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Generation After Next for Defence Simulation and Synthetic Environments

NATO Modelling and Simulation Group Annual Symposium (MSG-197)

20th October - Bath, UK

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Ministry of Defence

Dstl - What We Do

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We deliver high impact S&T for the UK's defence, security and prosperity

S&T Drivers

- Technology and its use are increasingly central to MOD's ability to deliver its strategy and how we operate

- The MOD S&T Strategy emphasises the need to
  - Understand the future
  - Find, nurture and fund **Generation After Next technologies**
  - Pull-through emerging technologies and innovation through demonstrators, experimentation and better exploitation processes and structures
  - Accelerate adoption of existing technologies at scale

- These were priorities for both the recent UK Defence & Security Integrated Review and Spending Review

The S&T landscape has changed

Generation After Next

“The next generation of military capabilities will spawn from technologies that have already emerged. Technologies vital for the generation-after-next of capabilities are those beginning to emerge now and in the near future.” MOD S&T Strategy 2020

Dame Angela McLean, MOD Chief Scientific Advisor – DSEI – September 2021

Three focus areas:

- Transform Now – Technology we can buy now and want to get into the hands of users as quickly as possible
- Innovation – Accelerating the Next Generation – Things we can buy or buy and adapt to our uses. Technology has emerged but is being applied to a military context.
- “**Generation After Next**; Things you cannot buy today – capabilities we know we need, but that require basic science and technology before they become available. This does not imply any particular timeline – Generation After Next could be this year”

GAN for Simulation and Synthetic Environments Study

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- What does “Generation After Next” mean for the Simulation and Synthetic Environments?
- What are the key areas that Defence should focus S&T funding on in the next 3 to 5 years?
- Criteria includes:
  - Technologies not yet available to purchase or developed into a purchasable product or service
  - Requires S&T activity to de-risk
  - Relevant to Defence Training, Education and Preparation
  - Identification of non-defence technologies and capabilities that are relevant through convergence or a ‘spin in’ process (as previously successfully demonstrated with COTS gaming technology)

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Task Approach

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Phase 1 - Definition

Review Inputs

Confirm S&T Themes

Build Networks

Phase 2 – Analysis and Production

Build roadmaps

Capture Landscape

Engage Supply Chain

Phase 3 – Dissemination and Exploitation

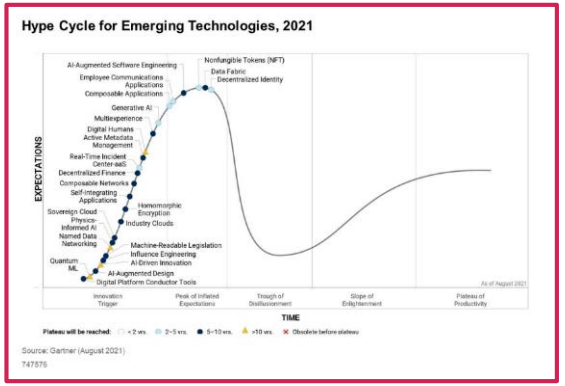
Brief outcomes

Peer Review

Finalise Report

Task Approach - Principles of S&T Development

- **Non Linear** – S&T does not move in straight lines (see Gartner Hype Cycle right). Periods of failure can be followed by periods of success
- **Right time place and cost** – Successful S&T interventions occur when the innovation is not too early, or too late, is in the right market and at the right cost. Innovations may need to bide their time to wait for these conditions (see General Motors EV1 right, introduced in 1996 – discontinued in 1999)
- **Convergence** – Brilliant solutions can result from combinations of technology emerging at the same time; for example smart phones emerged from improvements in processing, displays, positioning/navigation, cameras and hardware
- **Forward looking** – S&T investments are risky! Chances of success may be unknown



Task Approach – Wider Source Material

- **Community Engagement**
  - UK Synthetic Environment Community Of Practice and TechUK
- **Innovation Call**
  - Deep dive inputs in key areas: Mixed Reality, AI and Automation, Live Virtual Constructive (LVC) simulation, Metaverses, Digital Twins
- **Open Source Research**
  - Environmental Scan tool developed by Cordillera Applications
- **Expert Engagement and Input**
  - Prof Allan Shearer and Dr David Kilcullen – Cordillera Applications
  - QinetiQ Chief Technology Officer (CTO)
- **Doctrine/Policy**
  - Key UK future looking instruments – Future Operating Environment (FOE) 2035, Integrated Operating Concept 2025, Multi Domain Integration
  - NATO – Science and Technology Trends – 2020-2040
- **Conferences and Exhibitions**
  - Consumer Electronics Show (CES) 2022, Interservice/Industry Training, Education and Simulation Convention (I/ITSEC) 2021

Findings - Thematic Areas Identified

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Core Sim Tech

Information & Communications Technology (ICT)

Future Operating Environment

Learning Technology

Extended Reality

AI and Automation

Digital Twins & Data

Metaverses

For each thematic area the study identified

- GAN capabilities and technologies
- Forecast of their use and characteristics
- Benefits and Opportunities for use in Defence
- S&T activity required to de-risk their development

Findings – AI and Automation (Example)

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Forecast

Considerable investment in wider markets is expected to continue to drive rapid improvements. Promising early stage technologies include foundation models, which provide general purpose, trainable AI able to tackle a wide range of tasks. Developments in computing, including ‘web 3.0’ or edge computing, quantum computing and processor development may improve the capability of AI and Automation. Process automation in the civil industrial sectors may also provide potential cross over opportunities for the management and delivery of training, education and preparation. However, despite significant investment, there is unlikely to be a single ‘silver bullet’ general purpose AI and automation tool that will completely transform training, education and preparation. Instead, interventions may be on a more limited basis but will still likely be impactful. In addition to its capability, AI and Automation tools are likely to become more usable and easy to operate by end users. .

Technology

- Cloud / Edge Computing
- Games Frameworks
- Scalable simulation environments
- Environmental / Geospatial data acquisition tools
- Web 3.0
- Quantum Computing
- Foundation Models
- Improved Processors

Functionality and Capability

AI and Automation on data at rest

In a GAN world, AI and automation will continue to improve their ability to glean insight from training, education and preparation data at rest. Developments from the civil IT sector including cloud workloads are likely to become more capable and usable.

Intelligent Automation

Intelligent automation is likely to be subject to significant investment from the civil industrial sector. This could be used to optimize education, training and preparation processes, improving efficiency and effectiveness

AI to represent entity and system behaviours

Previous simulation research has investigated a number of frameworks used to represent entity and system behaviours. COTS frameworks, data acquisition tools and modular behaviour creation systems may improve the speed at which new behaviours can be generated and improve their realism.

S&T Requirement

- Advice to improve understanding of the use of AI/Autonomy to improve the efficiency and effectiveness of planning, executing, and analysis of training and preparation.
- Advice on how the use of AI and automation can improve utility of training and education data; use of intelligent or process automation; and use of AI to rapidly assemble simulation environments or components.

GAN Simulation Vision

User facing systems are able to leverage holographic projection, mixed reality technology, haptics, multi-sensory stimulation and highly realistic graphics to provide immersive experiences. These will allow seamless transition and interplay between live, virtual and constructive domains, facilitated by edge computing and powerful wireless networks

M&S systems are capable of delivering highly accurate and dynamic representations of the operational environment including multi domain complex systems. Through the seamless integration of digital twins, environment data and stand-alone complex models using open data standards and a composable approach, users will be able to rapidly build environments to meet their requirements

Enabling systems area able to leverage improvements in data analytics, wired and wireless networks, AI and process automation, computing and software systems. These will enable GAN simulations to be more quickly and cost-effectively provided and delivered securely at range

Defence Research Investment Identification

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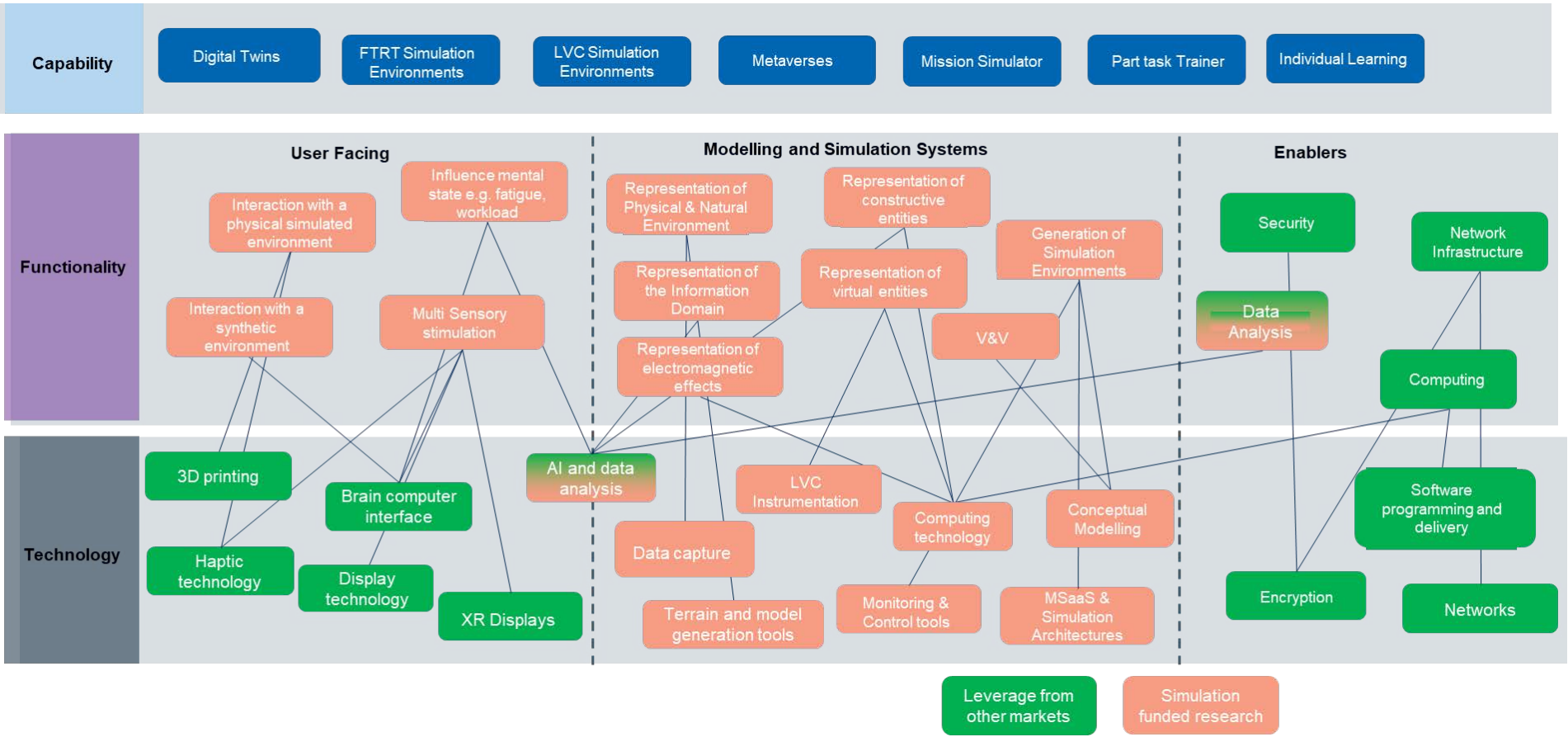
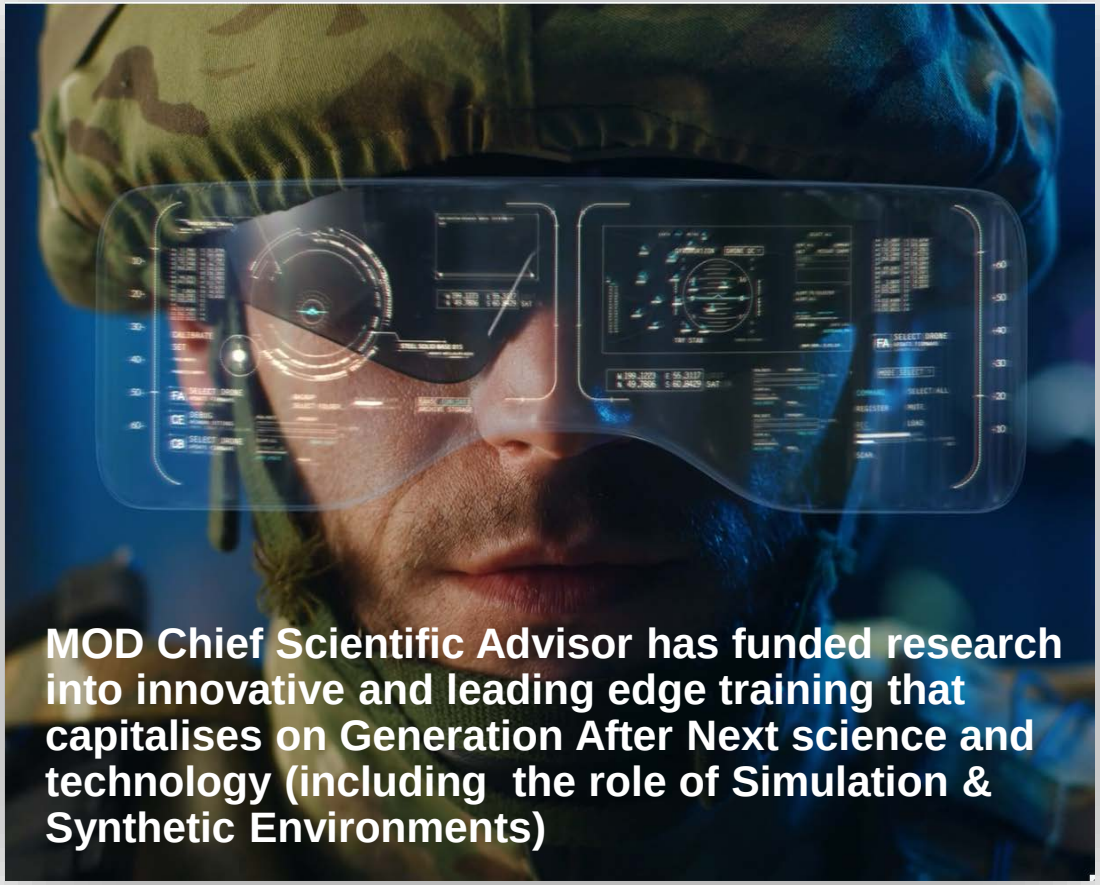


What Next?



S&T Outcomes Desired:

- **Inform future generations of learning systems**
- **Improved learning effectiveness and efficiency**
- **Drive strategic change in learning**

GAN Simulation - S&T de-risking summary

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	Monitor and Understand	**User Facing Systems** Haptics, Extended Reality, Multi-Sensory Stimulation, Brain Computer Interfaces	**IT and Computing** Thermodynamic computing, Web3.0 and edge computing	**Consumer Gaming and Metaverse** Games frameworks, streaming, develop defence view of metaverse
	Deep Applied Research	**Simulation Composition** Driving seamless interoperability and ‘zero integration simulation’	**Representation of the Future Operating Environment (FOE)** Improving representation of complex environments and driving effective MDI	**Exploitation of Digital Twins** Harnessing platform data and single authoritative representations of platforms and systems
	Practical de-risking	**Proving the effectiveness of consumer tech** Benchmarking against Defence requirements for security, ruggedness etc	**Exploitation of AI and Automation** Testing the utility against data at rest and in motion	**Delivering the GAN of instrumented live training and LVC** Fusing edge computing, displays, tracking and networks

Benefits, Opportunities and Risks

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	Benefits	Pull through of COTS capabilities continues to improve immersivity and accessibility of M&S Systems	Improvements to efficiency through use of open architectures, and COTS systems	AI and automation to drive improvements in efficiency and effectiveness
	Opportunities	Future M&S environments enabled by future computing and unconstrained by processing and storage	Ability to represent highly complex and non-kinetic environments	Data driven simulations exploiting open standards and rapid composition
	Risks	Verification and Validation (V&V) of underpinning source data and resulting simulation	Supply chain risks for COTS content	Intellectual Property (IP) risks for digital twins, simulation standards and COTS frameworks

Opportunities with Current NATO MSG activity

- **MSG-195 MSaaS Phase 3**
  - Development of simulation to adopt modern ICT infrastructure such as the Cloud
  - Containerisation, Metadata and other technologies to provide automation and discovery
  - Further research is required in GAN autonomy and efficiency to fully deliver the MSaaS ecosystem approach
- **MSG-198 Composable Human Behaviour Representation in Constructive Simulation Systems**
  - Required to represent and re-use human behaviour representations of the Future Operating Environment
- **MSG-203 M&S to Support Current and Future NATO Operations lecture series**
  - Opportunity to highlight the likely GAN technologies that are maturing for use by NATO and nations
- **MSG-205 Allied Interoperability and Standardization Initiatives for Digital Twins**
  - De-risking the role of Digital Twins to support NATO and the nations and how common approaches can be developed to enable their use
- **MSG-206 Common Framework for the assessment of XR**
  - Common ways of assessing and communicating developments in the consumer domain will be key to tracking and exploiting these technology developments.

Potential gaps in NATO MSG activity

- **The Metaverse**
  - Demystifying what the metaverse means for NATO and the nations.
  - Tracking and maintaining consumer technology developments will require resource and shared understanding across the community
  - Focus development through Military use cases
- **Technology Watch and Horizon Scanning of Consumer Technology:**
  - Need to provide quick insights and evaluations of emerging technology so to enable rapid use of technology as it emerges
  - A whole of community effort through a common way of evaluating, understanding and communicating such relevance will be key
- **Standards Groups**
  - MSG and SISO will need to expand their relationship with other standards organisations such as the Khronos Group and Digital Twin Consortium (among others)

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