Turn-Based Gaming for Convoy Commander Training

Rudy Boonekamp, Tijmen Muller
TNO
Soesterberg, The Netherlands
rudy.boonekamp@tno.nl, tijmen.muller@tno.nl

Jur de Vrijer
SIMCEN, Royal Netherlands Army
Amersfoort, The Netherlands
JC.d.Vrijer.01@mindef.nl

ABSTRACT

With the increasing complexity of current-day military operations, effective education and training of military commanders is of vital importance. Commanders need to perform within a broader range of conflicts; unpredictable threats and civil-military interaction place a great demand on their decision making skills. Because defense is transitioning towards a leaner organization, efficient and innovative tools are needed to provide better training value. The possibility to train frequently and learn from experience is indispensable.
The Royal Netherlands Army sees potential in the use of serious games to meet these demands. This paper presents the results of a research project that explores the use of 'turn-based gaming' for training convoy commanders. In a turn-based serious game, a scenario is played in rounds which have a distinct planning and execution phase, making it possible to control time compression and time pressure. The advantages of this concept are that 1) the trainee can gain experience controlling a large number of units; 2) less experienced trainees can focus on tactical decision making as the complicating real-time factor is removed; and 3) trainees can plan and reflect on tactical decisions while staying immersed in the game.
A prototype game was developed using VBS2, implementing the functionality and user interface for a turn-based convoy scenario. In a pilot session, seven logistics trainees played through three scenarios of increasing difficulty. The potential advantages of turn-based gaming were assessed using a questionnaire.
The results indicate that the participants gain relevant experience, insight in effective communication and that turn-based gaming helps them learn by experience through fast loops of planning, execution and reflection. However, technical limitations and the limited scope of the experiment keep us from final judgment whether turn-based mechanics help trainees stay immersed in the game.

ABOUT THE AUTHORS

Rudy Boonekamp is scientific researcher at the Training and Performance Innovations department at TNO. He is a simulation and serious gaming expert and specializes in the design of user experience, modelling of expert knowledge and the use of innovative technologies for training, experimentation and behavioral change, in both the military and civil domain. Rudy holds a Masters of Science degree in Information Science from the University of Utrecht in the Netherlands with a specialization in Content and Knowledge engineering.

Tijmen Muller is scientific researcher at the Training and Performance Innovations department at TNO. He graduated at the University of Twente in Enschede with a degree in computer science. He is a simulation and serious gaming expert and has specialized in the design and architecture of simulation, research into advanced simulation techniques and the use of simulation and serious gaming for concept development, experimentation and training, in particular for the military and safety domains.

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INTRODUCTION

Convoy movements are a vital part of combat operations, whether conducting in support of full-blown conflicts, peacekeeping, or disaster response. Without effective logistics and safe transport of troops, no crisis can be alleviated or battlefront sustained. Nowadays, with military operations taking place in urbanized environments, junior leaders such as convoy commanders need to perform within an increasing range of situations: unpredictable threats and civil-military interaction place a great demand on their decision making skills. The training of convoy commanders in tactical decision making is therefore of great importance. As the Dutch defense is transitioning towards a leaner organization, innovative and efficient tools to train these commanders are of increasingly vital importance. The ability to train frequently and provide learning experiences is indispensable.

This paper explores the use of 'turn-based gaming' for more efficient and effective training of convoy commanders. The state-of-the-art of convoy operations training is explored and characteristics and possible benefits of turn-based gaming are identified. The insights gained are put into practice in the design of a proof-of-concept game for convoy commander training. A pilot session and subsequent qualitative evaluation identified valuable insights in the experience of trainees with turn-based gaming in practice.

CONVOY OPERATIONS TRAINING

In the Royal Netherlands Army, the training of convoy logistics is the responsibility of the facility for Education & Training of Logistics (OTCLog). The OTCLog school offers a specialized training program (VTO) twice a year for officers training to become a convoy commander. This program aims to prepare the students for duty in an operational logistical unit. The program involves field exercises where one or more serials with subsequent march units are moved around. These march units usually contain seven vehicles with crews.

The execution of such an exercise is costly. The vehicles have to be taken out of regular duty and committed to the exercise, drivers and crew that are needed to facilitate the exercise have to postpone their daily tasks and there are additional costs associated with fuel and vehicle wear. Additionally, the environment in which logistics can be trained is limited: military training areas are small when used for logistics training, while Dutch regulations limit the size and frequency of convoys that can be driven in civil areas. Additionally, it is difficult to practice exceptional situations in the busy civil road infrastructure of the Netherlands.

The use of simulation and gaming techniques are a solution for these limitations. However, for training platoon commanders at the OTCLog, the use of simulation and serious gaming is still little developed. There is intent for the adoption of Virtual Battlespace, but, as is the case with many digital learning tools, this has not been implemented yet. As it is, most education and training is either theory or field practice, with little in between.
In the international theater there are examples of simulated convoy operations training in use. The US Army, Marine Corps, and National Guard use the Virtual Combat Convoy Training (VCCT) simulator designed by Lockheed Martin for convoy combat training. VCCT uses an immersive 3D projected environment (MetaVR) for training convoy tactics. The simulator allows for a maximum convoy size of six vehicles (Gourley, 2004).
An alternative simulator called Virtual Convoy Operations Trainer was developed by Raydon Corporation. This simulator differs from VCCT in that it uses 360° Virtual Reality headsets and is made to fit in truck-mounted containers (Martin, 2004).

Both of the above convoy trainers are relatively expensive simulation systems, concerned with tactical level combat training at the small unit and individual level. They involve one convoy unit conducting virtual training and reacting to simulated friendly and enemy units in the virtual environment. Digital tools for the training of a broader set of

learning goals, including the logistics of convoy operations, at a level where the interaction between multiple convoy march units is concerned, appear to be limited.

TURN-BASED GAMING

The Royal Netherlands Army sees potential in the use of serious games to meet the changing demands for training junior leaders (Anticipating and Innovating, 2008). The use of virtual environments could be an efficient and effective addition to live field exercises: only virtual material is needed, fewer facilitating personnel are required and there are fewer practical constraints. Such virtual environments are already in use in other training centers such as maneuvers (OTCMan) and fire support (OTCVust). Using tools such as Virtual Battlespace, trainees are immersed in a real-time 3D environment with authentic terrains and detailed scenarios. These virtual tools have shown to be effective [De Boer, 2015], however, once you scale up to training the platoon or company level, they can overload the commander-to-be with a great number of decisions in a very short time. This is not always desirable. While a commander is certainly required to deal with this complexity in the field, it may pay off to dose this complexity in training, starting with the crawl phase in the crawl-walk-run continuum. Additionally, the use of real-time simulations places a great demand on the instructors and role-players. In real-time simulation, the instructor needs to continuously monitor the progress of the scenario in order to provide events when necessary and just-in-time. When running a large-scale exercise, multiple instructors may be necessary to direct a scenario on platoon level. A large number of role-players may be necessary, not only to provide meaningful interaction with the environment (i.e. civilians, opponents), but also to facilitate as drivers within the convoy – in general, the artificial intelligence provided by state-of-the-art simulations is inadequate as of yet to control multiple vehicles within a convoy when run in real-time. Consequently, there is need for an immediate form of simulation that can control complexity for inexperienced trainees, and at the same time solve the practical problems with live exercises.

This paper explores the use of 'turn-based gaming' for training convoy commanders. In a turn-based serious game, a scenario is divided into rounds with discrete steps, between which time can be paused, skipped or slowed down. This offers the player more time to reflect on his actions and comprehend the complexity of the situation. Because reflection is part of the game design, a 'natural' break in the progress of gameplay instead of a time-out within a real-time game, it potentially interferes less with the players' immersion in the game. We expect that these properties of turn-based gaming make it suitable for inexperienced trainees who lack technical know-how and skills.

The turn-based game format

In a turn-based game format, a turn may signify a switch between who the active player is, a change in the players ability to interact with the game and/or a jump in time. Two common variations of this format are the 'We-Go' and 'I-Go-U-Go' constructs. In a 'We-Go' turn-based game, moves are planned simultaneously by all players, and then these player actions are executed simultaneously within the game. In this construct, players cannot modify or rescind their orders once the game has moved on to the execution phase. In contrast, the concept of alternating the active player is commonly called a 'I-Go-U-Go' turn-based game. In the I-Go-U-Go construct it is possible to assign and execute orders *within* the same turn phase. In this case, for a given turn, the simulation world is paused except for the active players' units and between turns the active player changes. The player often has limited resources, such as action points, which are exchanged for unit actions. Examples of this game format are entertainment games such as Jagged Alliance (Jagged Alliance series, n.d.) and the Civilization (Civilization games, n.d.) series.

In this study we make use of the We-Go construct because it better facilitates training situational decision making and communication across convoy leadership (see section 'Turn phasing'). All players simultaneously switch between an execution phase in real-time and a planning phase with a paused simulation. While the world is paused, the players have the opportunity to analyze the situation at hand more in-depth and make decisions accordingly. The players then assign sequences of actions to their units and confirms their plan. Note that this planning phase is not the same as a military operational planning phase, rather it involves situational decision making with some of the time pressure alleviated. In a real-time game, the player would have time-pressure in deciding a course of action, while the scenario would progress. In this turn-based game format, scenario time is paused, which gives the trainee an 'unnatural' large amount of time for his situational decision-making process. We believe this extended amount of time is beneficial for the learning process of unexperienced trainees.

Switching to a regular passage of time in the execution phase, the effects of the planned actions are shown. The game world is activated and the simulated units will realistically execute their actions in the virtual environment, within given time and space constraints. Examples of this format in entertainment gaming are Combat Mission:

Shock Force (Combat Mission: Shock Force, n.d.) and Frozen Synapse (Frozen Synapse, n.d.). The length of the execution phase is often constant and limited, switching to the next turn after a given number of seconds. This game mechanic is called turn phasing, and separates the decision making process from the main game flow.

In turn-based gaming, both the time spent within a turn and the move from one turn to the next can signify an adjusted passage of time in the game world. In Jagged Alliance a turn can take an unlimited amount of time, but in the game world only a few seconds have passed. In Civilization, you spend a few minutes planning your actions, but in the game world one hundred years may have passed. This game mechanic is called time-compression.

Using turn phasing and time compression, complexity can be controlled, challenging the trainee just enough for them to be immersed but not be overwhelmed. In this way, the game presents challenges according to the skill level of the trainee, avoiding frustration or boredom and keeping them in the state of flow (Csikszentmihalyi, 1991). Because the player progresses quickly from turn to turn, the premise of fast learning loops through immediate feedback, which real-time simulation provides, is still intact.

Benefits of turn-based gaming

In conventional real-time virtual training, a training scenario consists of consecutive stages of theory, planning, execution and reflection. This results in a single learning loop for the scenario, of which the actual gameplay is a part (see Figure 1).

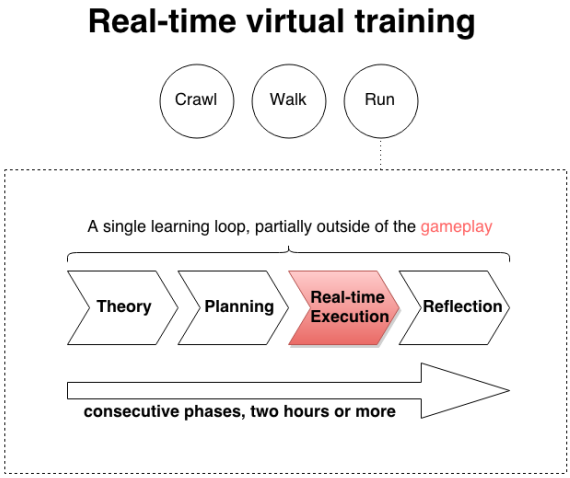

Figure 1: Real-time virtual training

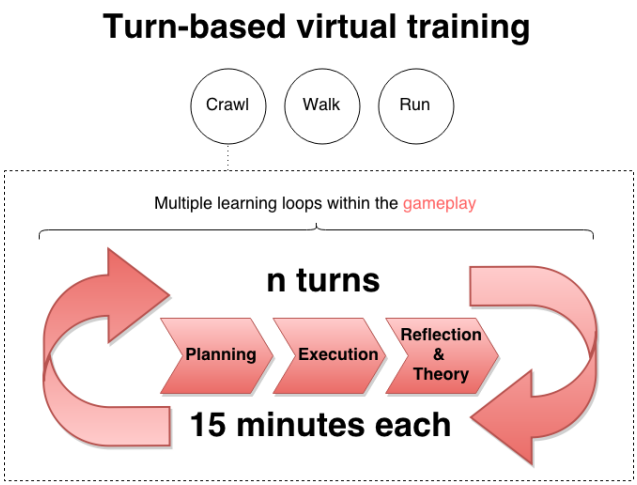

Figure 2: Turn-based virtual training

In turn-based virtual training a training scenario consists of a number of short turns, in each of which the phases of planning, execution and reflection/theory are integrated. The trainee plays through multiple learning loops in quick succession while staying immersed in the context of the same continuous scenario. This mitigates the disruption of immersion (see Figure 2).

The turn-based gaming format has potential benefits compared to real-time gaming:

1. Less experienced trainees can focus on tactical decision making as the challenging real-time factor is removed.
2. The trainee can gain experience controlling a large number of units. Because of time freezing the trainee can easily give out orders for a large number of units in more detail. Furthermore the player is not punished as harshly for errors in the game controls.
3. Short-cycle planning, execution and reflection. Because the turn-based structure allows quickly switching from planning to execution to reflection, trainees can plan and reflect on tactical decisions in rapid succession while staying immersed in the game.

4. Jumping straight to the essential parts of a scenario. Time compression makes it possible to shorten long-lasting scenarios or skip unnecessary parts that do not contribute to the learning goal.

A possible benefit of turn-based gaming compared to live fire exercise (LFX) is that officers can be trained with limited facilitating personnel as individual units and groups are simulated by artificial intelligence.
At the moment of writing, turn-based gaming on the tactical level has not been adopted as an educational tool within The Royal Netherlands Army. In this paper we investigate if the above promises of turn-based gaming can indeed contribute to the training of convoy commanders on the platoon and company level. In this way, we aim to contribute to the state of the art of game-based military training.

METHOD
The goal of this research is to explore the use of turn-based gaming in military training. This is done by creating a demonstrator of the game concept, which is an experimental proof-of-concept at a technological readiness level of three (TRL 3). This demonstrator is evaluated in a pilot with the intended audience. The following steps were taken:

1. Determine the learning goals of the specialized training program (VTO) with the School for Initial and Further Education of the OTCLog and a suitable didactical approach;
2. Design of the training scenarios and the digital game environment;
3. Refinement using an iterative approach with regular testing sessions;
4. Pilot session of the final demonstrator with trainees of the OTCLog involving observation by subject matter experts and a questionnaire;
5. Analysis of findings from the design phase, pilot session and subject matter expert feedback.

According to this method, a demonstrator was developed that allows up to eight players to train military logistical challenges in a turn-based virtual environment.

LEARNING GOALS AND ANDRAGOGY
The target audience of the turn-based game is the participants of the VTO program who are being trained to become convoy commanders (i.e. platoon level). A secondary audience is those in training to become commanders of a march unit (i.e. squad level).
The main learning goals for convoy commanders are:

- Effective communication with commanders of the convoy march units: actively sharing information and coordinating movements.
- Situational awareness: awareness of the terrain, position of march units, possible threats and relevant space and time constraints.
- Situational decision making: dealing with unexpected events such as threats, breakdowns or blockades.

Given the learning goal of communication, it is desirable that the learning method involves multiple trainees interacting with one another by voice. To train situational awareness, information of the situation at hand should be limited and specific to each player. Only through communication or active reconnaissance can players increase situational awareness or resolve ambiguity. For situational decision making, the learning environment should offer complex problems that have a sense of urgency. Over time, some assumptions are found to be invalid and the trainee has to be flexible in his solution.

The turn-based concept attempts to bridge the gap between theory and field exercise. This is done by putting practice before theory, according to social constructivism theories like Job Oriented Training (Hulst, 2008). Trainees are first immersed in the relevant problem situation, try to manage it as best as they can, and afterwards given the theory that helps them understand and improve. Immediately after, they can put this theory into practice in another problem situation.

Discussion and reflection is a big part of the learning experience as this is where trainees relate their in-game experiences to real-world applications (Lederman, 1992). It also allows them to share experiences and insights with one another. The instructor becomes a facilitator of this process, stimulating discussion between trainees, instead of a teacher telling them what was right or wrong.

THE TURN-BASED CONVOY OPERATIONS GAME

A demonstrator of the game was developed using Virtual Battlespace 2 (VBS2), a 3D simulation training solution, implementing the functionality and user interface for a turn-based convoy scenario. The following key design choices were involved in doing so.

Roles

In the game three distinct roles can be distinguished: convoy commander (CC), march unit commander (MC) and the game facilitator (instructor) (see Figure 3) . The roles of the CC and MC are very different:

- The MC can issue orders to his units on a tactical map (see section 'commanding units') and has a 3D perspective from his vehicle in the convoy (see section 'imperfect information').

- The CC has a tactical map without actual positions of his march units. The only way he can control the game is by communication. Therefore, the CC's main concern is communicating with the MCs in order to gather or provide information and coordinating by issuing verbal orders to the MCs. The CC can use simulated radio communication via a headset or place symbols on the tactical map akin a Battle Management System to communicate his plans with the MCs. Currently, the CC moves in his own vehicle, but is part of the convoy. As a result, he also has a 3D perspective from his vehicle, but is not able to control it independently.

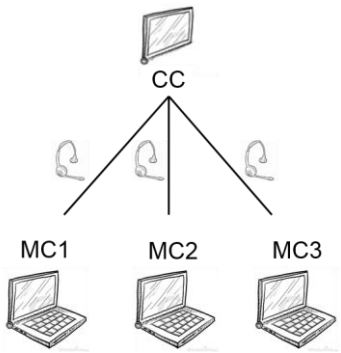

Figure 3: Roles

While the game is aimed at training convoy commanders, the role of march unit commander is also played by the trainees. This reversal of roles makes it possible for trainees to observe one another in the role of CC, socially learning from their successes and failures. Playing the role of MC provides important learning opportunities as well, as the prospective convoy commander gains insight in tactical decisions, paths of action and the information needs of units he will be commanding.
By playing the role of CC the commander gains insight in the coordination of tactical decisions and effective internal communication.

Setting

The convoy commander has command of three march units. The commander and march units are played by pairs of trainees. One trainee takes the lead in the controls while the other assists him. Between scenarios, this role is switched. The groups are separated in rooms so they are not in direct contact with each other (see Figure 4). This makes sure that they cannot see the perspective of the other march units, and have to rely on radio communication for situational awareness.

Figure 4: Convoy commander on his station

Turn phasing

A key design choice is how the gameplay varies between turn phases. In this game we choose to vary the time aspect, as a key goal is to reduce time pressure. Each turn consists of the following three phases:

1) Planning phase: the game is paused and the players have the time to do situation assessment, situational decision making and assign orders to their march units (in-game).
2) Execution phase: the game switches to real-time and the units execute their given orders. In this phase, players cannot make any adjustments.
3) Reflection phase: the game is paused, because of an event or manually by the instructor. The players leave their stations and gather around a table for plenary discussion led by the instructor.

We do not alternate the ability to assign actions between players as we want the communication and situational decision making to be a shared effort between the commander and march units (We-Go construct). Furthermore, regardless of the active turn phase, the commanders can communicate at any time using a headset. This means that even though the commanders cannot adjust orders in the execution phase, they are free to relay information and establish a shared view of the situation. As VBS2 does not support turn-based gameplay out of the box, the functionality for switching between planning, real-time execution and reflection has been added to the program.

Switching turn phases

The turn phasing as described above implies that the player cannot adjust his plans while they are being executed. Only after the execution phase ends, and possibly a reflection phase, can he adjust his course of action. This may seem like an arbitrary limitation at first and it is tempting to give the players the control they need to react to unforeseen circumstances. However, this limitation has a purpose: trainees are stimulated to think ahead and work methodically. They *have* to think of what-ifs because they will not be able to deal with it on the spot.
Switching back from execution to reflection or planning phase can happen in four ways:

1) When all planned orders have been carried out.
2) When a game event is triggered (see section 'Events').
3) When the CC or MC call for a 'TURN!' after a unforeseen circumstance has occurred.
4) When the game facilitator determines events have occurred that have a didactic value.

In cases 1 and 2, the game switches to the planning phase automatically. In cases 3 and 4, the facilitator determines whether there is didactic value in what has occurred up to that point. If so, the facilitator manually switches the game to the planning phase and the trainees get together for three minutes of reflection (see section 'Reflection'). As an example, the facilitator may call in a turn when march units do not coordinate their spacing and nearly run into each other. In the reflection, this accordion effect may be brought up. Switching to the planning phase, the trainees can apply this newfound knowledge. This is an example of how turn-based dynamics facilitate short-cycle planning and reflection.

Turn boundaries

Contrary to entertainment games like Frozen Synapse, the control over turn phases in this demonstrator lies mainly with the game facilitator. Furthermore, there is no fixed span of time or number of actions points that limit the turns. The reason for this design is that the turns are there to facilitate reflection. Artificial pauses at fixed intervals have no use, instead, turns are ended when there is relevant subject matter to discuss. The control lies for a great part with the game facilitator because he has knowledge of lessons to be learned in the scenario.

Time compression

Convoy operations can cover a lot of ground which means there are dead moments with no training value. Turn-based simulation can mitigate this shortfall by skipping time between turns. When switching from planning to execution phase, the facilitator has the option to advance the convoy units and advance the mission timer, putting the trainees right into the action.

Reflection

The turn-based game concept intends to remove some of the time pressure, allowing trainees to discover opportunities for improvement. This is done using short moments of reflection between the execution phase and the next planning phase. The advantage of this short-cycle approach as opposed to reflection at the end of the game session is that trainees do not have to recall and address all learning points in one go. A second advantage is that they can put lessons learned into practice right away, according to the theory of experiential learning. In the reflection phase, trainees leave their stations and gather around a table and discuss the current game situation. The game facilitator guides this process. In this face-to-face moment, trainees learn from each other's successes and errors, asking questions such as 'What would you have done?'. The turn-based play of the scenario is concluded with a longer, more conventional reflection session in which trainees are asked to step outside of the game context and relate their experiences in the game to their professional reality.

Imperfect information

Communications are an essential aspect of convoy operations training. The game concept takes this into account by introducing mechanics of limited information or in game theory terms: 'imperfect information' (Osborne and

Rubinstein, 1994). Imperfect information implies that the player has limited information about the state of the game world, meaning he cannot make a perfect prediction of the outcome of a tactical decision. This is akin to situational decision making where information is often limited, fast-changing and ambiguous. This concept is implemented in two design choices: perspective and 'fog of war':

- The MC views a 2D map and a 3D perspective from his vehicle. Contrary to a free camera or 'god view' this makes the MC more dependent on line-of-sight observations and communication to gain situational awareness. Technically, this has been implemented using two computer systems synchronized by a server (see Figure 5).
- Units cannot see each other's presence on the map or in the 3D perspective when they are not within a certain distance in their line of sight. This mechanic of fog of war means that the player may have to scout ahead to see traffic, civilians, obstructions or hostiles. Furthermore, any observations are only known to the concerned march unit. Again, communication is essential.

Figure 5: 2D and 3D perspective of the march unit commander

A second game mechanic that is used is the ownership of information. Certain information is only known to certain players. For example, the front march unit may observe boggy ground. This may be relevant for march units with heavier material. It is up to the MC to communicate this to gain a shared view of the situation.

Commanding units

One of the objectives of the turn-based concept is to make exercises require fewer facilitating personnel. To do this, individual units (e.g. vehicle drivers) in a convoy march unit are simulated by artificial intelligence (AI). Existing algorithms have been expanded to enable vehicles to follow a given march unit lead at a safe relative speed. The well-known accordion effect becomes apparent in case of acceleration or deceleration. The functionality has also been extended with the following actions:

- Creation or dissolution of march units
- Assigning march unit lead
- Adjusting headway distance
- Assigning waypoints
- Getting in/out of the vehicle
- Waiting for a given timespan

The convoy lead is assigned waypoints and the rest of the march unit follows. It is possible for the MC to detach units from the march unit, for example to scout ahead. The player has access to these functions using the turn-based menu on the map.

Pathfinding

To successfully train for commanding convoy units, it is important that the attention of the player is not directed at micro-managing individual units. Driving around bends is not part of the training for convoy commander, after all. To automate part of the convoy movements, an A*- pathfinding algorithm has been implemented (Hart et al., 1968). This algorithm calculates, using an underlying road model, the most efficient way to get from A to B. Thereafter,

the convoy moves realistically along the route using the previously mentioned convoy AI. The player can also set individual waypoints if he intends to divert off-road.

Events

The game facilitator has the option to trigger events in the scenario such as a conversation with a local, a road accident, obstructions, angry mobs or possible hostiles. These events are triggered using clickable symbols on the facilitator map overview (see Figure 6). The use of events allows the facilitator to react to the progress of the trainees and increase the difficulty of the scenario as needed. The main idea is that any adverse effect of events can be mitigated if the convoy march units coordinate effectively.

Figure 6: Clickable event symbols

Mission time

The planning of a mission involves an important trade-off between situation awareness and decisiveness: it is tempting to gain as much intel as possible and design the perfect plan; on the other hand one has to anticipate unexpected circumstances and react in a flexible manner. In this game concept mission time is used to challenge the player to deliver weapons, munitions, fuel and food to a military base within a given time. The turn-based dynamic means the player does not feel acute time pressure, however, the mission timer does create the possibility of failure (i.e. arriving too late) and motivates him to plan optimally. During the course of the game, the player finds out that he has to readily adapt his plan to unforeseen events.

Scenarios

The game demonstrator involves three scenarios of increasing difficulty. In this way, the level of challenge can be tailored to the skill level of the trainee, avoiding frustration or boredom. The three scenarios are:

- Basic training: In this scenario the controls of the game are practiced. Trainees follow procedural instructions to move units on flat terrain.
- Challenge: The first mission with an issued order. The goal is to resupply a base within a given time. An obstruction is encountered and the trainees decide whether they redirect one or more march units. This scenario involves one problem to which the trainees have to react appropriately.
- Adaptation: This mission has an order of the same scope. However, in this mission trainees encounter several problem situations, possibly at the same time: breakdown of a vehicle, protesting crowds, a request for help and difficult terrain. In order to manage these problems and get to the base in time, situational awareness, communication, decision making and coordination has to be optimal.

PILOT SESSION

A pilot session with the final demonstrator was held with seven trainees of the OTCLog in the rank of officer cadet. These trainees had no field experience as a convoy commander. The trainees played through each of the three scenarios in the didactical setting as described before, finishing with a final reflection session led by the game facilitator. The roles were assigned as follows:

- Two trainees acted as convoy commander – this role was changed for every scenario.
- Two pairs of trainees acted in the role of two march unit commanders.
- The instructor acted as game facilitator – he was responsible for the game events, timing and intermediate reflection phases.
- The project supervisor from the Simulation Center for Land Warfare (SIMCEN) assisted the instructor in his role.
- TNO employees had the technical lead and provided any technical assistance as required.
- Other trainees, TNO subject matter experts and the trainees' instructor from the OTCLog observed the game.

The potential advantages of turn-based gaming (see section 'Turn-Based Gaming') were assessed using a qualitative evaluation. An 11-item questionnaire was used to assess the turn-based dynamics, short-cycle reflection, communication, concentration, practical insights, relevance of the game for logistics training and general remarks and ideas for further improvement. After this, a plenary discussion was held to reflect on the game.

RESULTS

The results of the questionnaire indicate that the participants of the pilot are generally positive about the use of the turn-based game for the OTCLog specialized training program (see Figure 7). The relevance of each task in the game demonstrator is shown by the answers to question 1, 3 and 7: the participants are neutral to (very) positive about relevant tasks, insights and applicability, with the exception of one answer. In further remarks, participants see added value in training situational decision making in virtual but realistic situations. They feel they encounter relevant decision points and gain relevant experience as they must put their prospective role as convoy commander into practice. From the questions 2 and 4 can be deducted that the turn-based dynamics allowed trainees to purposefully think through decisions and learn from the collaborative reflection afterwards. In further remarks, the participants are positive about the turn-based dynamics of the game demonstrator. Especially the pause and reflection on the decision making of the convoy commander that follows an incident is deemed valuable. According to the answers to question 5, most participants gained valuable insights on effective communication. During the pilot session, it was clear that communication was a key element for success or failure of the mission goal. A number of participants did answer negatively to this question, possibly explained by the fact that the communication task was mostly up to the lead trainee who possessed a headset.

An example of a learning experience during the pilot is the bypassing of an obstacle during the 'challenge' scenario. A march unit decided to divert off-road to bypass a traffic accident. The state of the soil had not been explored, to which the game facilitator responded by having one of the heavy trucks get stuck in the mud (first learning point). Subsequently, the march unit commander communicated to the other march units that his vehicle had a mechanical failure. The convoy commander responded by letting the vehicle wait for a tow vehicle, letting the rest of the convoy pass. This resulted in a second heavy truck getting stuck in the muddy soil (second learning point). In the following reflection phase, the situation was reconstructed and possible improvements in decision making and communication were identified.

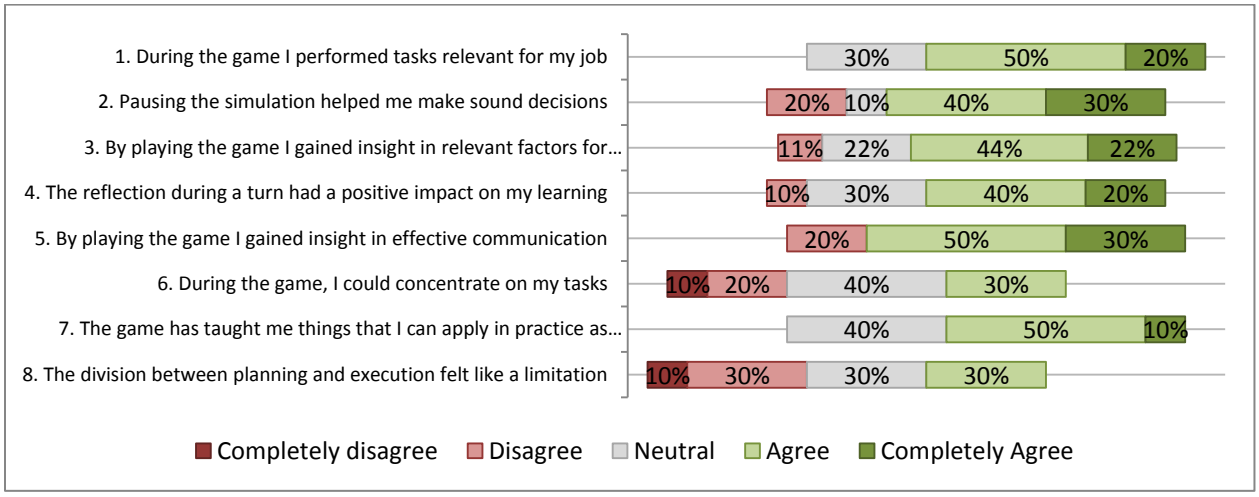

Figure 7: Results of pilot questionnaire

While most of the questions received positive evaluations of the demonstrator, question 6 does indicate that concentration was a concern. Some participants felt it was hard to stay immersed in the game. This can possibly be explained by technical limitations of a game demonstrator. One of the stations of the march unit commanders had to be reset due to a crash causing an unintended interruption of the planning process. Furthermore, the usability of the game demonstrator leaves room for improvement. Assigning waypoints involves a significant amount of delay and adjusting details of a route once planned is cumbersome. A number of participants indicated that this usability did interfere with their concentration on the role as convoy commander. Lastly, the inverse question 8 indicates that

there is a division over the use of the strict turn phases of planning and execution. Most participants do not think the turn phases limited them in their actions (40%), but a number do indicate that this felt like a limitation to them (30%). The rest is neutral. While the strict turn phases seem like a limitation to some, most participants indicate that pausing the simulation helps them make sound decisions (question 2).

CONCLUSION & DISCUSSION

The goal of this research was to explore the benefits of turn-based gaming in the context of convoy operations. For this purpose, a game demonstrator was developed and tested during a pilot session with prospective convoy commanders. The results of the pilot show:

- The turn-based format can help prospective convoy commanders gain relevant experience and insights about the decisive factors in convoy operations.
- The removal of time pressure through the turn phases of planning and execution can help trainees make sound decisions.
- The fast loops of planning, execution and reflection in turn-based can help trainees learn by experience.
- Employing virtual training environments limit the personnel requirements for role-playing individual units.
- The premise of more easily controlling a large number of units is plausible, however technical limitations and the ease-of-use of the demonstrator mean this potential has not been realized to the full extent.
- The same limitations keep us from final judgment on whether turn-based dynamics help trainees stay immersed in the game.
- Lastly, turn-based gaming proved to be particularly effective in gaining insights about communication between convoy and march unit commanders.

These findings illustrate that turn-based gaming is suitable for education and training of highly complex subject matter that could benefit from a gradually increasing learning curve. Simulation-based training offers a middle ground between theory and live field exercises. It is effective compared to traditional ways of teaching through the proven concept of experiential learning. It is efficient compared to live fire exercise (LFX) due to saving on facilitating personnel and resources. Additionally, the turn-based game format presented in this paper offers an alternative to real-time gaming, in particular applicable to trainees with little experience.

In future research, measuring actual learning performance compared to real-time gaming formats is desirable to identify the comparative value of turn-based gaming in virtual training environments. Furthermore, it is desirable to refine the game software in order to create a more immersive user experience. This research has tested turn-based gaming in the context of convoy operations. It would be of interest to see if the same dynamics can be applied to other military domains where complex decision making and communication are relevant.

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