

Defence IQ Naval Training &
Simulation Conference
London - 7 July 2016

Simulation - Transformation or Hype?

Andy Fawkes



Training & Simulation Background

12

MoD/NATO

4

Industry



Past Visions - Video



The Film

- A SIMNET Promotional Film (1990ish)
- We continue to hear very similar language
- The graphics have got better, but what else?

Questions

Was that hype?

Has the SIMNET dream been realised?

Maybe the Military don't want it?

Maybe it can't be Procured?

Is the Glass...



- How thirsty am I?
- What is in the glass?

Overview

- **A History of Transformations**
- **What about Now?**
- **Realising the Full Potential of Simulation?**

A History of Transformations

Link Trainer 1930s/1940s



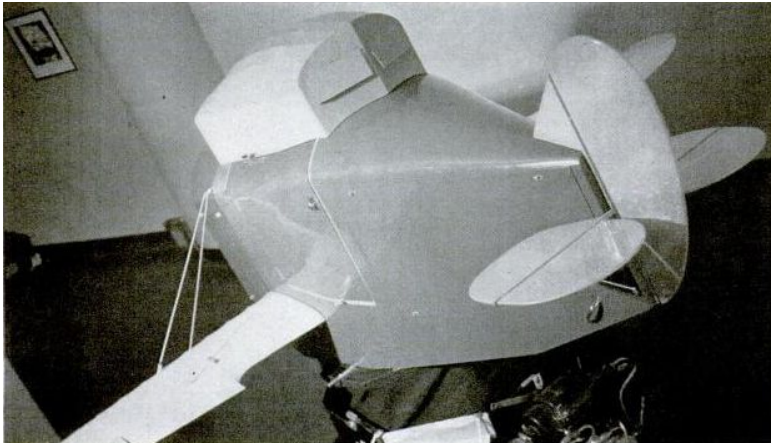
Edwin A. Link

THINKE

Link Trainers in WW2

- During the War the US Military purchased 7,316 Link trainers.
- The average cost was less than \$3.7k per unit (\$49k per unit at 2016 prices)
- Savings estimated at more than \$300m (\$4bn savings at 2016 prices)
- RCAN used Links for Pilot Screening
- Sperry Corporation used the Link as an Equipment Testbed

Cost Savings – Link v Harvard



\$0.04/hour



\$10/hour

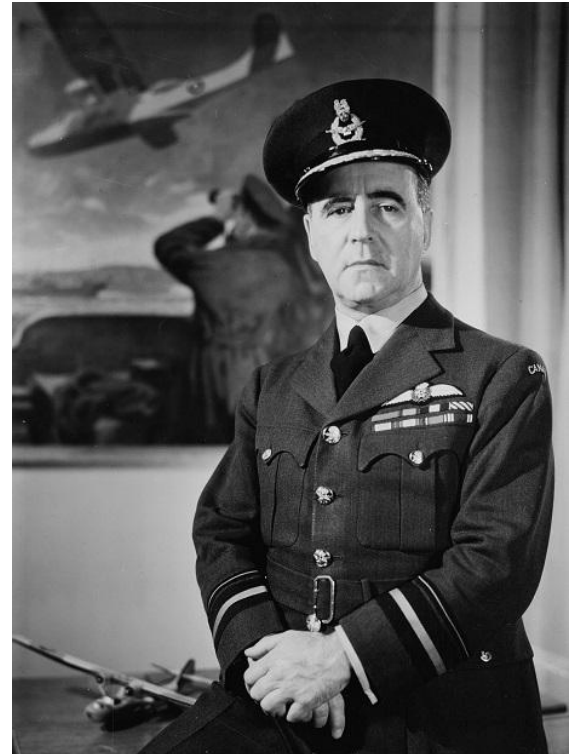
Link Trainer - Video



Air Marshal Robert Leckie RCAF Wartime Chief of the Air Staff:

"The *Luftwaffe* met its Waterloo on the training fields of North America. And at every one of those fields, in the British Empire as well as the United States there was a battery of Link trainers."

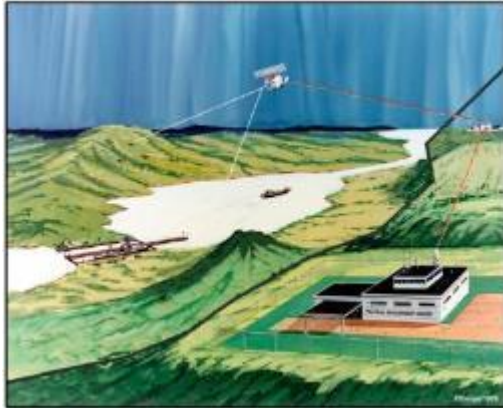
Flying Magazine May 1947



“Future Views: Aircrew Training 1980-2000”

Captain Jack A. Thorpe, US Air Force Office of Scientific Research - 1978

1



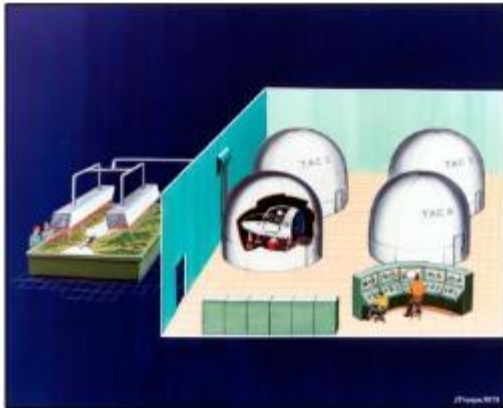
Enemy aggression detected

2



Planning a response

3



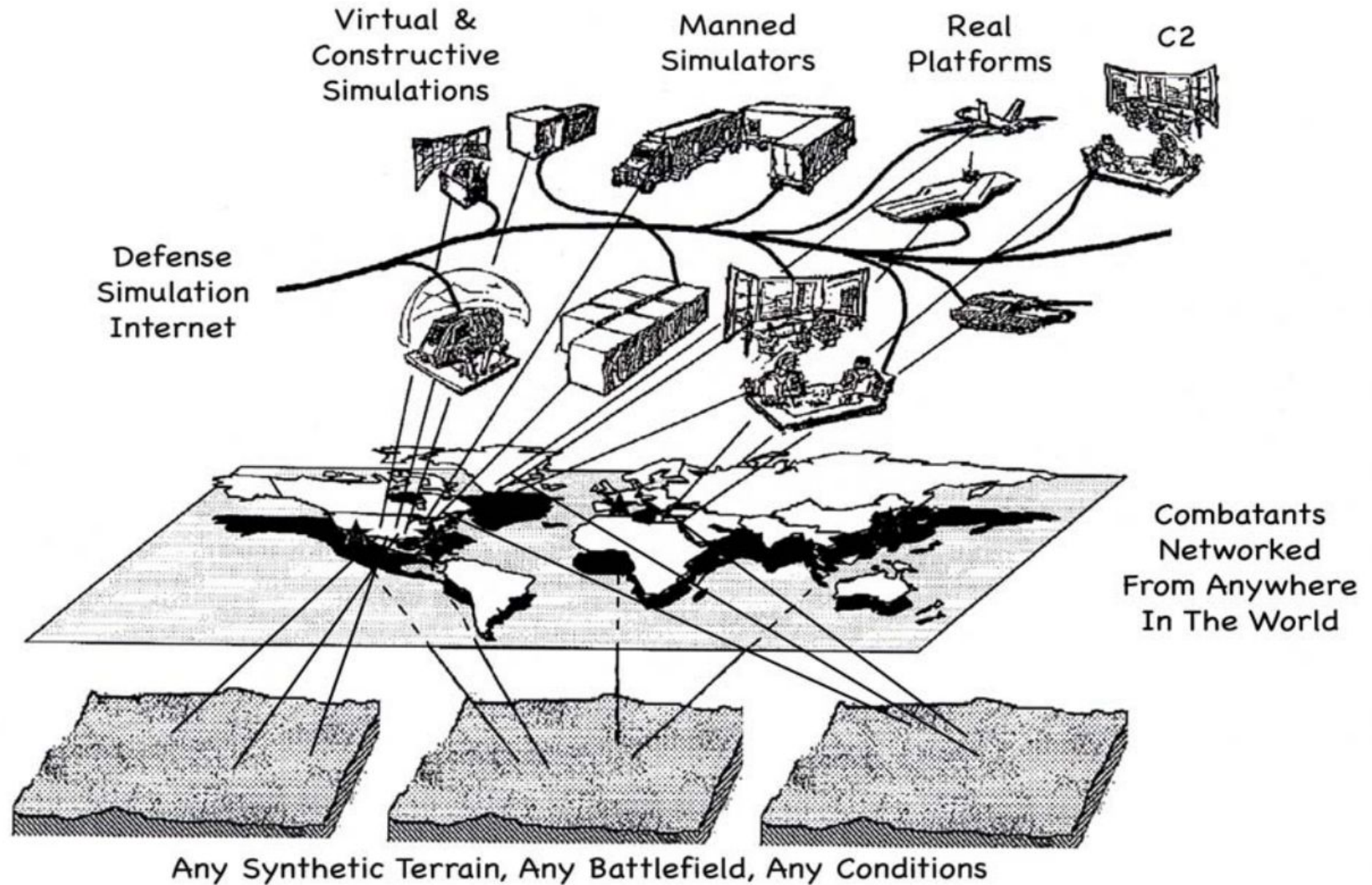
Rehearsal and analysis

4



Real time mission observation

SIMNET Distributed Simulation Concept

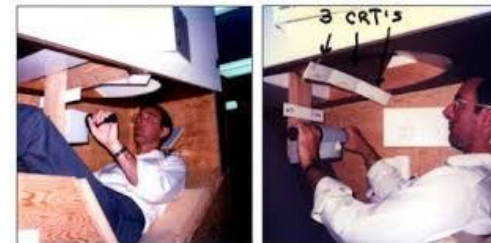


SIMNET Rationale - 1983



SIMNET Design Principles

- M1 Abrams Tank Simulator \$20min 1983 (\$48m now)
 - Different approach required
- Selective Fidelity
 - Fidelity designed around training need
- The 60% Solution
 - Solutions presented to military at 60% completion
 - “Fast, approximate, and cheap was better than slow, deliberate and expensive”
- Not driven by training requirements but empowering Commanders to exploit an unconstrained virtual battlefield as they saw fit



SIMNET Tank Engagement (late 80s)



US Defense Science Board Task Force on Computer Applications to Training & Wargaming (May 88)

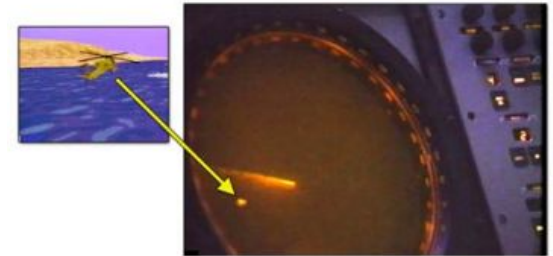
- “Computer-based, simulated scenarios offer the only practical and affordable means to improve the training of joint operational commanders, their staffs, and the commanders and staffs who report to them.”
- “Battle simulation offers the only opportunity to practice the use of certain weapon systems, sensors, tactics, and techniques against a skilled adversary.”
- “Make Joint Simulations Interoperable:
 - Internet existing service, college, training center, and joint games and simulations for education and training.
 - Evolve them to be distributed, so that commanders and staffs can train from their duty stations in peace or wartime.
 - Use one standard DoD communication protocol, and use cost-effective communications hardware and software.
 - To facilitate the sharing of simulation data, create a shared repository, a library of automated, validated data descriptions for simulation use. Make the data descriptions available DoD-wide.

US Navy Battle Force Inport Training (BFIT)

- From mid-80s USN connected ships to pier side simulators and stimulators
- In 1990 this approach was extended to other US-wide simulation systems
- Marines in tanks/rotary designated naval gunnery
- Virtual rotary appeared on real USS Wasp radar



USS Wasp in simulation and in the real world



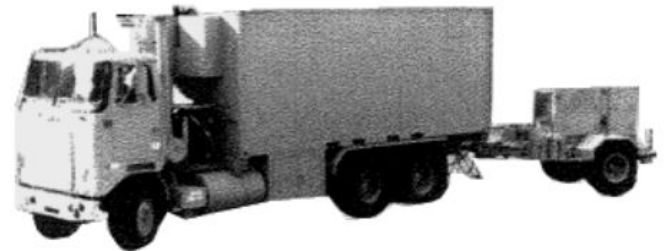
An Apache helicopter (simulator at Ft Rucker) off the coast of California appears on the air surveillance radar of the USS Wasp

US Navy Battle Force Inport Training (BFIT)



US DARPA Project Odin – 1990/1

- “Simulation centre on wheels”
- Support to Desert Storm
- Provide Commander with perspective visualisation and fly throughs
- “What if” simulation models
- After action replay and lessons learned
- Insufficient time to be integrated in existing command structure



1991/92 Gulf War - 73 Easting

- New interactive, dynamic, means of documenting history
- SIMNET provided the tools to take the 73 Easting data and turn it into an analysis tool.
- Presented on large projection screens, the 73 Easting briefings were given to everyone from visiting diplomats to members of Congress

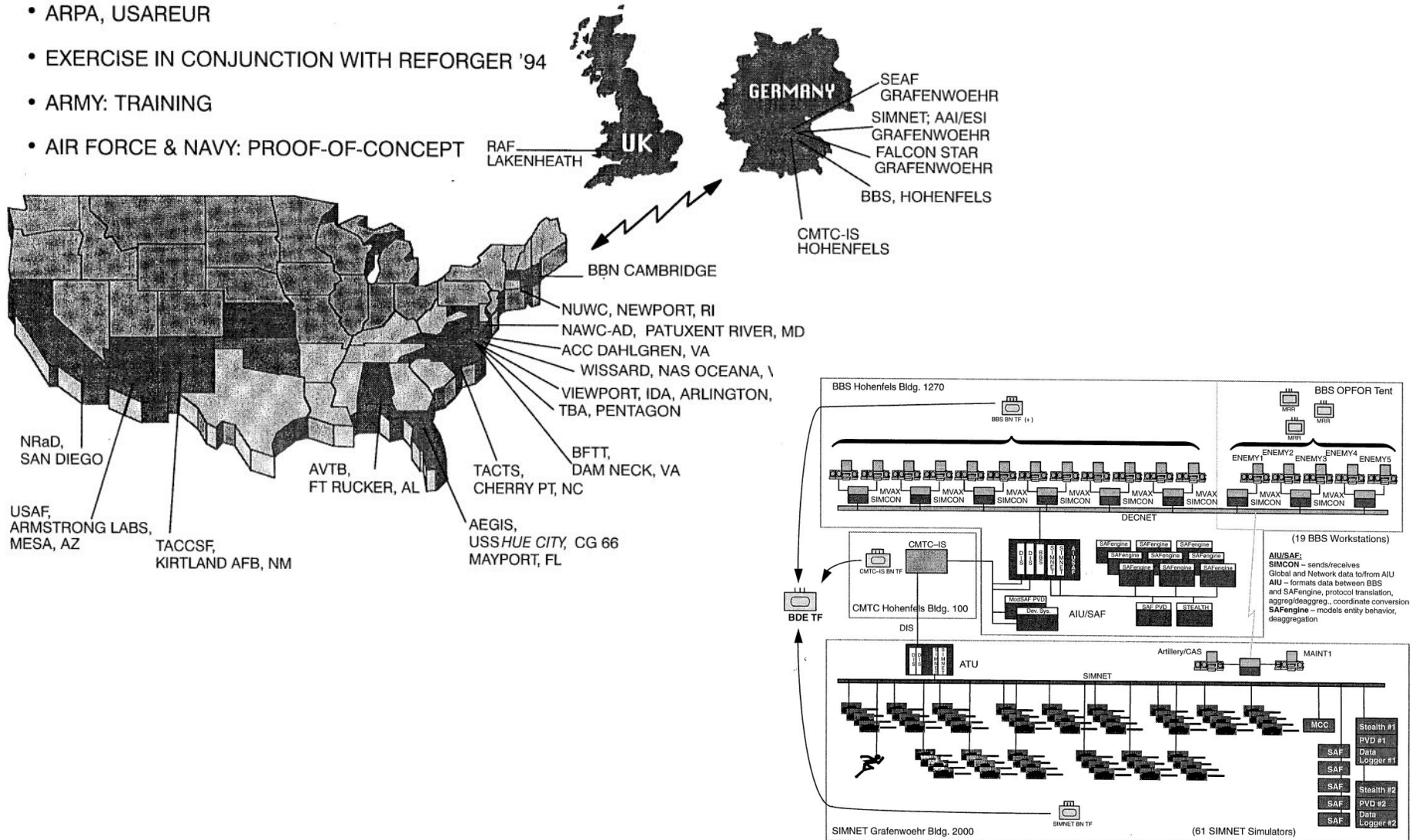


US Defense Science Board Task Force on Simulation, Readiness & Prototyping (Jan 93)

- **“Advanced Distributed Simulation (ADS) technology, if adopted and exploited,**
 - 1) will make very substantial enhancements in training and readiness,**
 - 2) will dramatically improve the requirements/prototyping process and**
 - 3) can transform the current acquisition process from within.”**
- **“the warfighting community has embraced ADS.. In contrast, the requirements/development community employs single and non-distributed simulation techniques.. and the acquisition process is slowed with resulting cost increases.”**

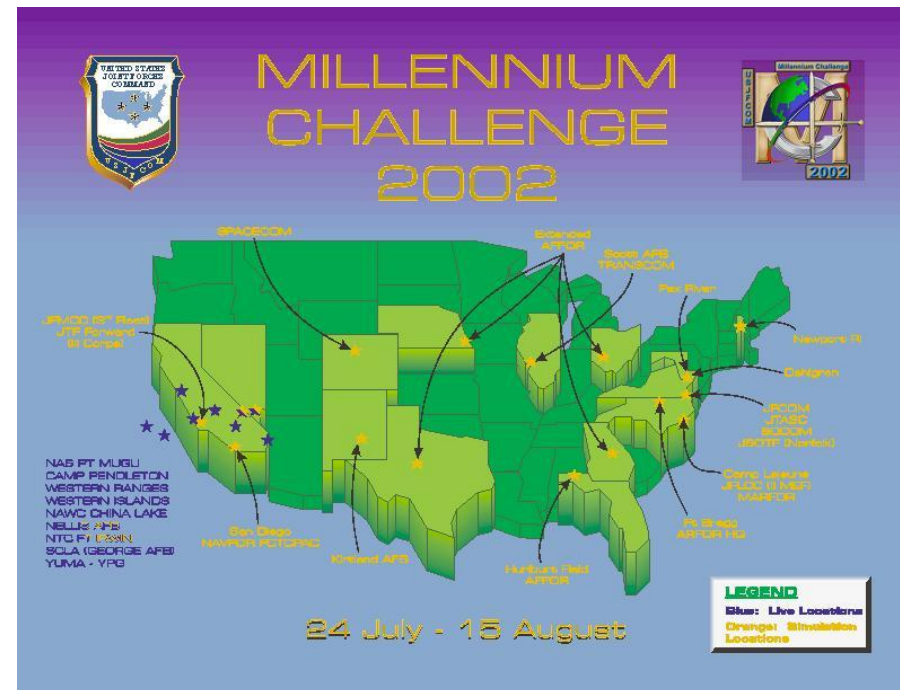
Synthetic Theater of War - Europe (STOW-E) (LVC) 1994

- ARPA, USAREUR
- EXERCISE IN CONJUNCTION WITH REFORGER '94
- ARMY: TRAINING
- AIR FORCE & NAVY: PROOF-OF-CONCEPT



Millennium Challenge 2002 (MC02)

- US war game exercise costing \$250 million, involved both live exercises and computer simulations.
- A test of future military "transformation"



MoD/Industry Collaboration Timeline

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	US/UK Synthetic Theatre of War Programme								
SEMB forms									
	NCD - FlasHLamp								
		NCD - ADSE							
	Virtual Ship; Project Vitesse								
				NCD - SeBA					
				FOAS					
			NIREUS						
					EUCLID 11.13				



Combined Arms Tactical Trainer (CATT) circa 2002

Comparisons...

BBC CATEGORIES TV RADIO COMMUNICATE WHERE I LIVE INDEX SEARCH Go

BBC NEWS

You are in: UK: **England**
Thursday, 24 January, 2002, 18:06 GMT

War simulator unveiled



Soldiers sit inside a replica tank to use the simulator

One of the largest war simulators in the world has been unveiled by high-ranking officers from the British Army.

The £290m unit, at the Warminster army barracks in Wiltshire, can recreate a tank battle involving 1,000 armoured vehicles in virtual reality.

The army hope the training simulator will give British troops the edge over any enemy in combat.

The combined arms tactical trainer, CATT, is also designed to reduce the massive costs of live military exercises.

Training 'watershed'

The simulator can reproduce vast sections of terrain from Salisbury Plain and other regions across Western Europe.

BBC Wiltshire
WHERE I LIVE >>>

Internet links:

- ▶ The British Army
- ▶ Defence Procurement Agency

The BBC is not responsible for the content of external internet sites

Top England stories now:

- ▶ Tories attack Brixton drugs scheme
- ▶ Police shoot man on the M6
- ▶ Leanne killer jailed for life
- ▶ IVF mix-up heads for court
- ▶ Inquiry into warship accident
- ▶ Britain 'sheltering al-Qaeda leader'
- ▶ Venables named Leeds boss
- ▶ Transplant first for cancer patient

Links to more England stories are at the foot of the page.

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BBC NEWS

You are in: **Science/Nature**
Thursday, 20 June, 2002, 13:58 GMT 14:58 UK

Troops in virtual combat



Up to eight soldiers can play together

The British Army is using a specially developed version of the celebrated computer game Half-Life to train its troops.

With the first-person shoot-em-up soldiers can try out new weapons and new tactics without encountering real bullets and bombs.

The Ministry of Defence hopes the system may help reinforce some of the lessons learned on more traditional training exercises.

Like the popular modification, or mod, of Half-Life known as Counterstrike, the army version allows up to eight soldiers to go into virtual combat at any one time.

See also:

- ▶ 24 Jan 02 | England War simulator unveiled
- ▶ 23 May 02 | New Media US military reveals computer game
- ▶ 21 Dec 01 | Reviews Half-Life revives for new generation

Internet links:

- ▶ QinetiQ

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Top Science/Nature stories now:

- ▶ Date for first Australians
- ▶ Fifth closest star discovered
- ▶ Mona Lisa smile secrets revealed
- ▶ The gene that maketh man?
- ▶ Gravity wave detector all set
- ▶ Robots get cheeky
- ▶ The big and the bizarre
- ▶ Botox 'may cause new wrinkles'

Links to more Science/Nature stories are at the foot of the page.

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CBBC news

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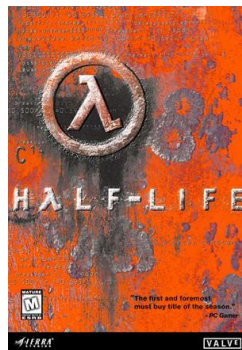
EDITIONS

- Change to World

Obviously, being killed in the virtual world isn't quite so serious
Major Bruce Pennell

Dismounted Infantry Virtual Environment

DIVE 1 & 2



2004 – NATO Games Workshop



NATO Modeling & Simulation Group

“Exploiting Commercial Games for Military Use”

October 20-21 2004

TNO, The Hague, Netherlands



Aims

- *UK MoD led, hosted by Netherlands (TNO)*
- Share national experience
- Identify:
 - best practice
 - Lessons learned
 - barriers to further exploitation
 - Areas for collaboration
- Networking:
 - Research community
 - Military
 - Internationally



What Makes a Game Useable?

- At least some of the following:
 - Robust user community.
 - Multiplayer functionality.
 - Scenario creation.
 - Open database.
 - After Action Review.
 - Developer engagement.
 - Validation and accreditation.
 - Support.
 - Use elsewhere - and for what.
- ADSO evaluates games against following "Six Criteria"
 - 1) User Requirement
 - 2) Representations
 - 3) Data availability and reliability
 - 4) Technology
 - 5) Confidence building approaches
 - 6) Cost/benefit



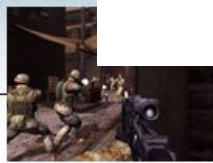
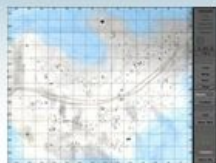
Dutch Perspective

Netherlands Aerospace Laboratory NLR

Flight Simulation Games and their Training Value

Infantry Cognitive Skills Training

Experience Leads to Better War Fighting



INSTINCT

INSTINCT = GHOST RECON + French Improvements

- INSTINCT exercises are defined according to the same process as field exercises
- AAR due to GHOST RECON particularities is only limited to replay the exercises
- Less than 2 hours INSTINCT tutorial prior exercises
- Short drills (4 Hours)
 - To learn procedures
 - Get the know-how
 - React with reflexes



"DIVE 2"

Copehill Down

VBS2 – 2008 - Video

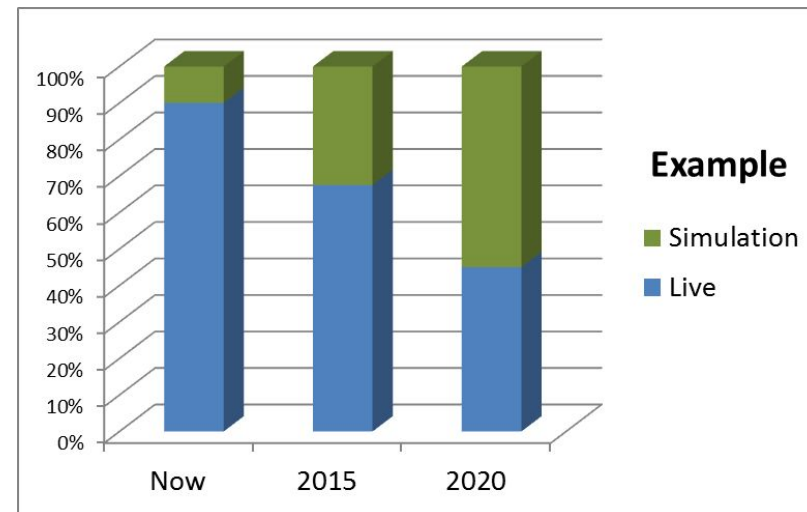


UK Strategic Defence & Security Review - 2010

- SDSR - Strategic Defence and Security Review
- The MoD and Country was “Broke”
 - eg. Loss of Carriers and Harriers
- Study tasked with generating options for saving money through greater use of simulation in training
- Study required to consider targets by 2015 and 2020

SDSR Simulation Targets - 2010

- 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
- 5% Change per Annum



2012 Defence Training & Education Capability (DTEC)

- Catalogue approach
 - common standards, software, services and content
 - research focused on supporting development of catalogue
- Visibility of funding across MoD
- Infrastructure convergence with IS
- Use existing standards such as DSAT

2012 – Defence Training & Education Capability (DTEC) Balance of Investment – lots of iPads or a Simulator?



What About Now?

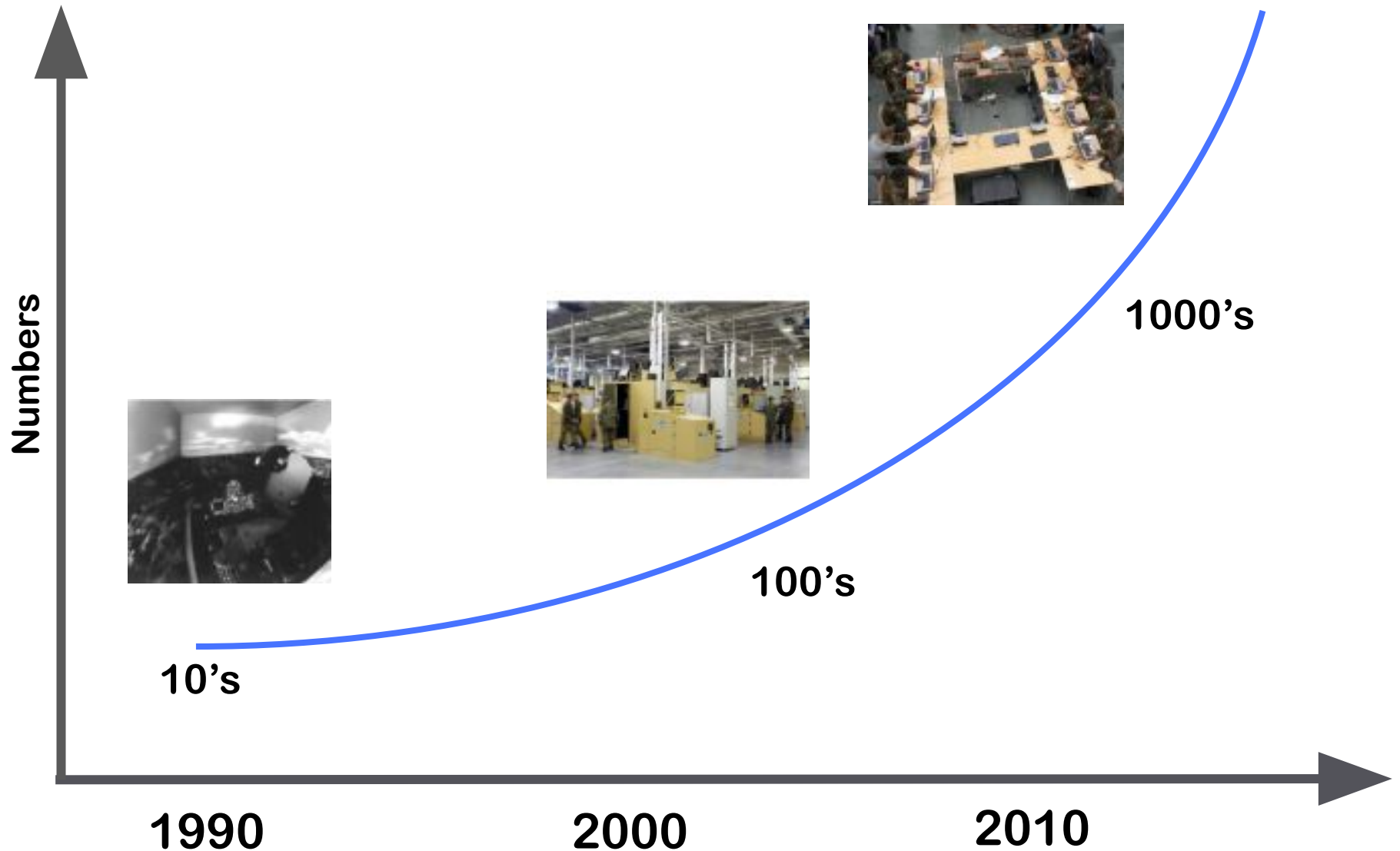
Is the Glass...



- How thirsty am I?
- What is in the glass?



Military Access to Simulation



Permanent ADS - USAF DMO



JTAC



A-10



F-16



AWACS



B-1

Civil Full Flight Simulator

- **Simulation Fully Integrated into Civil Aviation**
 - Supports conversion to a new aircraft type
 - Airline flight crews train 2 days every 6 months
 - 40-50 Level D FFS simulator purchased per year



Simulation Now



Simulation Technology Drivers

- Computing
- Games
- Networking
- Graphics
- Audio
- Human Interfaces
- Sensors



30 Years of Game Graphics



Quantified Human



THINKE

Increase Focus on Learning Analytics

- Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs



DEFINE



MEASURE



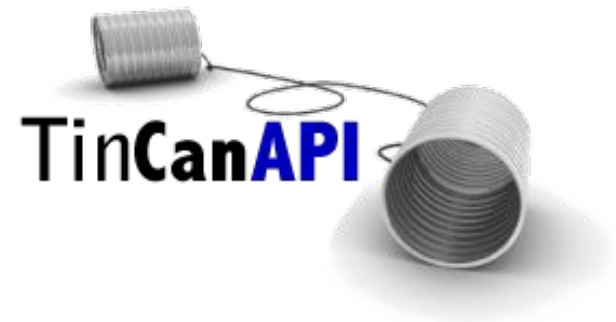
ANALYZE



IMPROVE



CONTROL



Google DeepMind AI (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.**

So What?

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



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](#)



A new artificial intelligence flight combat system dubbed ALPHA has taken on one of the Air Force's top tactical experts and won. Retired USAF Colonel Gene Lee -- an experienced combat instructor with "considerable fighter aircraft expertise" -- was repeatedly shot down during engagements with ALPHA in a high-fidelity air combat simulation. Lee called his computerized opponent "the most aggressive, responsive, dynamic and credible AI I've seen to date."

Human v Machine

Training Autonomous Systems in Simulation

9T05Google

PLUS ANDROID CHROME/OS GOOGLE APPS ANDROID TV YOUTUBE

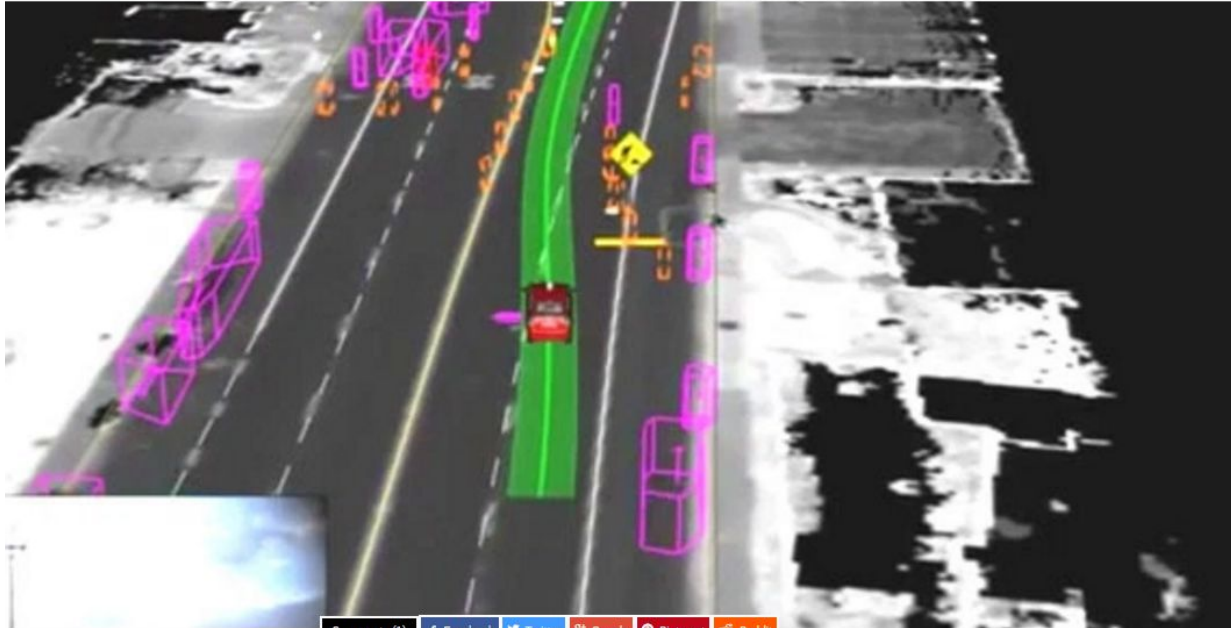
TODAY

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.



THINKE

Human Factors and Training often the Last Among Equals in Defence Procurement



Problems...

Dr J. Michael Gilmore, US Director of Operational Test and Evaluation's Report on F-35 Problems (Jan 16) included:

A lack of high-fidelity simulators to rehearse combat missions and specialized data for each major geographic area that pilots will use to test sensors and track enemy radar.



The Mysteries of Simulation

SOAP CGF VV&A LVC SEDRIS DIS
MSHTF TENA Agent-based
DTEC RTI Federate Architectures ASP HLA
SISO Cloud AI SCORM CBML CORBA
MCTS SEBA CATT AR DTED Serious Gaming
VR Monte Carlo Distributed M&S AVCATT
NMSG Human-in-the-loop FOM DoDAF
Synthetic Environment DSAL Latency ITEC
TinCan BOM T I/ITSEC
Constructive Accreditation Emulation

What the Military Customer might hear...

You Need an Architecture

“First Time Ever”

Procurement Stovepipes

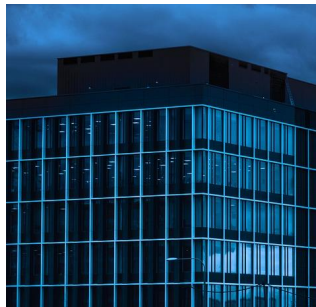
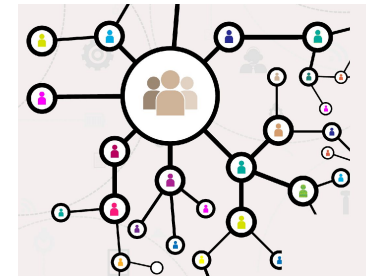
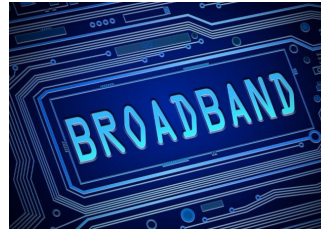
It's Your Changing Requirements

You Shouldn't Procure Training Technology

Questions for You

- Is simulation fully integrated into the military enterprise?
- Is enterprise-wide distributed simulation exploited on a day-to-day basis?
- Is the live-simulation balance managed on a scientific basis?
- Do trainees have to travel to simulation or is it across the enterprise?
- Are simulation and C4ISTAR converging?

Games Market Transformation



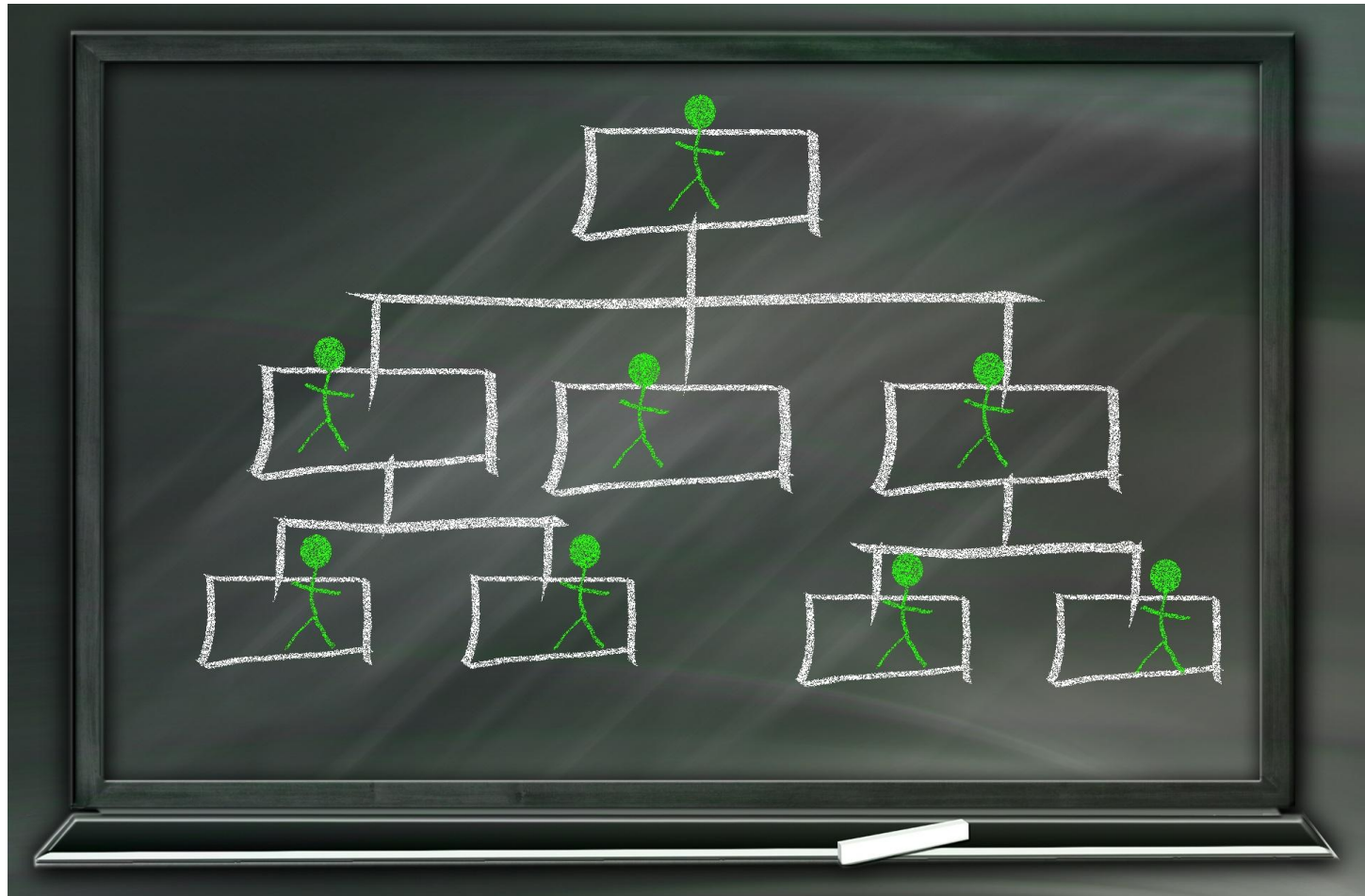
early 2000s
stratified, hierarchical

late 2000s

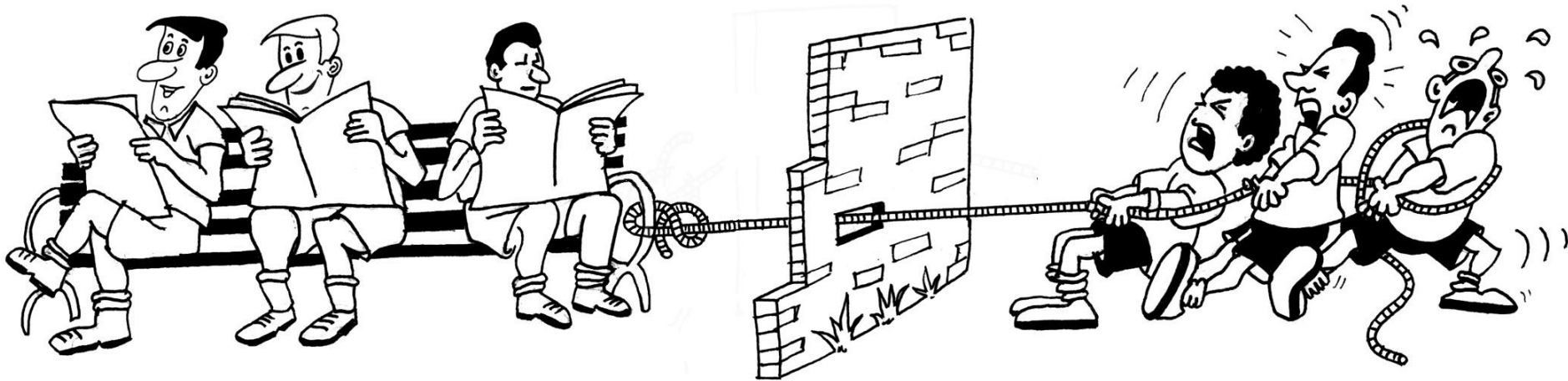
early 2010s
digital, fluid

**faster cycles,
cloud, VR**

Defence Research and Procurement Organisational Structures – Any Change?



Organisational Inertia



"All this effort!! ...Why are we not making progress?"

Organisational Processes

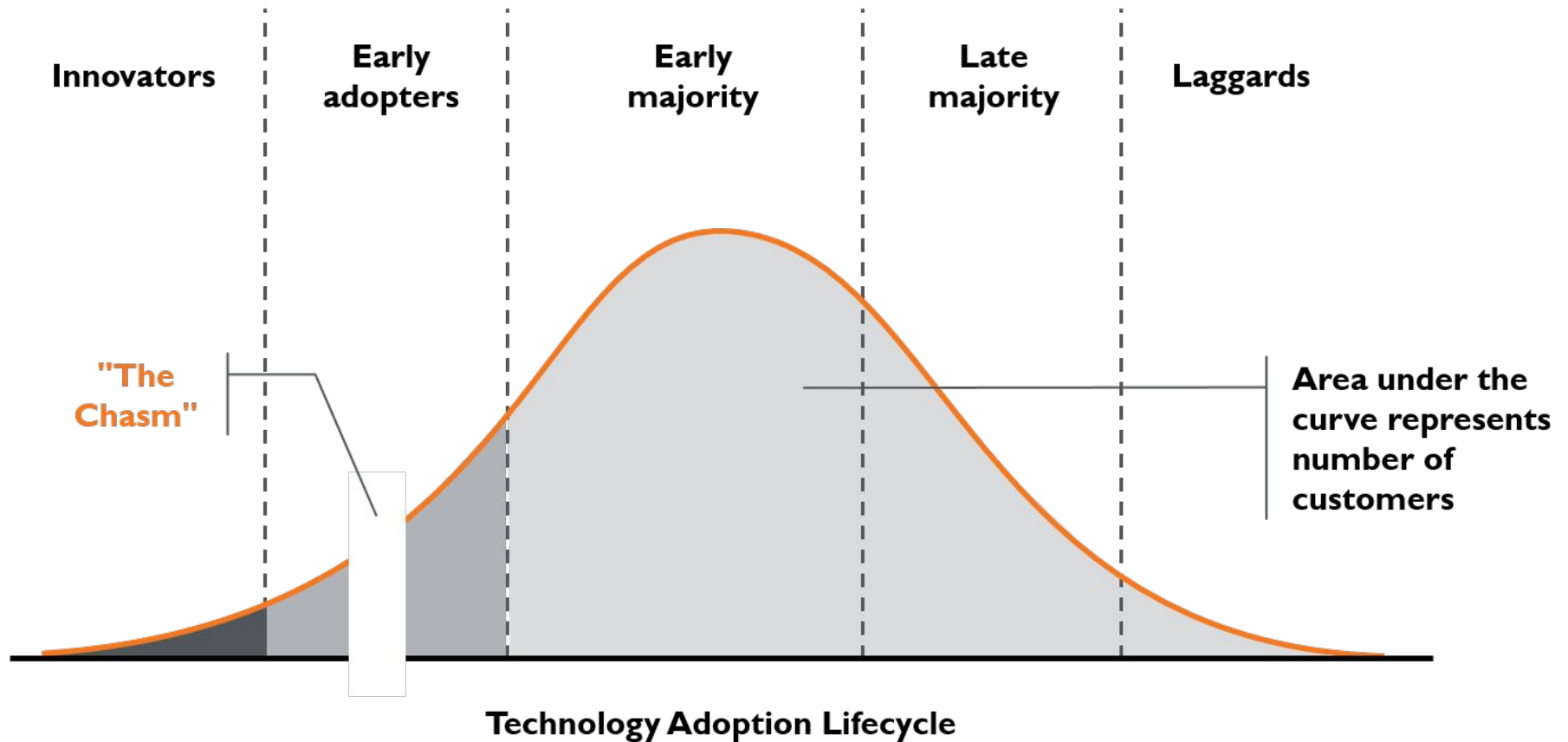


Beyond the Hype - Realising the Full Potential of Simulation?

**Some Simulation Applications are
Mature and Some are Not**

Why?

Technology Adoption Cycle

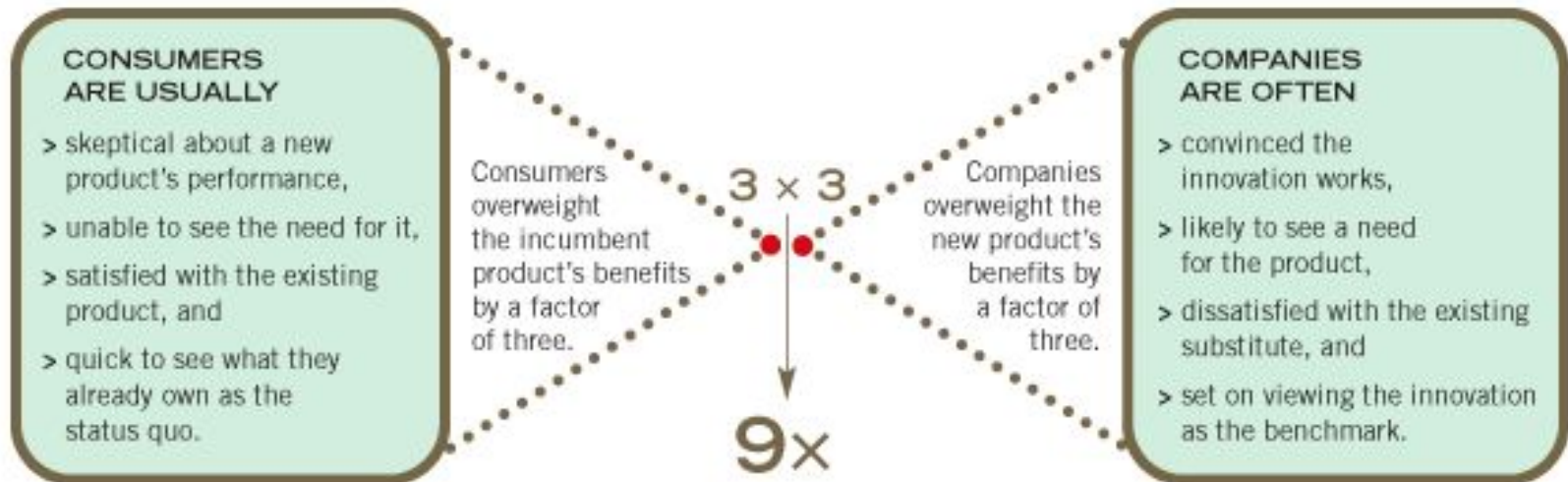


Technology Adoption Cycle

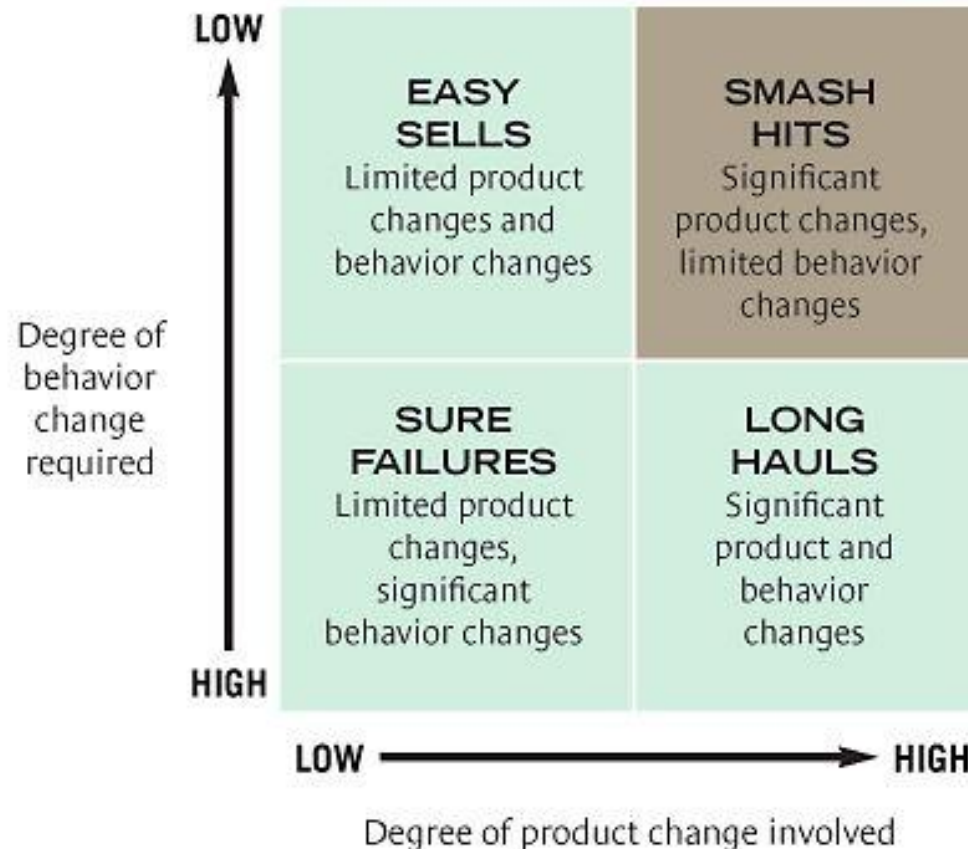
- **Innovators**
 - Focused on the Technology
- **Early Adopters**
 - Focused on new Product Concepts
- **Early Majority**
 - Pragmatic. Focused on Proven Business Benefit
- **Late Majority**
 - Conservative. Seeks Established Standard
- **Laggards**
 - Not Interested in New Product

Loss Aversion

- We value items in our possession more than prospective items that could be in our possession



Balancing Product and Behaviour Changes



In Summary

- In many applications areas the use of simulation is mature or maturing
- Simulation and training technologies continue to advance rapidly, potentially opening up new application areas
- Focus on Learning Analytics

Beyond the Hype – Exploiting Simulation Technology

- Minimise the need for behavioural change for the military customer
- Demonstrate and prove quantitatively simulation's cost effectiveness
- Marketing of simulation aimed at a pragmatic customer not a technology enthusiast or laggard

Questions?