Dedicated to innovation in aerospace

Fit for purpose training

Royal NLR - Netherlands Aerospace Centre

Welcome to Royal NLR. Discover more about the innovative training and simulation programmes we develop for military forces and other clients. The common goal is to make training more effective and efficient.

Our vision of military training is founded on competency-based and performance-based training (PBT) concepts using integration and interoperability of live, virtual and constructive elements. Our approach involves a thorough process of analysis, design, development and implementation with the client.

Our staff of nearly 100 people has knowledge of training, simulation, human behavioural assessment and regulations for military forces. This knowledge is combined with applied technical research and development in simulation. NLR actively develops innovative training technologies and training media. These capabilities and our in-house research infrastructure ensure that NLR can oversee the entire spectrum and stay on top and ahead of new developments and innovations in military training and simulation.

NLR – Royal Netherlands Aerospace Centre

Fit-for-purpose training environments

To assure continuous deployment and mission readiness, military forces need to make their training more effective and efficient. The time spent flying must be as effective as possible. This means more customised and cost-effective training. An optimum blend of live and simulated training, combining low and high-fidelity simulations, can help achieve this goal. By incorporating learning analytics, it becomes possible to tailor the training to individual or broader training needs.

Royal NLR believes that a modern vision of training requires a holistic instructional design approach that is capable of handling the high level of integration and interoperability of systems. Only then can a thorough understanding of training needs and an analysis of simulation and evaluation requirements be guaranteed.

The Royal NLR design approach is based on the 4C/ID instructional design system. This is about learning complex skills in a realistic context using four main elements: whole-task training, part-task practice, supporting theory and just-in-time information. In addition to 4C/ID, we advocate performance-based training, in which each individual receives customised training at the most suitable moment using the best blend of training media, based on learning analytics. The design and redesign cycle is then finalised through quality assurance, encompassing validation and qualification.

TRAINING NEEDS ANALYSIS (TNA)

Analyse operational training needs and determine the required competences through a Training Needs Analysis. The result is a competency-based qualification profile that can be used as input for the training design.

TRAINING MEDIA ANALYSIS (TMA)

Develop a training syllabus and select training media such as simulation, AR/VR, after-action review support tools, books, e-learning etc. When no suitable media are available, user requirements need to be specified. The result is a fit-for-purpose training environment in which training media are well balanced and properly integrated into the competency-based training design.

TRAINING DESIGN

Produce a rough outline of the training course. Define the learner scenarios and goals in line with the training needs. Determine and assemble the required whole tasks and part tasks and insert supporting and procedural information where required. The result is a blueprint for training that can be used to develop the training syllabus and define training media requirements.

TRAINING TECHNOLOGY & ECOSYSTEMS

Ensuring that training media meet the defined user requirements often necessitates technical development or improvement. This can involve developing custom VR-based simulators with targeted fidelity, integrating different simulation platforms, or data collection to inform learning analytics. These capabilities may not be available in existing systems. Complex training systems for large organisations will benefit from a well-defined and well-integrated approach to the total system: a learning ecosystem.

LEARNING ANALYTICS

Learning analytics are critical to competency-based and performance-based training. This is the engine of modern learning ecosystems, providing a process to select, gather and analyse more detailed data on proficiencies.

ADAPTATION OF NEW TRAINING SYSTEMS

Modifying your training to include new styles of teaching, new media, learning culture or even just new types of trainees can often also entail a cultural change. Nurturing a shift in organisational culture can be a critical success factor when entirely renewing or changing your training.

Our approach consists of three main elements: stakeholder involvement, trainer and trainee mentoring, and evaluation and feedback.

QUALITY ASSURANCE - SIMULATION & DIGITAL TRAINING DEVICES

Verifying, validating, evaluating and qualifying simulation and digital training devices throughout the lifecycle is extremely important. This will enable organisations to maximise the benefits of combining simulation and digital training media in their civil and military education & training programmes.

Project partners: Dutch Ministry of Defence, Royal NLR

Social Media Simulator

The information environment, especially social media, plays an important role in military operations. However, within European legal and ethical boundaries, the means to train and experiment with multi-domain scenarios in the information environment are almost non-existent. It is therefore important to study and develop methods and techniques to generate the required data.

THE CHALLENGE

Recent incidents highlight the importance of effective training and experimentation in Multi-Domain Operations (MDO). Realistic data is needed to be able to simulate the information environment. However, legislation such as the GDPR prohibits the collection and analysis of online social network data for training and experimentation purposes. To address this challenge, the following set of questions must be answered:

- Which types of open source information are essential for training in Multi-Domain Scenarios?
- How can we generate these types of information using techniques such as Generative AI ?
- What is the best way to set up a training and testing infrastructure for the information environment?

WHAT WE ARE DOING

NLR started by investigating which techniques and algorithms are applicable for generating realistic data. In parallel with these research efforts, a study was performed to determine approaches and architectures suitable for integrating the simulators from the various domains into a single battle lab.
The data generation research focuses on specific parts of the information environment, such as social media and other types of mass communication. The next steps are to extend our research to generate other modalities such as images, video and sound, and simulating complex behaviour of groups on online social networks.

THE SOLUTION

The current deliverable is an information environment simulator driven by generative AI models. The information environment simulator currently consists of simulated social media and news agencies. Generative AI models generate complex personalities and interactions between entities on various topics. Furthermore, the same AI models generate content generally expected from mass communication outlets (e.g. news agencies). The information environment simulator can communicate with other existing simulators by parsing DIS (Distributed Interactive Simulation)/HLA (High-Level Architecture) data. Combining these simulators enables the simulation of the bidirectional influence between kinetic effects in the physical domain and the information environment.

Enabling Distributed Synthetic Training across different Security Domains

CDSiMS

THE CHALLENGE

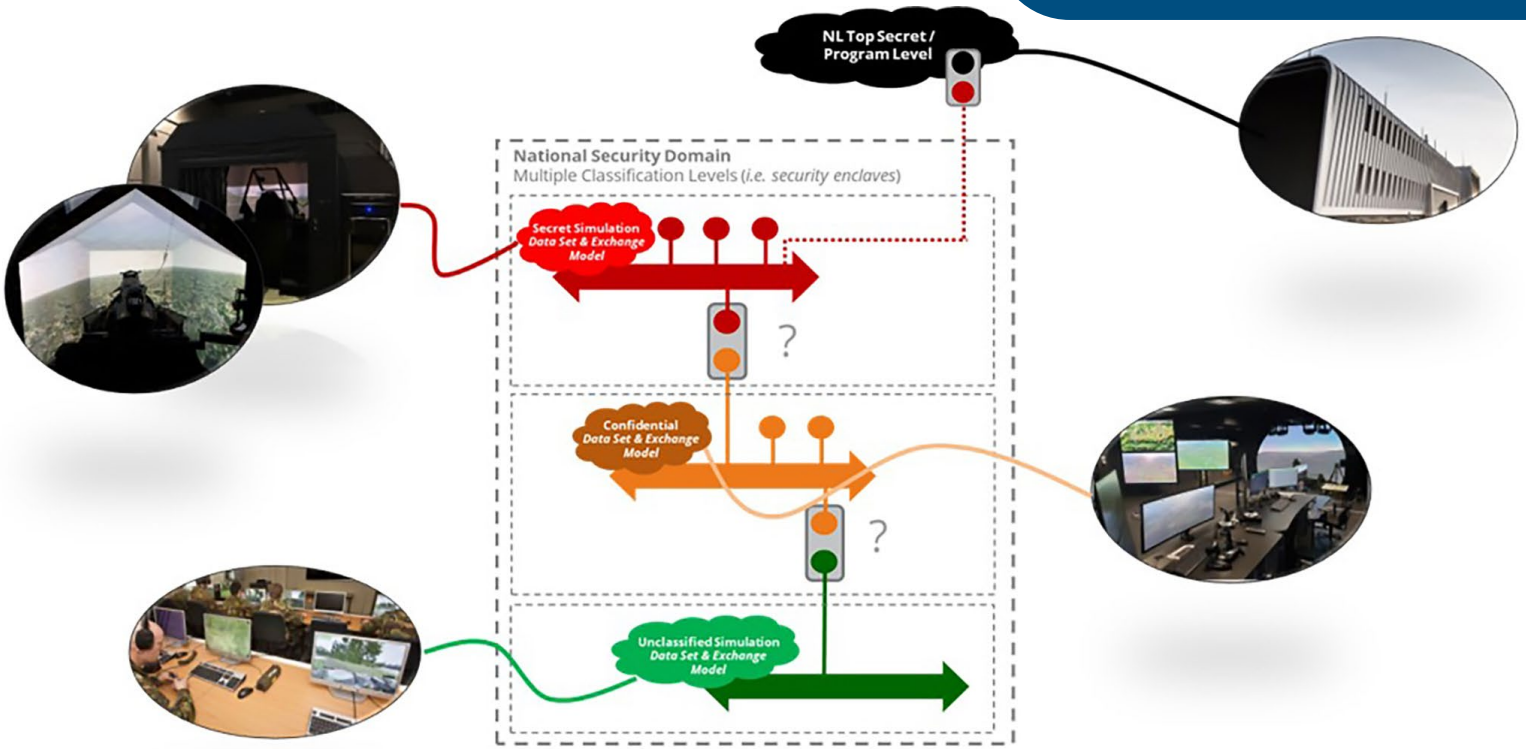
Within Distributed Synthetic Training (DST), simulation assets from different security domains must be able to interoperate within a single training environment. Cross-Domain Solutions (CDS) designed for such training environments are rare. In general, a CDS prevents information leakage between different security domains and protects the overall system integrity. The key challenge is to explore how simulation data can be filtered and processed by a CDS while maintaining real-time performance and training value.

WHAT WE DID

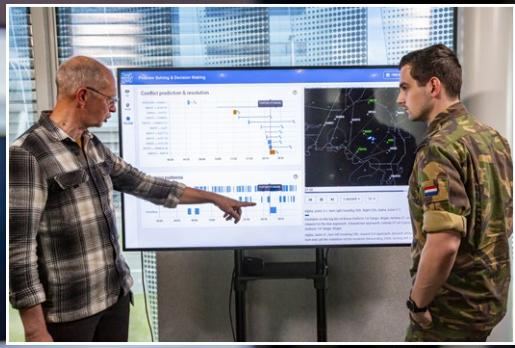
In the context of the "generic high assurance" CDS technology programme of the Dutch Ministry of Defence (NLMoD), Royal NLR joined forces with their Technolution B.V. to develop and evaluate a dedicated CDS prototype for NLMoD DST purposes. The generic CDS platform has been extended to handle HLA, DIS and DDS data. Dedicated simulation data serialisation protocols, filter language and algorithms have been developed. Together with our partner TNO, extensive real-time performance tests were conducted on this CDS solution. A realistic RNLAF and RNLA training use case was used to evaluate the impact on training value. It comprised distributed training scenarios between two NLD-Secret Apache flight simulators and NLD confidential JTACT (Joint Terminal Attack Controller) simulators.

THE SOLUTION

This project resulted in a viable Technology Readiness Level (TRL)-6 CDS prototype that could be used in future to interoperate NLD-Secret simulators for other synthetic training devices that operate in different (inter)national security domains. Its flexible and modular design, with reusable components, facilitates easy deployment of this CDS solution for different simulators within a broad range of distributed training scenarios. The reusable components, which are pre-certified by the national security agency, also expedite the acquisition of official security Approval To Operate (ATO).



Project partners: Royal Netherlands Command Material and IT (Commit), Royal Netherlands Air Force (RNLAF), Royal Netherlands Army (RNLA), Royal NLR, Technolution B.V., TNO



Project partners: Dutch Ministry of Defence, Royal NLR, TNO

Adaptive Learning Ecosystems

Realising performance based training for military ATC training

With Performance-Based Training (PBT) we seek to support personalised training through enhanced performance metrics, learning analytics and support to all stakeholders in the learning and development process. The Adaptive Learning Ecosystem Programme works towards tailored concepts for Royal Netherlands Forces, providing a reference architecture and maturing advanced analytics. The INSPECT (Instructor Support for Performance Based Training) project provides an example, focusing on instructors' insight into trainees' cognitive processes.

THE CHALLENGE

Learning Analytics often focus on the needs of training managers. In the INSPECT project, we aim to support the learning process itself by supporting the instructor acquire insight into trainees' cognitive processes, related to:

- Situational Assessment
- Workload Management
- Problem Solving & Decision Making

WHAT WE DID

The INSPECT project resulted in two prototypes to support analytics within a training session with:

- an Instructor Live Tool, which provides real-time insights into the trainees' Situational Assessment
- a Debrief Tool that allows instructors to review and analyse training sessions with trainees focusing on the three cognitive competencies.

The Adaptive Learning Ecosystems Programme develops predictive performance models to support personalised learning over a range of training sessions.

THE SOLUTION

An elementary learning ecosystem is needed to store and process large amounts of data from various systems within the existing training environment. The data includes eye-tracking data, audio recordings, and radar screen recordings. An analysis framework enables the calculation of metrics from this data. Meaningful usage of the data requires a user-friendly and comprehensive dashboard.

LVC for Joint and Combined Air Power

Training in simulation-based environments yields cost and material reductions, though Live training will always be essential for a balanced training programme. Training with Live systems, Virtual simulators and Constructive forces in one environment really pushes the boundaries of traditional training as it offers a more realistic, immersive experience. An integrated LVC capability also facilitates testing of new training concepts for fifth generation platforms.

THE CHALLENGE

LVC incorporates Live, Virtual, and Constructive elements into one training environment. How to set up seamless and effective LVC exercises while ensuring optimal training value for all participants is not fully understood. This remains one of the most challenging issues of Modelling and Simulation for modern Air Forces. There is a lack of interoperability, limited reuse and loose integration between the Live, Virtual and Constructive assets across multiple simulation and training environments. NLR focuses on efficient and user-oriented LVC concepts for training in the Air Domain.

WHAT WE ARE DOING

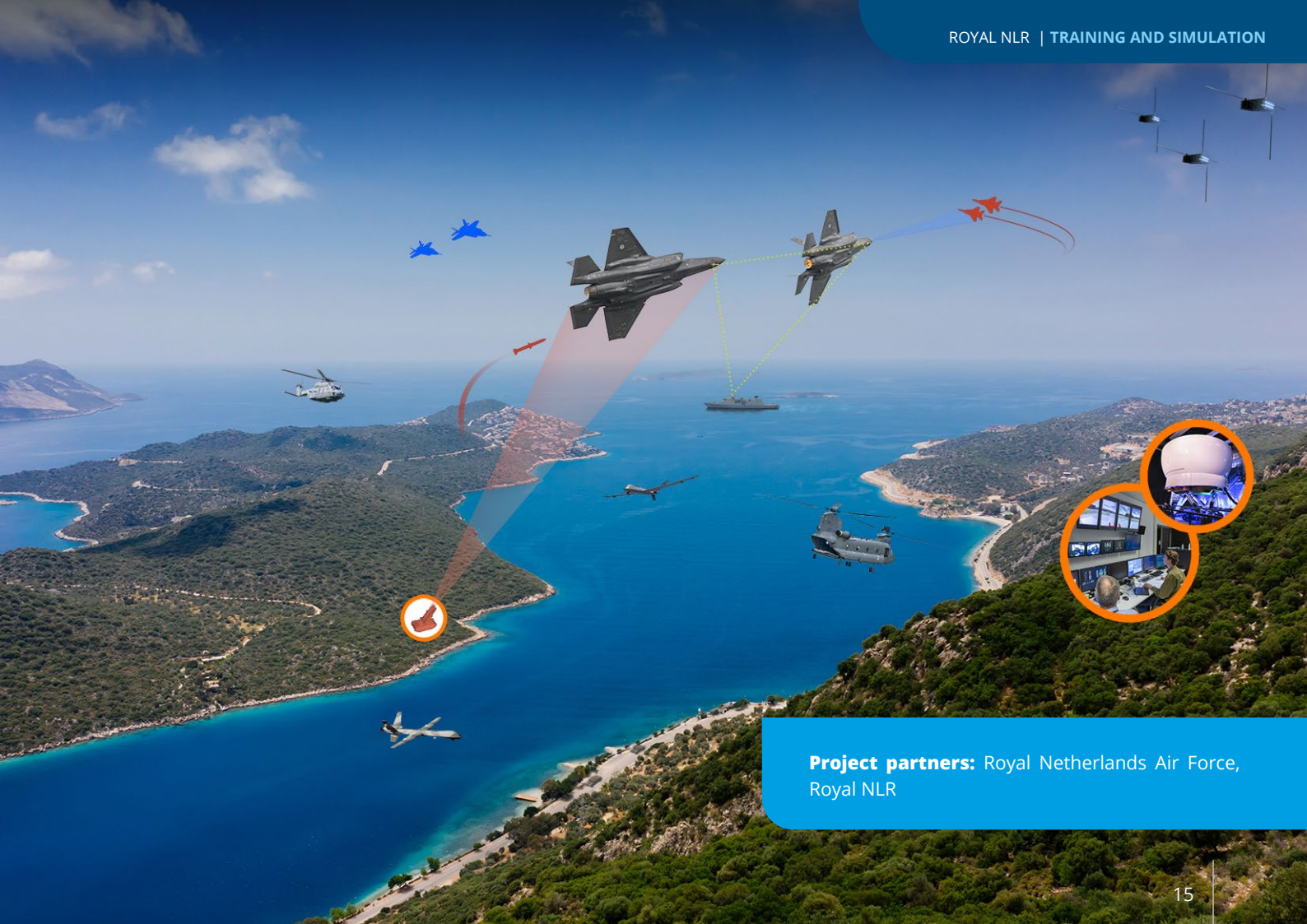
NLR has identified concepts and solutions relating to LVC training development, integrated service-oriented architectures, datalink and communication technology and LVC exercise operations. Topic-specific knowledge, processes and technology - known as building blocks - are combined in an overarching Air LVC concept. An LVC architecture is determined and used to implement a specific air domain LVC capability with existing systems, networks and tools. This capability has been tested and demonstrated at the operational exercise Frisian Flag 23. In this exercise, NLR investigated the technological requirements to facilitate LVC training using an operational datalink and identified the training benefits offered to pilots.

THE SOLUTION

The goal is to determine how LVC solutions can be exploited to enhance Air Power effectiveness, in collaboration with the Royal Netherlands Air Force.

This has resulted in:

- LVC concepts for flexible and scalable training in the Air Domain
- Testbeds and demonstrators of LVC technology
- Experimental tests of innovative LVC solutions connected to Live exercises
- Recommendations on how to use LVC environments for Concept Development and Experimentation



Project partners: Royal Netherlands Air Force, Royal NLR

Project partners: Dutch Ministry of Defence, Royal NLR, TNO, MARIN

Optimising training effectiveness in X-Reality

Extended Reality (XR) technologies, such as Virtual Reality (VR) and Augmented Reality (AR), are gaining popularity in the training sector due to their flexibility, cost efficiency and the level of immersion they provide.
However, the effectiveness of XR-based training is often compromised due to users experiencing side effects during use, as well as lingering aftereffects that can persist for hours after training completion.

THE CHALLENGE

Quantifying and mitigating side effects, such as cybersickness, is essential to achieve higher training effectiveness. Key obstacles also include navigating complex interactions between real and virtual objects. By understanding and overcoming these challenges, we can harness the full potential of XR technologies, leading to enhanced training outcomes.

THE SOLUTION

The results of the projects are aimed towards developing technical solutions and guidelines to mitigate cybersickness and other negative effects in XR-based training. Key outcomes include a method to quantify perceptual deviations in mixed-reality interactions with real objects. Additionally, guidelines for visualising real and virtual environments for cybersickness mitigation have been established, providing a foundation for improving XR experiences and reducing adverse effects.

WHAT WE ARE DOING

Two ongoing research projects examine how XR environments affect users negatively. To gain insights into these effects and evaluate mitigation techniques, human-in-the-loop experiments are conducted using a head-mounted display with flight simulation software, incorporating either a fully virtual cockpit or a partly physical cockpit. Careful consideration is given to the visualisation of both real and virtual environments, aiming to minimise adverse effects while preserving the user's sense of presence and monitoring the effect on the training process.

NH-90 Full Mission Flight Trainer Evaluation

Evaluation of NH-90 simulation device compliance

THE CHALLENGE

The purpose of this project was to evaluate the compliance of the NH-90 simulation devices with their respective regulations and/or standards. The NH-90 simulation can be split into two devices that can be used separately for specific crew training or combined for full mission flight training.

Simulation modes:

- Full Flight Simulator (FFS) used for pilot training
- Virtual Sensor Trainer (VST) used for sensor operator training
- Full Mission Flight Trainer (FMFT), used for mission training with pilots, tactical coordinators and sensor operators.

WHAT WE DID

For evaluation of the FFS, the NLR evaluation team first assessed the Qualification Test Guide (QTG) of the FFS. Based on the results of this appraisement, the project team determined if an onsite evaluation could be conducted. That took several days, during which the devices were evaluated objectively by rerunning QTG tests, functionally, and subjectively as per the regulation set. The VST cannot provide objective data, so all tests performed on the VST were subjective and functional tests.

Furthermore, the military aspects of the devices are not accounted for in the civil regulations agreed between the simulator operator and the manufacturer. To gain an understanding of the military/tactical capabilities of the devices, interviews were conducted with experts of all crew types involved in operations on the devices.

THE SOLUTION

The result of the project was an evaluation process (including V&V reports), making it possible to determine:

- whether the NH-90 FFS, VST, and FMFT are performing in accordance with the relevant regulations that will ensure safe operation of the NH-90 and its subsystems.
- whether devices are suitable for training pilots, sensor operators and tactical coordinators in both individual tasks and mission settings.

Project partners: Project Bureau NH-90, Test Flight Office, Royal NLR

Multi-Ship Multi-Type Helicopter Simulation Training Capability

Acquisition & Deployment Support

THE CHALLENGE

The RNLAF is currently acquiring and deploying a unique multi-ship multi-type (MSMT) helicopter simulation training capability to support the fight, tactical and whole-task mission training of CH-47F and AH-64E crews at all operational levels. The MSMT capability will incorporate a large number of high-end simulation training devices, a tactical control centre (TCC), an after action review (AAR) and training mission development systems within a single flexible, scalable and easily expandable training environment that will have to cover a wide range of training needs. The MSMT programme is a highly complex and demanding undertaking, with numerous RNLAF stakeholders and industry parties involved in its acquisition and deployment, as well as the many challenges and risks inherent in achieving the envisioned objectives.

WHAT WE DID

The MSMT programme was formulated as a staged process where each phase results in a training capability with limited but clearly scoped functionality. To guide the process, the MSMT training capability concept of operations (ConOps) has been developed with the RNLAF end users along with a comprehensive simulation training system architecture.

Throughout each programme phase, a multi-disciplinary team of NLR experts conducted activities that include:

- Corporate and platform specific TNA/TMA
- PoR development for simulators, TCC and AAR
- RFI/RFP development and response assessment
- Engaging and challenging industry parties
- Integration testing and validation of industry deliverables
- Simulation training method and technology CD&E
- RoI analysis and decision-making assessment
- Training programme optimisation for using the capability
- Training mission development and operations support

THE SOLUTION

The project results in a full lifecycle support process that reduces the burden on both the Dutch Defence Materiel Organisation (DMO) and the RNLAF in acquiring and deploying the MSMT capability. A support process that ultimately leads to the most versatile mission simulation training environment possible with the highest level of interactivity for the RNLAF within the programme budget and timeframe. Continuous availability and direct access to a dedicated pool of NLR training and simulation experts deployable at key positions within the DMO, RNLAF and contracted industry parties.

Project partners: Dutch MoD (Defence Materiel Organisation), Royal Netherlands Air Force Defence Helicopter Command, Royal NLR

Project partners: Dutch Ministry of Defence, Royal NLR

Decision support in military tactical operations

Enhancing military decision-making using AI and simulation

THE CHALLENGE

Technological developments in Artificial Intelligence (AI) are evolving at a rapid pace and offer many opportunities for military applications. The use of AI to support military decision-making has been identified as a key application area in many national Defence roadmaps for AI. However, applying AI algorithms for decision-support in complex, dynamic, and uncertain environments remains a challenge, as solutions need to be robust, transparent, and trustworthy to gain human acceptance.

WHAT WE ARE DOING

In this Defence research programme, NLR develops knowledge to enhance operational capabilities and the employment of decision-support tools in tactical operations. Through a variety of projects, we investigate the use of Artificial Intelligence and Modelling & Simulation to support operators and commanders in areas such as:

- Enemy intent recognition
- Tactics optimisation and human performance analytics
- AirC2 course of action generation and evaluation
- Helicopter mission planning & battle position planning

THE SOLUTION

The investigated areas for decision support are being explored in proof-of-concept demonstrators and validated with end users in order to maximise their operational value.

Virtual Assistant for next-generation cockpit environments

Supporting Human Autonomy Teaming in future fighter operations.

THE CHALLENGE

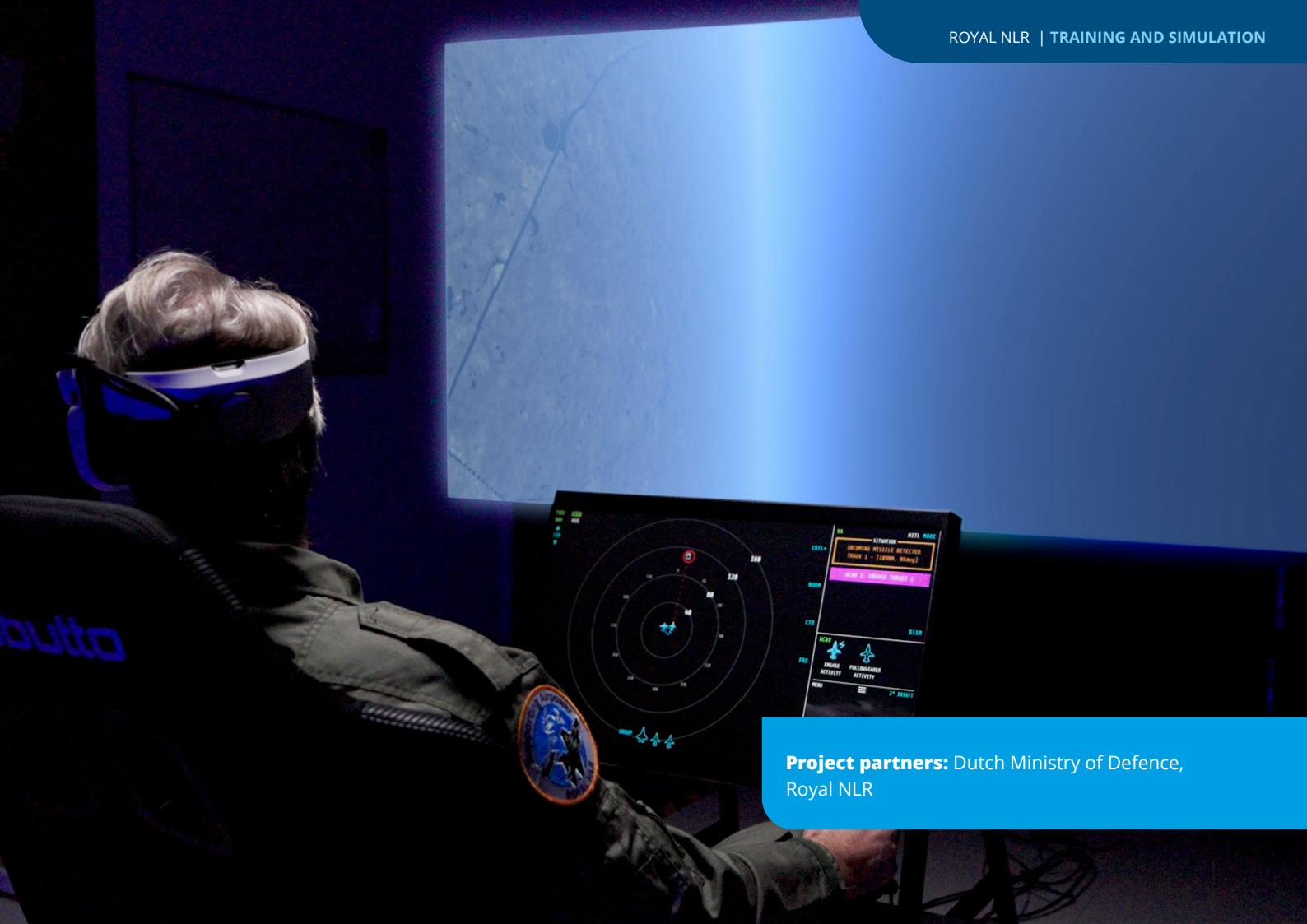
The future military battlefield will feature increased autonomy in both manned and unmanned platforms, where human pilots need to collaborate with unmanned combat aerial vehicles (UCAVs). This new Human Autonomy Teaming (HAT) task environment will affect the role of the operator, impacting situational awareness and the workload. The lack of proper assistance in the cockpit environment may lead to degraded performance, compromising overall mission effectiveness, safety, and success.

WHAT WE ARE DOING

NLR investigates concepts for a Virtual Assistant in a future cockpit environment that supports the operator in situational awareness, tactical decision-making, and teaming with UCAVs. The research includes strategies for HAT, adaptive automation, workload management, and multimodal human interaction.

THE SOLUTION

We developed a Virtual Assistant testbed that supports HAT in future fighter operations. The testbed enables a human-centred design approach for intelligent assistance in the cockpit through human-in-the-loop experiments. Integrated into NLR's Battle lab simulation environment, pilots can be subjected to future battlefield scenarios with high autonomy potential, informing relevant human factors and training research.



Project partners: Dutch Ministry of Defence, Royal NLR

Smart Bandits

Intelligent opponents in mission simulation

THE CHALLENGE

In military simulations, computer-generated forces (CGFs) are autonomous entities that represent friendly, neutral or hostile air, ground surface, or subsurface-based units, platforms or individuals. The behaviour exhibited by CGFs is modelled to mimic realistic human behaviour, as well as that of existing and emerging autonomous systems. CGFs are typically used in training, concept development and experimentation (CD&E) or decision-support applications. For each application, the CGFs require different behaviour models. However, traditional modelling techniques do not give scope for expression and keep modellers from quickly developing new models. Additionally, modelling coordinating masses such as drone swarms requires new tools that make use of the latest developments in computation. Constant innovation in the area of behaviour modelling is therefore required.

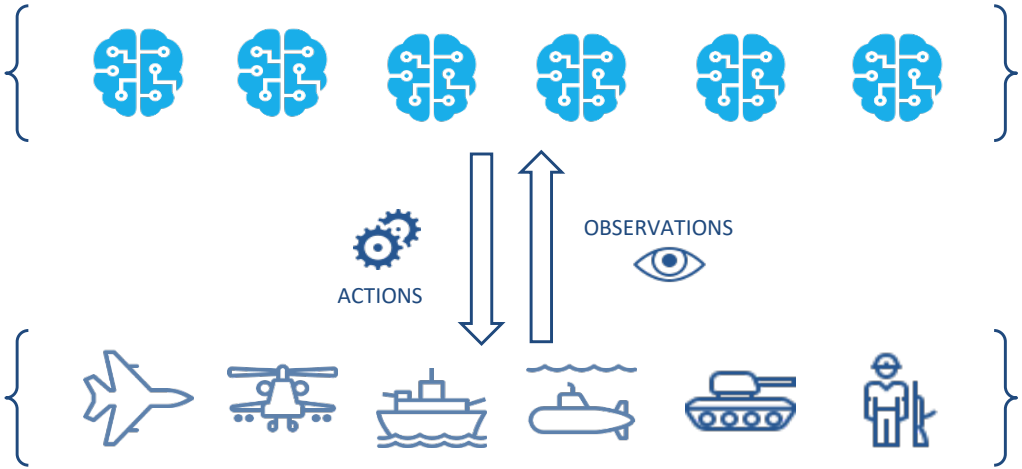
WHAT WE DID

The Smart Bandits project aims to explore various approaches to modelling human-like behaviour. To this end, we carried out research in two main directions, namely human behaviour and computational modelling. In the former, we specifically studied situational awareness (i.e. perception of the environment) and theory of mind (i.e. beliefs, desires and intentions).

In computational modelling, we studied the use of machine learning techniques for enhancing classical modelling techniques such as finite-state machines and behaviour trees. A key component of the Smart Bandits project was the evaluation of newly developed techniques in human-in-the-loop simulations, such as in NLR's Fighter 4-Ship networked F-16 simulator.

THE SOLUTION

The results of the studies have been combined in a user-friendly graphical behaviour modelling tool. The tool was named Smart Bandits (after the project). It lets modellers quickly implement behaviour models and link the new models to the CGFs in a simulation engine. While the CGFs make their observations in the simulated world, the Smart Bandits tool calculates their next actions. During simulations, the behaviour models can easily be inspected to see what the CGFs are thinking. Apart from being an intuitive modelling tool, Smart Bandits continues to be a platform for behaviour modelling research. NLR is continuously experimenting with new modelling techniques and new ways of interacting with CGFs, for example in the areas of cognitive modelling and coordination with autonomous collaborative platforms (ACPs).



SMART BANDITS
DECISION MAKING MODEL

SIMULATION ENGINE
PHYSICAL MODEL

Project partners: Royal NLR,
VU University Amsterdam

BROAD RANGE OF RESEARCH AND TESTING APPLICATIONS

- OPERATIONAL AND TACTICAL DOCTRINE DEVELOPMENT
- MULTINATIONAL COLLABORATIVE DEVELOPMENTS
- 5TH GEN AIRFORCE
- INFORMATION-DRIVEN OPERATIONS
- CONCEPT DEVELOPMENT & EVALUATION FOR OPERATIONS AND TRAINING
- SERIOUS WARGAMING

Warfighter focused CD&E

Cerebro: testing environment for research, development, testing and evaluation

All NLR simulators and tools for defence are integrated into Cerebro, a battle lab environment in which concepts for military operations developed, tested and evaluated - Concept Development and Evaluation (CD&E). It has a broad range of research and testing applications, such as investigating data-driven operations and multi-domain operations issues in a broader context.

KEY FEATURES

Cerebro integrates existing high-fidelity platform simulators and tools with additional proof-of-concept demonstrators and tools. It can also extend to other external battle lab environments, and be connected to live systems. Our facility supports both small and larger projects that require multiple simulators to work in an integrated environment. Consequently, this reduces costs for testing and development, and enables assessment of new functionalities concepts in a safe and classified environment.

TECHNICAL SPECIFICATIONS – SIMULATION SET-UP

The NLR CD&E infrastructure is based on a virtualisation solution. This allows for quick configuration of simulation tooling and scenarios, and rapid deployment of simulation exercises to end users. The core services are readily integrated, such as terrain databases, scenarios, chat, and simulation backbone. Cerebro's simulators include the CDEF F35 simulator, the helicopter pilot station (HPS), the multi-UAS supervision testbed (MUST), and others. Tools include the weapon engagement simulation tool (WEST) and the threat reference manual (TRM).

BATTLE LAB BASED ON VIRTUALISATION

The Cerebro infrastructure offers:

- Quick configuration of simulation tooling and scenarios
- Rapid deployment of simulation exercises to end-users
- Core services readily integrated, e.g. terrain databases, scenarios, chat, simulation backbone
- Promotes quick and agile development of simulation experiments

SCOTT: Smart Controller Training Tool

Diverse and realistic scenarios for fighter controller training

Fighter controllers are essential for the safety and effectiveness of fighter pilots. They provide the pilots with a complete and correct air picture. Fighter controllers must be well trained to observe, assess and communicate in rapidly evolving situations. This includes training scenarios that are diverse and have realistic fidelity and scale in terms of the platforms involved and their behaviour.

THE CHALLENGE

Training and educating fighter controllers is often highly labour-intensive, as well-designed and user-friendly tools to simulate air engagements are not readily available. Frequent training with live assets in the air is costly in terms of logistics, coordination and the number of platforms (blue and red) required. Typically, generating realistic behaviours for constructive platforms requires human input. The challenge, therefore, is to achieve the desired level of realism with minimal human intervention.

WHAT WE DID

NLR developed the SCOTT tool to enable the design and execution of air-to-air combat scenarios, which can contain autonomous and semi-autonomous tactical constructive entities. NLR added realistic tactics and missile performance that can be specified to national requirements.

These are based on tools that were developed in-house: Smart Bandits (AI behaviour) and WEST (missile performance).
This resulted in a user-friendly tool for easy control of the scenario and adjustment to the desired learning objectives.

THE SOLUTION

Royal NLR designed and developed SCOTT as an easy-to-use tool for instructors and pseudo-pilots for fighter controller training. SCOTT is a tool that can create realistic tactical simulation exercises using artificial intelligence (AI), consisting of both Blue and Red air platforms. It can run air-to-air combat scenarios autonomously, but a human can intervene in the tactical decisions of the constructed air platforms. As the scenarios are easier to control, larger tactically relevant scenarios can be implemented. SCOTT presents these scenarios via DIS to the operational system for fighter controllers. Interoperability between SCOTT and other simulator systems is also possible, e.g. for LVC or MTDS exercises


SCOTT
Tactic A
Tactic B
Tactic C
SAND BOX

Project partners: Royal Netherlands Air Force (RNLAF) Defence Equipment Organisation (DMO)**,** Royal NLR, Netherlands Organisation for Applied Scientific Research (TNO)

F-35 Acquisition & Operational Readiness Preparation

Design and construction of multiple training and evaluation plans

THE CHALLENGE

NLR helped the RNLAF with F-35 acquisition and operational readiness by focusing on transforming the Defence Materiel Organisation (DMO) into a smart buyer, and assisting the RNLAF with a smooth transition from the F-16 to the F-35. Within this programme, multiple training & education projects have been carried out to design and improve training for pilots, maintenance staff and mission support crew.

WHAT WE DID

The training methods, tools and activities used by NLR throughout the F-35 programme include:

- Training Needs Analysis (TNA) for pilot maintenance staff and mission-support roles
- Design of an F-35 pilot competency profile, initial and recurrent training course content
- Training Media Selection Analysis (TMA)
- Business case for a Maintainer Training Centre (MTC)
- Multi-Spectral DataBase (MSDB)
- Continuation training, including Performance-Based Training (PBT)

THE SOLUTION

The activities mentioned helped to develop a variety of products and services, including:

- Initial and recurrent training course content for pilots and maintenance staff
- Design and execution of an Operational Test & Evaluation plan for Continuation Training
- Design and construction of a WLT (Weapons Loader Trainer), including augmented reality applications

Augmented reality for maintenance training

THE CHALLENGE

KLM expressed the need for more innovative training media to modernise and improve maintenance training.

WHAT DID WE DO?

To ensure seamless integration of training media, the project started with a review of the existing training design and an analysis of current training content. This was followed by an investigation into the added value of Augmented Reality (AR) for aircraft systems that are challenging to train through traditional classroom methods. Requirements for the AR application and training design were defined before starting actual development. Finally, the prototype was evaluated through an experiment.

The project was performed in a highly interactive and agile manner. Bi-weekly sprints were held with experts from relevant areas, such as maintenance experts, application developers, human-machine interface experts, and educational experts, to ensure accuracy and acceptance of intermediate and final results.

THE SOLUTION

The result of the project is a modernised, problem-based training design for maintenance training that enhances understanding of the systems and system interaction. This design involves less traditional instruction and more trainee activity via paper-based assignments and problem-based AR scenarios.

The experiments showed that trainees perform better when using AR that is fully integrated into the training design; they retained more information, gained a deeper understanding, and had longer retention times compared to traditional classroom training. Key lessons learned include the importance of shared AR and a 20-minute limit for wearing AR goggles.

Project partners: Royal Dutch Airlines KLM, Royal NLR

Research organisation: Royal NLR
(knowledge development project)

Simulation-based Analysis of Logistics and Sustainment for the Armed forces

Simulation for the operational level

THE CHALLENGE

Military staff are concerned with the planning, preparation, conduct, and sustainment of tactical action. The intricate networks involved in supplying, maintaining, and transporting assets pose significant challenges to staff, from predicting demand and managing supply chains to ensuring the readiness of equipment and personnel.

WHAT WE DID

NLR investigated how simulation solutions may support the operational level. Traditional logistical simulations are highly detailed but lack insight into military needs. The rapidly changing security landscape calls for tools that allow commanders to easily test the effects of new operational concepts. This is what NLR aimed to capture in its new simulation model.

THE SOLUTION

SALSA (Simulation-based Analysis of Logistics and Sustainment for the Armed forces) is NLR's concept for comprehensive logistical simulation. It aims to support the operational level by simulating the effects of operational choices on military effectiveness, given a logistical network. The tool is designed to identify logistical bottlenecks, determine the maximum sustainable operational tempo, and predict the effects of disrupting events, providing data analysis and visualisation to aid military staff in their decision-making. With SALSA's integrated dashboard, the commander can focus on questions such as 'What mission tempo can we sustain in a crisis?' and 'What is the most successful course of action in case of a resource shortage?'. It enables the Armed Forces to make critical choices on day one and ensure ongoing success.

NLR in brief

One-stop-shop

Global player with Dutch roots

100+

Since 1919

Amsterdam, Marknesse
Rotterdam, Noordwijk, Brussel

Innovative, involved and practical

For industry and governmental

For civil and defence

800+
staff

€ 127 M turnover

78% Dutch, 19% EU and 3% worldwide

Active in 24 countries

Very high customer satisfaction

About NLR

Royal Netherlands Aerospace Centre

NLR is a leading international research centre for aerospace. Its mission is to make air transport safer, more efficient, more effective and more sustainable. Bolstered by its multidisciplinary expertise and unrivalled research facilities, NLR provides innovative and comprehensive solutions to the complex challenges of the aerospace sector.

NLR's activities span the full spectrum of Research, Development, Testing & Evaluation (RDT&E). Given NLR's specialist knowledge and state-of-the-art facilities, companies turn to NLR for validation, verification, qualification, simulation and evaluation. They also turn to NLR because of its deep engagement with the challenges facing our clients. This lets NLR bridge the gap between research and practical applications, while working for both government and industry at home and abroad.

Royal NLR stands for practical and innovative solutions, technical expertise and a long-term design vision regarding their fixed-wing aircraft, helicopters, drones and space exploration projects. This allows NLR's cutting-edge technology to also find its way into successful aerospace programmes of OEMs like Airbus, Boeing and Embraer.

NLR supports military forces in addressing any challenge in modelling & simulation, ensuring effective realism and cost efficiency.

Royal NLR:

- helps you define your training & simulation strategy
- performs operational training needs analysis
- designs training blueprints
- develops training media to meet training needs
- supports training implementation
- carries out training evaluation

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E1582-07 - November 2025