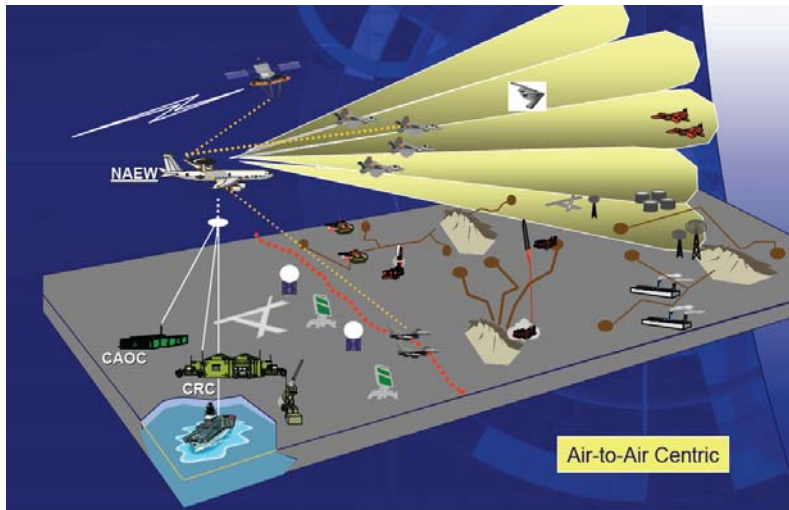




Executive summary

AWACS Training Concept and Media: The Need for DMT



Problem area

The NATO Airborne Early Warning & Control (NAEW&C) team serves to provide for airborne surveillance and command, control and communications functions for offensive and air defence forces. It provides the means to detect, identify, track and intercept airborne threats. The current NAEW&C training concept has to deal with the special considerations of multinational team with high rotation tempo and training media. The training program has been fundamentally unchanged since the early 1980s aside from minor process and course content improvements.

After returning from the Kuwait Theatre, C2 operators indicated that they were not adequately prepared using existing training capabilities.

They felt overwhelmed by the magnitude and intensity of the operations there. Many tasks that needed to be routinely performed were seldom practiced in training exercises. Fact is that the mission of the E-3A has become more complex than in the 1980s and additional systems like have made the job more difficult.

While the NAEW&C mission crew simulator is equipped with a mission simulation capability, it is difficult to use and inadequate for preparing operators for *theatre* duty. The existing simulation and portrayal of the synthetic forces is not scalable, does not provide realistic behaviours, and is not totally autonomous. Live flight is also not delivering the required

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training benefit to the mission crew anymore.

Description of work

During a visit to the NAEW&C component in Geilenkirchen our team conducted interviews about the existing training system and the planned update program. As a outcome of these interviews it can be stated that the component requires a robust simulation training capability that offers small and large force training scenarios on a consistent and continuous basis. The synthetic training environment shall effectively address all stages of training as well as the full range of NAEW&C missions.

Today, the Distributed Mission Training (DMT) concept opens up possibilities for multi-level training in virtual environments. DMT enables operational procedures to be optimised prior to the real mission execution. In order to interface with other players in a DMT exercise the AWACS Mission Simulator requires a suitable architecture standard that allows for compatibility without jeopardising security.

The mission that an AWACS crew has to perform is captured in a model with the various in- and outputs. Analysis of these in- and outputs leads to a list of tasks, which must be performed to ensure mission success. This process should be applied to all entities in the DMT exercise. Then a master task list can be created that aid in defining the DMT environment and syllabus. A purely task-oriented approach does not sufficiently take

the required integration of skills into account; therefore a competency oriented training approach will be employed. Practicing the skills is the core of the training program and knowledge is delivered to facilitate it.

Results and conclusions

NATO operations in the 21st century call for modelling and simulation capabilities that will provide realistic representation of peace support, crisis management and warfare activities up to full war operations. This will enable NATO to plan its operations and to train NATO personnel in their normal working environment and interact realistically with national staff or the simulations of those staff. For the AWACS it is critical that the crews are able to train effectively and to conduct this training in a realistic manner with scenarios developed to meet contingencies, which may arise with little time for preparation.

For realistic mission rehearsal and an increase of the opportunity for mission success, AWACS mission simulators shall be integrated in a compatible architecture with minimum security limitations together with external simulators and simulations. Collaboration processes are established to identify the upgrade potential of the simulation infrastructure for collective training. In our study a roadmap is established for the implementation of DMT for NAEW&C to satisfy current and future training requirements.



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AWACS Training Concept and Media: The Need for DMT

A.J.J. Lemmers, H.J. Abma and U. Keuter¹

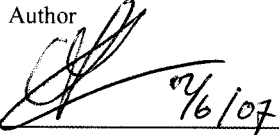
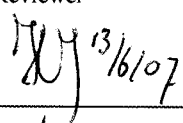
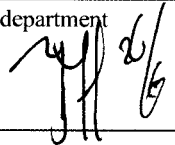
¹ EADS Military Air Systems

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Summary

NATO owns a fleet of Airborne Warning and Control Systems (AWACS) E-3A radar aircraft, which provides the Alliance with an immediately available airborne surveillance, warning and command capability. The fleet, formally called the NATO Airborne Early Warning and Control (NAEW&C) Force, is one of the few military assets that are actually owned and operated by NATO. The NAEW&C Force is capable of providing airborne early warning as part of the defence of NATO territory, but can also provide air and maritime surveillance data as a basis for political or military decision making.

The mission simulators are the primary tools used to train the mission crew members. The mission crew side of the simulators provide high fidelity situation displays and presentations to support integrated crew training using communications links similar to the aircraft. In 2005 a European/Canadian industrial group performed a study for NATO Force Command to define a "road map" for the implementation of DMT for NAEW in Geilenkirchen to satisfy the current and future training requirements.

In this paper we will zoom in on the training aspects that laid the base for the roadmap. We briefly introduce the current training situation. A Training Needs Analysis (TNA), already performed in 1999, has highlighted the need for improvement. Since this time mission scenarios have been evolved and time critical or time sensitive is now the keystone of the scenarios. Visits to the E-3A component in Geilenkirchen and discussions with the E-3A team have enabled us to refine the improvement needs. A list of training objectives has been derived. This shows clearly the need for DMT from a training perspective. The paper ends with recommendations for an effective employment of DMT using a competency oriented approach to the AWACS mission training.



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Abbreviations

AAR	Air-to-Air Refuelling
ACO	Airspace Control Order
ATO	Air Tasking Order
AWACS	Airborne Warning And Control System
C2	Command and Control
CAOC	Combined Air Operations Centre
CAS	Close Air Support
CSAR	Combat Search And Rescue
DIS	Distributed Interactive Simulation
DMT	Distributed Mission Training
ESM	Electronic Surveillance Measures
EW	Electronic Warfare
HLA	High Level Architecture
HVAA	High Value Airborne Asset
JTIDS	Joint Tactical Information Distribution System
MSMP	Modelling and Simulation Master Plan
NAEW&C	NATO Airborne Early Warning & Control
NATO	North Atlantic Treaty Organisation
NMT	NATO Mid Term
NPC	NATO Programming Centre
ROE	Rules Of Engagement
RSIP	Radar System Improvement Program
SMART	Simulated Mission And Rehearsal Training
SOF	Special Operations Force
TBM	Tactical Ballistic Missile
TNA	Training Needs Analysis
TST	Time Sensitive Targeting

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1 Introduction

NATO owns a fleet of Airborne Warning and Control Systems (AWACS) E-3A radar aircraft, which provides the Alliance with an immediately available airborne surveillance, warning and command capability. The AWACS are modified Boeing 707s (called E-3A), equipped with special radar dome capable of detecting air traffic over large distances including low flying aircraft over all different types of terrain. The data can be transmitted directly from the aircraft to command and control centres on the ground, sea or in the air.

The fleet, formally called the NATO Airborne Early Warning and Control (NAEW&C) Force, is one of the few military assets that are actually owned and operated by NATO. It is the Alliance's largest common-funded project and an example of what NATO member countries can achieve by pooling resources.

The NAEW&C Force is capable of providing airborne early warning as part of the defence of NATO territory, but can also provide air and maritime surveillance data as a basis for political or military decision making. This is accomplished by providing near real-time data on which any decision to increase reaction time and force deployment could be based. The NAEW&C Force is immediately available to respond to contingencies and its mobility allows for rapid provision of warning and control to support political objectives. In recent years AWACS have been sent to protect a number of major public events, including the 2006 World Football Championship and the funeral ceremonies for Pope John Paul II.

The mission simulators are the primary tools used to train the mission crew members. The mission crew side of the simulators provide high fidelity situation displays and presentations to support integrated crew training using communications links similar to the aircraft. In 2005 a European/Canadian industrial group performed a study for NATO Force Command to define a "road map" for the implementation of DMT for NAEW in Geilenkirchen to satisfy the current and future training requirements [Fligge07].

In this paper we will zoom in on the training aspects that laid the base for the roadmap. [Soyk07] discusses the scenario generation aspects. We briefly introduce the current training situation. A Training Needs Analysis (TNA), already performed in 1999, has highlighted the need for improvement [Vega00]. Since this time mission scenarios have been evolved and time critical or time sensitive is now the keystone of the scenarios. Visits to the E-3A component in Geilenkirchen and discussions with the E-3A team have enabled us to refine the improvement needs. A list of training objectives has been derived. This shows clearly the need for DMT from



a training perspective. The paper ends with recommendations for an effective employment of DMT using a competency oriented approach to the AWACS mission training.

2 Current training situation

The NATO Airborne Early Warning & Control (NAEW&C) team serves to provide for airborne surveillance and command, control and communications functions for offensive and air defence forces. It provides the means to detect, identify, track and intercept airborne threats. The current NAEW&C training concept has to deal with the special considerations of multinational team with high rotation tempo and training media that only allow for limited realistic scenario-oriented training. The training program has been fundamentally unchanged since the early 1980s aside from minor process and course content improvements.

After returning from the Kuwait Theatre, C2 operators indicated that they were not adequately prepared using existing training capabilities. They felt overwhelmed by the magnitude and intensity of the operations there. Many tasks that needed to be routinely performed were seldom practiced in training exercises. Fact is that the mission of the E-3A has become more complex than in the 1980s and additional systems like ESM, JTIDS, RSIP have made the job more difficult.

Post Cold War resource reductions have affected the frequency and quality of coalition live flying events, such as the NATO Air Meet. There is concern about the decay of the skills that had been developed during past exercises and combat. In particular, mission training for coalition operations has become prohibitively expensive, and subject to many airspace restrictions.



Figure 1: NATO AWACS

While the NAEW&C mission crew simulator is equipped with a mission simulation capability, it is difficult to use and inadequate for preparing operators for *theatre* duty. The existing simulation and portrayal of the synthetic forces is not scalable, does not provide realistic behaviours, and is not totally autonomous. Live flight is also not delivering the required training benefit to the mission crew anymore. There are obstacles affecting the team training:

- airspace availability,
- restricted weapons / EW envelopes,
- safety issues,
- environmental concerns

Additionally, cost-benefit skews to the favour of simulation training as live flight costs €10,000 per hour with no guarantee of training efficacy.

NAEW&C aircraft and mission simulator are upgraded currently to NATO Mid Term Phase 1 standard. This will relief some of the deficiencies of the training system and there will be an improved scenario generation capability. However the training fidelity will still be limited due to the continued reliance on internal training staff to play external agency roles [TUSP01].



3 Consideration on new training systems

The NAEW&C crew performs their tasks in a very complex, dynamic and stressful context. This requires a particular integration of skills, knowledge, attitudes and other mission crew competencies to enable performance of these tasks. Additionally many people with different disciplines are involved in the design and operation of a training system. Consequently, the intuitive overview is lost. In the end the required skills may be learned, but they may not be integrated properly.

In this context, Distributed Mission Training (DMT) will play an important role. DMT is a shared training environment that includes live, virtual and constructive simulations that allow war fighters to train individually or collectively at all levels of war [Tomlinson03]. DMT provides on-demand, realistic training opportunities for war fighters by overcoming many current constraints that limit training effectiveness [Gehr05]. It links participants across network lines, allowing individual war fighter training to occur concurrently in simulators whose presentation of a commonly flown mission occurs in real-time. This capability supplements flight hours with a synthetic reproduction of a complete and complex war-fighting environment that combines realistic scenarios with simulated operational systems.

Now the question arises which training approach maximises the training results using DMT. To answer this question a number of new questions are triggered:

- Which operational scenarios can be trained using DMT?
- Which skills can be trained using DMT?
- What does the training syllabus look like when deploying DMT? Does it affect the design of the current syllabus?
- What training scenarios have to be designed for the new training syllabus?
- How can the transfer of training be maximised?
- What are the consequences for other training issues (assessment, training evaluation, instructor deployment, course management, etc.)

DMT offers the opportunity for mission crew to rehearse realistic large force scenario in a synthetic environment that mirrors all contingencies of conflict and war. DMT federations can link all capable training facilities in an environment that incorporates all players into a modern synthetic battlefield. Therefore the vision for DMT is

Fly the mission virtually, before it flying real

4 Need of improvement

A Training Needs Analysis (TNA), performed in 1999 by Vega GmbH, demonstrated the need for serious intervention on the mission simulator [Vega00]. The TNA concluded the following (among others):

- The mission crew simulator lacks the potential offered by modern simulation technology
- The simulator lacks fidelity
- There is a lack of voice communication training
- Training system requires a significant amount of instructor-student interaction during flight.

The main findings of the TNA are still applicable and from training perspective the need exists to update the training environment, so that training effectiveness as well as efficiency will improve.

During a visit on the E-3A Component in Geilenkirchen January 2005 the team got the chance to conduct interviews about the existing training system and the planned update program NMT Phase I. In the interviews, instructors from both Training Wing and Ops Wing Training Branch stated the peculiarity of the Component due to its multinational environment. The Component has a high rotation rate of its people. That influences the training and operation of the E-3A fleet. The time for improvement of the developed operations after the training period is very limited.



Figure 2: NATO AWACS working positions

Communication between each other and with external entities is vital for successful operation. That makes it essential to train the crews as one entity because of their need to communicate, assess information and process it to relevant parties. The critical communication configuration activity still remains with the simulation cell and is not capable of being performed on the mission crew side of the simulator. This degrades the ability to perform crew integration training. Up to now, there is still no precision for connectivity to external agencies other than NATO Programming Centre (NPC) in Glons, Belgium.

The technician positions require robust emulation capability that replicates all faults and functionality inherent to the respective aircraft status. An independent as well as a scenario based training capability with the mission crew is needed.

In general, it can be stated, that the Component requires a robust simulation training capability that offers small and large force training scenarios on a consistent and continuous basis. The training environment shall be a realistic, high-fidelity replication of the functionality and configuration of the system in flight. The synthetic training environment shall effectively address all stages of training as well as the full range of AWACS missions.

5 Scenario orientation

The nowadays battlefield requires a rapid execution of Joint/Combined Force Operations. Training should always emulate combat conditions as closely as possible. There is a need to expand the training spectrum in the context of coalition operations. Complex mission exercises are considered to be of high training value. Training for these operations is best achieved by joint training. Till a few years ago live large-scale exercises like "Red Flag" or the NATO Tactical Leadership Program (TLP) were the only possibilities to achieve this joint training. These are the rare chances to train a full-scale mission with coalition partners and provide participants with the chance of an interface during briefs/debriefs. However these exercises are very difficult to use for mission rehearsal due to the long before planning and the non-adaptable natural environment. Today, DMT opens up new possibilities for multi-level training in virtual environments. DMT enables operational procedures to be optimised prior to the real mission execution.

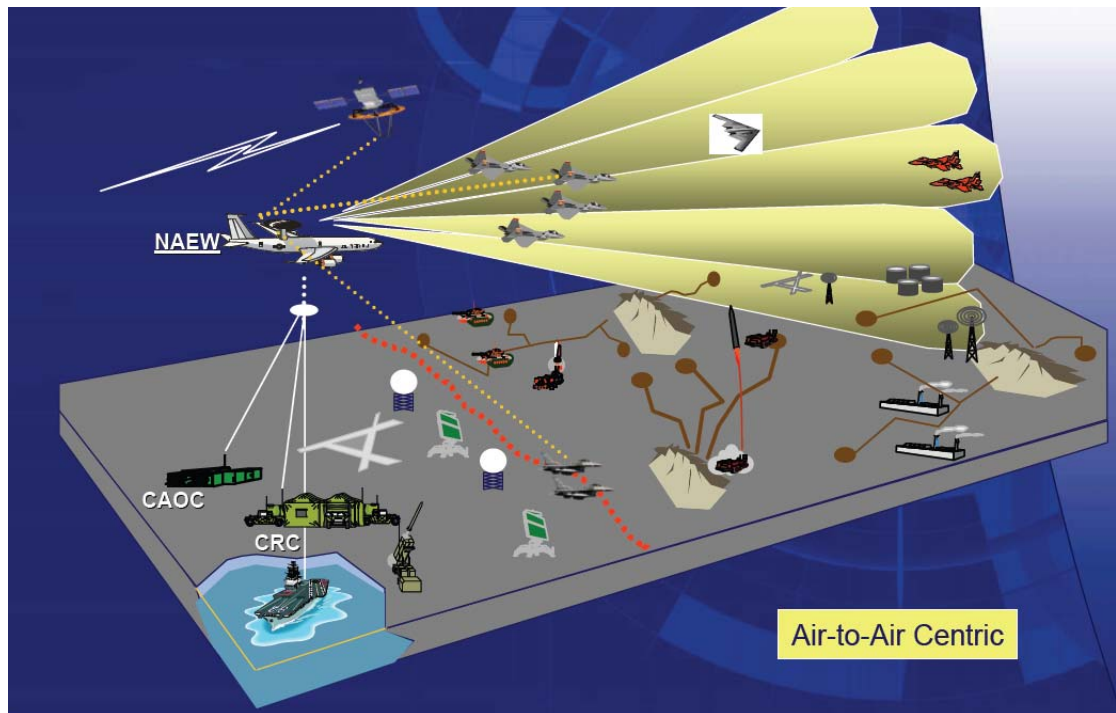


Figure 3: Current mission scenario for NAEW

The buzz word for the modern missions is "time critical" or "time sensitive". Close Air Support (CAS) missions flown in recent coalition operations are good examples of this. These CAS missions highlight the emphasis on operating as a homogeneous team. This requires mission rehearsal that meets individual, team, and team-of-team needs through realistic scenarios enabled by enhanced training opportunities offered by DMT.

Currently, various nations are building up their links between their own simulators. NATO partners of 7 countries developed exercise First WAVE, a distributed simulation mission training exercise conducted in November 2004 [Tomlinson03], [Gehr05]. In order to interface with other players in virtual scenarios the AWACS Mission Simulator requires a suitable architecture standard that allows for compatibility without jeopardising security. Therefore, DIS/HLA is required for the Component's mission simulator to meet the requirements specified within the NATO Modeling and Simulation Master Plan (MSMP) and to be able to join the NATO SMART initiative.

The mission that an NAEW&C crew has to perform is depending on the respective scenario. A simplified model of the various in- and outputs to perform an NAEW&C mission is shown below:

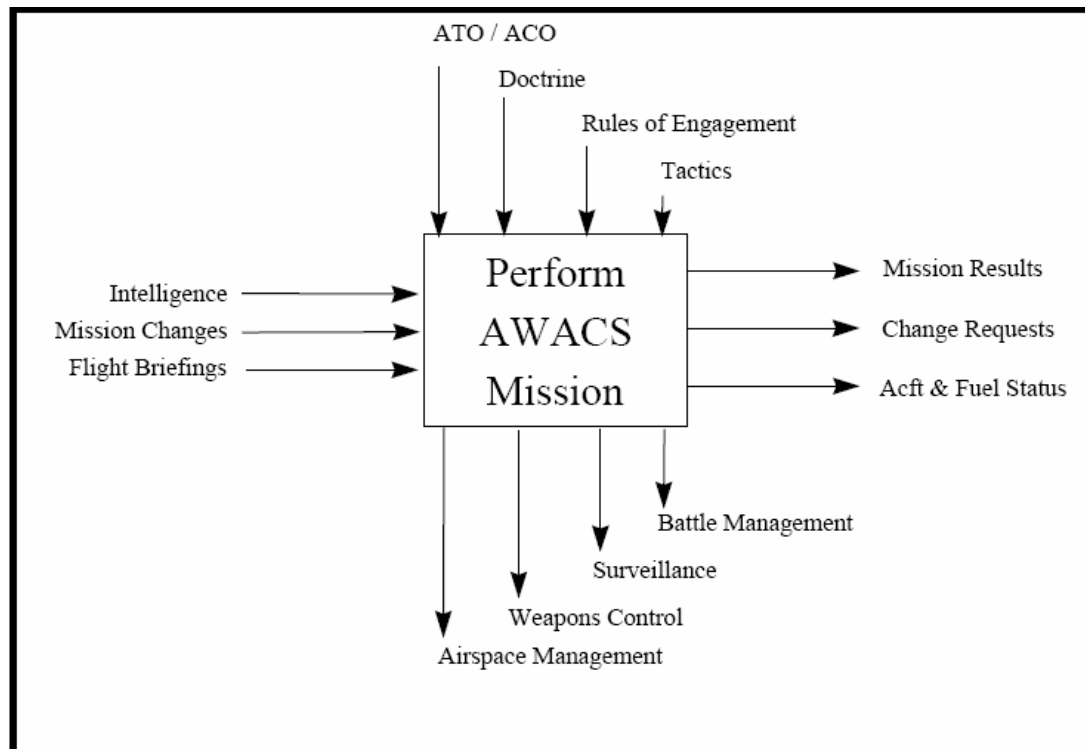


Figure 4: Input and output model AWACS mission

Analysis of each labeled item would lead to a list of tasks, which must be performed to ensure mission success. This process should be applied to all entities in the DMT exercise. The then created master task list represents all functions that are necessary for execution of a real world combat scenario from the development of the ATO to weapons on target. The task list would aid in defining the DMT network and environment requirements as well as developing a DMT syllabus.

6 Training objectives

The following list is showing the possible consolidated training objectives / scenarios to be trained within the context of NAEW&C DMT:

- Multiple E-3A operations, to include station handovers
- Deconfliction of assets between C2 assets through the ATO/ACO plan
- Air Mission Commander duties during CSAR operations
- Kill box procedures/de-confliction for Special Operations Force (SOF) assets
- High Value Airborne Asset (HVAA) retrograde through, including handover of assets
- Inputs for passive controller (ESM) including various ground/air threats
- Time Sensitive Targeting (TST) requests from Combined Air Operations Centre (CAOC)



- Effective Patriot integration, including voice communication and link
- Exercise Rules Of Engagement (ROE) including defector profile, low/slow SOF infiltration, and civilian aircraft.
- Control of Air-to-Air Refuelling (AAR) assets
- Force accountability
- Tactical Ballistic Missile (TBM) threat
- Fighter Link 16 training
- Passing 9-line requests from CAOC

7 Effective employment of DMT

A purely task-oriented approach does not sufficiently take the required integration of skills into account, although tasks may appear in concrete terms of "what needs to be done", they actually are *abstractions* from the task *context*. Consequently essential requirements of real operations may be lost and the approach will lead to training objectives assigned to the tasks only. This in turn may lead to inefficient and perhaps even detrimental integration of skills; one may be skilful under (traditional) training condition, but not competent in real operations.

Competency-oriented training refers to training program that emphasises the mastery of skills, knowledge and attitudes needed for job performance in the real world. It is practice-based; it focuses on the performance of skills in a specific context. In an early stage, trainees are confronted with simplified, but authentic training tasks that are directly derived from operational practice.

In competency-oriented training, knowledge is supportive to skill performance, which means that practicing skills is the core of the training program and knowledge is delivered to facilitate it. Training is used to simultaneously build skills and the mental models or problem solving strategies needed for job performance. A competency-oriented training program for a fighter allocation for example should centralise skill practice. Although knowledge is an essential prerequisite for successful training, it should be tailored to practicing the skills needed to control fighters in a certain sector for successful intercepts [Lemmers04]. In between the different training exercises new knowledge and information can be handed on, assisting to compose the mental model and the required problem solving strategies.

In order to prevent trainees from cognitive overload in competency-oriented training, the complexity of the exercises should be increased gradually in the course of the training program.

The starting point of training may be simplified, but authentic and complete tasks have to be derived from the real world, if possible, even for the first exercises. To assist the trainees during the first exercises the trainer's task is to provide sufficient support such that the trainees do not get drowned.

Skills play the dominant role in a competency-oriented training approach. This however does not mean that knowledge and attitudes are not important. Knowledge is needed to provide trainees with a prerequisite mental image of the world in which they are supposed to do their job. When looking at different types of knowledge, it is useful to distinguish instructional strategies for learning facts, concepts, procedures and principles, and models.

8 Conclusion from training perspective

NATO operations in the 21st century call for modelling and simulation capabilities that will provide realistic representation of peace support, crisis management and warfare activities up to full war operations. This will enable NATO to plan its operations and to train NATO personnel in their normal working environment and interact realistically with national staff or the simulations of those staff. For the NATO E-3A it is critical that the crews are able to train effectively and to conduct this training in a realistic manner with scenarios developed to meet contingencies, which may arise with little time for preparation.

Modernisation programmes for the AWACS aircraft and its ground based training system are underway and planned. For realistic mission rehearsal and in consequence, an increase of the opportunity for mission success, NATO E-3A mission simulators shall be integrated in a compatible architecture with minimum security limitations together with external simulators and simulations. Conducting DMT prior to the live flying phase of training or prior to contingency operations will ensure maximum benefit for live flying missions. Collaboration processes are established to identify the upgrade potential of the simulation infrastructure for collective training. In our study a roadmap is established for the implementation of DMT for NAEW to satisfy current and future training requirements.

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