Chapter 20

Critical Thinking in Tactical Decision Games Training[1]

Karel van den Bosch and Anne S. Helsdingen
TNO, The Netherlands

Introduction

As a result of changes in the international political situation, military missions are more and more focused upon peace-enforcing operations in regional conflicts. There is often uncertainty about the intentions, capabilities and strategies of the parties involved. Successful preparation, execution and management of military operations in complex and unstable conditions therefore requires competent commanders and staff personnel.

Recent studies have shown that experts in military tactical command treat decision making as a problem-solving process [5]. Experts have large collections of schemas, enabling them to recognise a large number of situations as familiar. When faced with an unfamiliar tactical problem, experts collect and critically evaluate the available evidence, seek for consistency, and test assumptions underlying an assessment. They then integrate results in a comprehensive, plausible, and consistent story that can explain the actual problem situation.

Being able to interpret a tactical situation requires the adequate recognition and judgement of relevant factors (e.g. weather, terrain, time of day, etc.). Insight in the nature of a particular problem is not so much the result of knowledge of individual factors, but more the appreciation of the specific combination of factors in the specific

[1] Van den Bosch, K., & Helsdingen, A. S., (2007). Critical thinking in tactical decision games training. In: M. J. Cook, J. M. Noyes, & Y. Masakoski (Eds.), Decision making in complex systems (pp. 213-222). Aldershot, England: Ashgate

context. Experts capture such interrelated and contextualised knowledge in the form of mental tactical schemas [10]. Novices do not (yet) have elaborated mental tactical schemas. They are therefore more inclined to focus on isolated cues and tend to take these at face value. Further, they are often not aware of assumptions they implicitly adopt to fill in missing parts; hence, they cannot be critical about them, and are more likely to "jump to conclusions".

If we want novices to become experts, training tactical command therefore needs to address two components: (a) expansion and refinement of tactical schemas, and (b) practice in solving complex and unfamiliar tactical problems.

Training tactical schema acquisition

Experienced decision makers can quickly and accurately achieve situation awareness in critical situations due to their large knowledge base of tactical patterns. Their experience enables them to make fine discriminations between cues and to detect anomalies in 'prototypical' cases [9], [12].

Acquiring expertise in a high-level complex skill like command and control is a matter of intensive, deliberate and reflective practice over time [7]. It requires active engagement in situation assessment and decision making in representative and relevant cases. Studying such cases from different angles, and acknowledging the relevance of cues and their intercontingencies help students in the build-up of mental tactical patterns.

Exposure to command and control situations can take place in operational and in training settings. Although the value of experiencing operational missions is undisputed, such missions are seldom ideal for learning tactical patterns. For one, commanders participate in only a small number of missions. Furthermore, the decision to assign a mission is usually based on operational considerations, not on a commander's training needs. Therefore, commanders are likely to be assigned to the type of missions with which they are already familiar. Secondly, the emphasis of current military missions is on peace-enforcing. Bringing these missions to a success depends heavily on a commander's competencies in for example, management, administration, logistics, negotiating, administration, but seldom requires handling combat situations. Thirdly, the course of such missions is normally too uncontrolled and unstructured for effective learning. Taken together, experiences in operational missions are valuable, but do not provide the conditions for effective and efficient learning.

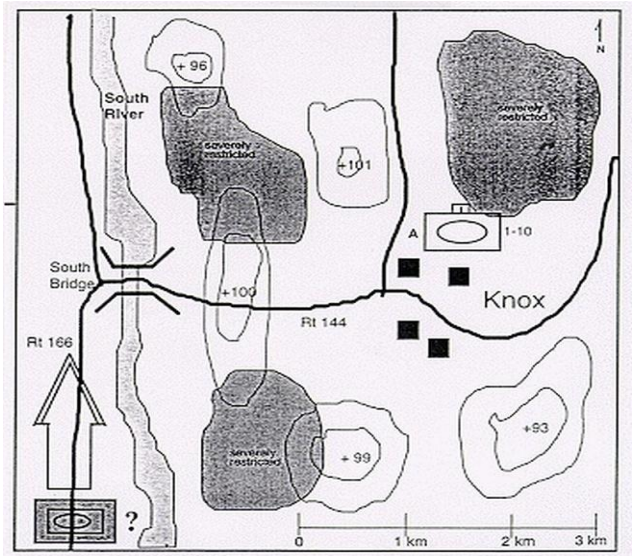
In a training setting, the nature and difficulty of live and simulation exercises can be controlled, thus enabling the delivery of training tailored to identified training needs. However, again, this potential is seldom achieved, not in live training exercises nor in simulator exercises. Live exercises are expensive in terms of costs and organisational efforts, and are therefore organised scarcely. Furthermore, achieving training goals are only one of multiple goals in live exercises, and generally not the most important. More often than not, the focus is on determining operational readiness or team building.

Training tactics in simulators also requires a high overhead in terms of personnel. A popular way to solve this problem is to let students play the role of a team member. Sometimes, students receive more training as support player than as commander. Thus, even simulator exercises require substantial logistic and organisational efforts, making exploitation of simulator training costly and inefficient.

In sum, current operational and training practice provide commanders insufficient opportunities to build up a framework of mental tactical patterns. What is required is a method by which to provide a commander, either along with the command team or not, with intensive, reflective practice over time. The skill of decision making can improve by learning to deal with specific cases and to approach problems from different angles. The method should enable the expansion and sophistication of an individual's database of mental tactical patterns.

Tactical decision games

With this goal in mind, the US Marines adopted a low fidelity training technique to present tactical problems to trainees: Tactical Decision Games (TDGs) [11]. A TDG is a tactical problem consisting of a short written scenario, a sketch or map, a requirement, and (optionally) a time limit. The scenario tells the players who they are, what they have for assets, defines their mission, and presents some type of enemy situation. The enemy situation is often vague and incomplete, forcing the players to make assumptions. Scenarios should be tailored to a commander's or a unit's training needs, and is preferably realistic and challenging. The written scenario is usually no more than a few paragraphs. See Frame 1 for an example [8].



Situation: You are CO TM A, TF 1-10 AR. The TF is occupying hasty defensive position north in preparation for a morning attack to the south. They are approximately 5 km to the north. You and a TF scout section are the screening force for the TF. You have two tank platoons and one mech platoon. Currently you have halted your company north of Knox. TF scouts are ahead of you conducting a route recon south along Rt 166. Your mission is to provide early warning to the TF. You have permission to engage the enemy, but are not to become decisively engaged. The enemy, which has the ability to mass up company size units of T-62s and BMP-Is, is not expected to attack. You have priority of mortars and FA. As you survey the terrain to your front, you watch the scouts cross South Bridge and head south along Rt 166. Suddenly you hear MG and tank main gun firing west of the bridge. You try to contact the scouts but receive no answer. What is your plan?

Figure 1. Example of Marines-TDG

Participants make decisions, consider the consequences of a selected course of action by mental simulation [9], and compare this with other possible courses of action. TDGs are not script-driven, but stimulate participants to review and discuss the reasons for why a particular decision was made rather than focusing upon the decision itself. TDGs can be administered individually or to groups. They can be static, requiring trainees to develop a detailed and founded plan. TDGs can also be dynamic by introducing events upon which trainees must respond.

TDGs have been used successfully to present a wide variety of relevant tactical situations to trainees, and to enable them to practise situation assessment and tactical decision making [8]. The use of TDGs has been further developed and refined for civil emergency management training. Case studies show that TDG-training enhances planning, communication and decision making [6].

Training tactical problem solving

The approach of expert decision makers when handling difficult, unfamiliar and new situations has been used to develop a new training concept: critical thinking (CT) [4], [5]. Critical thinking involves a problem solving approach to new and unfamiliar situations. It is a highly dynamic and iterative strategy, consisting of a moderately sized set of methods to build, test and critique situation assessments. These methods are to some extent general but they can only be taught if grounded in a specific domain and trainees have already a certain level of knowledge of that domain.

Effective training in critical thinking combines instruction with realistic practice [5]. The design of scenarios is very important since these have to provide opportunities to practise critical thinking processes, in particular:

- Producing different explanations for events
- Recognising critical assumptions of situation assessments
- Critiquing and adjusting assumptions and explanations
- Mentally simulating outcomes of possible decisions

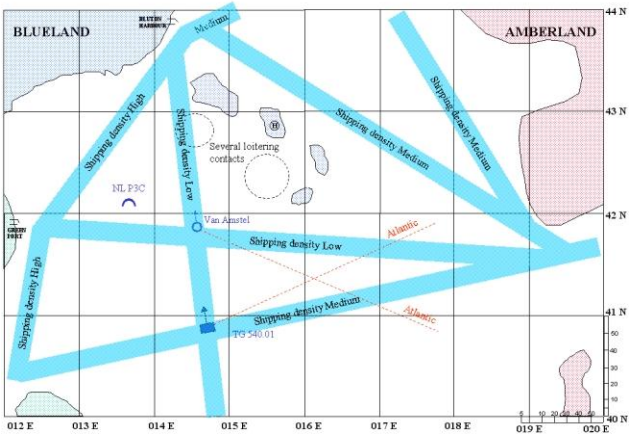
One principle aim of critical thinking training is to keep trainees from assessing tactical situations solely on isolated events. Instead, trainees are taught when to collect additional information, and how they can integrate the available information into its context, which may include elements as: the history of events leading to the current situation, the presumed goals and capacities of the enemy, the opportunities of the enemy, etc. Trainees are instructed how to identify inconsistency and uncertainty, and how to adjust or refine their story by deliberate testing and evaluation. CT training also includes a procedure for handling time constraints.

Field studies showed positive effects of CT-training on the *process* of tactical command as well as on the *outcomes* [4], [2], [3]. It stimulates trainees to produce a founded situation assessment, and helps them to anticipate to alternative courses of events by developing contingency plans. The method supports not only individual commanders in situation assessment and decision making, it is also particularly suitable for team

members to clarify their assumptions and perspectives on the situation to other team members [1].

CT/TDG: A Navy application

Recently, we applied the concept of critical thinking training and the use of TDG in the training for CIC (Command Information Centre) officers. The Operational School of the Royal Netherlands Navy experienced a gap between theoretical classroom lessons and practical exercises in the tactical trainers. Theoretical lessons emphasised learning tactical procedures and properties of sensor- and weapon systems. The relevance of the presented materials to tactical situation assessment and the implications for decision making often remained implicit. When, later in the training course, students were required to bring this knowledge into use during exercises in the tactical simulators, they often lacked the skills to do so. In order to solve this bottleneck, classroom lessons had to be redesigned in such a fashion that its content and form are congruent with the knowledge and skills associated with expert task performance. We aimed to achieve this by embedding critical thinking into Tactical Decision Games exercises. A series of four paper-based exercises were developed. See Figure 2 for an example of TDG.



Mission: The mission of the Task Group (TG) 540.01 is the safe arrival of Her Majesty Rotterdam in the harbour of Bluton.
History and setting: NATO is at war with Amberland. Several land, sea and air battles have taken place. Amberland is determined to keep the islands off Blueland's coast occupied. Greenland's position is officially neutral, but intelligence information

indicates they sympathise with Amberland. There is a busy merchant shipping lane along Blueland's coast. The TG picked up an enemy MPA's radar signal.
Task: you are the ASuW officer of the "van Amstel", picket of the Task Group, sailing 60nm ahead of the TG. Develop your plan and at least one contingency plan.
Tactical issues: When student develop (contingency) plans, instructors observe whether the following tactical issues are taken into account: the loitering contacts in the area (who are they; what cues are used to assume their identity?); is our task group located and/or identified?; is the "van Amstel" identified/classified?; if the helicopter is used for reconnaissance, what instructions regarding course, speed and emission are given?; do students take into account that towed array works only to the rear?

Figure 2. Abridged example of ASuW TDG

Prior to the actual training sessions, scenario leaders and instructors were instructed extensively on the concept and principles of critical thinking. Observation protocols and performance measures were designed to support instructors in their tasks.

For the trainees, we developed an instruction book on critical thinking within the context of surface warfare, including self-study questions and exercises. In a two-hour classroom session on critical thinking, we familiarised students with TDGs and explained what was to be expected from them in the TDG-sessions. TDGs were administered to groups of four students (see Figure 3).

Figure 3. Group performing a TDG

In turn, one of them was assigned the role of observer using a scoring form to evaluate the group on the following dimensions:

- information selection and acquisition
- argumentation and reasoning
- planning and contingency planning
-

In addition, an experimenter-observer also evaluated the group's performance. Students were asked to clarify their assessments, thus giving observers and the instructor access to the assumptions and reasoning underlying their decisions. In order to enhance critical thinking processes, the instructor guided the session by specific CT-exercises, like "now try to finalise your initial assessment into a story", or "now test your story upon conflicting, unreliable or incomplete information", or "identify a critical assumption in your story and apply the advocate-of-the-devil technique". After completion, each group presented their assessments, plans and contingency plans to the other groups. Tactical key decisions were discussed collectively.

Results and Conclusions

After the series of exercises were completed, we interviewed students and staff about their experiences and asked them to fill in a questionnaire. The majority of students were enthusiastic about the training program and tried to follow the instructions to their best. They responded to appreciate the exercises as a suitable method for consolidating and applying their tactical knowledge, and for practising their skills in tactical assessment and decision making. A few individuals, however, considered the concept of critical thinking not useful. This may have been due to insufficient domain knowledge required to conduct critical thinking as intended. For instance, these students had difficulty identifying critical assumptions in assessments, and were often unable to judge the tactical relevance of ambiguous information.

Instructors were of the opinion that the exercises will enable students to successfully prepare for the practical simulator training. They also argued that the required elaboration on the tactical issues helps students to develop tactical schemes, and that critical thinking helps shaping the necessary strategic skills.

We observed that proper facilitation of exercises brought about a high work load for the instructors as they had to simultaneously teach, guide, monitor and assess critical thinking processes and task performance. Although all the navy instructors were enthusiastic and motivated, it is important to realise here that they are domain-experts in the first place. In a three-week course they learn the basic didactic methods how to transfer knowledge and skills to students. The methods addressed in the course do not include the training principles described in the present chapter. For that reason it is

understandable that instructors tended to fall back on traditional teaching techniques and provided students with the expert-solution too quickly. The importance of adequate preparation and training of instructors for delivering CT-training can therefore not be overstated.

The shortage of personnel and the high costs involved with developing domain experts into good instructors induces the defence organisation to investigate new forms of training that are less dependent (or even independent) of location, time and staff. Thanks to their entertaining and involving qualities, computer games are potentially suitable for this type of training. However, using games successfully for training purposes requires control over the scenario. For decision making tasks, the control problem lies in the fact that an instructor must be able to respond adequately to any situation emerging as a result of the trainee's decisions. It turns out that this is hard to automate in a computerised instructor agent. In contrast to software-agents, human instructors have the ability to take the context into account when evaluating (on-line) the appropriateness of trainee behaviour and to assess whether the training scenario develops in the intended direction. That is probably the reason why human instructors are now still in control in simulation-based or game-based decision making training. However, human instructors have their disadvantages as well. One problem is that these experts tend to evaluate trainee performance intuitively, without being able to precisely point out which cues (or absence of cues) they use for diagnosing trainee behaviour. Furthermore, experts often differ in opinion on what is to be considered appropriate and inappropriate behaviour. It is clear that this hampers transparency of performance measurement and feedback. Finally, the need for domain experts elevates costs of training and requires high organisational and logistic efforts. If we can develop software agents that (semi)autonomously and intelligently evaluate tactical assessments and decisions, training can become more traceable, more systematic, and more cost-efficient. Promising research into that direction has taken the approach to develop agents whose behaviour is a function of simulated cognitive processes (e.g. beliefs, intentions, goals) [10, 14]. The heart of such agents is a cognitive model. A cognitive model represents the knowledge and cognitive processes of an individual or entity (e.g. the instructor) in a certain domain, task or scenario. This representation needs to be so specific that, when provided with input, the cognitive model produces realistic behaviour as output. There is growing evidence that cognitive modelling can be used successfully to improve tactical training [13].

This pilot study has explored the effects of intensive and reflective practice in situation assessment and decision making in tactical decision games. Results are promising and have lead to ideas on formalising these principles for use in game-based environments.

More standardised and formal methods of performance are needed to fully evaluate the strengths and limitations of this approach.

References

1. Bosch, K. van den, & Berlo, M. P. W. van (2002). *Training en evaluatie van tactische commandovoering*. (in Dutch) (Report No. TM-02-A025). Soesterberg, the Netherlands: TNO-TM.
2. Bosch, K. van den, & Helsdingen, A. S. (2002). Improving tactical decision making through critical thinking. In *Proceedings of Human Factors and Ergonomics Society*. Held at: Baltimore, MA. HFES.
3. Bosch, K. van den, & Helsdingen, A. S. (2001). Critical thinking in tactical command: A training study. In *Proceedings of Conference on Simulation Technology for Training (SimTecT)*; Canberra, Australia. SimTecT; 2001.
4. Cohen, M. S., & Freeman, J. T. (1997). Improving critical thinking. In R. Flin, E. Salas, M. Strub, & L. Martin (Eds.), *Decision making under stress: emerging themes and applications* (pp. 161-169). Brookfield, Vermont: Ashgate.
5. Cohen, M. S., Freeman, J. T., & Thompson, B. B. (1998). Critical thinking skills in tactical decision making: a model and a training strategy. In J. A. Cannon-Bowers, & E. Salas (Eds.), *Making decision under stress: implications for individual and team training* (pp. 155-190). Washington, DC: APA.
6. Crichton, M., Flin, R., & Rattray, W. A. R. (2000). Training Decision makers: tactical decision games. *Journal of Contingencies and Crisis Management*, 8(4), 208-217.
7. Ericsson, K. A., Krampe, R. Th., & Tesch-Römer, C. (1993). The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Review*, 100(3), 363-406.
8. Gonsalves, J. D. (1997). *The Tactical Decision Game: An invaluable training tool for developing junior leaders* [Web Page]. URL: http://call.army.mil/products/etc_bull/armor/mayjun97/ article1.htm.
9. Klein, G. (1998). *The source of power: how people make decisions*. Cambridge, MA: MIT Press.
10. Norling, E. (2003). Capturing the Quake Player: Using a BDI Agent to Model Human Behaviour. In *Proceedings of the Second International Joint Conference on Autonomous Agents and Multiagent Systems, pages 1080–1081, 2003.*
11. Schmitt, J.F. (1994). *Mastering tactics: A tactical decision games workbook*. Quantico, VA: Marine Corps Association.
12. Stokes, A. F., Kemper, K., & Kite, K. (1997). Aeronautical decision making: cue recognition and expertise under time pressure. In C. E. Zsambok, & G. Klein (Eds.), *Naturalistic Decision Making* (pp. 183-196). Mahwah: Lawrence Erlbaum Associates.

13. Doesburg, W.A. van, & Bosch, K. van den (2005). Cognitive Model Supported Tactical Training Simulation. In *Conference on Behavioral Representation in Modeling and Simulation* (BRIMS) (pp. 313-320).
14. Zachary, W., Ryder, J., Santarelli, T., & Weiland, M. (2000). Applications for executable cognitive models: A case study approach. In *Proceedings of the Human Factors and Ergonomics Society 44th Annual Meeting*, Santa Monica, CA: Human Factors and Ergonomics Society.