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Modelling and simulation in the defence technology sector

Modelling and simulation (M&S) are closely associated not only with the Bundeswehr's reorientation to an expeditionary warfare role and the modernization of many other security and armed forces around the globe: M&S also figures prominently in Rheinmetall's plans for the future.

Modelling and simulation play an important role in helping the Bundeswehr to prepare and conduct its missions. Rheinmetall has been a proud supplier of simulation and training systems since the 1970s. Today M&S accompanies a soldier's career from basic training right through to certification of combat readiness and mission execution.

The purpose of M&S is to improve forecasting abilities, to support competent and comprehensive decision making, to identify innovation potential at an early stage, and to put these into action through the efficient use of resources at reasonable cost and risk.

M&S supporting an armed forces mission

The Bundeswehr's M&S sub-concept, dated 6 March 2006, specifies four areas where M&S is used within the German armed forces: analysis and planning; requirement identification and fulfilment within the customer product management (CPM) framework; operations; and training and exercises.

In all of the aforementioned areas, M&S can help to support the decision-making process as part of such established processes as operational research (OR), concept development and experimentation (CDE), customer product management (CPM) and individual training, including mission preparation.

During analysis and planning, the underlying objectives and capabilities of the armed forces need to be examined and introduced into the operational planning process. In terms of technology, the requirements imposed on M&S lie first and foremost in being able to quickly and flexibly provide the necessary analysis capabilities and capacities for these situations and scenarios.

When it comes to procurement, M&S can help to identify capability gaps, to develop proposals for bridging them and to serve as a test bed for prototypes and systems under development. Furthermore, M&S is useful for conducting trials and operational

testing of systems as well as for fostering interoperability with other systems. For example, high-performance hardware and software such as the “Verteilte integrierte Erprobungslandschaft” – “distributed integrated test bed” or VIntEL – make it possible to simulate the impact of integrating a certain subsystem on a weapons platform – mounting a guided missile launcher onto an infantry fighting vehicle, for instance – and thus to determine what parameters would have to be taken into account in real life. In a naval context, combat direction systems are one of the most challenging systems, dealing as they do with complex sensor and weapon suites. Powerful and advanced sensor and weapon simulation provides a test and training environment for teaching naval personnel to handle and deploy these systems effectively.

Moreover, M&S can be useful for actual mission support. Sophisticated simulation systems are available for analysing op plans or for evaluating past operations in order to incorporate lessons learned into subsequent plans. It is possible to enter actual terrain data from an area of operations – or a single segment of it – into the software of a training simulator. This makes it possible to scout out approach or escape routes, for instance, and thus to weigh possible tactical options in advance. As a decision-support system, M&S today already helps users to understand environmental effects such as underwater sound propagation or ducting effects in radar propagation, which have a direct impact on sensor and weapon effectiveness. With augmented reality and future real-time analysis systems, it will be possible to enhance a crew’s situational awareness and ability to respond more effectively in critical situations as well as to forecast future situations.

Another vital area of M&S activity involves providing support for basic and advanced training, along with training in command and decision-making processes. Simulation-based training systems help trainees to learn about their systems both from an operator’s and a maintainer’s standpoint. Part-task trainers can be used to train personnel to perform specific tasks, e.g. driving a tank, handling a ship’s sonar system or steering a submarine while experiencing its original dynamic behaviour. Full mission simulators help crews to understand the complex effects involved in conducting a mission scenario in a real environment. M&S of course has to comply with the one of the fundamental principles of training: train as you fight. Using M&S for training therefore helps to save resources and to train more efficiently when using real systems... M&S is thus vital for achieving combat readiness.

The Bundeswehr’s simulation and test environment

In 2009 Rheinmetall won the competition to develop systems for the simulation and test environment for the German military. Known as SuTBw for short, it forms the technical basis for conducting experiments, tests and synthetic exercises in a networked environment of simulation systems involving real systems.

Rheinmetall, in its capacity as main contractor for simulation and network systems, is in charge of coupling simulated and real systems at 27 Bundeswehr locations in

Germany and one site in the United States. A particularly useful feature of the SuTBw is being able to couple different simulation systems and real systems with widely varying capabilities to integrate different information and protocol layers through gateways in order to create high-performance “systems of systems” simulations, which in turn enables the armed forces to conduct complex joint and combined tests and exercises. Furthermore, national and international sensor, weapon and C4I systems can be included in this IT infrastructure.

This Rheinmetall-built simulation and test environment makes a valuable contribution to networking and coupling national and international simulation and real systems as well as integrating tactical data link and command and control information systems. Given its multifaceted performance spectrum, the SuTBw forms an important element in the creation of a network-enabled warfare capability.

Areas of military simulation solutions

First of all, military simulation solutions encompass virtual simulators. These are used at levels below small-unit tactical training to impart the necessary skills and prepare troops to perform their individual missions. This includes, for example, computer-based training (CBT) as well as part task trainers (PPT) to train individual skills. For example, infantry fighting vehicle gunners can prepare for live-fire training in simulators such as the AGSM, a system specifically designed for the Marder IFV. Remote-control weapon simulators are used to train operators to handle a specific weapon system on board naval vessels.

Within the virtual simulation, simulators can be used to train crews in tactics at unit level. Examples are the AGPG combat simulator for mechanized infantry platoons, anti-submarine warfare simulators, and flight training devices. Looking ahead, networked simulations for army, navy and air force platforms will provide joint synthetic training and mission preparation capabilities. For example it will be possible to train a joint fire support team interacting with different crews of a fighter-bomber, a land-based spotter and a supporting frigate.

Live simulation at unit and battalion level supports effective real world training, enabling tactical training for entire units, up to and including major combat formations. At live training centres like the combat training centre run by Rheinmetall in cooperation with the German Army near Hannover, it is possible to train units in missions as varied as peacekeeping operations and high-intensity combat in a combined arms environment. In live simulations, exercise participants use their original equipment and manoeuvre across a major training area. Participants and their equipment interact using laser duel and communication systems. Every movement, every action, every radio transmission, etc., is recorded for post-op analysis. Besides supplying reliable simulation technology, hardware and software, the defence contractor’s role here includes operating the infrastructure as well as keeping it up and running.

Finally, constructive simulations are used to train leaders at operational level. Here, simulated manoeuvre elements operate in a simulated environment. A well-known system for constructive simulation is Rheinmetall's Advanced Naval Synthetic Environment ANSE. This system forms the core of all Action Speed Tactical Trainers from Rheinmetall and is also the core system for naval testing and training systems. ANSE is capable of serving multiple scenarios with more than 1,000 targets in a sophisticated simulation interacting with a complex environment, giving instructors the ability to define their own specific targets through various parameters based on behaviour experienced out in the real world.

Current challenges

An effective defence technology industry has to serve the armed forces with advanced simulation technology that provides troops with as realistic training environment as possible, helping to prepare them for the many complex situations they are sure to face.

The current technical challenges arise first and foremost from altered strategic settings. Today's armed forces operate in a joint and/or combined environment, i.e. in cooperation with other services, civil agencies or foreign armed forces. Moreover, they have to be ready for a whole host of different missions. This expanded operational spectrum leads to higher requirements with regard to simulation. Scenarios such as peace-enforcement operations require a multitude of actors – own troops and allied units, civilians, irregular elements and opposing forces – all of which have to be depicted, frequently in a complex setting.

The simulation depiction of these complex scenarios must proceed at a realistic, natural pace. This too requires sophisticated, high-performance hardware, software and a great deal of know-how.

Another important task is networking various simulator sites for joint and combined exercises. Enabling various participants to take part in exercises at multiple sites requires high-performance, service-oriented architecture as well as central data storage and maintenance, which, thanks to short running periods, can create virtual major training areas and distribute and process the corresponding data.

Increasingly often, customers insist on the integration of commercial-off-the-shelf ("COTS") components. A prominent example is the incorporation of game-based technology into military simulations. Rheinmetall simulations now combine the strengths of game engine visualization with the high-fidelity replication of modern simulators, thus giving users the best of both worlds.

Outlook

In light of the aforementioned increase in "jointness" and combinedness" among military customers, major future tasks will include standardization of interfaces and databases in order to make different simulation systems compatible with each other at national and international level.

Furthermore, the simulation industry will have to take the rapid pace of change into account. A realistic depiction of the ever-evolving real world requires constant updating of existing systems. The accelerating pace of change applies equally to procurement. The defence industry has to be able to meet its customers' needs more quickly.

As one of the world's leading suppliers of defence technology, Rheinmetall is ready and willing to take on future challenges in the field model building and simulation.

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