Enhancing Operational Effectiveness in the Norwegian Army through Simulation-Based Training

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Abstract—The Norwegian Military Academy (Army) has initiated a project with the main ambition to explore possible avenues to enhancing operational effectiveness through an increased use of simulation-based training and exercises. Within a cost/benefit framework, we discuss opportunities and limitations of vertical and horizontal integration of the existing tactical training system. Vertical integration implies expanding the existing training system to span the full range of training from tactical level (platoon, company) to command and staff level (battalion, brigade). Horizontal integration means including other domains than army tactics and staff procedures in the training, such as military ethics, foreign languages, leadership and decision making. We discuss each of the integration options with respect to purpose and content of training, "best practice" for organising and conducting simulation-based training, and suggest how to evaluate training procedures and measure learning outcomes. We conclude by giving guidelines towards further explorative work and possible implementation.

Keywords—Effectiveness, integration, simulation, training.

I. INTRODUCTION

THE purpose of this article is to establish a foundation for an evaluation of how the tactical trainer can become a more efficient tool in the education of the military profession at the Norwegian Military Academy (NMA). Feedback from the cadets and instructors imply that the tactical trainer (henceforth referred to as TT) can be used more, not only more often, but also in other subjects and topics than the purely tactical ones. When the TT is in use, it is often used during whole days or weeks. The installation is passive more than half the year. When tactics is being lectured, the TT is used in the start or in the finish, for instance evaluating a plan in a TEWT (tactical exercise without troops).

In this article we propose suggestions to how one can develop and conduct computer assisted exercises within subjects and topics such as military ethics, international law, language, leadership, decision making and logistics. It is desirable that this type of experience learning takes place in its natural environment, and this must be reflected in the way that the training is planned and executed. We want to argument for, and show examples of that the TT can be used to train both on a lower tactical level (platoon and company level, as today at the NMA) and on a higher level (battalion and possibly brigade, like the Army's command- and leadership trainer today, and that tactical exercises with the integration of other subjects can take place at each of these levels.

II. EXPERIENTIAL LEARNING AND COMPUTER ASSISTED PRACTICE/EXERCISE

A review of the literature on the efficiency of computer-aided/simulation-aided training and exercise (civilian sector), reveals that this form of training not only can be as good as other types of education when it comes to communication of knowledge, but that it also may have a considerable motivating effect to participate in this type of training. Especially within subjects in which one places weight upon learning through experience, the literature reveals that simulation based training/exercise gives better results than conventional methods (for instance teaching in a classroom) [1].

The action based approach to learning build upon the principles of making visible, sharing and collectively reflect upon ones own and others understanding and actions, and what importance the reflecting process have upon the following action [2]. Within this approach learning takes place when errors are revealed and corrected, and one may divide between two types learning: single loop learning takes place when errors are revealed and corrected but without that one at the same time changes the underlying understanding of the problem.. Double loop learning means that one in addition also changes the underlying understanding (including values and assumptions) [3]. The goal of computer-aided training and practice will be to be as close as possible to the ideal of double-loop learning.

In his research on decision making in complex, dynamic situations, Berndt Brehmer has been surveyed the challenges that leaders and other decision makers has when it comes to achieve a double loop learning in among other things military operations. The main challenges are as follows [4]:

- To much emphasis on the now-situation: Decision makers have a tendency to put emphasis on the information that is available at present without an understanding of how earlier incidents, actions and

conditions has had an impact upon the present condition. The world is perceived as here and now, and the picture of the situation and situational understanding becomes static rather than dynamic.

- Lack of system thinking: Decision makers have a tendency to think in a linear fashion, meaning that they perceive causes and effects as directly related, and thereby overlook the so-called "side-effects" of actions. This can also be considered as focussing to great emphasis on information that is easy available, and having a tendency to overlook smaller less obvious connections.

By surveying a typical military decision making process Brehmer has identified several factors that may lead to bad decisions and weak learning. Mainly this is related to big time gaps between different types of military activities in the decision loop, for instance the time it takes from an order is given until it becomes possible to observe an effect on the battle field. In addition it will often exist considerable uncertainty as to whether the observed effect really was a result of the order given, and to what degree the effect can be ascribed to other factors that one is not directly in charge of, at the same time as there exists uncertainty about the observations that are being conducted (sensors).

In a simulated computer-aided training situation one has the possibility to reduce or completely remove the time gap between decision and effect, as well as uncertainty tied to the observations being done. It thus becomes possible to make visible the real, underlying relations between cause and effect in for instance a model of a conflict situation. This is however not enough to achieve double loop learning: in addition one need sharing and collective reflections on actions, outcomes and relations. First when one has learned the "real" relations and one is able to make the correct choices in a simplified (simulated) operational context, it is time to introduce time delays and uncertainty in the simulator in order to investigate what importance the elements of complexity will have in a more realistic situation [5], [6].

Colonel Charles T. Rogers [7] underlies the practical importance of an experience based approach to learning: "[I]f we wish to succeed [in war fighting on the modern battlefield] we must train and educate our officers in intuitive thought that emphasize the "art" in command rather than the "science" (p. 50)". From this it follows that military leaders must be made to face training situations of a scope and width that makes it possible to build up "a bank of background knowledge" (p. 49). In this way it becomes possible to urge leaders to take responsibility without excessive control in detail under the motto "an honest mistake is a lesson well learned" (p. 50). It can be a challenge to facilitate for this type of training, and not only within the defence establishment.

Gary Klein has developed a decision making model in so-called "naturalistic environments", this means environments where decision making takes place under severe time pressure and other conditions that normally (for most people) would create stress [8]. The model builds upon studies of among other things military leaders decision making, indicates that experienced decision makers are able to make quick and good decisions because they quickly will recognise a situation based on previous military characteristics, and quickly identify solutions that will work. At least such decision makers are able to perceive those characteristics that indicate that a situation is decisively different from known situations that may demand other actions in order to be solved. A central point in Kleins theory is that the possibility of quickly making good decisions in over-complex situations is dependant that the decision maker having built up a broad basis of experience, and that the previously experienced situations are the foundation for this building of experiences [9].

We will therefore claim that if computer-aided training and exercises are going to have any desired effects, it is imperative not only to have a large broadness in the scenarios, but also to make sure that the training is conducted as much as possible close to its natural condition. This is however not any obstacle to conduct training with a progression that starts with simulating simple situation and relations, that gradually can be made more complex and therefore more realistic.

III. SOME FACTS ABOUT THE TT AND THE STAFF- AND LEADERSHIP TRAINER

NMAs TT at Linderud and the Army's Staff- and leadership trainer (SLT) at Rena is designed and built around the same software platform, and has the same technical software functionality. The most important technical difference between the two implementations, TT and SLT, is that the TT runs on a standard PC (with Linux as its operative system) while the SLT uses dedicated Unix/Linux work stations. At Rena the exercises are focused around the upper command levels in the Army (battalion/brigade level), while the tactical exercises at NMA are conducted on platoon- or company level.

The main part of the software program consists of a simulator system (GESI) produced and delivered by a German company, CAE Elektronikk GmbH (www.cae.com). To connect this system together in the SLT one has been using a command, control, and information system (C2I) delivered by Kongsberg Defense & Aerospace. The system is designed for training at brigade- and battalion level, but it can also by used on lower levels (like in NMAs TT). The respective commanding officers and staff conduct the exercise sitting in realistic command posts or vehicles and lead their forces by communication systems and maps. Each commanding officer has an assistant who types in his or her decisions on their own PC and interprets what happens in the area where the fight takes place. The commanding officer controls the situation on his own map made of paper while the simulator reveals the terrain characteristics, weapon effects, weather- and wind conditions, losses inflicted upon the enemy, own losses, artillery field of fire, smoke screens, visibility to a target and any thing else the a computer may be able to simulate.

After the operation has been conducted the participants usually gather in a common room where the instructors can conduct an "After Action Review" (AAR). The purpose of the AAR is to evaluate how the fights were carried out, what went wrong, and what can be changed. While one in the SLT conduct the exercise sitting in realistic command posts or vehicles and lead their forces by communication systems and maps, the TT is run as a classroom setup with 18 work stations for the players and 2 work stations for the instructors.

When running the TT it is the individual player who operates his computer and interprets the situation from the map. This makes the need for individual maps of paper unnecessary. Today the TT is mostly being used as a "test station" where the cadets can test their plans in a simulated tactical scenario. The simulator maintain the complexity of a greater operation, not only by representing the manoeuvre elements (for instance tanks), but also by medical support, technical support and reinforcement supplies (the last is only available in the SLT).

IV. THE USE OF THE TT IN OTHER SUBJECTS

The TT can be used to support the education in other subjects than the purely tactical ones at NMA. In the following part of the article we give some suggestions to how one can develop and conduct computer-aided exercises within subjects and topics such for instance military ethics, international law, language, cultural understanding, leadership, decision making and logistics.

Language subjects may through simple actions become integrated in the exercises with the TT. At the simplest level this may occur by letting the verbal and written communication take part in a foreign language. Dependent upon the ambitions of learning, one may entwine the terminology of the specific subject both in the planning phase, conducting phase, and during debrief or AAR. It will be natural to increase the level of difficulty for each exercise, and in accordance with the progression of learning that takes place. One has the possibility of making it extra demanding if one place demands upon that all communication, inclusive the communication between instructors and cadets is being conducted in a foreign language.

The relation between language- and cultural understanding can be illustrated by for instance using an interpreter when simulating international operations. Using an interpreter can be a source of a lot of misunderstandings, not at least on a cultural level. The interpreter can be either a physical person who masters both Norwegian and the foreign language being used, or the interpreting service can be provided through electronic communication. It will in this way be possible to investigate consequences of the misunderstandings that may arise by using an interpreter [10].

Problems to be addressed within international law and military ethics are as relevant as never before. For one thing the Norwegian Defence Command and Staff College has together with the Red Cross and the Institute for Human Rights at the University of Oslo proposed to make a "military manual in international law" [11]. With such a handbook one can give answers to questions that one ponders upon in specific cases, so it is mainly through practical training dilemmas of international law and ethics that one may exercise the ability to practice reflection and considerations that will be necessary also in over-complex situations with large time pressures. A handbook will not be able to cover all possible and thinkable dilemmas that may rise. It will in addition often be little flexibility in order to adapt to situations that bears the hallmark of unpredictability. The single decision maker (the military leader) may therefore develop an ability to reflect as a basis in order to make well considered decisions in situations with conflict management in crisis and war. It may therefore be a point to bring into play situations that *not* (or to a limited degree) will be covered by the handbook, in order to develop an ability to handle unpredictable incidents pertaining to international law.

Both the SLT at Rena and the TT at NMA will be able bring into play international law and ethical problems to be addressed in a training session or exercise. The software can operate with civilian/neutral elements present in "the battlefield". In addition one could use militia groups, and paramilitary groups with different affiliations. It will automatically be recorded if a civilian part has been hit or injured (collateral damage), and one of the fractions may use civilians as "human shields". Furthermore "fractions that surrender" is also represented. It is also possible to include terrorism and different forms of criminality, but this demands more preparation. The function of the software is constantly being developed by the supplier in Germany, CAE, also with regard to the abovementioned areas. It is in many ways easier to simulate ethical problems in the TT than in the SLT, because one gets closer to the situation in the TT, and because the situations one faces in the TT are situations that demands that one acts "here and now". The SLT on the other hand has a considerable time span from the plan is put into the system until the execution of the plan is finished. As an exercise with the SLT is built up, the players may have to play these types of challenges up the chain of the command that is to the battalion staff. In the TT one has individual resources and direct access to these.

It is not unusual that single individuals (also military leaders) that are about to make decisions regarding ethical dilemmas in a war situation, intuitively choose solutions that deviates from the strict rational, that is from the mathematical "optimal" solution. This may not be a problem in isolated cases, but it is important the individual decision-maker gets to know his inclination towards choosing "deviant" solutions and how to correct such an inclination. An example of this is a study that showed that military leaders may be more risk seeking than civilians in certain crisis situations [12].

Field logistics (Combat Service Support) may be included in the exercises with the TT, but is limited to represent the consequences of lack of supplies. At present it is not possible to simulate the effect of planning to re-supply in the TT (this is a software limitation, and one would have to go to the SLT

in order to practice on this particular moment of the game). The TT can therefore not play any long lasting operations (beyond a few hours) in a logistically realistic way.

V. AN EXAMPLE OF A PRACTICAL SOLUTION: DECISION MAKING

Decision making training is a simple method to train using simulation support, and it is based upon that the individual that is supposed to practice is faced with one or several series with decision making dilemmas that has to be solved under time pressure. Learning does not mainly take place during the decision making process, but rather during debriefs (between the decision making series). These debriefs are critical discussions of the incident course with other decision makers and instructors. The aim of these debriefs is to synthesising the correct actions to be taken (and to expose errors) in typical situations. Decision making training can be done with or without the simulation support. The advantage with simulation support is that one can gain control of time, get more precise judgments, consistent conditions, and easier replayed incident course to be used during a later debrief.

This type of training is to a very little degree used in the Norwegian Army today. As an extension of the possibilities of the TT, one could for instance give the cadets an offer to voluntary play for half an hour before starting at the academy or after finishing the service for the day. In such a "minigame" different outcomes could be registered and it would be possible to make a performance profile. In short: A situation is played out: one get the overview over ones own resources. A description of the enemy is given: a mission is given: and the mission is to be solved. The enemy will react independently upon what the player does with his or her resources, and the conditions will then be the same for all 20 players. Some times the player will "win", sometimes the enemy will "win". In the scenario one could add different types of operations, battle forms (attacking, defending, stabilising, minefields, ambush and so on), and vary this over several days/or weeks. This will not affect the capacity of the TT, as such games can be put to periods when the facility of the TT otherwise will not be used.

An important condition to be able to conduct this type of training with minimal overhead is that instructors in other subjects than the pure tactical ones at NMA, will be able to construct and modify scenarios where different exercise moments from these subjects is integrated into the scenarios.

VI. TRAINING HIGHER LEVELS BY USING THE TT

Leadership and decision making is in many ways the generally "abilities" one can train on in both the TT and the SLT. On the other hand, this is also where the two solutions differ clearly from each other. While one in the TT can emphasize quick decision making and "direct" contact with the battlefield, the SLT is build up around a staff organization, where decisions usually will be a part of a bigger plan. In the concept of the Network Based Defence (NBD) elements of both the planning- and decision processes, the organizational

structure, and communication is emphasized [10]. All these elements are supposed to contribute to an increased operational tempo and an increased ability to fight [13]. A fundamental condition is that NBD will give a better situational awareness and understanding of the leaders intention, which is exercise elements that should be taken into account in all group based exercises. Within the NBD-concept decisions will be taken both in a centralised and de-centralised way, dependent upon the situation, something that demands a lot of the decision maker. It is therefore unthinkable that such an ability to make decisions can be developed without the use of simulator based training support, also within the leadership area.

VII. AN EXAMPLE OF A PRACTICAL SOLUTION: STAFF TRAINING

In order to use the "TT as SLT" one has to build an infrastructure that is an imitation of the structures one can find on the staff level (battalion and eventually brigade) in the field. This will demand that the TT is equipped with a communication allowing the staff to sit outside the room where the TTs work stations are placed. This can be in a classroom, a tracked vehicle (with a tent attached to the tracked vehicle) or something similar. It is the so called players that mans the work stations in the TT-room, whereas the staff is sitting outside and does not have direct access to the simulator generated situational picture. Such a form of organising will not lead to any additional costs, because the NMA has the disposal of two tracked vehicle for use in exercises and combat fatigue courses. There is however some practical preparations to be done before each exercise starts. The preparations are related to preparing the infrastructure for the staff before each exercise is about to take place, especially the communication link between the staff and the players. In comparison this will already be in place and ready to run at the SLT, so this will take no time to prepare.

Another challenge regards the carrying out of the training or exercise. In order to be able to train with higher level units it will be a lot of units to keep track of for the players. When carrying out an exercise at the SLT it is normally local personnel that support the players with expertise within specialist units. At the SLT normally 10-15 cadets fill the positions staff support functions, while the rest (up to 20) are players, that carries out the staffs plans. The staff has as earlier explained standard staff equipment, without computer screens that reveals the units, and they base their combat leadership upon manual maps with overlays. The communication between staff and players takes place with "normal" communications equipment, a system known as NORCCIS (NORTAC, with e-mail, web or something similar) and regular radio or line communication. Still at the same time one can send the "commander" forward to the unit, and the commander will then be able to see the computer screen the players have (that is what the company commander sees). NORTAC machines are available at the NMA and can be used for exercise purposes.

VIII. Cost Impacts

While decision making training, as discussed earlier, may be executed with the existing equipment in the TT, the staff training will have to make local adjustments that can be solved temporarily or through economic investments. An advantage with a permanent adjustment of the system at NMA geared towards training the staff is that one will gain an economical saving through the reduced use of the SLT at Rena.

The relevant economic saving concerning the reduced use of the SLT at Rena is mainly attached to the reduction in travel, stay, and extra wage bills that is caused by training at Rena rather than at Linderud. The cost for NMAs use of the SLT/Rena will be dependent upon which type of accommodation that is used. By overnight stop and food at Rena camp the extra cost will be possible to almost neglect. By staying outside the camp in a hotel in Rena or close to Rena, the added cost will be about 10000 USD for each training session, in addition to food and transport. Working hours for instructors participating at the SLT is accounted for as an exercise during working hours. The instructors may either take overtime that is built up during an exercise as unpaid time off (an exercise week lasts from Monday until Thursday), or get paid for the overtime at a rate of 50% extra in addition to the normal salary. The normal situation is that each instructor accumulates 6 hours overtime for each instructor pr day. As a contradiction, an exercise in the TT at the NMA is normally conducted during the normal working hours, and therefore the instructors normally does not accumulate any overtime for this.

If one wants to conduct staff training at Linderud one have to make adjustments in allocation of rooms and communication solutions. This is adjustments that has to be done before and after each exercise week, and it may well be that one uses a lot of time and focus in order to solve the practical problem compared to the pedagogical content of the exercises. It may also be relevant to emphasize that these "temporarily solutions" may affect the motivation of both the cadets and the instructors in a negative way. This may further lead to a reduced effect of learning.

It may therefore be relevant to consider more permanent investments in room- and communication solutions at Linderud.

IX. The Road Ahead

The road ahead may include the involvement of different sections at the NMA in order to evaluate the further development of the TT. This could best be accomplished in the direction of decision making training and/or staff training. Three different approaches may be possible to follow in the future.

1. Only decision making training – this does not demand any investments or increased operating costs, only training the instructors.

2. Decision making training and temporary adjustment in order to be able to conduct staff training – this hardly demands any additional investments, but may on the other hand lead to more work which again may generate overtime.

3. Decision making training and permanent solutions for staff training – this demands investments, and the NMA will have to make a budget taking into account new purchases as well as increasing operating expenses and cyclic re-purchases.

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