A Tactical Trainer for Air Defense Platoon Commanders

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ABSTRACT

In this paper we will demonstrate how simulation can upgrade the learning process substantially when used according to principles of Job Oriented Training (JOT). The context is instruction for Air Defense (AD) Platoon Commanders. We describe a practical co-operation between instructors, educational and technical specialists in an integrated approach to curriculum- and simulation development. Furthermore we discuss the result of a try out and clarify the role that the tactical trainer plays in the curriculum.

Currently, military jobs put high demands on human performance and expertise development. Considering this context, the value of good training is obvious. The JOT philosophy is based on modern insights about learning and human development. It puts the learner, their responsibility and performance on the job, at its centre. It supports 'natural learning' by making use of the self learning ability of people. Although JOT shows clear results and is supported by people's intuitions, in daily practice training developers and instructors seem to be constricted to more traditional, content driven and instructor centered, training paradigms. An often used argument is that traditional training is less time consuming. In a traditional setting, simulation is often employed late in the curriculum and, from the perspective of learning, not used to its full potential. We demonstrate how the tactical trainer, because of the possibilities of simulation and when used early in the curriculum, increases the efficiency of learning significantly.

We argue that the bond between simulation and JOT helps realize modern requirements of training. On the one hand the JOT approach guarantees effective use of simulation. On the other hand, and more importantly perhaps, simulation helps demonstrate the strength of JOT to professionals in the training field and is therefore a tool for the implementation of modern insights about learning in the daily practice of training.

ABOUT THE AUTHORS

Maud Stehouwer is a senior consultant in the field of Command & Control and Simulation at TNO. She is a cognitive psychologist with a background in artificial intelligence. She has 20 years of experience in training and has been working in research as well as in development of training programs and training tools. She has been working in a wide variety of professional contexts, especially in civil aviation and the military. Characteristic of her approach is a close co-operation with instructors, subject matter experts and technical specialists. The last 15 year she has been specializing in job oriented training, a training philosophy that gets more and more attention because of its potential in making training more effective and efficient

Michael Serné is Captain within the Army Organic Air Defence of the Royal Netherlands Army and head of the instructor group responsible for the training of future platoon commanders. After his graduation at the Royal Netherlands Military Academy he was Platoon Commander of an Armour Air Defence Platoon for four years. He developed into a training specialist in the field of Air Defence. The past four years he has been working on upgrading the initial course for air defence platoon commanders. The current challenge is twofold. On the one hand the demands on professional performance are high because air defence platoon commanders have to be able to work with limited means and be assertive in the discussion with the Battery and Battalion Commanders; he needs a high level of tactical thinking. On the other hand, efficiency of training is a major issue in the Royal Netherlands Army.

Chris Niekel Is a senior software engineer, working for the Education and Training Department at TNO. After graduating at the Vrije Universiteit in Amsterdam, he has been working at TNO for eight years. As a team leader he has been involved in the design and development of various prototypes and demonstrators for tactical training and advanced instructor support. Important focus in his work has been to manage complex information to support instructors and students in their insight about what happens in a scenario.

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INTRODUCTION

In the past ten year developments in technology have led to advanced simulation systems, which provide important opportunities for tactical training. However, when we compare the possibilities that are offered with those that are actually used, we are in for a disappointment. In this paper we describe our development into making effective use of a tactical trainer in the course for Air Defense (AD) Platoon Commanders.

First, we introduce the AD training matter with a personal story by Michael Serné, head of the AD instructor group. Second, as the focus in the project has been on upgrading the learning process, we briefly discuss human learning and elaborate on training cognitive complex tasks. We address the issue of how simulation can help to make a big step forward in improving training effectiveness. Third, we discuss the importance of an explicit training philosophy and explain the Job Oriented Training (JOT) philosophy as opposed to a more traditional approach. Fourth, we describe the tactical trainer and how we used it in the course for AD Platoon Commanders. Fifth, we present empirical results and reflect on why the approach works. Finally we draw conclusions about our results.

Our research is qualitative and focused on the practical development of JOT for air defense training. This paper should be considered as a position paper. Where this article refers to he; he or she should be read. For reasons of readability this has not been incorporated throughout the article.

TRAINING AD PLATOON COMMANDERS A PERSONAL STORY

"Having worked for nearly four years as an instructor for AD Platoon Commanders, a large section of the junior air defense commanders have had their initial training under my responsibility. As trainer-observer I also had the pleasure to watch the former students perform as commanders during exercises. During these years, I have been reflecting on the way I was taught the trade of being a platoon commander. My conclusion was that despite all the best efforts made, I was not trained in the proper and most current doctrine.

The theoretical battlefield I was taught did not match operational reality. This meant that I had to do an immense amount of training on the job and in retrospect performed in a manner which was below par. Thankfully my commander in those days spent a lot of time developing my skills. Most of my current insights are based on this self taught method.

The challenge was to share my lessons learned. When the official training time was reduced from 9 to 6 months, it was a logical moment to update the curriculum. All lessons were scrutinized asking the simple question: is this piece of knowledge relevant. We organized the subject matter following the principle of "crawl, walk, run". We made sure that as instructors we continually remain up to date with the most current doctrine. Having done all this we implemented our new training course.

At first the instructors group was satisfied, but as we followed the progress of our students during their operational phase, we were often surprised by their difficulty to tackle what seemed simple air defense problems. When we asked them about it, they often admitted that they had forgotten the basic knowledge they were taught and that their daily business of managing their platoon had given them little opportunity to keep "up to speed" with their primary task; air defense.

The instructor group sat down and discussed a means of tackling this problem. We had managed to hand them the relevant knowledge but somehow it didn't stick. At the same time we were asked to get involved in a project developing an air defense simulator. This involvement turned out to be a blessing in disguise. With help of technicians and cognitive psychologists,

we came to realize that this combat simulation tool might provide the solution to our problem. "

LEARNING

It is time for us to realize that the computer is not a good metaphor for human learning and decision making. Recent research shows that only in experience, when solving challenging problems, will serious learning take place. We give two examples of important insights. First, brain research teaches us that rational decision making requires tuning in with emotions. The concept of the embodied mind introduced by for example Damasio (1994), suggests that learning is not an isolated activity of the brain "gathering knowledge". Instead the whole body is involved and the brain is processing experiences in many ways and on many levels. Human performance is largely dependent on subconscious behavior that is the result of the complex trails that experience leaves in brain and body.

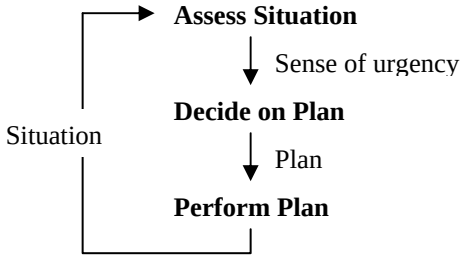
Second, educational psychology teaches us that only with challenging problems will we develop and actually use efficient strategies. Otherwise, no matter what we have been told or even discovered ourselves, chances are we stick to sub optimal approaches (Siegler, 1996). Further feeling competent as a result of rising to a challenge is a good motivator for development (Bransford at all, 2000). In short, experience and challenge are like magic to human learning. This is especially true for cognitive complex tasks.

TRAINING COGNITIVE COMPLEX TASKS

Dutch AD doctrine is based on the principle of preventing the enemy from doing his thing. The challenge for the AD Platoon Commander is to realize effective deployment with the usually limited means available. A platoon works with a specific assignment in the context of a mission in a specific area. Job performance implies reconnaissance, deciding on a plan, advising higher officers on air defense issues, deployment and battle command.

The AD platoon commander's job is what we call a cognitive complex one. The character of a cognitive complex task is that a lot of factors need to be considered and decisions need to be made with lacking or uncertain information. The expertise of an AD Platoon Commander can best be characterized by the fact that he needs to be good at running detailed mental simulations of what might happen in a particular situation. In this mental simulation he needs to consider factors like the overall mission, the specific assignment, terrain and weather conditions, enemy behavior and opportunities, own possibilities and opportunities and anticipate on the progress of a battle.

When analyzing cognitive complex tasks it is practical to distinguish between Assess, Decide and Perform tasks and important to realize that assessment is the basis of all effective performance.



Experts continuously assess a situation and continuously assess the quality of their plans. They do this when planning as well as while executing the plan. Based on their assessment, experts will act when they feel a sense of urgency. A sense of urgency is a strong feeling that action is required. The embodied mind is at work here. Based on the sense of urgency a plan is made and decisions are taken. The quality of a plan and evidently the ultimate performance are highly dependent on the quality of the assessment. The assessment task is at the heart of the expertise. It is the most complex of the three task types and it takes the most time and experience to develop to an expert level.

The assess task may be essential to expertise, sadly in training it is also the most neglected. If we speculate about the reasons, two should be considered. Primarily, especially for developing the highly intuitive assessment skills, practical task experience is indispensable (Klein, 1998). For the air defense domain this has been hard to realize. With the tactical trainer available we set the condition to solve the problem. A related issue here is that some consider it too difficult or even impossible to address this kind of cognitive task in training. In this paper we hope to prove them wrong.

The second reason is rooted in the educational dogmas of our time. Training from simple to complex is a logical principle. However, too often it is translated into training simple skills first. A very popular one is to start training procedures before training decision making. This is a major pitfall, which we ran into as

well. Our experiences are described further on. The main problem is that novices that focus on procedures tend to not use their common sense. They perform the procedural steps more or less mindlessly. As they don't really understand the logic of the procedure, they perform the task mechanically and dogmatically instead of using their brains. Thus they learn to focus on solutions outside themselves instead of inside. When students don't actually use their brains to solve their problems and think for themselves, their expertise development slows down. It may sound trivial but the point is for learning, using your brain is a requirement.

Expertise development, especially for the assessment skills, requires integrated training. The task should be trained as much as possible as a whole. From simple to complex should be translated in terms of complexity of the problem to be solved and the performance standards that are gradually set to a higher level. If we design our training like this, students will develop an expert way of thinking, which they can expand further on the job. Good experts keep developing their assessment skills throughout their entire career.

JOB ORIENTED TRAINING PHILOSOPHY

The significance of an explicit training philosophy

Every choice we make in training, whether it is about programs, training tools or exams, is based on beliefs. Often the beliefs we act upon are unconscious and implicit, but not necessarily true. To give an example of a persistent belief, most of us seem to think it is a good idea to start a course with 'a firm base in theory'. Despite that research proves us wrong (Bransford at all., 2000; Siegler, 1996; Holt, 2004) and we all have the experience of attending lectures that didn't affect us at all, the belief remains common and widely shared. The advantage of making our principles explicit is that we have a touch stone available to explicitly justify our choices. Thus we give less room to unconscious beliefs and enhance chances that we support learning.

Traditional paradigm

Traditional training is based on the, often implicit idea, of knowledge transfer. Standard programs usually start with theory. Next, procedures and basic skills are practiced. The first chance to practice the task is on the job. The instructor is in control. He knows the next step and the relevance of all parts. Students follow and are quite passive considering it is intended to be a learning process. Students apparently are supposed to learn through the activity of the instructor. The instructor centered approach is often an assault on students' motivation.

Of course there is a lot of effort around to make training practical, but most of the time changes are fit into the traditional paradigm. Even with modern technology available that helps us create dynamic environments, the tendency is to fit the new tools into the existing ways of training. We stick with what we usually do and don't think of adapting to the new possibilities. Simulation nowadays is often still just used to train procedures. The real added value of offering a reality to develop expertise is left unexplored. It also took us some time to see that we were not using the opportunities that the tactical trainer offers.

Job Oriented Training

First, where traditional training puts theory and skills or competencies at the centre, JOT puts the focus on the job. Second, JOT approaches trainees as the natural learners that they are. The traditional training paradigm puts the focus on the instructor and whether he has tackled the subject. JOT puts the learner at the centre and focuses on whether he learnt something relevant in terms of job performance. Two principles summarize the JOT philosophy:

- Focus on the responsibility of the job
- Challenge and practice in a relevant reality

Focus on the responsibility of the job

During the entire course trainees are challenged by meaningful tasks that give them the opportunity to master the new responsibilities in all its details. They get feedback continuously in terms of objectives to be achieved and the role they are meant to play. Favorable learning conditions means setting clear demands and make trainees responsible for their own learning. In JOT clear, high level training objectives are set in terms of meaningful tasks. The desire to feel competent is the motivator. People set a goal and try to achieve it. In the process they try to make sense of the world. This structuring and "sense making" process is a large part of what we call learning. With the traditional approach of "offering bite size chunks", we don't use that natural strength.

In a JOT course, the trainee starts practicing the job on day one. This first experience should give him a good overview of his new responsibilities. For example on the experience of performing a simplified version of the job, the trainee can form a picture of what he was

hired for. Good job performance is only possible with a clear idea of what is expected.

Challenge and practice in a relevant reality
The power of people is that given a clear objective and favorable conditions, they will develop autonomously. Given the objective of a job, trainees need to get the opportunity to practice the job. "Learning is doing" states Holt (2004) and learning a job implies that we practice that job. You won't learn to ride the bicycle without a bike and a road to ride it on. Also you won't develop any critical thinking without solving problems. The issue was recently addressed by Jeff Loube, the managing editor of MS&T (issue 2, 2005). He noted "there is more critical thinking in military forces than perhaps we think we have, or think we need". The development of critical thinking may have been underestimated or perhaps the focus on procedures simply fits better into the traditional training paradigm and prevented us from seeing the real requirements.

The challenge of training cognitive complex tasks
JOT means integrated task training. The task is trained as a whole. Knowledge, procedures and system handling are trained in the context of performing the job in a realistic environment. The challenge is to set up a *curriculum of growing competence*, presenting high level training objectives in terms of job performance, gradually making the task more complex, offering appropriate challenges all the time and providing clear feedback. From simple to complex is translated into performing the job under circumstances of growing complexity and setting higher performance standards. The student gets the opportunity to grow into his job.

The significance of simulation for JOT
To be able to learn through experience we need an environment for practicing the job. With simulation we can construct a reality where formerly this was impossible, difficult or expensive.

HOW WE GOT STARTED

In the training of AD platoon commanders, the need for feedback on performance has been an issue for a long time. It is difficult to create an environment in which trainees can practice the job and get feedback on performance. Until now trainees had to rely on the judgment of instructors, without any experience to back up his statements. With improving simulation techniques, the opportunity became evident. A system was created where students could perform reconnaissance, and where, using existing CGF-software, the deployment of the platoon can be tested with airplanes flying a predetermined route. The students could perform reconnaissance in the simulated environment, in the same way they usually perform this task. With the results, they planned the platoon deployment. The positions were given to the training staff and simulated vehicles were positioned in the environment. Multiple aircraft would fly over in predefined routes. This gave the students insight into whether their reconnaissance and planning had the intended effect. Whenever the airplanes broke through the defenses, the students evaluated the cause, and if time permitted, they could perform another reconnaissance, planning and testing phase.

Working with the system proved a big step forwards. Trainees were confronted with the effects of their plans for the first time. These were easily accepted by students without having to resort to the "yes but what if" discussion that often tends to shift the focus from what in essence the job entails; the bringing down of an aerial target before it can perform its mission. This allowed students and instructors to rapidly come to the core business i.e. a professional discussion about air defense. The sessions were intense; students were involved and reported lots of "eye openers". At first we held a two day session at the end of the six month course. Having worked like this for three courses we realized that the system had much more potential if we planned it earlier in the program and use it for training tactical thinking and decision making rather than a simple "wrap-up" procedure.

HOW THE SIMULATION DEVELOPED SOME TECHNICAL DETAILS

New functionality was required. In order to discuss on a professional basis, one needs feedback that is both relevant and believable. This instills confidence in the system that presents the environment that provides this feedback. Anything less would divert attention from the true professional lessons learned. It was decided that the performance of the weapon systems should be properly defined in the simulation. First, this meant that the instructor group had to deeply delve into the technical aspects of the involved weapon and sensor systems. Secondly, the system also needed to make use of the evaluation and planning tools currently in use with the RNLA air defense units. This was done such that students could work with the same tools in the simulated environment that they would be in "real world "operations. Thirdly, the team of instructors and technical staff worked together to make sure that all tools could be applied in a user friendly manner. Once

again, this is needed to ensure the focus on what is really necessary: the proper and relevant feedback.

The simulation software is based on the Forward-Air Controller (FAC) simulator (Kuijper & Jense, 1998). What was originally used by the instructor to create a scenario for the FAC-student was turned into a planning station for the platoon commanders. The key requirement was that the students had to be able to start experimenting with their platoon very quickly, without the need to master the complex interface of one of the readily available CGF-programs. The interface of the FAC-simulator was a good match for this.

The application was extended with the initial requirements for the air defense task: displaying the sight-coverage for the RADAR, and the ability for the platoon to engage enemy aircraft and helicopters that were within range. With the prototype the trainees were able to experiment with the positions of their platoon, and to determine how effective these are, i.e., whether enemy aircraft are able to penetrate the defenses.

The radar coverage diagrams had to be a true reflection of the 3D environment. This is important. Students have to understand the influence of terrain on their radar capabilities. But it goes even further than that; students need to understand what that same terrain does to an approaching aircraft. Does the aircraft have a line of sight with the intended target? Is a particular approach a vulnerable approach? The answer to such questions might greatly influence the eventual deployment. This three-dimensional experience allows students to visualize the effect of their deployment before they present their solutions based on two-dimension overlays.

TRAINING WITH THE SYSTEM

The training staff has been adapting the training program to upgrade the quality of learning. The backbone consists of four field training exercises. The exercises gradually grow in complexity. Planning deployment and battle command are at the core of all exercises. As levels of expertise increases, challenges are added such as time pressure, day and night operations, sleep deprivation, complex coordinated missions with other combat units, NBC circumstances and rapidly changing circumstances.

In this context and based on the first experiences with the tactical trainer, new ideas about how to use the training system ‘emerged’. We focused on stimulating the self learning ability of people. We decided to integrate a new version of the tactical trainer in the renewed training program and identified three moments where we expected a substantial result in terms of learning. We describe briefly how we used the system.

Session 1: Gain insight into tactical cardinal rules

We start using the system in the first week of the course. Without any prior knowledge in the field, students are asked to plan a deployment for a simplified air defense assignment. They work in syndicates of two people, each team approaches the problem in its own way. Available to them is their own common sense and the simulation that they can use to experiment with. They save their solutions which are later presented and discussed during a plenary session, where each syndicate demonstrates their solutions. The instructor’s, major role is guiding the argument and asking critical questions from the expert’s point of view. After the discussion, the group as a whole is asked to decide together on what they now consider to be the best solution.

During the two days two cases were solved. The better part of the time, students were discussing amongst themselves while experimenting with the system. The role of the instructor was limited to observing, answering an occasional question, leading the discussions and drawing conclusions. At the end of day one, the instructor made explicit the cardinal tactical rules that are worked with in air defense. Though students were not able to formulate these themselves, they recognized them immediately. After all, they had been working with them intuitively during the day, even using the terminology. They found out the rules by themselves, using their own common sense. They understood the concept of the rules and knew how to apply them before someone told them about it. Therefore the rules were theirs.

The result of these two days was that they had an idea of the air defense problem, their responsibility and the strategies they have available to perform their task. They not only knew the basic rules, they also set a first step in the direction of applying them. During the practical reconnaissance training they had later, trainees would regularly refer to experiences they had during this first session.

Session 2 & 3: Planning and command and control

During session 2, students are asked to solve a realistic assignment in a realistic organizational context. The

system is again used to experiment with their ideas and solutions.

The idea is to work according to the same pattern as in the first session. Students experiment freely by themselves, ideas and solutions are discussed under the supervision of the instructor and new insights are consolidated by formulating what they now consider to be the best solution for the assignment.

In session three, the focus is on skills needed during the execution phase of an operation. Students are in command of their platoon in the battle for which they planned in session two. We start the session with planning contingencies. Trainees are asked to asses the potential negative effects of their plans and how they can deal with them. Again they first discuss among themselves and the system is used to experiment with, in order to investigate their views and solutions. Next ideas are discussed with the instructors. The results of this professional discussion might lead to an adaptation of the deployment or to a plan for redeployment in case an anticipated contingency occurs during the battle.

Once the students are confident that they have an effective battle plan, the instructors and the students engage in a war gaming session. The results of this session are discussed and if need be the students may opt for a change of plan. The crux of this session is first to give an overview of the flow of events in a battle, secondly to introduce a capability of recognizing situations that require action or a change of plan and thirdly have students experience how planning for contingencies may speed up the necessary actions needed for a successful redeployment. These are essential skills in battle command.

RESULTS

We expected trainees to develop faster than previous groups and to perform at a higher standard at the end of the course. This was indeed the case. We based this conclusion on expert's observations and judgment.

Three expert observations are discussed:

- Significantly higher competence levels
- Independent and creative thinking
- Professional and self confident attitude

Significantly higher competence level

The level of competence and understanding expected at the end of the course was reached half way through the course. This sometimes took the instructors by surprise and can best be illustrated by an example. During the third FTX (Full Troop Exercise), instructors were wondering why things were going so smoothly. The combat radio net was calm and the usual friction seemed to be lacking. They checked the scenario and wondered what they had forgotten. This was not the case. The students were actually understanding and solving all problems in an expedient manner. The instructors decided to add a few curve balls by presenting them extra problems. Again these were dealt with in an expedient manner.

During the same FTX, a deliberate attack is part of the scenario. In the past, it would always take about 4 hours. This time it was done in one and a half hours.

Further the instructors became aware of the fact that they almost unintentionally had raised the bar. What used to be satisfactory in the past wasn't anymore. They realized they had started developing experts that are initially capable to fully compete with fellow operational platoon commanders. This could give this group an immense jumpstart once they become operational.

Independent and creative thinking

When performing as an air defender, the platoon commander is confronted with engagement zones which either are ordered by the battery commander, or are developed by themselves in case of a TACOM relationship with a battle group. The engagement zones are defined on the 2Dmap based on commander's intent. They are often expressed using tactical ground rules. These are rules such as depth in defense, overlapping fires, fire in all directions, mutual support, weighted coverage or early engagement. In the past, we were confronted with students just filling in the engagement areas with fire without truly understanding the relationship between radar line of sight and the resulting coverage with fire. They didn't seem to consider practical consequences of choices. This led to solutions that seemed satisfactory but on close scrutiny fail to reach the desired effect. This problem often occurs because it is hard to imagine the three-dimensional aspects of air defense. This becomes particularly true when the platoon commander has to present his results on a two dimensional overlay.

The current group of students has developed a profound understanding of the three dimensional environment. This has become noticeable during our feedback sessions in the field. Their deployments show that they to understand the desired effects of engagement zones. They presented solutions that did

not meet the given or developed engagement zones and were able to demonstrate that with their solution they managed to attain the desired effect. This free thinking, creativeness and willingness to take initiative is important. The engagement zones are planned on a map and do not take into detailed consideration the true effect of terrain. The students are able to adjust their plans based on the reality they are confronted with, without losing sight of the desired effect. This understanding is a crucial development which many operational commanders have yet to grasp.

Finally, students came to creative new ideas when they experimented with the ground rules. Our doctrine states that in order to combat multiple planes, overlapping fires and depth in defense are the standard answers. The students were able to demonstrate that by striving for early engagement using maximum range fire, they are also able to combat multiple aircraft with a single weapon system. This is a very novel approach, which the instructors had not been confronted with before. Even though this solution does pose some problems, it certainly has its merits and shows that student are looking and thinking outside the box.

Professional and confident attitude

The use of the simulator allowed instructors and trainees to create and solve numerous cases. The feedback has always been very simple and confronting. The aircraft is downed or not. This has made it easy to focus on solutions. Was it effective or not. Why not? What can be done and let us try again. Eventually the instructors noted a higher level of confidence and willingness to experiment. They demonstrated typical expert behavior i.e. the search for effective tactical solutions and the willingness to openly discuss with the instructor these solutions. More importantly, the students among themselves discuss their solutions. Failure is not regarded as incompetence but as a valuable lesson learned that needs to be addressed. The search for an effective tactical solution has become the driving force behind the search for more knowledge. Never before has this instruction group noticed students who have shown so much self-initiative in self-educating themselves. For example, they had originally planned to use the simulator three times during the current course. The students have requested a fourth session because they want to test some solutions they have developed on their own.

In short, instructors are noting a professional attitude and true expert behavior; the continual search for effect driven creative solutions and a willingness to think outside the box.

REACTIONS OF TRAINEES

Trainees were used to being trained in a traditional way with lots of lectures and knowledge testing. With JOT, they at first felt insecure to do exercises without the traditional theory classes and detailed guidelines, but soon they realized the advantage it gave them in terms of learning. Where originally they felt uncomfortable as they were trying to find the ‘right’ answers, this later changed into a feeling of tension associated with the challenge of doing something new.

They learned to appreciate the sparsely provided guidelines as support for focus on generating one’s own solution and as opposed to looking for the “correct solution’. They experienced that it was more inspiring if everyone came up with different solutions and arguments than with the perfunctory answers they were used to. They liked discovering the logic of the job themselves and found this resulted in a better understanding and that relevant knowledge is remembered with more ease. To quote one of the trainees: “When you play first and then talk about it, it is easier to understand what it is all about. You start asking yourself questions and are not limited by what someone else imposes.”
They valued being treated as responsible professionals and this inspired them to adopt a professional attitude and to take responsibility for their own learning.

Trainees liked working with the tactical trainer. To them it was indeed a chance to practice the job, get a feel for it right from the start. The simulation to them served as a decision support tool. Experimenting with the system resulted in a better understanding of the situation and its possibilities. They feel the system certainly helped them to develop their mental simulation skills.

All trainees felt confident that they were up to the job.

REFLECTIONS ON WHY JOT WORKS

Independent thinking and expertise development

The major impact of practical training before theory seems to be that students learn to rely on their own thinking. Instead of using principles someone else told them, they discovered them based on their own common sense. They learnt to be creative, discuss and take themselves seriously. Thus students developed self-confidence and a professional attitude quite

quickly. All this led to an earlier start of expertise development. Halfway through the course they were professionally assessing and deciding. Not that their assessments and decisions always matched those of the expert, but the approach to the problem was identical. The fact that they dared think outside of the box and come to conclusions about the doctrine that raised discussion among experts proves the point.

Mental simulation as an important expert skill

One of the important added values of the system seems to be that it helps students to develop the skill of 'mental simulation' more quickly. The system can be especially helpful in at least two respects. Firstly, when an AD expert sees a map or drives through a terrain, he sees good and bad spots and can instantly visualize what will happen. Because the student can switch between the ground and air perspective, he can more easily master this "assess terrain skill". Secondly, an AD expert will run a mental simulation of a fight in order to be able to plan, anticipate on contingencies and support his decision making during combat. The system gives students the opportunity to see a fight develop while having an overview.

Training procedures mindlessly is dangerous

One of the outstanding observations was the interference that previous procedure oriented training had on the expertise development of our trainees. With some trainees we observed a tendency to approach the job as the set of formal steps that had been taught to them before entering this course. The phenomenon especially occurred in session 2 where students spent a lot of time writing reports conforming to the prescribed standards and very little time experimenting with their ideas in the system.

Before entering the training program, most of the students attended the Royal Netherlands Military Academy. There they have been taught the formal steps in the decision making process as applied in the RNLA. Because at the time they couldn't imagine what the process implies, to them it was largely a meaningless procedure. In her psychological research Ellen Langer (1997) points out the effects of learning steps or concepts without understanding. Basically people are inclined to apply these mindlessly and dogmatically, without thinking or meaning. It is a tendency that is very difficult to change later on. Further it frustrates creative thinking and as a result the learning process is obstructed. In our case the procedure orientation of some, blocked their creative process of experimenting and discussion.

Our conclusion is that when students were previously exposed to 'mindless' procedure oriented teaching, we should be careful with assignments that steer them in the 'applying mindless procedure' mode. In session 3 we learned that if we tell student to ignore the detailed procedure and just focus on working out the best solution, the problem disappears. They then focus on the logic set by the job. Once they master the job and have developed strong concepts, the logic of the procedures will come naturally and hardly any further training is required to make them work conforming to procedures. Now they will also be able to judge when a situation calls for a diversion from the procedures.

The role of student and instructor

The project showed how working with the tactical trainer changed the relationship between student and instructor almost naturally towards one between professionals. The student is responsible for his own learning. The instructor is responsible for guarding the standards. In this context it is important to note the importance of the instructor being an expert in the field. Only an expert will explicitly and implicitly focus on what really matters (Klein, 1998). Such a relationship can never exist if the instructor is not an expert.

Three simple steps

The three simple steps we formulated provide a guideline for how to use the tactical trainer:

1. Trainees are presented with a challenge and experiment freely with the tactical trainer.
2. Trainees and experts discuss solutions and issues.
3. Consolidation of insights in a final solution.

Central in the approach is trainees performing the job and getting a chance to develop their own thinking by solving relevant problems and experience the effects of their ideas. The, in our culture, almost natural tendency of students to focus on the instructor and what he wants, vanishes.

INSTRUCTOR REFLECTIONS ON THE CHANGE PROCESS: A PERSONAL STORY

"In developing the simulation tool the instructors were forced to take a deep plunge into the ins and outs of our trade. In applying the tool, the cognitive psychologist kept reminding us of our prime mission and to focus on what is essential to perform as a professional air defense platoon commander. At first we used the trainer at the end of the course as a final

wrap up of everything that had been taught. The students were enthusiastic, but their solutions were lacking imagination and when confronted with a rapidly changing threat, students had problems.

We decided to use the simulation throughout the course starting from week one. Students got the opportunity to build up relevant experience and most importantly, get feedback on their plans. This influenced the curriculum. When students were introduced to the simulator and given problems to solve, they became highly involved in acquiring the knowledge needed to solve the challenges they were given. They gradually became information junkies. They asked more and more questions, and created their own working formats. True, the students themselves had to adapt to this type of learning. At first they just wanted 'right and wrong' answers. The instructors had to review their role and learned to reply with answers as "what do you think" and "find out yourselves". The instructor would observe and if need be coach the students. He would act more as a mentor then a classroom teacher and give his expert opinion instead of lectures.

Compared to students in earlier courses we noticed a radical change in both the level of competence and attitude. Halfway through the course instructors and students had discussions on a true professional level. They could differ in opinion but these differences were always discussed on the basis of content and not settled based on the 'classical teacher student relationship'. The interaction between instructors and students was based on trust. This, in our opinion, greatly facilitated learning and free thinking and instilled the confidence needed for future pro active commanders who are willing to take risks.

We also noticed that during our backbone field exercises, the instructors and students often referred to the lessons learned during the simulation sessions. This allowed us to properly evaluate their chosen and reconnoitered deployments in the field. In the past this was impossible since instructor and student would not have had this shared experience. All in all, students have surprised the instructors with novel and innovative ideas and deployments and at times have even kept the instructors on their toes. What more could one wish?

Perhaps the greatest benefit of the simulation as currently employed by the air defense platoon commander's course, is that it keeps both student and instructor focused on the prime task. In solving air defense problems we need to understand this prime task and all relevant factors determining the successful outcome of any solution in tackling this problem. We are in essence training them to become professional problem solvers. "

A PRACTICAL INCREMENTAL PROJECT APPROACH WORKS

We started from a global plan with a vision on learning and a focus on the learning process. The mindset was to explore and use the opportunities that arose along the way. We relied on the intuition and expertise of the project team. We set up a training session, adapted the training system to the requirements, did a try out with trainees, saw what happened and adapted our training plan and system to the new insights. In this incremental approach we gradually shaped the training for AD Platoon Commanders.

We did not design a perfect program and training tool beforehand. Instead we worked with an open minded multidisciplinary team of air defense instructors, training experts and technical experts in an incremental project approach. The role of the training expert was largely to guard the training philosophy. Together we developed the training program and system along the way. After each session we would evaluate and discuss how to set up the next session and adapt the training system to the newly formulated requirements.

Things did not always go smoothly. The main obstacle was the old paradigm. Session one was pretty perfect, but in session two we probably stuck to the old exercise and way of thinking a bit too much and session two was not as effective as it should be. In session three we used this experience and loosened the demands on procedures to prevent the pitfall.

With our incremental approach, set backs like this were to be expected. The instructors were experimenting themselves. Seeing how our ideas actually worked in practice turned out to be very inspiring. Seeing the effects, how natural it feels and how easy it is once you just do it, brought about new ideas logically. We rapidly made progress in terms of designing, implementing and testing relevant functionality for the tactical trainer, designing and testing the training program, working out the role of the instructors and further developing our insights in what works and why.

At the end of our six month try out, we had developed our ideas far beyond what we had imagined beforehand. By now the training approach seemed so

logical, that it is hard to imagine why anyone would want to train otherwise.

CONCLUSIONS

First this project showed how simulation and JOT can support the natural learning process. For development to proficiency two things are required: clear objectives and practical challenges. JOT ensures that the focus is on the responsibilities of the job. Simulation creates the safe and dynamic environment in which trainees can deepen their understanding of what their job is all about. It provides the opportunity to practice and experience the new job from day one and get direct feedback on their performance. Above all the instructor is the expert who interactively sets the standards. He presents appropriate challenges and gives his expert opinion in professional discussions with trainees.

Secondly this project showed that a practical incremental project approach with a multidisciplinary team is a good way to bring about the paradigm shift required for JOT. In the approach the development of the user is leading. The system is developed synchronously. During the try-out the instructors learned by experience and changed their views on effective training. Insights were implemented immediately and led to new observations. The results were beyond anything anyone could have imagined beforehand.

Consolidation of results

Further research should focus on the consolidation of results. Three aspects are considered:

- The required paradigm shift
- Maintaining proficiency
- Measuring proficiency

The issue of a paradigm shift should not be underestimated (De Geus, 1997; Robbins & Finley, 1997). In this project a first step was set, but to assure consolidation continuous effort of the organization and management support is essential.

Further research should establish whether proficiency is maintained and investigate how the system can be used to support further professional development on the job.

We need to develop a formal evaluation system that actually measures proficiency in terms of what is important to the job. Make measurable what is important should be the motto.

Potential for the RNLA

With JOT, proficiency levels are significantly higher after training. This is of interest to making effective use of expensive FTX's. Higher standards can be acquired and the return on investment will increase.

The JOT philosophy supports the ambition of the RNLA to further integrate individual education and training on the job. As the approach stimulates a professional attitude and specifically encourages the learner to take responsibility for own development, the transition to training on the job will be relatively easy.

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