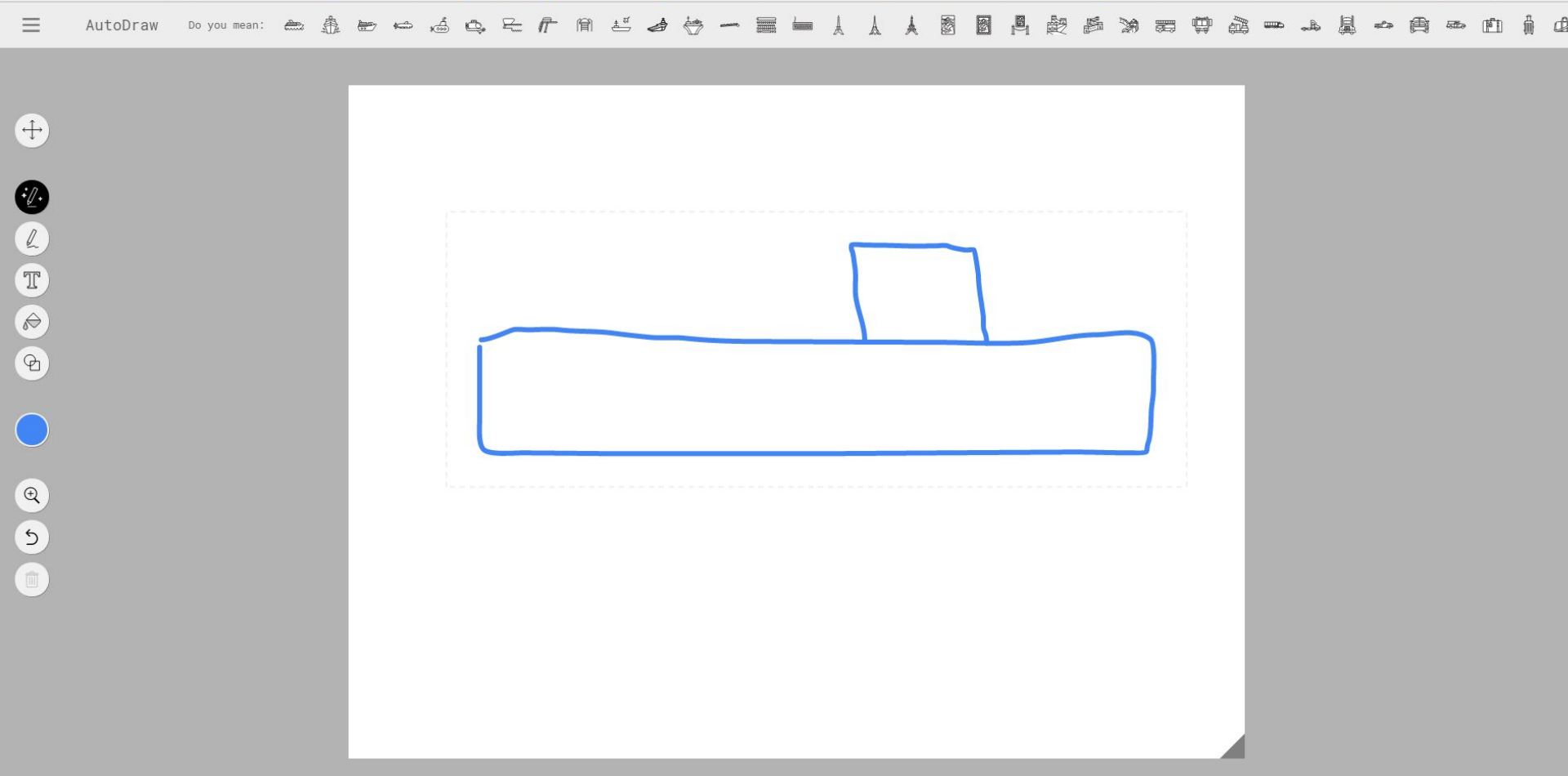
- **Descriptive**
  - What happened?
- **Diagnostic**
  - Why?
- **Predictive**
  - What will happen?
- **Prescriptive**
  - Make it happen



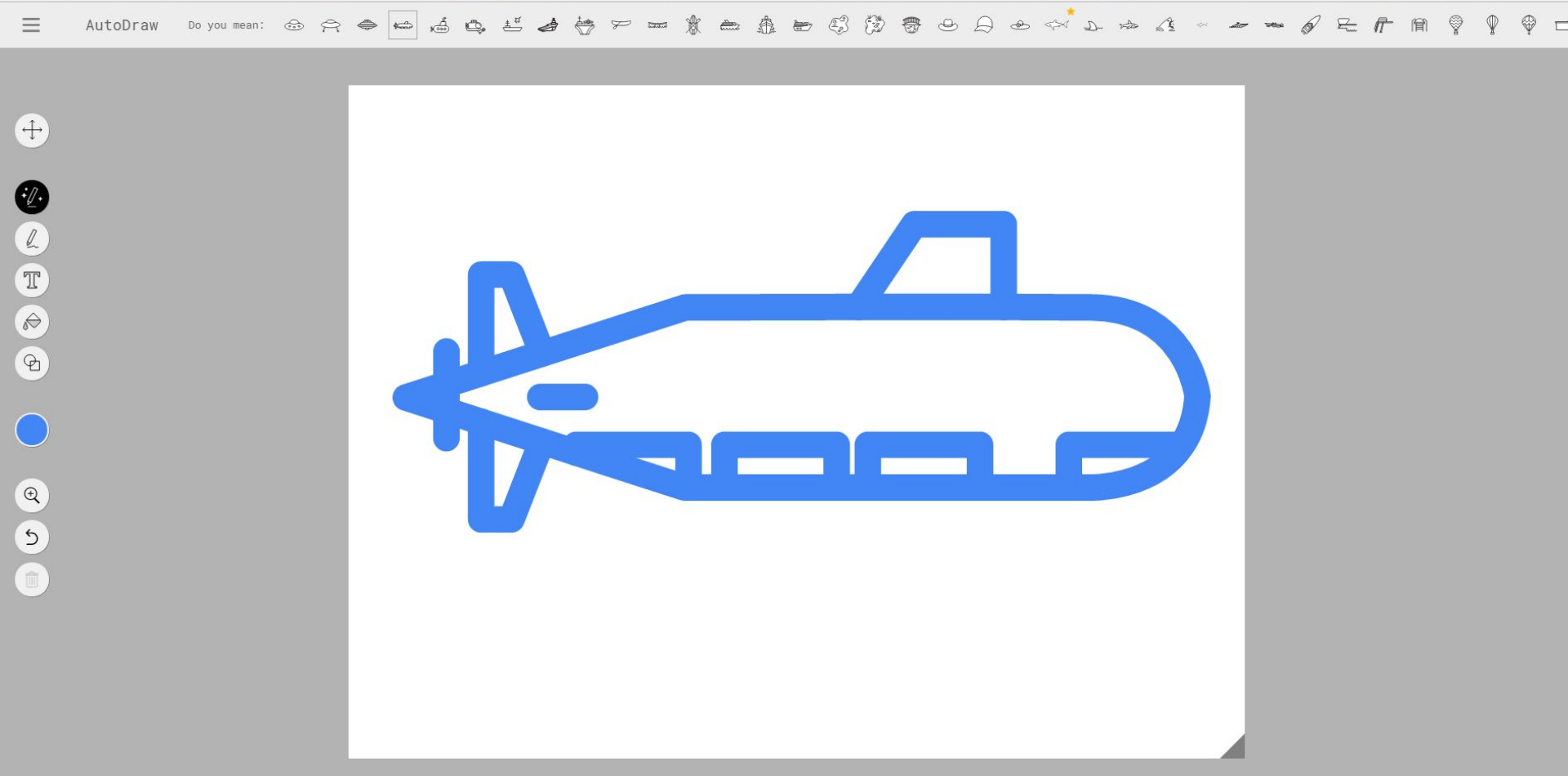
# Microsoft Windows 10 - 3D Builder



# Google AutoDraw with Machine Learning



# Google AutoDraw with Machine Learning





# Will Humans be Redundant?

# Nothing new in the world.. Queen Bee Target Drone – 1930s/40s



# DARPA ASW Continuous Trail Unmanned Vessel (ACTUV)



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# Textron Common Unmanned Surface Vehicle (CUSV™)



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# US Navy X-47B Drone



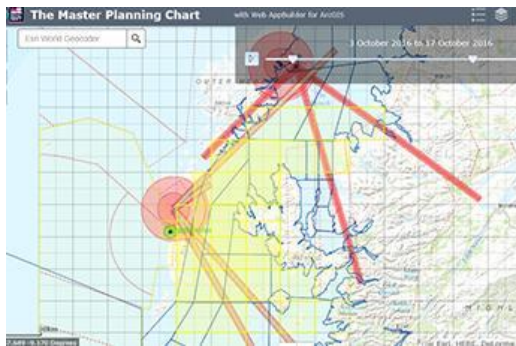
**August  
2014**

**April  
2015**

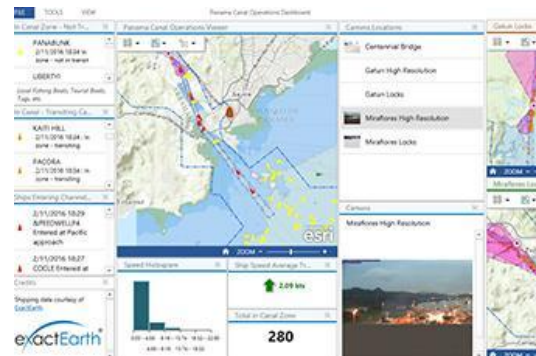


# RN's Unmanned Warrior 2016

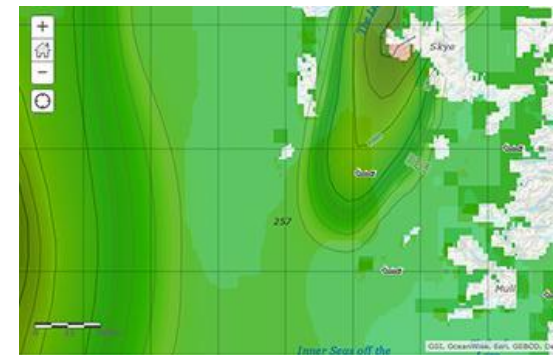
- 50 Unmanned Vehicles Demoed
- “The first RN exercise planned in the Cloud”



Planning



Deployment



Post Deployment





# Rolls-Royce Remote-Controlled Ships Concept



theguardian

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[Business](#) > [Rolls-Royce](#)

## Rolls-Royce plans remote-controlled ships with no captain or crew on board

British engineering company claims huge cargo carriers will be cheaper, greener and safer than fully manned vessels

Rupert Neate

The Guardian, Friday 30 May 2014 20.12 BST

[Jump to comments \(74\)](#)

A fleet of giant cargo ships, up to almost a quarter of a mile long and wider than a motorway, are to crisscross the world's oceans without a captain or crew on board.

The remote-controlled vessels, which could set sail within the decade, are the latest development in the growing trend for unmanned vehicles, with drone aircraft already flying and Google planning to introduce driverless cars.

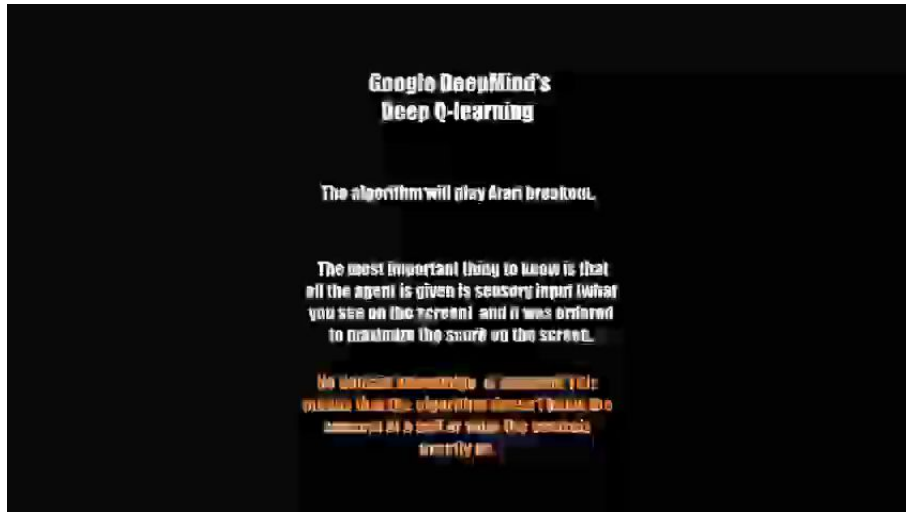
Rolls-Royce, the British engineering company developing the ships, claims the unmanned ships will be cheaper, greener and safer than those with a full complement of captain and crew.

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# Non-Defence



# Games/Simulation Training AI (Google DeepMind)



2015



2016

The Programs only see the Video Streams



# Google DeepMind AI and “Go” (2016)



Artificial intelligence  
(AI)

# StarCraft II: DeepMind unveils latest game its AI plans to conquer

The AI research firm is teaming up with gaming company Blizzard to take on the real-time strategy game

Alex Hern

@alexhern

Friday 4 November 2016 18.45 GMT



Shares

379

Save for later



A screenshot from StarCraft II, one of the most popular eSports in the world. Photograph: AP

After its success at mastering the ancient Asian boardgame of Go, DeepMind is planning to learn its next game - and it's about as different as it can possibly be.

The London-based AI research firm, a subsidiary of [Google](#), is teaming up with Californian gaming company Blizzard to take on the real-time strategy game StarCraft II.

## AI v Humans – Strategy Games

So What?

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



# Training Autonomous Systems in Simulation

9T05Google

PLUS ANDROID CHROME/OS GOOGLE APPS ANDROID TV YOUTUBE

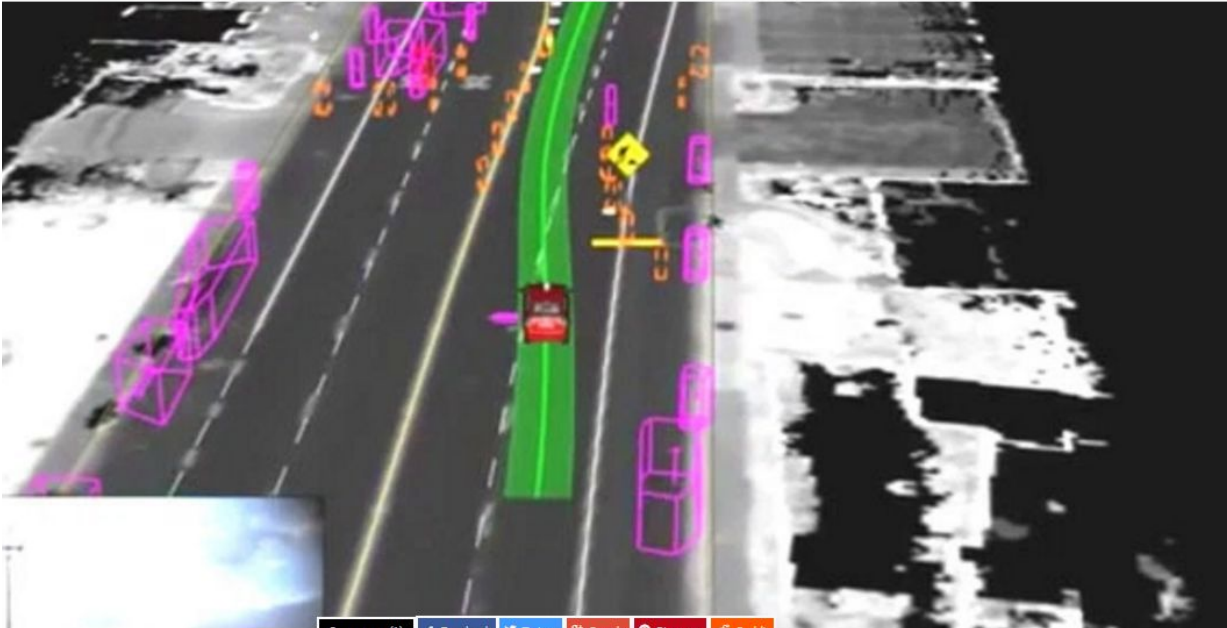
TODAY

GOOG: 764.65 12.65

## Google's self-driving cars drive three million miles a day, without leaving the lab

Ben Lovejoy · 11 hours ago @benlovejoy

SELF-DRIVING CAR X



Comments (1) Facebook Twitter Google+ Pinterest Reddit

Google's self-driving cars have notched up almost 1.5 million miles in autonomous mode since the project began in 2009 – but they drive twice as many miles every single day in the lab. Google's latest monthly report reveals that every software change is tested by using it to simulate driving the entire driving history of the fleet, autonomous and manual.

# (Humans) Learning to Drive

- **Passing the driving test takes, on average, 45 hours of lessons**
  - UK Driver and Vehicle Standards Agency
- **The average new driver only feels truly confident after clocking up more than 20,000 miles**
  - Co-operative Insurance Research



# Computers still aren't that clever





# AI in Games/Simulation can be Bad!



& Humans  
might get  
even  
better...

## 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



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.

# **Advances in Artificial Intelligence are Unceasing and Simulation has a Significant Role to Play**

- **But, it AI is still very challenging and success depends on where it is applied**
- **We must work towards the optimum human/machine blend**



# Chief Automation Officer Required?



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# Training Systems and Procurement

# Human Factors/Training Last in the Queue in Defence Procurement?



Wikimedia

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# Operations are the Tip of the Iceberg



# People Deliver Military Capability

Training

Equipment

Personnel

Information

Concepts and Doctrine

Organisation

Infrastructure

Logistics

# People Support the Whole Submarine Lifecycle





# The Challenge of Synchronising...

**REQUIREMENTS**

**ORGANISATION**



**TECHNOLOGY**

**SOCIETAL**

# Training System Quality Assessment

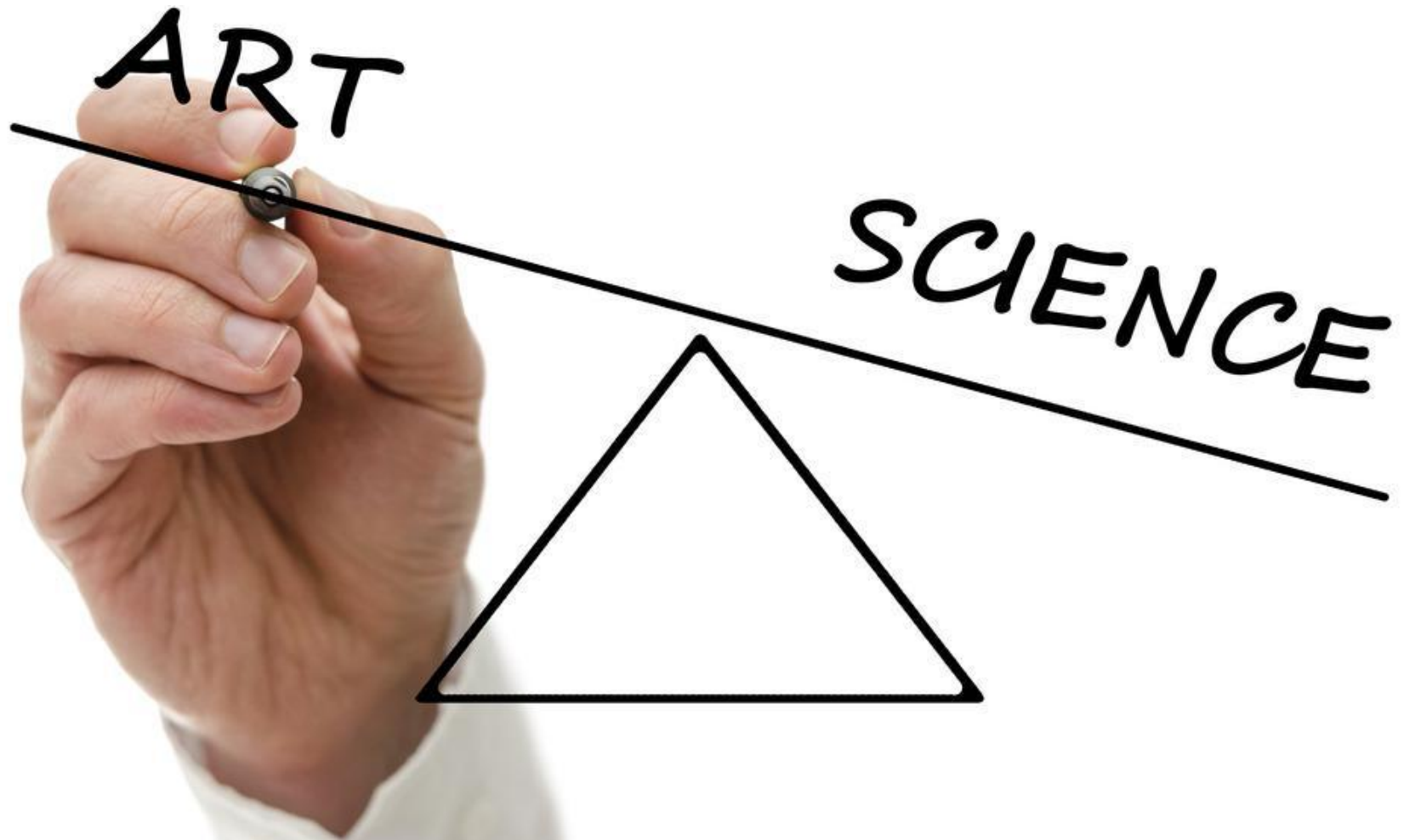


# Where is the Data?

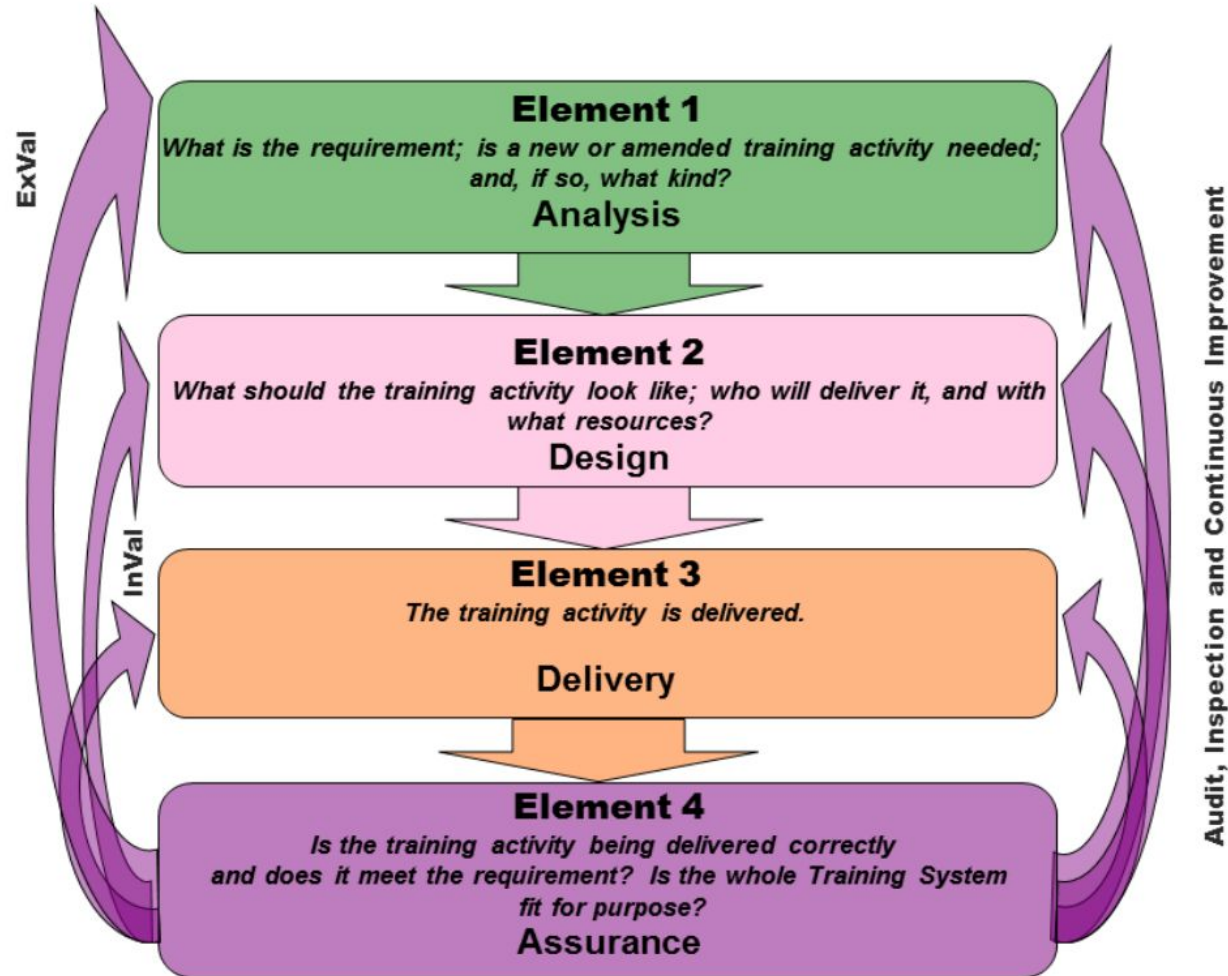




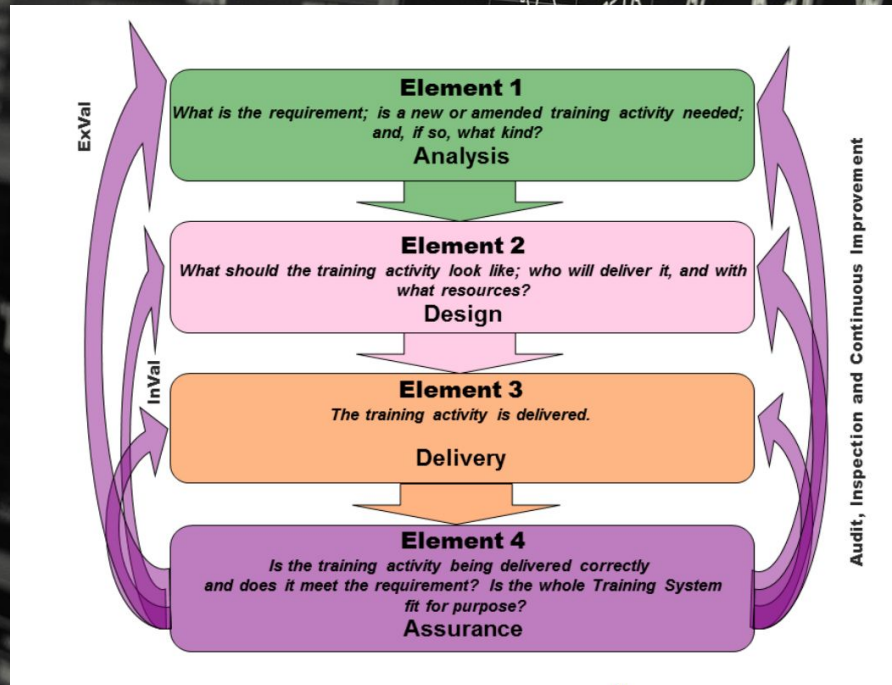
# Training More Art Than Science?



# UK JSP 822 - Defence Systems Approach to Training (DSAT)

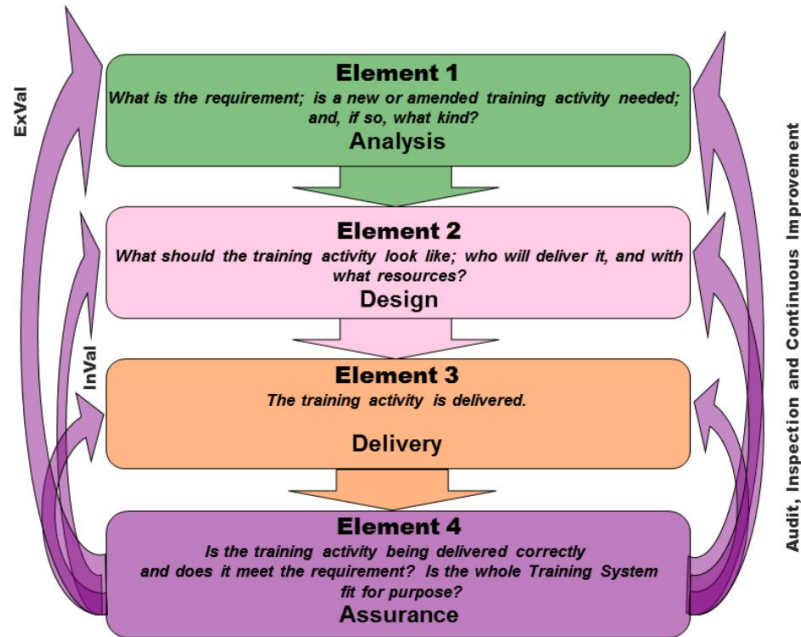


# Data Driven





# Through Life



C

Concept

A

Assessment

D

Demonstration

M

Manufacture

I

In-Service

D

Disposal

# SUMMARY



# Summary

- **People are Critical to the Submarine Enterprise**
- **Autonomous Systems do not change the need for People**
- **Training must enable People to be Ready and Adaptable**
- **Training should be Data Driven and Through Life**
- **Training Systems should be kept up to date with actual systems**
- **Simulation can play a greater role in training both people and autonomous systems**



# People are the Most Adaptable Component of Military Capability



# Questions?

