Innovative Debrief Solutions for Mission Training & Simulation: Making fighter pilot training more effective

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ABSTRACT

To enhance and improve the quality of mission training and simulation for fighter pilots, TNO and the Royal Netherlands Air Force (RNLAF) investigate various innovative debrief concepts.

In this paper we will describe our work on Innovative Debrief Solutions for Mission Training through Distributed Simulation (MTDS). Mission training and simulation put high demands on various (use of) analysis and debrief tools. This is even more the case in distributed debriefs. Also, with the increasing options for data-capture and retrieval in combination with the increasing number of on-board systems, sensors and other capabilities of modern fighter jets, the challenges arise how to maintain or even increase debriefing effectiveness and efficiency, without creating an overload of information. Therefore, an important question in our research is how to (re-)present the right information, at the right time in the right format to the operational user.

Today, most operational debrief systems focus mainly on capturing and replicating information in exactly the same manner as presented in on-board systems. In this paper we argue against this paradigm and propagate a data-fused approach. We will present and discuss the results of our first trials with IDE-FIX, the Innovative Debrief Environment, used in our research to investigate, demonstrate and "FIX" new debrief concepts. Special focus is on adaptive information representation in a novel manner and the visualization of complex information in a user-centric and mission-specific manner.

ABOUT THE AUTHORS

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INTRODUCTION

Over the past decade developments in technology have led to many advances in the capabilities of mission analysis and debrief systems, which (can) provide increasing opportunities for improving tactical training. There are extensive developments in 'operational' debrief systems. These are the systems used in live training events for gathering and analyzing data retrieved from operational platforms. There are also, more recently, many developments in the world of Mission Training through Distributed Simulation (MTDS). These developments, and their challenges, are described in the next section and form the basis for our research.

In this paper, we describe our work on new debrief concepts for mission training and simulation. The Royal Netherlands Air Force (RNLAF) currently investigates, with support from the national research institutes, various possible solutions to improve the quality of mission analysis and fighter pilot training. With respect to debriefing, the primary focus is on defining an *integrated debrief solution* that, in the nearby future, effectively supports and improves all types and levels of fighter pilot training, both in live and simulated training events, at any location. With this vision in mind, the research described in this paper focuses on finding innovative debrief solutions for MTDS events.

First, we describe various debrief challenges faced from an operational, technical and training point of view. Second, we describe what, according to our opinion, defines and characterizes an adequate debrief system. Third, we zoom in on the approach and methods used in our research, before presenting, as fourth, IDEFIX, the innovative debrief test bed used to develop and validate various debrief concepts and solutions. Fifth and finally, we discuss the results of our first trials with IDEFIX, and reflect upon the way ahead of our research.

This paper argues against the data-replication paradigm used in many 'operational' debrief systems and propagates a 'data-fused' approach with a strong focus on adaptive information representation and the visualization of complex information in a user-centric and mission-specific manner. As such, this article can be read as position paper.

CHALLENGES

Approximately 90 percent of all military fighter missions involve training to prepare for 'the real thing'. Flight time is costly and availability of training assets is not unlimited. This calls for getting the most training results or 'lessons learned' out of every training mission. Lessons are learned throughout the whole training mission, starting at mission preparation and execution. However, the most lessons are learned during the mission debrief. The fact that the average time spent on a mission debrief is similar to the mission execution time indicates the importance of the debrief or mission evaluation. Besides their personal inputs, fighter pilots use recorded mission data to help them during the mission debrief. This data could include video, audio, and selected operational flight parameters and results recorded in the aircraft system. Normally this data is used to 'replay the mission' giving the pilots the opportunity to analyze the mission in detail.

The most important operational challenge of running a debrief in an effective manner is the amount of detailed information to process within the limited time available. Pilots will have to choose mission, team, and individual objectives and relate the lessons learned to these objectives as it is very difficult to learn every possible lesson from each mission.

Another important challenge is to carefully choose the objectives in relation to the intended level of training. Training will vary from the most elementary flight training to very complex tactical missions. The debrief and used data should aid the aim of getting the most important lessons learned related to the training level. Also, the audience will determine the specific needs for various types of data representation and information visualization. A debrief at the level of just one F-16 team (two pilots) or flight (four pilots) calls for a different set of views and data as the same mission debrief at the collective level for all mission participants (could be up to a hundred persons). In practice, however, various debrief systems, seem to copy all aircraft data and present similar data without asking whether the user needs, wants or can use this information to enhance his learning process.

Debrief systems will aid the pilots during their debrief. These systems traditionally consist of software packages presenting a synchronized replay of data combining individual video and audio of all mission members. Flight data is presented in the form of a 'mission overview' containing a "god's eye view" showing all mission members in relation to each other and flight data in tabular form. Although every software package is different, the data is presented similarly. As individual nations or mission members are using different debrief tools, it is a challenge to combine these individual systems into a 'common' debrief from which every member can evaluate their performance. This calls for an *integrated approach* towards debrief systems.

With the reduction of Defence budgets and at the same time a greater demand for complex tactical missions there is a call for alternatives for 'live flying'. With improving technology, mission simulation becomes more and more acceptable to replace certain aspects of operational fighter pilot training. These simulated missions will require Mission Training Centres (MTCs) and similar training approaches as used during 'live' flown missions. It is an operational challenge to debrief and use the same debriefs systems for 'live' and/or 'simulated' missions.

Until recently, the required data for debrief purposes was recorded by analogue means. Present technologies allow digital recording and an increasing size of recording media. This results in an increase in the already enormous amount of data available to be evaluated. This calls for even more effective debrief systems and methods. Also, aircraft systems improve and change in time, and some of these changes are essential to address during debriefs. More important mission data will become available, which has direct impact on the required debrief tools. The challenge will grow as future generation aircraft will have very sophisticated mission systems, which will generate even more data.

The operational importance and growing challenges related to mission debrief and the effective use of debrief systems should not be underestimated. This paper stresses the point that innovative debrief solutions are required to deal with the growing challenges to guarantee effective mission training in a changing environment.

MTDS

Mission Training through Distributed Simulation (MTDS) events, as experienced by the RNLAF in Exercise First WAVE (Gehr, Schurig, Jacobs, Pal, van der, Bennett & Schreiber, 2005) pose additional debrief challenges and call for extra capabilities in debrief systems. With MTDS events, it is very likely that participants operate from distributed locations during the entire mission, from preparation, execution to debrief. This requires adequate *distributed debrief systems and facilities*. Usually, a Video Tele Conferencing (VTC) system and SMART board technology (see: SMART technology at www.smarttech.com) are used to facilitate communication at dispersed sites in various manners, such as: voice, video, file and data sharing. In addition, both *single site mission replay facilities* for (local) formation debriefs and an *overall mission replay facility* is necessary for distributed mission debriefs at the collective level with all participants.

In addition, MTDS events can pose several technical challenges with data-capture and exchange of relevant mission data, especially when different types of simulators and legacy systems are used. This technical challenge can be overcome by using and adhering to common data exchange protocols such as DIS/HLA (both IEEE standards, see: www.ieee.org). One of the major lessons learned in Exercise First WAVE was that MTDS debriefs put high demands on the network availability and stability (Gehr, et.al., 2005)

Distributed performance assessment poses both technical and organizational challenges that differ from co-located debriefs. Experiences in various MTDS events (Gehr, et.al., 2005) revealed the importance of having well defined exercise management and assessment protocols that support distributed performance assessment in an appropriate manner for the *entire* training audience. This calls not only for appropriate analysis, assessment and debrief tools (of which many are yet to be developed) but also for a 'distributed' organizational awareness, where sufficient attention is for: how to set up a clear chain of exercise command, how to define clear training objectives for all participants, how to set up distributed debriefs and facilitate 'distributed' learning, and how to set up exercise and assessment protocols that assist distributed performance assessment. A final, complicating factor will rise in exercises where both synthetic and live training are merged. For the debriefs at such events it will be very important that several technical challenges, such as data capture, transfer and fusion can be overcome to create effective debriefs.

Given the fact that MTDS events provide similar debrief challenges and even a few extra ones compared to live training events, we chose to focus on mission simulation. Another advantage was that simulation in itself can provide a test environment for our research, where actual experience with debrief concepts can be gained.

WHAT DEFINES A DEBRIEF SYSTEM?

An adequate debrief system is designed to efficiently support its user in evaluating the performance of his task. A debrief system can be used by various operators (e.g. pilots, mission support and maintenance) for different reasons (e.g. training, performance assessment and system diagnosis). In this paper, we focus on improving fighter pilot training.

In this research, our objective is to define new debrief concepts that assist and optimize the learning processes by making performance assessment easier within the (limited) time available. For an operational F-16 pilot in the RNLAF this means that he needs a debrief system that can be used in live and simulation training events, in an easy and flexible manner. This implies, for example, that a team could prepare for a live mission, then fly the mission in a MTC due to changing weather conditions, and debrief the mission either at the MTC or at the squadron debrief room. This asks for a similar, yet flexible, debrief system Graphical User Interface (GUI) and the seamless integration of live and simulation data at both locations. For out of area operations and training at deployed bases a debrief system should be compact, easy transportable and robust.

From a (team) training point of view the analysis and debrief are the most important learning events. Here, ideally, the lessons are learned from all the previous events and the performance is assessed against the mission and training objectives, and according the standards/criteria as set by the instructors. There is an increasing focus on defining clear measures of effectiveness and using objective performance assessment tools to enhance mission training (Schreiber, Watz, Bennett & Portrey, 2003). One should, however, focus not only on establishing useful outcome measures but also on supporting and optimizing the learning process (Gehr et. al., 2005). The basic assessment principle should be to show (in debrief) and measure what is important, instead of making important what can be shown and measured.

An effective and efficient debrief (system) supports both the individual learning and learning as a team and asks for a debrief or training philosophy that optimizes learning. We will elaborate on this later. Performance assessment should be an effective combination of the three elements depicted in the model below (Cannon-Bowers & Salas, 1997).

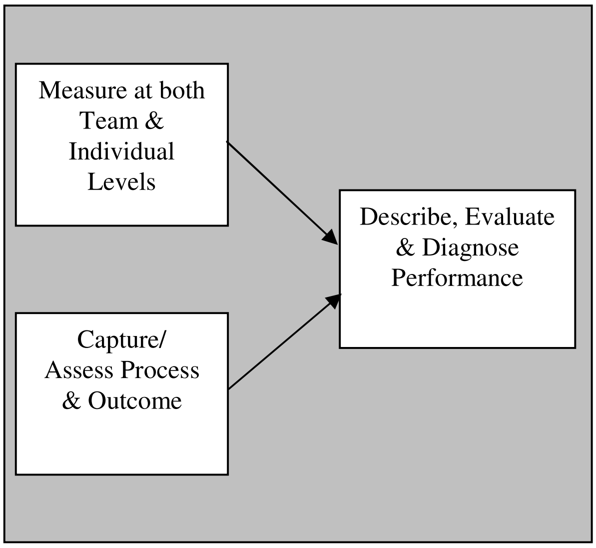

Figure 1: Elements in performance assessment

Evaluation should be done both at personal and team skill levels and both in terms of the process -how did the individual/team conduct its task?, and outcome- was the task accomplished by the individual and/or the team?

Referring to the operational challenges, the requirements of an effective debrief system as described above are not met for different reasons: there is, for example, no structured/automated relation between objectives and results, no specific data-presentation related to the different training levels, ineffective data-presentation leading to information overload, and there is no integrated approach towards mission debrief. Given the importance of effective debriefs, we investigate in this research how innovative debrief solutions can enhance mission and training effectiveness.

PROJECT APPROACH AND RESEARCH METHODS

Our research started mid 2005 and runs until the end of 2008. The project is part of the TNO Defence training research program on innovative training solutions (Korteling, 2006).

We think that our quest for innovative debrief solutions can only be successful if we enhance both the debrief *system* (the technology focus) as well as the debrief *method* (the human performance approach). We hereby use two different bodies of research: innovations in technology and new insights in learning and human perception.

In 2005, the research started with an operational task analysis (OTA) at the 323 squadron of the RNLAF and (technical) explorations of commercially available (F-16) debrief systems. They were conducted with the next purposes in mind:

1. To get a clear view of the operational needs, continuation training events at the squadron were attended, the debrief systems were reviewed (also during training) and experts were interviewed and consulted for debrief brainstorms. This resulted in an extensive list of debrief system needs, improvements and innovative debrief concepts.
2. A market analysis was conducted to get a clear view on the type of systems that are commercially available, their capabilities, and pro's and con's of certain approaches. This was done to investigate whether some of our ideas were or were not already incorporated in operational systems (we would like to do innovative research and not replicate existing features of other systems) and to investigate options for connecting our debrief test bed to an operational system at a later stage of this research.
3. By combining the OTA with a technical feasibility study, a selection from the list with ideas was made, and the design and development of the test bed could start.

From the market investigation we learned that there certainly is no shortage of (F-16) debrief systems at both team level, such as for example FACE (www.rada.com), and at the collective level, such as ICADS (Hauk, 2005). We also learned that most debrief systems focus mainly on capturing and replicating information in exactly the same manner as presented in on-board systems.

In 2006, we selected some of the innovative debrief concepts for this year's investigation and started with the development of the debrief test bed. In two trials we plan to demonstrate and discuss the debrief concepts developed so far with operational and scientific experts.

Based upon the outcome of these trials a further selection and/or development of debrief concepts will take place. By keeping time between trials short and working closely together in a multidisciplinary team with operational experts actively involved, we hope to make quick and small but significant iterative steps forward. A close(r) cooperation with the industry (debrief system designers) is foreseen at the end of 2006, maximizing both research and industry efforts.

In 2007 we hope to take our research to the next level where we would like to connect our test bed to (F-16) flight simulators. This will enable us to actually plan, brief, execute (fly), and debrief missions, using new debrief methods. By doing so, we can conduct trials where both pilots and scientists can gain actual *experience* with pros and cons of a certain (de)brief approach (both system and method) and evaluate the developed concept.

FROM DATA TO INFORMATION

One of the biggest challenges is to obtain valuable and relevant mission information out of the huge amount of available data, such as data coming from the aircraft data bus, video images from the cockpit, and sound recordings. Within a simulation environment, the availability of data is even larger, but has the advantage of being in a digital format. Since there can be different formats and protocols used it can be quite challenging to merge and use this data for debriefs as experienced in MTDS events such as EFW.

The first issue in the fusion of data coming from a mission is *synchronization*, since we have to deal with both digital and analogue data (such as videotapes from the cockpit) from at least two aircraft, more often four or more. This involves the digitalization of analogue data and generation of appropriate time marks to enable the synchronization of the data streams. The second challenge is to reduce the preparation time involved in the process of converting audio and video files, placing time markers, and elaborating data: even if real-time execution is not necessary, it should be possible to have the data ready to use within a few minutes to maximize the user's debrief time. The conversion of analogue video streams can be skipped in the nearby future as solid state digital recorders are being used for recording the video streams.

Once synchronized data is available, the biggest challenge is the *elaboration* and *presentation* of the data into "useful information". Previous research (Geest & Gouweleeuw, 2000) demonstrated enhanced training effectiveness by using different complementary views integrated with the presentation of additional information. The trainees use the information obtained in this way to evaluate their performance. To achieve this it is important that the system is tuned to the training objectives and type of training mission and presents the right information at the right time in a convenient way, e.g. using the right combination of views, graphics, audio and video and not only a copy of on-board systems. This has a great impact on the design of the system, which should be flexible and adjustable to different types of users and missions, and also be able to interpret the incoming data and present the most relevant information only when needed to avoid an information overload.

IDEFIX

To investigate and address the debrief challenges described above you need a means to develop, test and validate new debrief concepts. Therefore, we develop(ed) a test bed that is called IDEFIX, an Innovative Debrief Environment, where we hope to 'FIX' our debrief challenges. IDEFIX gives us not only the opportunity to investigate various technical challenges in the design and development of a debrief system, it also provides us with an operational mini-debrief environment where actual experience with new concepts can be gained and tested.

We start with describing the development of IDEFIX before elaborating further on some of the innovative debrief solutions that were selected for investigation in 2006.

As a result of the operational task analysis, the primary focus for the design and development of IDEFIX initially was on the Graphical User Interface (GUI). The main goal was to create a really adaptive, flexible and user friendly interface. We chose to develop the GUI in Tcl/Tk, an open source scripting language used for many types of applications or parts of applications, such as cross-platform GUIs, web and desktop applications, network programming, embedded development, system administration and database work (see: www.tcl.tk). The main advantage of using Tcl/Tk is that it is highly portable to different operating systems, giving great flexibility and the possibility to run our test bed on any operating system of choice.

Effort was put in the choice of the layout, colour combination, and screen arrangement. Every window on the screen is designed to offer minimal redundancy and maximal use of the available screen space. The entire GUI is fully adaptable to the user wishes. We also considered the use of the so-called 'skins', to change the look and feel of the application: even if this is only a cosmetic change in the GUI, it might have a positive impact in the user friendliness (see: en.wikipedia.org/wiki/Skin_%28computing%29). However, the benefits of skinning are not yet proved in scientific research and are still matter of discussion. A highly customized interface might become totally unfamiliar to a user who knows the same application under a different appearance. Since we should aim for 'multi-user friendliness' (debriefs are team events), we expect to experiment only with principles that make the GUI adaptive and user friendly instead of using personalization principles such as skinning.

In the design of the GUI we put major efforts into the *user-centric man machine interaction*: every system function must be quickly available with the least amount of effort. We can achieve this by combining a smart user interface with smart pointing devices. However, technology is not yet so far that it can provide the ideal pointing device, which unifies the functionality of a remote controller and a laser pointer/receiver, which totally emulates a wireless mouse (Bi, Shi, Chen & Xiang, 2005). What we need is a smart, easy-to-use multimodal device with a simple layout that avoids the pitfalls of many modern devices where the number of functions per square cm increases exponentially and the user friendliness decreases at the same rate.

Another important set of requirements in the design of the GUI is *flexibility* with respect to the use of the debrief system in different configurations and locations: it must be possible to use the system, for example, in a smart board configuration, or a laptop + beamer configuration. This influences the design of the internal interfaces as well as the layout of the GUI.

INNOVATIVE DEBRIEF SOLUTIONS

As described before, if we really want to develop successful debrief solutions, we need to focus on advances in both the debrief system (the technology perspective) as well as the debrief method or training approach (the human performance perspective). At the moment we have a wide variety of ideas for innovative debrief system concepts ranging from GUI layout to ideas about complete systems for planning-briefing-and debriefing. We divided our list into the next subcategories: GUI, data-fusion, tracking devices, hardware configuration, performance metrics, and generic ideas. We describe some of these ideas in our debrief system concept after presenting our training principles/philosophy first, because we think that a system should support the user, instead of the other way around. Since we also believe that the training philosophy 'dictates' the requirements for a system, we start with describing the basic assumptions of our training philosophy.

The Training Philosophy

The job of a fighter pilot is a complex cognitive task, constantly demanding expert decision making. A fighter pilot's main job is to accomplish his mission successfully. This requires that he sufficiently masters a set of mission essential competencies (MECs) (Colegrove & Alliger, 2002). MECs are mission specific and *integrate* the necessary knowledge, skills and attitudes, so that a fighter pilot is, under varying circumstances, able to adequately assess the situation, decide which action to take, and perform the action according to the plan. Of course, a lot of 'what-if' planning occurs during the mission preparation, yet a lot of things can go surprisingly different during the real mission execution. With complex cognitive tasks there is not always a single or best solution to an (unforeseen) mission event. Therefore, it is very important to have effective debriefs that enhance the learning process and the expert decision making model (assess, decide and perform). Debriefs provide fighter pilots with the opportunity to analyse, learn, 're-learn' and evaluate their performance. The (self)evaluation of the performed actions and 're-experience' of the mission allows them to grow their competence.

To become an expert you need to gain *experience.* Effective training environments provide opportunities to gain these experiences and should provide similar, or even better, the same challenges as in real operations. This probably explains the great strength that mission simulation holds, since it can provide the military with gaining experiences that can not always be created in live training events. Debriefs can enhance the experiences gained during the mission, and will assist the fighter pilot further in becoming an expert.

To assist the professional in his learning and to improve expert decision making, the concepts we develop(ed) focus on finding adaptive, user-centric and mission specific solutions. They should support both novice and senior fighter pilots in developing their professional competence. This calls for a training and debrief approach that puts the professional in control over his own learning by giving him a set of flexible tools that assist his debrief process. We call this a job oriented training approach, which aims to raise professionals that are committed to their job (Stehouwer, Serné & Niekel, 2005).

The effectivity of a debrief will depend on the debrief method that is used and how the information is presented by the debrief system. It is crucial to incorporate knowledge on human perception and cognitive training principles in the debrief system's design. With the rising age of the 'techno teens', who seem to possess 'parallel processing skills', one wonders whether worrying about information overload is still necessary. Senior pilots, for example, experienced in a next generation flight simulator that novice pilots were much quicker to adapt to the new system interfaces and to process new information. Given the extensively growing amount of flight data available for debrief purposes, we think it will remain important to take information overload into account. We therefore develop(ed) debrief system concepts that accommodate for differences in preferred debrief visualizations, methods and approaches by various users (e.g. novice pilots versus senior pilots). We also develop(ed) and investigate debrief methods based upon the latest insights in human perception and cognitive training research. Experience revealed that simulation in combination with a job oriented training philosophy, where novices on the job were given control over their own learning, resulted in learning curves that were (much) steeper than expected and professional competence was grown much quicker (Stehouwer, et.al.,2005).

The Concept

One of the most important aspects of our debrief concept is *adaptive information representation* by following two main principles: timing, and selection of information based upon training objectives (Geest & Sabel-Pikaar, 2004). We divided our debrief system concept into three sections: data, the system, and its GUI, as depicted in Figure 2.

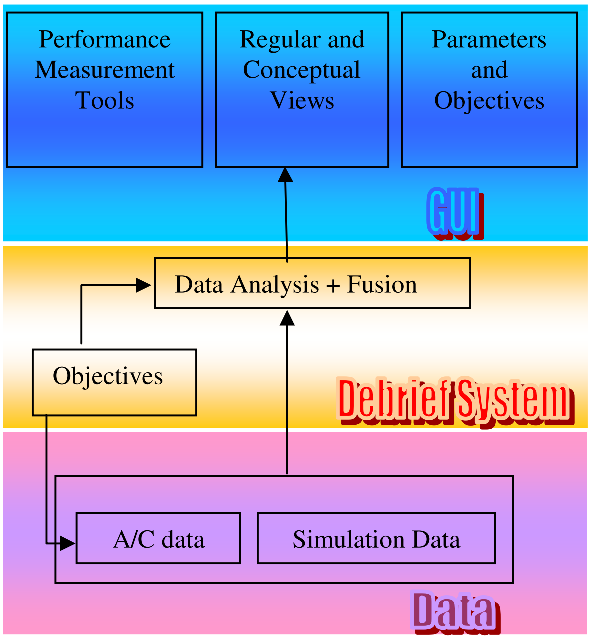

Figure 2: The concept

Data coming from the aircraft and /or the simulation will undergo a series of transformations before it is used in the debrief. Based on mission and training objectives, used as input for our debrief concept, the data will be selected, fused, and presented via 'regular' views and can even be transformed into 'conceptual' views that provide complementary or 'new' information. The views are 'complementary' in order to avoid information overload, and 'conceptual' to avoid the copycat pitfall of many debrief systems, that can result in ineffective information representation and consequently ineffective information processing by the system and its user.

In a debrief system, the views are subject to changes: often, these systems offer a 'fixed' set of views that are used in the same manner during the entire debrief, whether this is useful or not: it can distract the user and make him focus on irrelevant information, or even worse, prevent him from noticing an important training moment. To prevent this, our system can suggest valuable views (both regular and conceptual) and present them, based on the type and stage of the mission, and the type of objectives. When, for example, presenting information about the radar coverage of one or more aircrafts, the system can be set up to present: the visualization of a radar replication (as it is presented in the aircraft), or an emulation of it, or a conceptual view were all relevant information is assembled and transformed, or just a coloured metric/parameter indicating the performance. The 'presentation choice' is made upon the importance and relevance of the data at a specific moment related to the mission objectives.

Even if the system is capable of choosing and presenting the most valuable regular views and creating new conceptual ones, the user should be free to select a different set of views. To enhance the concept of presenting valuable information at the right moment we will also use overlays and blanking that add or hide information to one present view. Overlays are just simple additions to the present views, such as enhancing one section of the screen or of the presented data underlying the importance of it. Blanking will hide the irrelevant information. The use of overlays and blanking is based on timing: information will be offered only when it is relevant. To achieve this, the system must select, elaborate and present aircraft data that underline the training objectives selected for the mission.

Next to the views, we developed an 'adaptive form of navigation'. A training mission is quite a long event, and there are quite a few moments that are really of interest for learning purposes. For this reason, and also due to the amount of data involved in one mission, we need to facilitate the navigation during the different stages of the mission. This gives an easier way to analyze the important (learning) events, limits the amount of data processing and the time needed to jump to the next relevant mission event, without having to fast forward view the entire mission. We work on a concept in which our system recognizes and marks the mission stages and the relevant events within these stages in such way that it will be easy to 'read the mission' in an instance and select the important events in an order as suggested by the system or to the user's preference.

RESULTS & CONCLUSIONS

In this position paper we have listed the challenges related to debriefs and argued that innovative debrief solutions are required to deal with the growing challenges to guarantee effective mission training in a changing environment.

The most important operational challenge of running a debrief effectively is the enormous (and growing) amount of data to process within the limited time available. This calls for debrief systems that can provide novel ways of data representation and visualization, facilitating the learning process and enhancing the training effectivity.

So far, we developed several innovative debrief concepts that are based upon our training philosophy to effectively support experts in their learning process and improve their job performance. IDEFIX, our innovative debrief test bed, enabled us to test various solutions and gain experience with the design and development challenges for next generation debrief systems.

We will demonstrate and discuss our debrief concepts in IDEFIX with operational and scientific experts in two trials in October and December 2006. The results of these trials will be presented during the paper presentation at the IITSEC 2006 Conference.

WAY AHEAD

We would like to conclude with describing the way ahead for our research and giving a summary of important developments that evoke the increasing operational demand for more effective debrief solutions.

In 2007 and 2008 we will continue our trials in an environment where we can actually plan, brief, execute (fly), and debrief missions. This enables us, both pilots and scientists, to gain actual *experience* with a new (de)brief system and/or method, and evaluate the pros and cons of the developed debrief concept.

The increasing demand to get more out of debriefs is a direct consequence of various operational developments. Today's military operations, with an increasing use of Networked Enabled Capabilities (NEC) and use of data links between all participating platforms in a mission, ask for more coalition training. These types of training events are increasingly difficult to support, in so-called large force exercises (LFE's), due to a lack of (suitable) air space, training ranges, environmental and safety regulations, and peacetime restrictions. For this type of training, MTDS can provide a solution, since it can provide a *synthetic training world* that can be used for mission training and rehearsal. Not surprisingly, the future of coalition training events lies into merging live and simulated training events, where both virtual and live assets participate (e.g. Virtual Flags and Exercise Red Skye). We think that the future of effective analysis and debrief solutions is also headed into this direction. This increases the pressure to come up with *integrated solutions* that support the debriefs and learning processes (in any training environment) of the entire training audiences at all appropriate levels, which is very challenging as any participant in a large force exercise can tell.

According to our vision, the way ahead for *the next generation debrief systems* is to focus on three main areas for improvement. The first is the increasing need for standardized data exchange formats, which will simplify the participation in coalition training events. The second is data-fusion and data-enhancement principles to create useful debrief information and prevent an information overload. The third is to develop really user centric and mission specific debrief solutions. These will not only enhance the effectivity of daily training debriefs at the squadron, but also multi-level debriefs for various training audiences in large force exercises. This leaves us with the challenge to define a balance between various generic solutions for the debrief system design - for the sake of reusability- and domain specific information representation - for the sake of operational usability.

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