SCENARIO DESIGN FOR SERIOUS GAMING

GUIDING PRINCIPLES FOR THE DESIGN OF SCENARIOS AND CURRICULA IN MILITARY JOB ORIENTED TRAINING.

JANUARY 2009

BY CASPER HARTOG
Scenario design for serious gaming

Guiding principles for the design of scenarios and curricula in military Job Oriented Training.

Report for the

Master Thesis Project

in

Systems Engineering, Policy Analysis and Management

by

Casper Hartog

Studentnumber: 1155016

January 2009

Graduation committee
prof. mr. dr. J.A. de Bruijn
dr. I.S. Mayer
prof. dr Jr. A. Verbraeck
dr. A.H. van der Hulst

DELFT UNIVERSITY OF TECHNOLOGY
Faculty of Technology, Policy & Management

TNO
Defense, Security & Safety
PREFACE

This thesis report has been written in the period of May 2008 – January 2009 during my internship at TNO Defense, Security & Safety and is the last stage of my MSc. education in Systems Engineering, Policy Analysis and Management at the Delft University of Technology. Writing this thesis has been an effort, both personally and intellectually. I experienced what it is like to do an individual research in a social setting, where numerous challenges are there for you to face. As such, it has been a very valuable experience.

I experienced the organization I was doing my internship at, TNO Defense, Security & Safety, as a very flexible and helpful organization. TNO is an organization that focuses on making scientific research applicable to real life cases. One thing I have definitely concluded from this thesis project is that this suits me more than fundamental scientific research. Not only did I write my thesis report in the seven month period at TNO Defense, Security & Safety, but I also actively participated in the daily activities of the serious gaming project team. This means that I contributed to the development of scenarios and helped during test sessions, mainly at the Royal Netherlands Army base in Amersfoort. Just as I contributed to their work, they also contributed a great deal to my research. I therefore want to thank TNO Defense, Security & Safety as an organization as a whole, but in particular the people I directly worked with: Anja van der Hulst (my supervisor at TNO, also part of the graduation committee), Tijmen Muller and Sam Besselink. Your views on military training with serious gaming proved to be very valuable to my research. I would also like to thank the people that contributed their time and knowledge during the validation process: Koen Alderliesten, Nathalie Vink, Dennis Coetsier and Rogier van der Hee.

Furthermore I would like to thank my graduation committee at the Delft University of Technology Igor S. Mayer (first supervisor, section Policy, Organisation, Law and Gaming), Alexander Verbraeck (second supervisor, section Systems Engineering) and Hans de Bruijn (chairperson, professor section Policy, Organisation, Law and Gaming) for their guidance and feedback. I hope the enthusiasm you showed towards my thesis project and the subject it deals with is expressed in this thesis report.
SUMMARY

Serious gaming is a phenomenon that finds its way into more and more areas of application. It can best be defined as the use of games for non-entertainment purposes, such as training, sales and marketing. Defense organizations around the world also use Military off the Shelf games (games that were designed to be used for military training) to train their personnel. The Royal Netherlands Army, in cooperation with TNO Defense, Security & Safety, also deploys such games at their training schools as an innovative mean to train commanders, albeit in an experimental phase.

The Job Oriented Training concept (JOT), developed by TNO, is used as the didactical founding for these serious gaming sessions. This concept puts the job at the issue; instead of instructor-centered learning where the instructor conveys theory to the student, it uses student-centered learning where the student constructs the knowledge. One of the most important principles of JOT is that the knowledge and skills that are needed to perform the job are acquired during the serious gaming session in contrast to the instructor providing the theory prior to this session i.e. in a classroom setting. The students become active learners. The ultimate goal of the serious gaming sessions is to let the students acquire the various competencies (the combination of knowledge, skills and attitude) needed to perform the job.

The scenarios in the serious game that is used should be designed in such a way that this goal can be achieved. They should be consistent with the JOT concept and should therefore aim at acquiring the various competencies needed to perform the job. However, a scenario in a training environment will never be independent but will always be part of a bigger collection of scenarios: the curriculum. The objective of this research is to formulate guiding principles for the design of both scenarios and curricula. These guiding principles should assist inexperienced scenario designers in applying JOT to scenario and curriculum design. The main research question that is answered in this thesis report is therefore: "What guiding principles will assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming?" A combination of literature research, interviews with scenario design experts and observations of experts while designing scenarios has been used to formulate the guiding principles.

The decision making skills proved to be an important part of the competencies a student should acquire. By making various decisions related to the job, the knowledge needed to perform that job will be constructed by the student automatically and by confronting them with new situations in
which they have to make decisions they are required to build a professional attitude towards the job. This research therefore focused on acquiring the decision making skills. Naturalistic Decision Making and Situation Awareness theories were used to identify the important factors that influence decision making in rapidly changing environments, such as those on the battlefield. From these theories, it was concluded that a scenario should stimulate decision making skills by providing the right cues to students. Cues are those elements of a scenario a student can give meaning to.

Based on these findings, guiding principles were formulated that focused on implementing the right cues for an array of learning goals; the critical decisions that have to be made while performing the job. The conceptual design framework presented in this report will help scenario designers to structurally design scenarios that focus on competency acquisition. Besides guiding principles for the translation of learning goals into scenario elements, there were also guiding principles formulated for the design process itself. The agile scenario development model was drawn up to facilitate the design process in which different perspectives on scenario design join. The role of the instructor, which is very important in JOT, is also covered by the guiding principles for scenario design.

For curriculum design a number of guiding principles were formulated that mainly focused on the arrangement of the different tasks in the curriculum, the required complexity progression and the balance between short- and long cyclic scenarios. It proved to be very important that a curriculum starts with a long cyclic scenario in which all the aspects of the job are presented to the student. This will allow the student to be able to link different subtasks to each other and to create the right mindset needed to perform in the rest of the curriculum. The principles for curriculum design have been combined into a general JOT curriculum for serious gaming.

The guiding principles were validated by means of an experimental validation with inexperienced scenario designers to validate their usability. In addition, face validation was used to validate the consistency of the guiding principles with the JOT concept. Both validation methods showed that the guiding principles are usable and consistent with the concept for which they were formulated. However, in order to get an more robust set of guiding principles it is recommended that they are adopted and applied on scenario and curriculum design activities as many times as possible; something that was not possible in the short amount of time this research was conducted in. Only then, one can evaluate their real effect on scenarios and curricula.

The findings in this report were done in the context of military training, but they can also be used in other domains that focus on acquiring competencies related to the job at hand.
# CONTENTS

CHAPTER 1 – INTRODUCTION

CHAPTER 2 – PROBLEM DEFINITION

   2.1 Problem description
   2.2 Research questions
   2.3 Research methods

CHAPTER 3 – COMPETENCIES & DECISION MAKING

   3.1 Naturalist Decision Making
   3.2 Situation Awareness
   3.3 Using the decision making skills
   3.4 Conclusions

CHAPTER 4 – SCENARIO? WHAT?

   4.1 Scenarios used in other domains
   4.2 A military JOT scenario
   4.3 Scenarios & Cues
   4.4 Connection with learning goals

CHAPTER 5 – DESIGN THE SCENARIO

   5.1 Learning opportunities
   5.2 The Conceptual Design
   5.3 Implementation of cues
   5.4 Designing is not a one man effort
   5.5 The Agile Scenario Development model
   5.6 Flexibility for the instructor
   5.7 Conclusions

CHAPTER 6 – DESIGN THE CURRICULUM

   6.1 Tasks as building blocks
   6.2 Scenario progression
   6.3 Dimensions of complexity
   6.4 Application of the dimensions
   6.5 Task independent competencies
   6.6 Short or long cyclic scenarios?
   6.7 Conclusions

CHAPTER 7 – VALIDATION

   7.1 Validation method
   7.2 Validation results
   7.3 Validation conclusions

CHAPTER 8 – CONCLUSIONS

   8.1 Guiding principles for scenario design
   8.2 Guiding principles for curriculum design
   8.3 Validity
   8.4 Reflection
   8.5 Recommendations
In the last decade in more and more fields of activity, computer-based training is used for the training and education of employees. This is in line with the rising perception that traditional learning methods such as classroom instruction may not be that effective to learn certain skills or abilities. There are different forms of computer-based training (or e-learning) of which one of them is the concept of ‘serious gaming’. While the exact definition of serious gaming is subject of debate, an often used definition is “the use of computer and video games for non-entertainment purposes such as training, product design, sales, marketing, etc.” Especially in the field of healthcare, defense, education, policy, government and corporations the use of Serious Gaming has increased significantly (Susi et al., 2007).

The concept of ‘wargaming’ is not new within armed forces all around the world. In the early days they already used wargaming as a mean to analyze tactical situations and to develop a proper mission plan (Roos & Van der Hulst, 2008). Usually this involved miniature models or any other kind of unit representation, which were pushed back and forth on a large, physical map or sand table. With the technical developments in the last decades (computers & computer games) the army forces now have a virtual ‘sand table’ at their disposal including intelligent 3D models. The concept of serious gaming within army forces was born. Following this trend, the Royal Netherlands Army also uses serious gaming in their training programs in cooperation with research institute TNO Defense, Security & Safety. One of the first of such games was Steel Beasts Pro which was predominantly used for training cavalry operations (tanks and armoured vehicles). In 2006, following the success of Steel Beasts Pro, Virtual BattleSpace1 (VBS) was introduced in various military training centers (albeit in an experimental setting) to train infantry operations in various environments, including Urban Operations. It is essentially a 3D First Person Shooter with the ability to render and display large amounts of terrain data and it has very detailed military objects such as equipment, vehicles etc.

Both of these games are so called Military off the Shelf (MOTS) computer games. In contrast to Commercial off the Shelf games, these games were designed to be used for military training and are thus subject to some professional criteria2. One of the most important aspects of a MOTS computer game is the reality aspect; the game play must be realistic and must resemble reality. An example would be that it should not be possible to fire endlessly without having to reload your weapon or to

---

1 At the moment of writing, a new version of VBS is used; VBS2 VTK
2 E.g. the ability to create self made terrain databases, scenarios and detailed vehicle/equipment models (Roos & Van der Hulst, 2008)
carry infinite amounts of magazines. In VBS, the amount of magazines to be carried can be set and reloading your weapon will take about 5 seconds.

As such, MOTS games are a low-cost alternative to traditional wargaming (such as the ‘sand-table’) and more complex, expensive simulation- and training systems. One of the premises of using serious gaming in a military setting is that it will not replace 'live' training. It is, however, very suitable as a preparation method for live training, which has proved to increase training results (Roos & Van der Hulst, 2008). It can also serve as a preparation tool for actual missions in operational countries such as Afghanistan and Iraq. By modelling the terrain and all other aspects of the environment soldiers are about to work in, they are better prepared and will most likely function better once they are 'in the field'.

The games are mainly used to train the use of tactics and command and control. By solving tactical assignments and practicing these in-game, the participants train their command and control skills extensively. However, exactly these aspects are underexposed in the traditional, 'expository' training methods. In the relative tranquility of an educational setting one can draw up an adequate plan with relative ease but in the chaos that exists during a real mission this is an entirely different story; incomplete information and time pressure requires the decision maker to continuously adapt his plan to the changing circumstances. This type of decision making can be characterized as situational decision making where situation awareness is a very important aspect. Situation awareness provides "the primary basis for subsequent decision making and performance in the operation of complex, dynamic systems..." (Endsley, 1995) and involves understanding the environment (i.e. the information/events) in order to make the correct decisions. Situational decision-making is considered very complex. By using serious games such as VBS dynamic situations can be simulated in so called scenarios in which the student is confronted with a diversity of conditions that could also occur during real missions and which require tactical decision making.

**Job Oriented Training**

An important didactical concept that is used in these games is that of Job Oriented Training (JOT), originally developed by TNO (Stehouwer et al., 2005, 2006; Van der Hulst et al., 2008). This concept essentially means that all knowledge that is needed for the execution of a mission is acquired during game play in contrast to providing theory prior to the mission. Another important principle of JOT is the fact that participants should be confronted with the effects of bad decisions and be able to reflect on them. This will hopefully lead to them making a better decision the next time they will be in the same situation. JOT, in this way, closely resembles the concept of scenario-based learning where learning takes places in a certain context and where participants have to assess situations and react
appropriately (Kindley, 2002). Besides the above mentioned aspects there are a few more principles that characterize JOT, which are listed below:

**Active learning**
Traditional tactical instruction was mainly focused on conveying theory by the instructor to his students; instructor-centered learning. This resulted in an active instructor and a passive student. Especially for younger people this passivity goes against their nature and can be counterproductive (Teurlings et al., 2006). Job Oriented Training makes the student active learners by actively engaging them in a mission. The learning process becomes student-centered.

**Relevant reality**
JOT states that learning has to take place in a relevant reality. This means that students have to become aware of (the aspects of) their environment as they would encounter it during their real job. For serious gaming this means that the virtual environment students are training in should provide the necessary cues required for performing the job at hand (see chapter three and onwards for a detailed explanation of cues).

**Challenge**
Another fundamental principle of JOT states that providing a certain challenge to students is a key issue in stimulating their creativity and their ability to apply effective strategies (Bransford et al., 2000). Consequently, Job Oriented Training should provide complex and sufficiently challenging scenarios. This will at the same time increase the motivation of students to participate in that particular training because making training too easy usually results in bored students.

**Cooperative/social learning**
By placing students in small groups or syndicates, JOT stimulates cooperative learning in which students work together on cases and scenarios. They verbalize motivations for certain decisions to their colleagues and subsequently discuss these. This will give students valuable insights in each other’s motivations and reasons for certain choices. Experience and measurements have shown that every succeeding student performs better then the previous one because of this cooperative learning (Van der Hulst et al., 2008).

**Integrated task training**
Instead of part-task training where each time a different part of the whole task is taken out of their context, JOT immediately starts with the complete and integrated task. The tasks gradually increase in complexity while performance requirements increase. This is supported by studies on complex decision making, for example by Klein (1998).

The preliminary results of applying Job Oriented Training are very promising. Both students and instructors indicate that their learning experience improved as a result of JOT. Besides personal...
experiences of experts, measurements have indicated an improved performance of students when being trained with JOT. More information on JOT and its effects can be found in Van der Hulst et al. (2008).

A typical Serious Gaming session
This section will shortly elaborate on a typical serious gaming session at the Royal Netherlands Army, in particular the use of VBS for infantry training. Because the scenarios currently used by TNO and the Royal Netherlands Army are designed to be executed by a ‘squad’ – an organic military unit consisting of a squad commander, his replacement and six soldiers – a typical training session is usually done with a group of eight students to keep its organic composition. There are always one or two instructors present (who are also domain experts, so they have extensive knowledge in the military domain) that guide the session and keep an eye on the learning process. The ultimate goal of the serious gaming sessions is to train all students to become squad commander, also the (role-played) soldiers whom are serving under the squad commander. However, during a training session, which usually lasts three days, the role of squad commander rotates among the students, so each student will have his or her turn. A typical training session essentially consists of three phases: 1) experimentation and planning phase; 2) execution phase; and 3) reflection phase.

1. Experimentation and planning phase
In the first phase of the session, the experimentation and planning phase, the acting squad commander and his replacement will receive mission orders from their superior, role-played by the instructor. They are provided with materials such as a 2D-map of the geographical environment. They may also get to experiment with the 3D virtual environment. Usually (hopefully) a tactical plan will be developed, based on the mission objective and the information they received from their superior.

2. Execution phase
The second phase of the session starts with the acting commander briefing his soldiers about the upcoming mission. He will explain them the objective of the mission and will present his tactical plan. The students then execute the mission in the virtual environment (in this case VBS) based on this tactical plan. During the mission
execution, the acting commander will have to steer his soldiers to let them act according to his plan. He will thereby practice command and control skills while, at the same time, getting feedback on his own performance.

3. Reflection phase

In the third and final phase of the session the students will collectively reflect on their performance during the mission. The key to a successful reflection is the discussion among students that will emerge. It is essential that the instructor does not interfere in this discussion, let alone give his own view on the performance. Only after the students have finished their reflection he can give his expert view. If the whole process is conducted properly, the expert opinion will be void of authority and based on merit.

Scenario design

The didactical principles used in these types of training/games (JOT) require a high quality scenario design. After all, the context and conditions in a scenario have to be designed in such a way that the learning goals are reached, i.e. the student has experienced all aspects of his real job and has built the necessary practical experience. It also means that a scenario should give proper feedback on the performance of students.

It is exactly this subject, the design of scenarios, that is covered in this master thesis research. A new curriculum is to be designed for the game VBS to train infantry in Urban Operations. There is little experience with applying the Job Oriented Training concept to the design of scenarios and curricula. This has led to the question: "What guiding principles will assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming?"

The outline of this thesis is as follows: Chapter two elaborates on the problem definition. It describes the motivation for this research and the problems currently faced by TNO and the Royal Netherlands Army in the design of scenarios. The problem definition will lead to research questions and corresponding research methods which are also presented in chapter two. Chapter three and four serve as a basis for the subsequent chapters; they provide the theoretical foundation for this thesis research. Chapter three deals with decision making processes military commanders use while performing their job. Chapter four deals with the definition of a scenario in a military JOT context. Based on the finding in these chapters, chapter five presents the guiding principles for scenario design while chapter six presents the guiding principles for curriculum design. The validation of the
guiding principles will be covered in chapter seven. Finally, conclusions will be drawn from this thesis research which will be presented in chapter eight.
CHAPTER 2 – PROBLEM DEFINITION

This chapter will further elaborate on the problem definition, which will be the foundation of this thesis research. In section 2.1 I will describe the problems that are currently being encountered in the design of scenarios. These will lead to the research questions presented in section 2.2. The chapter will be concluded with section 2.3, where the methods used to answer the various research questions are presented.

2.1 Problem description

Various scenarios have been designed in recent years, and thus quite some experiences have been drawn from these activities. However, those scenarios were not JOT-based. They were based on traditional training methods which mainly focused on knowledge transfer to the students. Scenarios were basically dedicated to applying the tactical knowledge that had been presented before. The scenarios however, would never explicitly target decision making skills, or command and control skills\(^3\). The traditional scenario was a ‘giver’ in the sense that the scenario did not let the students acquire the knowledge themselves; it more or less presented the knowledge to them. The JOT concept is the opposite of traditional training, its goal is not to transfer knowledge but to let the student acquire certain competencies. It assumes a more active role of students. And thus, a JOT scenario should be an ‘enabler’ where the scenario enables students to acquire skills, knowledge and as well as a professional attitude, which, in an integrated form, are called competencies.

JOT-based scenario design is currently still in its infancy. Various aspects of applying JOT to military training have already been covered such as the expert role, the overall learning process and the setting in which learning takes place. However, an important part of applying JOT to military training has yet to be explored; that of scenario and curriculum design. A recent discussion among TNO experts on this topic emphasizes this\(^4\). The motivation for this research thus lies in the knowledge gap regarding the application of the JOT concept on scenario and curriculum design for serious gaming. TNO Defense, Security & Safety, as a dedicated partner of the Royal Netherlands Army, is in need of guiding principles that will help non expert scenario designers to design scenarios and curricula that are consistent with the JOT concept. Consistent, in this context, means that the scenarios are indeed ‘enablers’ and are able to let students acquire competencies instead of solely applying previous gained knowledge. Using the guiding principles while designing scenarios and curricula, the ultimate objective of this thesis research, should help to accomplish this.

---

\(^3\) Curriculum VBS1 VTO infantry school

\(^4\) See Appendix A
End user

Besides the lack of knowledge on how to apply JOT on scenario and curriculum design, there is a second problem that is fundamental for the motivation of this research. The end user of the guiding principles will be inexperienced ‘scenario designers’. This imposes the question: Who are the people responsible for scenario design? The Royal Netherlands Army is currently in an experimental phase in using JOT based serious gaming. This means that sometimes pilots and test are being done, but it also means that serious gaming is not officially embedded in the training trajectory of students. In this experimental phase, the scenarios are being designed by JOT experts at TNO in cooperation with domain experts i.e. it is mainly TNO experts who are delivering the content. But ultimately, when the JOT conceptualization has been crystallized, this responsibility will transfer to the instructors of the Royal Netherlands Army. In that case, TNO will only have a supporting role.

The responsibility shift mentioned above brings about some organizational challenges. Experienced instructors who are able to carry out the JOT ‘message’ are scarce and on top of that, every so often they change functions. As such, the guiding principles presented in this report also function as a knowledge base. This knowledge base will preserve the valuable knowledge that might be lost if an experienced instructor changes functions. But it will also give new, inexperienced instructors a solid base from which they can develop themselves into experts. By quickly giving new instructors an overview of the fundamental steps involved in scenario design this will allow them to rapidly apply that knowledge and get to work.

Summarizing, guiding principles are needed that will help inexperienced scenario designers on two aspects of JOT application to military training:

1. designing a scenario where the focus lies on one scenario and
2. designing a curriculum where the focus lies on the progression of multiple scenarios.

1. Scenario design

Designing a scenario mainly consists of the translation of learning goals into specific elements in a scenario. An example of a learning goal would be applying the Rules of Engagement (RoE) i.e. the rules for the application and use of military force (Voetelink, 2005). Especially in – the nowadays very relevant – peacekeeping operations, soldiers should be very reluctant in using military force. One of the possibilities to achieve this in a scenario is to confront the students with an armed insurgent that is not directly a threat to them e.g. the insurgent faces away from the squad. The squad commander then has to make a decision on whether or not to use military force. As this example shows, the learning goals are very much aimed at competencies; the students have to assess the situation and subsequently make a decision based on this assessment. By confronting the students with various elements of the scenario – in this case the armed insurgent – they are required to assess the situation, make a decision and thereby acquiring the necessary competencies. The scenario
enables the students to acquire these competencies. One of the first steps in this thesis research is to elaborate on acquiring competencies; what aspects are involved in assessing a situation and consequently making a decision and what is their relation to the various elements of a scenario? In order to be able to identify the relationship between acquiring competencies by students and the elements of a scenario it is important to fully understand the subject scenario i.e. identifying the various elements of a scenario within the context of military JOT training. The RoE example mentioned above is a very specific aspect of a scenario and only describes one element. On a more generic level, each scenario has certain generic elements such as a purpose, used resources and most importantly the scene; the context of the scenario i.e. where, when and how certain events take place (Witworth et al., 2007). These two aspects – acquiring competencies and identifying the generic elements of a scenario – serve as the starting point for formulating the guiding principles. From then on I will focus on the elements that should be implemented in the scenario to let the student acquire the competencies related to the learning goals of that specific scenario.

Besides the content related guiding principles mentioned above, there are also guiding principles needed that will provide guidelines on the scenario design process itself. As of now, it is not clear how the design process should be arranged in order to create consistent scenarios.

2. Curriculum design

Besides the design of a single scenario, the design of a scenario curriculum is also very important. A scenario in a training setting will never be independent but will always be part of a sequence of scenarios: the curriculum. A curriculum will address the various topics the students should learn. In the case of military training these topics are referred to as tasks. The guiding principles for curriculum design should mainly focus on the arrangement of the different tasks within a curriculum i.e. what tasks should be trained at what point of time in the curriculum?

On the other hand, the didactical principles used at the Royal Netherlands Army – JOT, as described in the introduction – require a certain progression in scenario complexity. This means that in the beginning of the training, scenarios should be kept fairly easy in order to let the participants familiarize with the new training setting and not having them be discouraged by an overwhelming complexity, after which complexity should gradually increase. Study has shown that this indeed has a positive effect on gained knowledge (Swaak et al., 1998). However, making scenarios too easy takes away the challenge for the students, which is needed for proper engagement and motivation. In order to achieve the most effective learning, the scenario curriculum should progress in such a way that each scenario that is executed at a certain point in time matches the competencies of the participants at that moment. For one, scenario complexity depends on the tasks that need to be performed within the scenario. Some tasks are naturally more complex than others. But there are also other dimensions that increase complexity, independent of the task that is being performed. Examples of dimensions that may increase or decrease the complexity of scenarios within a military training
context are: time pressure, number of events, threat level etc. However, the identification of these dimensions and their relation is far from complete. Once these dimensions have been identified, the following question will be how to design the curriculum by means of these dimensions. How complex should each scenario in the curriculum be, and how do we reach this complexity level?

Another issue in the design of a curriculum is the balance between small scenarios that train single tasks and skills such as movement only (also referred to as short-cyclic scenarios) or more extensive scenarios that train integrated tasks and skills such as a combination of movement, reconnaissance and offensive actions (also referred to as long cyclic scenarios). As was mentioned in the introduction, integrated training is an important aspect of the JOT concept. However, if too many long cyclic scenarios are used, the efficiency of training can decrease because a lot of time is spent on training tasks and skills that are already known to the students.

Although it might seem otherwise from the description above, the design of a scenario and the design of a curriculum are not two independent design activities. There is a relation between them. The curriculum prescribes when certain tasks should be trained and at what level of complexity. This puts a restriction on the elements of a single scenario. In other words, the design of a curriculum (e.g. task trained, complexity level) prescribes to some extent the elements used in a single scenario.

Everything mentioned above can be represented in the following figure, which is also the research framework for this research:

![Figure 4. Research framework](image-url)
Put together, the research objective is defined as follows:

The objective of this research is to formulate guiding principles that will assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming. The (ultimate) goal of these guidelines is to help scenario designers create JOT consistent scenarios and curricula, where the focus lies on acquiring competencies. Two important design activities have been identified:

1. the design of a singular scenario which focuses on translating the learning goals to scenario elements and arranging the design process itself, and
2. the design of a scenario curriculum which includes arranging the different tasks, determining the required complexity progression and determining the balance between short- and long cyclic scenarios.

The guiding principles

In this research, the term guiding principles refers to a set of rules, norms and/or values that guides the design of a JOT-based scenario and curriculum, and clarifies the reasons for certain choices in the design process. Validation of the guiding principles is an important part of the research. Once the guiding principles are formulated it should be determined whether or not they actually do what they intend to do i.e. are the guiding principles valid? In this case, the guiding principles should help scenario designers with designing JOT consistent scenarios that focus on acquiring competencies instead of only applying previous gained knowledge. This raises the question: what makes a scenario consistent with the JOT concept? And how do we encourage the acquisition of competencies in scenarios? Another question that is important in the validation phase is: Can they actually be used by scenario designers? Guiding principles that are hard to understand or that represent unrealistic choices would therefore be useless.

Naming of guiding principles

There is a risk that the guiding principles presented in this report are rather vague and hard to remember when actually designing a scenario or a curriculum. To be able to design scenarios without having to read the whole description of the guiding principles again, I aim to give them short, characteristic and easy-to-remember names. This will ensure that once the reader has read the names and descriptions of the guiding principles, their names will give some mnemonic support during the design of an actual scenario and curriculum. A similar system has been used by Björk et al. (2003) when describing game design patterns. These patterns describe best-practices in the field of game design interaction and are very similar to the guiding principles presented in this report; their ultimate goal is to provide guidelines for the design of a gaming element (whether it be a game itself or the scenario within a game).
Requirements for the guiding principles

Apart from the naming requirement, I decided not to set any fixed requirements to the guiding principles during the thesis research. One of the main reasons for this decision is the fact that initially, there was absolutely no clue on what the final guiding principles would look like. Neither was there any clue about the content of the guiding principles. The only thing that was clear was that some sort of guiding principles were needed. Setting up very clear requirements in such a situation could restrict the research more than you would like. The consequence would be that the research area becomes too narrow and valuable guiding principles – which may not meet the requirements – are missed. Therefore this research was very open and any guiding principles that may be of value for scenario and curriculum design could be included in the final report.

2.2 Research questions

In the previous section the research problem is described and a corresponding research objective has been formulated. This objective can be translated into the following main research question:

Main research question: “What guiding principles will assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming?”

A number of sub questions are formulated that will help to answer the main research question, these are presented below.

1. What are competencies in a military context and how do people acquire these?
Acquiring competencies (a combination of knowledge, skills and attitude) is one of the primary goals of the scenarios for which the guiding principles are formulated. What exactly are these competencies? Decision making seems to play an important role in this process. By answering this sub question the concept of competencies and the way people acquire these will be studied.

2. How can a scenario for serious gaming be defined within a military training context?
For a successful execution of this research it is important to fully understand the term ‘scenario’. That’s why a separate sub question is devoted to the exploration of the term scenario. A scenario can have different definitions depending on the domain it is used in. First an overview of scenarios within other domains is given. Then a scenario should be described within a military context and its various components should be explored. What does a scenario actually consist of in terms of its various elements? An indication of this aspect has already been given in the problem definition section. And finally, a short exploration of the types of scenarios that are being designed is helpful as it functions as delineation for further research.
3. What are the guiding principles for the design of a single scenario?

The problem description mentioned that the final guiding principles should reflect two different design activities: scenario design and curriculum design. This third sub question targets the first of both activities, the design of a single scenario. Based on the way people acquire the necessary competencies (sub question one) and the definition of a scenario in term of its elements (sub question two) statements can be made on how the learning goals (competencies) can be translated into the elements of a scenario, but also on how to arrange the design process itself.

4. What are the guiding principles for the design of a scenario curriculum?

This sub question targets the second design activity; the design of a scenario curriculum. In particular, this sub question focuses on the arrangement of tasks in a curriculum. Assessing the right complexity levels of the different scenarios is also a key aspect here. Therefore the various dimensions of scenario complexity – such as time pressure and threat level – should be identified. Another important aspect that is covered in this sub question is the balance between short- and long cyclic scenarios as it influences the efficiency and effectiveness of learning.

5. Are the guiding principles valid?

The guiding principles – the objective of this research – are based on the findings on the previous research questions. Once the guiding principles are formulated one question remains; do they actually do what they intend to do i.e. are the guiding principles valid? This sub question deals with the validation of the guiding principles. First a proper validation method must be chosen, based on the characteristics of the guiding principles and the available resources to conduct the validation. Once the validation method is chosen the final guiding principles should be validated. This will result in either the acceptation or a further refinement of the guiding principles.

Based on the main research question, the validation question can be further refined into two parts.

5a. Are the guiding principles for scenario and curriculum design actually JOT consistent and do they therefore aim at acquiring competencies?

The first part deals with the consistency of the guiding principles with the JOT concept. Applying JOT on scenario and curriculum design means that the concept should be embedded in the designed scenarios and curricula. As a result of using the guiding principles, the scenarios and curricula should be consistent with the JOT concept. This first part of the validation question will validate whether or not this is true.
5b. Are the guiding principles usable by scenario designers and do they have a valuable contribution to the design process?

The second part, one that is actually inherent to all design guidelines, deals with the *usability* aspect. In this particular case it is even more important because the guiding principles are designed for a specific target group: inexperienced scenario designers. In the end, they should be able to design singular scenarios and scenario curricula by means of these principles i.e. the guiding principles should be usable and should contribute to the design process. They should not be too difficult nor too straightforward and therefore useless. This part of the validation question will validate the usability of the guiding principles for inexperienced scenario designers.

The relation between the different sub questions is presented below in figure 5.

![Figure 5. Research questions](image)

### 2.3 Research methods

The following research methods were used to answer the research questions presented in the previous section. Essentially it is a mix of literature research, interviews and observations.

*Literature research*

An important source of information on the more theoretical issues in this research was literature, especially for the first sub question which deals with competency acquisition. Literature on decision making theories was used. Especially the Naturalistic Decision Making theory by Klein (1998; 2008) was interesting as this theory greatly resembles the way experienced commanders make decisions. Literature was also used for the second sub question which deals with the definition of scenarios within serious gaming. Some literature was found on scenario assessment (Witworth et al., 2007) where scenario components are described but literature on scenario design in general should also give information about scenarios and its components.
During the preliminary literature research some documents of the U.S. Army research institute for the behavioural and social sciences institute proved to be very relevant for this research. Especially Phillips et al. (2001) is considered a key piece of literature. For sub question four additional literature on scenario complexity and model progression in general will be used.

**Observation**

During this thesis research, I was embedded in the project team 'Serious Gaming' at TNO Defense, Security & Safety. This means that I was able to observe everything that happened in this project. Activities that are part of this project are for example: designing scenarios, testing scenarios and having frequent meetings with various experts in both educational and domain related fields. Observation was therefore a major research method that was used during this thesis research. I observed the people who are responsible for scenario design in what they were doing and I also observed test sessions of scenarios with military soldiers. Both types of observations gave me valuable information for this thesis research.

**Design**

Besides observing the actual activities in the Serious Gaming project team I also actively participated in these activities. This means that I designed scenarios and helped testing them. In order to answer sub question three for example, I designed a scenario from scratch that is in full comply with the JOT principles (see Appendix C, D and E). By proceeding through all the steps involved in the design of a scenario I was better equipped to formulate the guiding principles.

**Interviews**

A lot of the information needs for this research project were fulfilled by interviews held with experts in both educational and domain related fields. As was mentioned, the Serious Gaming project team at TNO Defense, Security & Safety has close relations with various experts, especially with domain experts (hereafter “Subject Matter Experts” or “SME”) at the Royal Netherlands Army. A couple of very experienced squad and platoon commanders are dedicated to this project, meaning they can assist whenever they have the time. They mainly provided the domain related information, such as military procedures and experiences of operating in ‘the field’. Besides domain related information I also needed information on educational principles, such as the JOT concept that is used in military training. Various people at TNO Defense, Security & Safety have an educational background and by having interviews and discussions with them I was able to retrieve the valuable information needed to conduct this research. In an interview for example, it was mentioned that the experience from an educational point of view is the fact that students in training sometimes need success experiences. This means that sometimes they have to conclude that a mission has succeeded, even though some
small things may have gone wrong. Obviously this is very valuable information for the guiding principles.

Analyzing existing scenarios and curricula
Analyzing existing scenarios and curricula is a research method for answering the question related to scenario definition. TNO Defense, Security & Safety already has a number of scenarios prepared which were analyzed on its various elements. By doing this, recurring elements in the scenarios could be extracted to eventually abstract these to a general concept. In addition, current curricula were evaluated on their complexity progression, task arrangement and lessons were drawn from them.

Specific research methods
Some research activities in this thesis research required a specific research method, which was significantly different from the general research methods described above. If this is the case the research method are described prior to its corresponding section. For example, the validation process requires a separate research method. This is described in chapter seven, which deals with the validation phase.
CHAPTER 3 – COMPETENCIES & DECISION MAKING

The target groups of military JOT are groups of students that just finished military school and are destined to be commanders (whether it be squad, platoon or company commanders) in the near future. They have little experience with being in command of a group of people. Commanders continuously have to make decisions in a dynamic environment, which is characterized by incomplete information and high time pressure. The JOT method aims to train the aspirant commanders on these tactical decision making skills. However, the skills related to decision making are not the only training goal of Job Oriented Training. The decision making skills needed to perform the job are part of a higher level concept called competencies. The general definition of a competency is "the integration of knowledge, skills & attitude".

By knowledge I mean the practical knowledge on the various aspects of the military job, e.g. knowledge about what weapon tools to use in which situation. By skills I mean the ability to make decisions in a rapidly changing environment, e.g. determine which weapon tool to use now, based on the information that is received from the environment (the situation)? In order to make a good decision on the weapon tool to use, the commander has to do a proper situation assessment, i.e. he has to assess the situation and subsequently determine how this situation will change over time. Situational awareness is a vital aspect of military decision making. Finally, attitude, as the name implies, focuses on the attitude towards the job one performs, this includes having a professional attitude, being able to make decisions independently and being result driven.

For this research it is assumed that the students have a basic knowledge on the various aspects of their job, e.g. the various procedures required to do a proper movement. This elementary knowledge is needed to make decisions. This assumption is justified by the fact that the target groups of Job Oriented Training at the Royal Netherlands Army are students that just finished the KMS (Royal Military School) or KMA (Royal Military Academy) where they had their elementary military training. In this training basic procedures regarding the various tasks have been covered. But, independently of their prior education, students will also gain the necessary knowledge by continuously making decisions in a relevant setting. When they are required to make a decision on a specific task which requires practical knowledge, the students should gather that knowledge from the environment and they will thereby build a solid knowledge base.

---

5 Interview A.H. van der Hulst, November 2008
This concept is also applicable to the attitude part of competencies. A premise of JOT is that, by continuously confronting students with new situations in which they have to make decisions, the professional attitude will be acquired automatically. An active student, who is required to take responsibilities for his decisions, will eventually create a professional attitude towards his job.

This means that by continuously making decisions, the students will automatically acquire the knowledge and attitude part of competencies. Decision making is therefore essential in the learning process of the students. The skills that are needed to make such decisions are underexposed. How do we train students to become competent commanders who:

- are able to make decisions in a rapidly changing environment and thereby acquiring the necessary knowledge and attitude towards the job?

Before this question can be answered, two important theories on decision making in rapidly changing environments will be described, the Naturalistic Decision Making theory by Klein (1998; 2008) and Situational Awareness by Endsley (1995).

### 3.1 Naturalist Decision Making

Decision making by military commanders in a dynamic environment can be best described by the concept of Naturalistic Decision Making (Klein, 1998; 2008). Naturalistic Decision Making (NDM) studies how people make decisions and how they perform cognitively complex functions in demanding situations. It is a reaction to traditional analytical theories. These analytical theories primarily identified optimal ways of decision making (choices among alternatives) and were mainly based on controlled experiments in well-structured settings where important decision making aspects such as limited time, uncertainty, high stakes, vague goals, and unstable conditions were excluded. Exactly these aspects characterize the decision making problems military commanders are faced with. The traditional analytical theories are therefore not suitable to describe decision making in practical situations (Endsley et al., 2007).

The main premise of NDM is the fact that in practical situations, experienced people make decisions based on their previous experiences. They recognize the situation, classify it based on their previous experiences and subsequently make a decision which they think best fits the situation. The concepts described here have been elaborated in the so called Recognized-Primed Decision making model (“RPD model”). This model describes how people use their experience as a repertoire of patterns and focuses on making rapid decisions in a dynamic environment (Klein, 2008). The model is presented in figure 6.

---

6 Interview A.H. van der Hulst, November 2008
The RPD model focuses on two sub processes: 1) diagnose (recognition of the pattern) and 2) mental simulation. The two sub processes have four by-products: expectancies, relevant cues, plausible goals and typical action. Both sub processes and their by-products will be described below.

Diagnose. The first thing people will do when they experience a certain situation in a dynamic environment is to determine the familiarity of the situation, i.e. do they recognize the situation? Instinctively, the various relevant information sources presented in the situation (relevant cues) are perceived. At the same time expectancies will be formulated regarding these information sources; a mental image of the most likely future situation will be made. In this way, the perceiver can mentally prepare himself to what is coming, but he will also determine if and how the situation deviates from the typical situation he is familiar with (based on his experiences). In the simplest case, the decision maker will instantly recognize the situation and will go to the mental simulation sub process. However, if he does not have enough information to recognize the situation he can look for more relevant cues. This is called the diagnose process.

Mental simulation. Based on the assessment of the situation an overview will be made of the plausible goals that can be reached. Finally, the most logical course of action (typical action), corresponding with the situation assessment will be initiated. But how does the decision maker evaluate his typical action? This is where mental simulation comes to play. Klein (2008) concluded that an experienced decision maker evaluates his typical action by using mental simulation to imagine how it would work out within the context of the current situation. If it would work in that mental simulation, he would initiate the typical action. If it would not work, he would consider adapting the typical action or using less a typical action. This process is repeated until a satisfying typical action has been found and is called the mental simulation.
3.2 Situation Awareness

As was mentioned in the introduction of this chapter, commanders have to have a good situational awareness ("SA"). A widely cited definition of situation awareness is provided by Endsley (1995), she defines SA as ‘... the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future’. This essentially means that in order to make decisions in a rapidly changing, dynamic environment one should recognize the elements in the environment that influence the decision, understand them and determine the influence of them on the future. According to his definition, Endsley (1995) provides a hierarchical model of SA which consists of three layers. 1. The first layer is perception; this is the part where the relevant elements of the environment are perceived. Perception is the building block for the next layer, comprehension. 2. This second layer is the cognitive phase where the disparate elements acquired from the environment are integrated to form a holistic picture of the environment and to comprehend the significance of its objects and events. 3. Based on the perception of the status and dynamics of the elements and comprehension of the situation one can project the future actions of the elements in the environment. This provides the knowledge (and time) necessary to decide on the most favorable course of action to meet one's objectives. This is the third and final layer of Endsley's SA model. Only if all three layers of the SA model have been passed can one make a proper decision. Situation awareness is a prerequisite for a good decision. Once the decision has been made, the results of the decision can be analyzed through the performance of the actions, corresponding to that decision.

The Situation Awareness theory of Endsley (1995) and the Naturalistic Decision Making theory of Klein (1998; 2008) correspond on a few important points. The most notable communality between the two theories is the identification, and thereby the importance, of cues in the decision making process. In the Situation Awareness theory, cues are those elements in the current situation that are perceived by the decision maker (layer one), based on which the situation is comprehended (layer
two) and their influence on the future situation is projected (layer three). The Naturalistic Decision Making theory sees cues as the information sources perceived by the decision maker, based on which the situation is diagnosed. A second communality between the two theories is that cues are important for the assessment of the future situation (projection of future status in the SA theory; expectancies in the NDM theory). In both of theories, cues are the foundation of the decision making process.

3.3 Using the decision making skills

Two distinct phases can be identified in which decision making by commanders takes place: the planning phase previous to a mission and the actual execution of the mission.

1. Planning phase

In the planning phase commanders receive mission orders and additional information about the environment in which they have to operate. The Experimentation and planning phase of a JOT session mentioned in the introduction of this report is the training equivalent of the planning phase which occurs in a real mission. Based on the mission orders and the additional information about the environment (such as a map, situation description, etc.) the commanders make a tactical plan. Various decisions have to be made while drawing up this tactical plan, e.g. deciding what route to take when executing a reconnaissance mission. Analyzing the situation is a very important step in this process. A commonly used method for analyzing the situation is the OTVOEM method (see the glossary of terms on page 83 for an explanation of this abbreviation). Essentially, this is a method which is used to analyze the various elements of the environment e.g. terrain, weather, enemy, resources etc. Decision making in this phase is characterized by a relative tranquility with relatively more time to assess different alternatives. The situation is static because the information that is received is static.

2. Execution phase

Based on the tactical plan that is made in the planning phase, commanders will execute the mission. However, the situation description that was received in the planning phase may turn out not to be accurate. Unforeseen elements may have been added to the situation (e.g. an obstruction placed by opposing forces), which were not included in the situation description received beforehand. In this rapidly changing environment decision making is a lot harder because there is no time to carefully assess different alternatives; something that usually can be done in the planning phase. In many cases the original tactical plan should be adapted based on the changing situation. In addition,

---

7 See glossary of terms at the end of this report for a more detailed description of this method.
commanders have to make sure that their subordinates act in accordance to the (adapted) tactical plan and will thereby make use of their command and control skills (CoVo).

The goal of JOT is to train both types of decision making skills. However, training decision making skills during the execution phase is especially interesting because virtual environments such as VBS are very suitable to create the dynamic situations which characterize the execution phase.

3.4 Conclusions

The processes described in both the Natural Decision Making and Situation Awareness theories are processes that lie at the foundation of acquiring decision making skills which are so important in competency development. A very important part of these theories is devoted to situation assessment: what is the situation I am currently in and how will it change in the future? This assessment is done based on the perception of the elements of the environment; these are called cues. NDM states that experienced decision makers perceive the relevant cues based on which they will classify the situation. SA adds the comprehension of the cues; cues are perceived but should also be interpreted, i.e. what do the cues mean in this particular situation? The situation assessment will eventually lead to a decision.

Situation assessment and decision making is conducted in two phases of the commanders’ job: the planning phase and the execution phase. This means that cues are used in both phases to make situation assessments and subsequent decisions. The cues in the planning phase are mainly present in the situation description received beforehand. The cues in the execution phase are mainly present in the environment in which the mission takes place.

What does this mean for the design of scenarios? Well for one, in order to stimulate decision making skills, students should be placed in a situation which is relevant for their job. This situation should, at the same time, present relevant cues (both in the situation description and the virtual environment) which are needed to assess the situation. This information is the basis for the next chapter, which defines a scenario within a military Job Oriented Training context.
CHAPTER 4 – SCENARIO? WHAT?

It is important to understand the main subject this report deals with: a scenario, and more specifically: a scenario for serious gaming within a military training context. This distinction has to be made because the term scenario is used for many different applications in various domains and its definition can vary among those domains. The question that will be answered in this chapter is therefore: How can a scenario for serious gaming be defined within a military training context? First, I will give a short overview of the types of scenarios used in other domains in section 4.1. Then I will describe a scenario from a military JOT point of view in section 4.2. Finally, in section 4.3, I will relate the findings of chapter three to a military JOT scenario.

4.1 Scenarios used in other domains

4.1.1 Policy Analysis
Scenarios, and gaming in general, are widespread in policy analysis and decision making support. Scenarios are, for example, used in policy decision making to determine the effects of possible decisions on the future. A scenario in this setting represents a possible future. By preparing a set of different scenarios (and thus different possible futures) uncertainty about the future will be reduced. This will make it easier to anticipate on the future and therefore making a decision will also be easier. As such, a scenario functions as a decision support tool. Mayer et al. (2004) make a distinction between a scenario and a game in development planning, and view them as being two separate entities. They see scenarios as being largely model based and/or conceptual representations of the future. Games on the other hand allow a more experiential and social interactive exploration of the future (Mayer et al., 2004).

4.1.2 Information sciences
Another application of the term scenario can be found in the information sciences. In this domain, scenarios are used to describe the interaction between the user and the system or between the components of a system itself. It is frequently used in software development to identify the functional requirements of a system. A commonly used term for these types of scenarios is ‘use cases’. Each use case focuses on a different goal or task of the system and describes how the interaction between user and system should be in order to achieve that goal or task. According to Brittner & Spence (2002) use cases simply “allow the description of sequences of events that, taken together, lead to a system doing something useful”. “Use cases have gained widespread acceptance because they make
requirements less ambiguous by specifying exactly when and under what conditions certain behaviours occur.” (Brittner & Spence, 2002).

4.1.3 Simulation games
Scenarios are also used in simulation based training, e.g. in supply chain management games. In this context they are used to create the right state of the model at the right moment under the right conditions. Scenarios in simulation games can be defined as “the context in which the game takes place, the desired development of the game over time, and some events that take place during game play to enhance the learning.” (Van Houten & Verbraeck, 2006). As such, they function as a script for the game play. They define the rules of the game. An important aspect of such scenarios is their goal; a scenario should have a concrete goal where a set of target skills are to be learned.

In all these different domains the common characteristic of scenarios is the fact that they describe some sort of chronological events that occurred or still have to occur. Time thus seems to play an important role in a scenario. Another distinguishing fact is the fact that a scenario represents or tells a certain story. It’s not a coincidence that people who make up stories for movies and games are called scenario writers. In the next section I will define a scenario from a military JOT point of view, which resembles the simulation game type of scenarios, as described above, the most.

4.2 A military JOT scenario
In this section I will describe a scenario from a military JOT point of view. To be able to define and describe a scenario from this point of view I analyzed a number of existing scenarios which where already designed by TNO. Out of all these scenarios, I tried to extract recurring elements and I eventually abstracted these to a general concept. This general concept of a military JOT scenario is presented below. You will see that many of the elements that have been identified in the other domains, as described in the previous section, recur here, such as the time aspect. But also the story proved to be an important part of a scenario in military training.

4.2.1 The mission order
In fact, a scenario in a military JOT setting usually starts with a story. However, in a military setting it is called the mission order. In this order the background of the mission, the current situation and the mission objectives are described. Something like:

<table>
<thead>
<tr>
<th>Order: Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your squad just did a successful reconnaissance and now it has to move along route “ORANGE” to a pick-up point where transport and reinforcements await you. Recently, quite some threat has been observed in the surrounding area so be alert. Due to this threat the reinforcements at the pick-up point can not assist in your mission.</td>
</tr>
</tbody>
</table>
The order is usually issued orally to the student by his role-played superior, just like a real soldier would receive his mission orders from a superior. In real missions, NATO affiliated nations use a standardized order layout to improve interoperability between nations: the NATO-5-section order (Boelke Pienter, 2008). This standardized order is divided in five subsections (situation, mission, execution, logistics, command & signals). The orders used in military JOT scenarios comply with this standardization, for the sake of reality. An elaborated example of a mission order can be found in appendix B. This order, written in cooperation with a domain expert, is actually used in one of the scenarios designed by TNO (The Market Place scenario).

4.2.2 Virtual environment
Once the mission orders are issued, the students are about to execute those orders in the virtual environment. As was mentioned in the introduction, VBS is used to model this virtual environment. It is important that the virtual environment represents the situation as described in the mission orders. This can be done by modeling the various elements of the virtual environment. I have identified four main elements which define the virtual environment: 1) base terrain 2) objects and 3) behaviour.

1. The base terrain defines the scenery of the environment. This includes, but is not limited to, height differences, rivers and other infrastructures. VBS is especially suited to model these terrain elements because it is able to render and display large amounts of terrain data. On top of that, VBS has the option to customize the base terrain, even from real-world source data, with their VBS Development Suite. With this option, it is possible to realistically model operational countries such as Iraq or Afghanistan, based on satellite photos.

2. Various objects are placed on this base terrain. These objects can be buildings, vehicles, human entities, natural or man-made obstructions, vegetation, etc. To facilitate the creation of objects on the base terrain, VBS has a large database of various objects ranging from simple furniture to sophisticated Apache helicopters. Figure 8 illustrates this.

3. Besides the base terrain and its objects, or static elements as I would call them, there is a third and final very important element that defines a scenario within the virtual environment; which is behaviours. Without behaviours, the virtual environment would be very static. In some situations this could be desirable, but in the case of military operations (which deals with people and the behaviour of people) behaviours are very important. Behaviours mainly relate to the behaviour of human entities (e.g. displaying aggressive behaviour, walking around) but can also relate to vehicles (e.g. moving) or even animals. Each entity that can display behaviour can be controlled in the scenario editor of VBS. You can for example give human entities waypoints which they will follow, or you can order (virtual) combatants to shoot at the student at a certain point of time. You can also let the
behaviours of entities depend on the actions of the students during the scenario execution. However, the artificial intelligence model of VBS is the biggest limitation to successfully model behaviour of virtual units. Therefore sometimes human entities will be controlled by the instructor.

4.2.3 Communication

The third and final part of a scenario in military JOT is the communication between the students and their role-played superior(s). The role of superior is usually played by the instructor and the communication is done outside of the virtual environment. An option would be to simulate this in the virtual environment by means of headsets and microphones, but this is currently hard to realize technically. Besides, communication outside of the virtual environment (i.e. just talking to each other) proved not to restrict game-play in any way. The communication will mainly be about the events that take place during the execution of the mission orders in the virtual environment. The role-played superior can for example ask the student to give a status report of the mission. The student then has to clearly communicate the situation to his superior. A superior can also give additional information during the execution based on which the student may have to alter his plans.

4.3 Scenarios & Cues

How does the cue, which proved to be so important in scenarios, fits into the description of a military JOT scenario? First, let me elaborate some more on the concept of cues.

---

8 Serious Gaming project team meeting, October 2008
Cues provide valuable information based on which students make decisions (see chapter three). Phillips et al. (2001) define cues as “the perceptual elements of the environment that influence the challenging decisions”. This suggests that a cue is always somehow embedded in the environment of a scenario. A cue is actually that element of the scenario (whether it is in the mission order, virtual environment or communication) one can give meaning to with regard to the objectives. A hill in the scenery of the virtual environment in itself does not mean anything. However, a hill situated near an enemy base, when you have to conquer that enemy base, does mean something. It means it is a location where one can have a good overview of the situation at the enemy base; the hill in the scenery becomes a cue.

4.3.1 Relevant reality
The cues should be presented as they would in a real life situation, to ensure that the environment represents a relevant reality. Some authors support the concept of ‘augmented cueing’, which means that cues are given to students that are normally not present in real life situations but, for the sake of effective learning, are implemented in the scenario anyway (Bosch & Helsdingen, 2000). It is arguable whether or not this is a good method as it reduces the relevant reality which is so important in Job Oriented Training.

4.3.2 Types of cues
As was mentioned, a cue can manifest itself in all parts of the scenario: this means both in the mission orders, the virtual environment and the communication between students and superior(s). Although I must say, that most cues were found to be present in the mission orders and the virtual environment, and less in the communication with superior(s). To clarify this, I will give an example of a cue in the three different elements of a scenario.

**Mission order cue**
In the mission order information is given e.g. about the mission objective and the current situation. It could be that the mission objective is to patrol in a certain area and that the situation description states that there were recently hostile activities in that area. This means that you will be very alert when performing your patrol. If you did not receive that particular information, you would probably be less alert. Therefore, the information about recent hostile activities is a cue.

**Virtual environment cue**
When executing a certain mission, the students should be able to identify (latent) dangerous situations. Especially in Urban Operations civilians play a big role. A civilian suddenly running away from a certain area in the virtual environment can indicate the presence of combatants or some other kind of threat. To the soldiers observing that civilian it means something in the context of his job. The civilian that suddenly runs away is therefore a cue. Note that this example is behaviour related.
4.4 Connection with learning goals

Cues are tightly linked to the learning goals (the competencies described in chapter three) associated with a particular scenario. The set of learning goals is actually the starting point for the design of a scenario. By executing the scenario the student should reach the associated learning goals and thus acquire the competencies corresponding to those learning goals. In order to achieve this, chapter three stated that the scenario should place the student in a situation which is relevant for his job and provide cues that will stimulate or even force decision making.

Therefore, for each learning goal (a) specific cue(s) should be designed that triggers the student to make a situation assessment and to make a decision, so he will consequently reach that learning goal. The decision that will be made by the student will eventually result in certain behaviour (the performance of actions). During this process, which starts with perceiving the cue and ends with the performance of actions, the situation awareness theory applies. The student will assess the situation based on the cues he receives, make a decision based on this assessment and display certain behaviour related to that decision. This may alter the situation he is in. It is therefore an ongoing process; the student will assess the new situation and will decide whether or not this behaviour needs to be altered. The following figure illustrates this Assess, Decide, Perform ("ADP") process:

![Figure 9. ADP process. Adapted from Klein (1998) & Stehouwer et al. (2005,2006)](image)

Feedback

Now, one of the main principles of JOT is the fact that students should be confronted with the consequences of their actions (or behaviour). This can be achieved by giving the students new cues in the scenario that will give them information on how well their decision turned out. These cues essentially represent the new situation. The scenarios that are currently designed by TNO do not...
provide feedback in the scenario itself. This is solved by having an extensive reflection after the execution of the scenario (see phase three of a typical JOT training session described in the introduction, page 14). In general, this reflection will aid the development of concepts by analyzing and discussing the cues for relevant experiences (Van Der Hulst & Muller, 2007). However, such feedback cues would be very helpful as they can serve as a facilitator during the reflection process.

The following text box illustrates learning goals, cues, behaviour and their relation:

### Rules of Engagement

An important learning goal for students during their training is knowing how to deal with the Rules of Engagement (RoE) i.e. the rules for the application and use of military force (Voetelink, 2005). Especially in current peacekeeping operations, soldiers should show restraint in using military force. In a scenario this can be achieved by implementing a cue that confronts the students with an armed insurgent that is not directly a threat to them (for example by turning his back to them). They then have to make a decision whether or not to use military force. Shooting the insurgent is considered inadequate behaviour and a new cue can be presented to the students to indicate they made the wrong decision. This can for example be done by having their superior communicate to them the consequences of their action.

One last note: the learning goals and reflection afterwards are not actually part of the scenario but do influence it greatly (especially the learning goals). The cues that give feedback on behaviour are part of the scenario.
CHAPTER 5 – DESIGN THE SCENARIO

The previous chapter elaborated on the concept scenario itself. It described the general elements a scenario consists of. Both chapter three and chapter four indicated that a very important part in the design of a scenario is the implementation of relevant cues in the scenario. As was mentioned before, acquiring competencies is the starting point of scenario design. Only when you know what the student must learn, one can design and implement cues to stimulate learning. The job of a scenario designer is essentially to create the right cues associated with each competency or learning goal. It is this job that will be covered in this chapter. Besides focusing on the translation of competencies and learning goals into scenario elements (cues) I will also provide guiding principles on the design process. The research question that will be answered in this chapter is: What are the guiding principles for the design of a single scenario?

A structural method for designing scenarios will be described and presented in paragraph 5.2 and beyond. But first, the following section will go deeper into the two different types of cues that have been identified before.

5.1 Learning opportunities

The process of perceiving the cueing, processing it, acting upon it (the situation awareness model presented in chapter three), and being confronted with the results of this process (the feedback) is what I call the ‘learning experience’. This is the essence of scenario design. The goal is to maximize this learning experience by providing the proper cueing.

Figure 10. The learning experience
In cueing, a distinction must be made between trigger cues and response cues. The cue that triggers the ADP process is called the trigger cue. This is the cue that the student perceives, processes and acts upon. Other authors (Stacy et al., 2007) mention the importance of trigger cues but define them as "the conditions necessary for trainees to work towards training objectives". In other words, trigger cues provide the conditions for students to reach a specific learning goal. The eventual performance such cues trigger from the student can be anything, ranging from deliberately doing nothing to a fierce reaction. Sometimes it can be hard to recognize certain performance, especially when that performance is not clearly visible (which is the case when doing nothing). More importantly is the process preceding the performance; the assessment of the situation and the subsequent decision that is made. This process is even harder to recognize. In order to have the virtual environment recognize this assessment it needs to have advanced cognitive features. Currently this is not the case, at least not in the current available MOTS games. That is why there should always be an experienced instructor present that can recognize whether or not the assessment a student made was adequate. However, in most cases the performance of the student does reflect his situation assessment, i.e. if the assessment was inadequate, the performance will most likely also be inadequate. Because giving feedback on an inadequate assessment is hard, it is also possible to give feedback on inadequate performance.10

The feedback of the virtual environment on the outcome of the ADP process (the measurable performance) is called the response cue. This is the cue that confronts the students with their performance. Not much literature was found on the use of response cues. The reason for this is probably the fact that they are considered less important than trigger cues, because there are other ways to deal with inadequate performance (outside the scenario) such as reflection afterwards. The JOT principles mentioned in the introduction however justify the use of response cues, as long as they are realistic. Augmented response cues (cues which would normally not be presented in reality) will lessen the reality of the scenario and should therefore not be implemented. Feedback on performance for which no realistic response cues can be given should be given in the reflection afterwards.

As displayed in figure 10, the different types of scenario cues mentioned in section 4.3.2 can be either trigger cues or response cues, with the exception of mission order cues. Mission order cues are given before the scenario is executed in the virtual environment and can therefore only be trigger cues; there is no option to give response cues in a mission order. With the concept of trigger cues, response cues and the ADP process, a scenario design process has been formulated that is presented in the following sections.

---

10 Discussion Serious Gaming project team, December 2008.
5.2 The Conceptual Design

One of the main problems in the design of scenarios currently is the fact that the design process is rather unstructured. There is a general idea about what should be taught and modelled in a scenario but it is rather unclear how this should be done. Most of the time the scenario designer has his own personal view on how to arrange the scenario and uses his mother wit to come up with a solution. A possible risk to this ‘natural’ process is that the designer focuses too much on his own perception and misses valuable aspects in the scenario. One of the additional goals of this research is to provide more structure in the design process, thereby creating more effective scenarios.

Chapter three elaborated on the general learning goals of the JOT scenarios; acquiring competencies. These competencies are used in the various tasks a commander has to perform in his job. As mentioned before, these form the basis of a scenario. A major part of the necessary competencies are the decision making skills. In this particular case – where decision making is so important – the learning goals are directly related to decision making. In fact, the ways decisions are made are the learning goals, as being a commander is all about making the correct decisions. The scenarios that have to be designed should therefore primarily train the students in making the critical and challenging decisions they face once they are in the field. In order to able to make those decisions, the student will automatically have to do a situation assessment.

Just as the learning goals should be specified before making a scenario, the decisions the students are required to make should also be specified. Because there are so many decisions to be made for each task, it can be hard to keep an overview of the required decisions. In order to keep an overview of the various decisions commanders have to make in Urban Operations, Phillips et al. (2001) provide a simple hierarchical model which makes a distinction between ‘decision requirements’ and ‘critical decisions’. Decision requirements are high-level decisions that have to be made when executing a certain task. Each decision requirement contains a set of lower-level critical decisions corresponding to that decision requirement. Below is an example of both types.

<table>
<thead>
<tr>
<th>Decision requirements</th>
</tr>
</thead>
</table>
| An example of a high-level decision could be “determine how to approach a certain object”. Critical decisions (low-level) corresponding to this high-level decision are “choose a certain route”, “determine how to obscure the approach” and “identify possible hazards during the approach”.

11 Observed during the thesis research
Step 1

The first step in designing a scenario should be to formulate the decision requirements and their corresponding critical decisions. While the term decision requirements can be confusing I would rather use the term “high-level decisions”. Identifying the decisions is actually a much harder task than it may seem. Some decisions are fairly evident and easy to formulate, even by a person with little domain knowledge. Other decisions are less clear and most of the time they are buried deep inside the minds of the more experienced people who have been in such a situation before. The information related to these decisions is so-called ‘tacit knowledge’. In their study Phillips et al. (2001) used different methods to acquire this knowledge from experts, for example by various knowledge elicitation methods. It is beyond the scope of this research to go very deep into these methods but it is important to note that the required information for making a scenario often resides with the subject matter expert. The formulation of high-level decisions and their corresponding critical decisions should therefore always be done in cooperation with a subject matter expert with up-to-date operational knowledge.

Guiding principle “S.1 DOMAIN EXPERT IS VITAL”
- Always design a scenario in close cooperation with a subject matter expert.

Critical decision: coordinate with security assets
For a cordon and search mission there are multiple groups responsible for different tasks i.e. an entry group who enters the building and a security group securing the direct surroundings of that building (the inner cordon). During an interview with an experienced platoon commander, he mentioned that coordination between these groups is very important. This especially concerns the approach phase where the entry group has to cross the securing group (that already secured the surroundings). The commanders of those groups have to coordinate this action i.e. by designating a certain spot in the inner cordon where the entry group can cross. “Coordinate with security assets” was therefore marked as a critical decision within the higher level decision “how to approach the object”.

Step 2

Once the high-level decisions and their critical decisions are clear it is time for the next step. Each critical decision has a certain degree of complexity, which will induce the risk of a decision that is not optimal in that particular situation. Because each decision can vary in optimality, determining whether or not a less optimal decision is actually a faulty one can be hard, especially when you consider that each decision is made in a certain context and this context can vary in each situation. However, for a subject matter expert, or instructor, it should be possible to identify decisions that are really suboptimal and therefore not right in the particular situation. These are called the typical
mistakes. According to one of the JOT principles, students should receive feedback on their performance, as this is a very potent source of learning (Van der Hulst et al., 2008). Actually the only real mistake is the one from which we learn nothing. In the scenarios that are being designed here, we aim at letting the student experience their performance for the sake of learning. But in order to confront students with their mistakes in the scenario itself, the scenario designers should have a good view on what typical mistake(s) can be made for each critical decision. Therefore the second step in the design of a scenario is to link each critical decision to one or more typical mistakes.

**Typical mistake: sealing off an area**

Consider the critical decision “determine how to seal off the area”. The purpose of sealing off an area (the outer cordon) is to not let any one enter or leave that specific area for safety reasons. When a military unit is operating in that area you don’t want the enemy to be able to reinforce. Those reinforcements usually enter the area through so called ‘feeder roads’ which are the main roads leading into that area. A key issue in sealing off an area is to secure those feeder roads. A typical mistake corresponding to this critical decision is therefore “not securing all feeder roads”.

**Step 3**

For each typical mistake the cues that trigger the student’s decision (and thereby the ADP process) should be defined. We make a distinction between trigger cues and response cues. As was mentioned in section 5.1, a trigger cue is a cue that triggers the students to make the critical decision. In other words: you could say that a trigger cue provokes the students to make that typical mistake. A response cue is a cue that actually confronts the students with their mistakes, so they only occur after a mistake has been made. Defining these cues is very important because these are the elements that will be modelled in the scenario.

**Cues: sealing off an area**

In order to provoke the critical decision “determine how to seal off the area” one can place a number of feeder roads in the scenario. The location and number of feeder roads determines how the responsible commander should seal of the area. This is therefore the trigger cue. When the commander overlooks or misjudges one of the feeder roads and therefore does not secure it (the typical mistake) a typical response cue would be to let enemy forces re-supply themselves through this feeder road. This confronts him with the direct consequence of his inadequate or suboptimal decision.

---

12 Quote John Powell.
Design framework

Once all steps in the design process have been completed one ends up with a table as presented in figure 11. This is the conceptual design framework for the design of a single scenario. In order to illustrate the framework a fully elaborated version can be found in Appendix C which describes a “cordon & search” mission for platoon commanders, which I personally designed.

<table>
<thead>
<tr>
<th>High level decisions</th>
<th>Critical Decisions</th>
<th>Typical mistakes</th>
<th>Trigger cue</th>
<th>Response cue</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH LEVEL</strong></td>
<td><strong>DECISION 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical Decision 1.1</td>
<td>Typical Mistake 1.1.1</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical Mistake 1.1.2</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical Mistake 1.1.3</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td>Critical Decision 1.2</td>
<td>Typical Mistake 1.2.1</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical Mistake 1.2.2</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td>Critical Decision 1.3</td>
<td>Typical Mistake 1.2.3</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HIGH LEVEL</strong></td>
<td><strong>DECISION 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical Decision 2.1</td>
<td>Typical Mistake 2.1.1</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical Mistake 2.1.2</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
<tr>
<td></td>
<td>Critical Decision 2.2</td>
<td>Typical Mistake 2.2.1</td>
<td>Trigger cue 1</td>
<td>Response cue 1</td>
</tr>
</tbody>
</table>

*Figure 11. Design framework*

Guiding principle “S.2 CONCEPTUAL DESIGN”

- Based, upon the learning goals, formulate the high level decisions and their corresponding critical decisions, the typical mistakes a student is likely to make, the trigger cues that provoke the critical decisions and the response cues that give feedback on the performance. This is the conceptual design of the scenario, which can look like the table presented in Appendix C.
5.3 Implementation of cues

During this thesis research cueing turned out to be a very (if not the most) important aspect of scenario design, as designing scenarios is all about designing the right cues for any given learning goal. This section further elaborates on this particular activity. This section begins with the implementation of cues, i.e. how can we select the right cues for specific critical decisions and what do they mean? The second part of this section gives the reader some background information on the various issues that arise when designing and implementing cues in scenarios.

5.3.1 Cues and their meaning

Based on the conceptual design framework presented in the previous section one should, in theory, be able to design a single scenario. However, the actual implementation process of the trigger and response cues is rather underspecified. In order to be able to choose the right cue for a specific critical decision it is necessary to have an overview of the possibilities of different cues. Specifically, this section elaborates on the meaning of cues i.e. the perception and interpretation of cues. While different people can interpret cues differently, as was mentioned in the previous section, there should always be a generally accepted meaning to any cue. It is exactly this meaning that is sought after in this part of the research. How this can be done is described in the research method below. The final goal of this section is to come up with a large collection of cues and their meanings – within a military setting - to help scenario designers with designing the right cues for the critical decisions.

Research Method

For this small piece of research various educational- and domain experts were questioned to come up with a list of cues and their meanings. They were questioned about cues that would be relevant for military operations in operational countries such as Iraq and Afghanistan (i.e. in an Urban Operations context). Their assignment was to come up with a list of relevant cues and their meanings. No extra information (e.g. categories of cues) was given, meaning they were totally free in their cue generation task. The result of this process was a large list of cues on various topics within military operations such as terrain, local population, opposing forces, etc. Based on this list, my job was to see if there was any overlap in cues, identify the distinct cues and possibly identify categories in cues so it will be easier for the scenario designer to choose certain cues.

Results

One of the most apparent results is that most respondents automatically divided their cues into two categories: threat presence cues and threat absence cues. The main reason that was given for this distinction is that ultimately, almost every decision is based on the existence of threat. For example: the decision on the approach route to a certain object depends on the hazards that can be
encountered on the possible routes such as large open spaces, crossings and tunnelling terrain. All these factors (which are also cues) increase the perceived threat level of the concerned route i.e. they indicate the existence of threat.

However, not all cues are threat related. There are also cues that do not indicate whether or not there is a certain threat. While the majority of the respondents had threat related cues on their list, there were also some non-threat related cues. Consider for example this cue in the conceptual design for the cordon & search mission (appendix C): “available transportation means” corresponding with the critical decision “determine the evacuation method”. The primary goal of this cue is not to mitigate threat (although a faster transportation method such as a chopper could be safer in some situations) but to increase the effectiveness of the mission. Usually when a High Value Individual (HVI) is captured, it is essential that he or she is transported to the authorities as fast as possible so there is more time for interrogation. By choosing a fast transportation method to evacuate the HVI, the effectiveness of the mission can be higher. More cues were identified that had an effectiveness related meaning; actually almost all non-threat related cues were effectiveness related.

Effectiveness related cues are task dependent; each task has its own cues for effectiveness. For this reason they are hard to formulate for person with little domain knowledge because it requires an extensive analysis of the task at hand, which in turn requires a lot of domain expertise. But even for a SME it takes a lot of time to identify all possible cues. This issue is supported by the lack of such cues in the respondents’ cue lists. In order to come up with a list of task-dependent, effectiveness related cues one should conduct a larger-scale research, which is out of scope for this thesis research. That’s why I have decided to focus mainly on threat related cues. These cues are more generic and are therefore easier to identify and are still of great value for the design of scenarios.

**Main categories**

See Appendix F for the final list of threat-related cues. I identified four main categories, which are:

1. the presence of acute threat
2. the presence of latent threat
3. the absence of threat
4. the ability to control threat.

The absence of threat is quite self-explanatory; the cues within this category indicate that the situation is safe and that friendly forces should not expect hostile activities anytime soon. The presence of latent threat is more ambiguous. It involves threat that is still hidden and not visible yet

---

13 Classified, not present in public version
i.e. threat that is not tangible. However, latent threat cues indicate that there might be (acute) threat
soon. They are signs that the situation might be changing from a rather safe one into a threatening
one. Such situations can eventually lead to the presence of acute threat, where the threat is actually
visible to the friendly forces. Usually this is the sound of gunfire or visual contact with opposing
forces. Finally, there is a category of cues that relates to the ability to control threat. Such cues
indicate possibilities for friendly forces to reduce or mitigate possible threat. A typical example is the
cue “cover and concealment opportunities”. Regardless of what type of threat is encountered (acute,
latent or no threat) taking cover will always reduce threat as opposed to standing uncovered.

Subcategories
Within the main categories, there are a few sub categories that I have identified. These are:
1. terrain-related
2. behaviour-related
3. setting-related
4. IED-related.14

Terrain-related cues are those aspects of the terrain to which one can give meaning to with regard to
threat indication, such as channelling terrain. Behaviour-related cues are cues that stem from the
behaviour of the local population, such as civilians suddenly running away or the presence of men
only where normally women and children are abundant. From this behaviour, friendly forces can
deduct very valuable information. The local population functions as the eyes and ears of the
environment and usually notices events earlier than friendly forces. Especially in Urban Operations,
the behaviour of local population is a vital source of information and is therefore very important in
scenario cueing. Setting-related cues are the contextual cues in which the setting of the mission is
outlined. Examples of such cues are the nature of the conflict or the fact that a particular day is an
official national holiday (in which case it will be less likely that a local enemy will engage). Last but
not least, IED-related cues are becoming increasingly more important. If you read the news regularly,
you will notice that most of the threat encountered in Afghanistan (the country in which the Royal
Netherlands Army currently operates) is caused by Improvised Explosive Devices (IED’s). These are
small improvised bombs made from urban materials such as rubber tubes and coca-cola cans, by IED
facilitators. They can easily be made and require very little resources. Usually they are placed near a
frequently used road and detonate when friendly forces pass (be it automatically or manually from a
remote distance). Therefore, special attention was paid by the respondents to IED related cues i.e.
cues that indicate the presence of an IED (facilitator).

14 While it is not a generic category like the other three are, I decided to give IED-related cues a separate category because
they are so relevant currently.
NOTE: the reader might have noticed that words as ‘indicate’ and ‘might’ are used to explain cueing. This is done on purpose because a cue is not a prescription for a certain situation. A cue merely depicts a possible situation. The perceiver of the cue still has to determine – albeit based on the cue he perceived – his expectancies of the future situation (see chapter three). The cues described in this section are his tools to build up a proper expectancy, but the situation can still turn out differently.

5.3.2 Issues regarding cueing

As was mentioned before, cues are “the perceptual elements of the environment that influence challenging decisions” (Phillips et al., 2001). They are implemented in a scenario for the user to recognize and process, in order to reach a certain learning goal. However, there are various issues one should be aware of when using cues for learning purposes. These will be described below.

Ambiguous cues

In a perfect situation only those cues are present that are understandable and unambiguous. However, in reality you will also find ambiguous cues. As such, they should also be implemented in a training scenario. An ambiguous cue is essentially a cue that can be interpreted differently in different situations. A learning goal of a particular scenario could even be to handle ambiguous cues!

Cue combination

Sometimes cues do not provide enough information by themselves and have to be combined with other cues be able to assess the situation properly. This ‘cue combination’ is actually an active area of research in cognitive sciences that deal with perceptions. The main question in this area is: how do people combine information from various sources to create a single perception of the state of the environment? While this requires a research on its own and is far too complicated to integrate in this thesis research, it should be taken into account, or at least be kept in mind, when designing cues for scenarios. The concept of cue combination can better be explained by an example in a military setting.

Cue combination

Image the two cues ‘Man with weapon standing on market’ and ‘Operating in Afghanistan’. A normal person living in a western country (which most soldiers operating in Afghanistan and Iraq do at the moment) would perceive the first cue on its own as a dangerous situation in which that armed man could pose a threat to the perceiver. If I would see an armed man walking around the center of Rotterdam I would at least be far away from him at all times. However, the second cue tells you that you are operating in Afghanistan which means that it is quite normal that an armed man is walking around in a certain area. It could for example be a police officer, who is generally harder to recognize than in western countries. Based on the first cue alone one would consider the perceived threat much higher than in case both cues are combined.
The example mentioned above stresses the importance of a proper cue structure. One can not implement single cues without looking at the bigger picture. The relations between cues should be identified and the effect of this relation on the effectiveness of the cue should be determined.

Unrealistic cues
Unrealistic cues are probably the most undesirable cues of all. Unrealistic cues are cues that were not intended to be implemented but do, for some reason, manifest themselves in the scenario.

Unrealistic cues
During a demo/test session of one of the scenarios TNO has designed an unrealistic cue emerged. Due to technical limitations a civilian had to be used to represent the opposing forces. When the players made a mistake, one of them was shot by this civilian (role-played by the instructor) to confront them with their mistake. For a technical reason, everyone got the message “X was killed by friendly fire” on their computer screen. The consequence of this unrealistic cue was that players got confused and did not know what was happening. As a result, the learning goals for this particular scenario were in danger.

They usually have a disruptive effect on the person that perceives them. Cues like the one described above can generally have two consequences:

- **The perceiver thinks the unrealistic cue is normal and makes a decision based on a wrong cue.**
  This is a very bad thing, as it increases the chances of a negative knowledge transfer to the real world. Training people with the wrong cues can cause them not to function in the real world because such cues are not present there\(^\text{15}\).

- **The perceiver is taken out of the ‘reality’ and thinks he is playing a game again.**
  This is what happened in the example described above. The cue was so unrealistic and confusing that the players refused to accept it and were thus thrown out of the ‘realistic’ game and back into the ‘game’ game which gave them the wrong mindset.

5.3.3 Cues conclusion
While generating the final list of cues I soon made the observation that a distinction can be made between cues that have threat related meaning and cues that have an effectiveness related meaning. These are actually the most important aspects of military decision making. The questions a good commander should always ask himself during a mission are ‘How can I improve the safety for me and my squad’ and ‘What options do I have to increase the effectiveness of the mission?’ An attempt was made to generate a comprehensive list of cues on both categories. Unfortunately, it was not possible

\(^{15}\) See also section 8.4
to create a sound collection of effectiveness related cues. This requires a lot of research and extensive task analyses. The time span of this thesis report was simply too limited to do this. Therefore I focused on cues with a threat related meaning. The results can be found in Appendix F. However, hopefully the results presented here will give the scenario designer insights in what options he has to design his scenario, also on effectiveness related content.

For the design of a scenario, the findings in this section essentially mean that a scenario designer has the possibility to implement threat-related cues and/or effectiveness related cues in his scenario. The choice of either category should be based primarily on the learning goals. When the learning goals refer more to increasing safety/decreasing threat then he should focus more on threat related cues and Appendix F will help him choosing and implementing the right cues. When the learning goals lean more towards increasing effectiveness of the particular mission it is important that, together with a SME, the mission (task) is analysed thoroughly and options that might increase the effectiveness are identified. These can subsequently be implemented in the scenario as cues.

**Guiding principle “S.3 THREAT AND EFFECTIVENESS”**
- Trigger cues will be either threat related or effectiveness related; it depends on the learning goals in which category the cues belong. To implement trigger cues that are threat related, the list in Appendix F can be used. To implement trigger cues that are effectiveness related, the mission should be thoroughly analyzed together with an SME, to identify the effectiveness related cues corresponding to the mission.

### 5.4 Designing is not a one man effort

Most of the time a scenario will not be designed by one person only. There are different ways of looking at a scenario and these different views should be incorporated in the design process. First I will give an overview of the three main design perspectives that were identified in this research. Then I will present a design process that accounts for the differences in perspectives.

#### 5.4.1 Educational perspective (Learning possibilities)

From an educational perspective there are certain learning needs and the question is: How can we design such a scenario so that these learning needs are met? Most of what has been described before relates to this educational perspective. The definition of learning goals, the design of cues that correspond with those learning goals and the anticipation on the student’s behaviour are all part of the educational perspective on designing scenarios.
5.4.2 Technical perspective (Technical feasibility)

The technical perspective on scenario design looks at scenarios with the thought: Can the proposed solution be realized in the technical system that is used? An example: According to the educational perspective only a very sophisticated cue can be used to realize a certain learning goal. However, this cue is very hard if not impossible to implement in the current technical system. Usually this is not accounted for in the educational perspective. It requires a thorough knowledge of the technical system to be able to identify the possibilities and constraints of that system. Evaluating the proposed solution based on the possibilities and constraints of the technical system is exactly how scenarios according to the technical perspective should be designed. The starting point is therefore usually the combination of the possibilities and constraints of the technical system used.

**Technical constraint**

One of the difficulties I encountered with the technical system VBS is the fact that (movement within and around) buildings are not modelled in very much detail. One of the learning goals of students is to recognize and assess different methods of entering a building i.e. through windows, doors, manholes. However, in the current version of VBS it is impossible to blow up walls to create manholes or to enter buildings through windows, and this therefore limits the possibilities to achieve this particular learning goal.

5.4.3 Domain perspective (Reality)

The domain perspective (represented by the subject matter expert, or SME) guarantees the fidelity of the scenario. The question he asks himself is: Are the proposed learning goals and their corresponding cues realistic enough? Especially within the concept of Job Oriented Training this is an important issue. Certain cues in the scenario can seem very valid to reach a given learning goal but if they do not correspond with the reality as it exists today, one can question the effectiveness of that particular scenario (see also section 5.3). The SME that represents the domain perspective usually has a lot of knowledge about the ‘real deal’ and is therefore able to determine whether or not certain (proposed) aspects of a scenario are feasible in terms of reality.

NOTE: The existence of three different perspectives doesn’t necessarily mean that at least three different persons should be involved in the design process. It could very well be possible that one person with knowledge on all three perspective can design a scenario by himself. This would, however, require him to look at the scenario with all three different views.

**Guiding principle "S.4 NOT A ONE MAN EFFORT"**

- A scenario should reflect three perspectives: an educational, a technical and a domain perspective. The elements in the final scenario should consequently be 1) of educational value, 2) technically feasible and 3) realistic.
5.5 **The Agile Scenario Development model**

There is an evident risk that the three different perspectives will conflict with each other. This would mean that every perspective takes the view that only that particular perspective is relevant and the possibilities with regard to the other perspectives are endless. This is not the case, as there are always restrictions to each perspective with regard to its possibilities. Besides conflicting, it could also be that the three different perspectives are pulled apart too far. This may result in three incompatible perspectives on the scenario. In order to prevent this phenomenon, a process is needed that will reduce the risk of conflicting perceptions on the design of a scenario. This process is presented in figure 12.

1. **Conceptual design**

The first step in this process is to draw up the initial list of learning goals and cues as described in section 5.2. All three perspectives should be involved in this activity with a lot of feedback between them. All options that could be included should continuously be checked with the other perspectives. The result is a comprehensive list of all learning goals, typical mistakes and cues that at first sight:

1. seem of educational value,
2. are technically feasible and
3. passed the reality/fidelity check.

This is the initial *conceptual design* of the scenario (see Appendix C for an example).
2. Implement and refine

The second step in the design process is an iterative process where the initial conceptual design is implemented and continuously refined based on testing and evaluation. These tests should be held with the target group of the scenario (the students) and conducted by the people responsible for the three perspectives. This gives the latter the possibility to see the different effects of cues on the students. Based on the results of these tests, the implemented design is evaluated. What cues turned out to be not that realistic, were (too) hard for the students to perceive or were simply missing? What learning goals may not be suitable in this scenario after all? It can be decided to add or leave out certain cues and/or learning goals from the scenario if this seems necessary. This second step makes the scenario design process very agile.

3. Finalizing

Eventually this will lead to a scenario that has been tested so thoroughly that it can be finalized into a final implemented design. In this design all flaws and mishaps should have been removed. This can mean that some learning goals and/or cues are removed from the scenario because they somehow did not work correctly.\(^\text{16}\)

One could say that drawing up the initial conceptual design which includes all possible learning goals and their cues is a waste of time because many of them will not be used due to technical and reality/fidelity restrictions (encountered during the refinement). During this research I actually encountered that this is not an issue but instead an opportunity for the following reason: things evolve, technical possibilities grow each year and changes in reality are not uncommon (example: from classic war fights to an irregular performing enemy). As things evolve, learning goals and cues that were irrelevant at first become relevant over time. In this case, one can easily refer back to the initial list of learning goals and cues without having to rethink about what’s missing now (which would take more time). The agility in the design process described above provides the ability to incorporate such changes.

Guiding principle “S.5 AGILE DEVELOPMENT”

- The Agile Scenario Development model was drawn up to facilitate the design process, involving the three perspectives, in which a conceptual design is continuously refined into an implemented, final version.

\(^{16}\) It will always be subject to debate whether or not a scenario is actually final. One could say that a scenario will never be finalized because new elements may seem important over time. Therefore, the final implemented design that is mentioned here can also be seen as being "satisfactory" at that particular point in time.
5.6 Flexibility for the instructor

The instructor fulfills a special role within scenario based JOT. One of the key aspects of JOT training is the fact that the instructor should not impart wisdom to his students; he is more of a coach and ‘merely’ guards the quality of the learning process. It is crucial for the instructor to understand that students are supposed to make mistakes (Van der Hulst et al., 2008). Usually, when running a scenario, the instructor controls opposing forces and civilians, role-plays a superior commander while at the same time tracking the students’ assessments, behaviour and progression. With his active participation in the scenario he has the possibility to adapt it to the students’ behaviour, thereby increasing the flexibility of the scenario. However, the scenario should be designed in such a way that instructors can indeed make use of this flexibility.

This especially concerns the feedback on mistakes. Sometimes you don’t want to punish each mistake. If the students make a mistake very early in the scenario – for example by choosing a very dangerous route to an object – a typical response cue would be that opposing forces shoot them (dead). In itself, this seems a valid learning experience for the students. The consequence, however, is that the rest of the mission (scenario and thus learning goals) are endangered just because they can’t continue. An instructor should always have the possibility to weigh the severity of the mistake (in the particular context) against the negative consequences if this mistake is punished.

Another important factor is that sometimes, the behaviour of students does not reflect their situation assessment. As was mentioned in the beginning of this chapter, the situation assessment is at least equally important in the acquisition of competencies. This assessment can not be made visible to the technical system, but it can be visible to an experienced instructor. If he thinks the assessment was good, but the behaviour that stemmed from the assessment was inadequate for some reason, he may not want to give negative feedback on the behaviour.

For the design of a scenario this means that the use of automatic response cues should be avoided. These are cues that are automatically presented to the students by the system when they display a certain mistake. Currently these cues are quite hard to implement in the system because the artificial intelligence is not advanced enough and it takes a lot of scripting to accomplish this. An option would be to have the cue be ‘built-in’ to the scenario but only let it be triggered by order of the instructor. Another option would be to design cues in such a way that the instructor is fully responsible for the implementation of the cues. This can be achieved by e.g. letting the instructor control opposing forces, giving him the possibility to shoot at the students if he feels that’s the right cue at that moment.

**Guiding principle “S.6 FLEXIBLE FEEDBACK”**

- Avoid the use of automatic response cues, instead work with optional response cues (whether it be by built-in options in to the scenario or a cue presented by the instructor himself).
For the instructor this means that he constantly has to track the student's situation assessment and behaviour, weigh that behaviour against the bigger picture and give feedback on that behaviour when he feels necessary. This can be quite overwhelming for the instructor without proper instructions; therefore a scenario requires extensive documentation for the instructor. This documentation should include the learning goals (the critical decisions) that will be trained in this scenario, the typical mistakes they are likely to make and the options (cues) the instructor has to react on possible negative behaviour (mistakes). See Appendix B and E for an example of such documentation.

Guiding principle “S.7 GUIDE THE INSTRUCTOR”
- Document the scenario for the instructor in terms of decision requirements, typical mistakes the students can make and possible cues the instructor can use to react on these mistakes. The format presented in Appendix B and E can be used.

5.7 Conclusions
A number of important guiding principles for scenario design have been identified in this chapter. The first part of Appendix I gives an overview of these guiding principles. The guiding principles cover both the content related aspect of scenario design, which consists of translating the learning goals into a scenario, as well as the process related aspect of scenario design, which includes guidelines on the design process itself. Appendix I relates the guiding principles to these two aspects in order to clarify the structure of the guiding principles. In the next chapter, the guiding principles for curriculum design will be presented.
CHAPTER 6 – DESIGN THE CURRICULUM

In a training environment a scenario will most likely never be independent, i.e. it will always be part of a bigger collection of scenarios which is called a curriculum. Generally, a curriculum can be defined as “a specific learning program containing a set of courses, and their content, in which the student gradually gains certain knowledge and skills”. This definition also corresponds to old fashioned, formal education – by means of books – where different chapters can represent different ‘courses’. In mathematics courses I had in high school, for example, there were various successive books that built upon the previous ones. There was, however, a relationship between them. This relationship can express itself in two ways:

- Successive subjects. These can be entirely independent subjects (e.g. theory of probability and theory of differentiation) or dependent subjects where the previous subject is a building block for the next, meaning you can not do the second subject properly if you have not done the first. In educational science those building blocks are called prerequisites. A prerequisite is that part of a training a student must master, before he can start a new part of that training (VU Brussel, 2008). For a proper execution of the new part he should master all the competencies connected to the first part.

- Same subject but each time getting more and more complex. In this case only one subject is trained. However, it usually starts easy with not all elements of that subject being treated. Then, gradually, the complexity will increase by adding new elements to the subject.

This distinction is very important for this chapter as both of these types of relationships are present in a scenario curriculum within JOT based serious gaming, as will be described later on in this chapter. The research question that will be answered in this chapter is: What are the guiding principles for the design of a curriculum? As was mentioned in the problem description in chapter two, in answering the research question I will focus on three aspects of curriculum design: task arrangement, complexity progression and the balance between short- and long cyclic scenarios.

6.1 Tasks as building blocks

Just as in formal education, different subjects can also be identified in military JOT training. The subjects are in this case referred to as ‘tasks’. In infantry training, different types of tasks can be distinguished (Fiamingo & Otter, 2007). They are numerous but can be narrowed down to the following main tasks: Reconnaissance tasks, Movement tasks, Patrol tasks, Defensive tasks and
Offensive tasks. This distinction is not as strict as it may seem because some tasks are a combination of multiple tasks. Generally speaking, without external interferences, movement tasks are the easiest of the five because it is a very basic building block used in other tasks. Reconnaissance tasks also use movement tasks but other tasks, such as dealing with possible contact or identifying objects of interest, are added. Reconnaissance tasks are therefore more extensive and require the control of multiple simultaneous tasks. On about the same level of complexity with reconnaissance is patrolling an area. The distinguishing factor here is that there is no clear mission goal, most of the time it is just showing the flag (showing you are present as a friendly force in order to get support from locals) not knowing what to expect. Defensive tasks (e.g. securing and defending a building) are clearly more difficult as these involve force most of the time. They are easier than offensive tasks (e.g. capturing an enemy base) however, because the latter require more mobility and coordination which makes it more complex. Both defensive and offensive tasks require that the area of operation is explored first; they therefore make use of reconnaissance tasks.\footnote{Determining the complexity and relations between the main tasks was done in various discussions with the Serious Gaming project team.}

An important notion that can be extracted from this task distinction is the fact that there are basically no independent tasks to identify. Reconnaissance & patrolling tasks require the use of movement tasks, while defensive and offensive tasks both require the use of reconnaissance tasks. The following figure clarifies this:

![Figure 13. Prerequisite tasks](image)

**JOT remark**

The attentive reader will recall the JOT principle *Integrated task training* as described in the introduction. This principle states that there should be no part-task training, but only complete and integrated task training. The text and figure presented above would suggest otherwise. However, the difference with other training methods that use part-task training is that they use *artificial* part-tasking. The original integrated task is chopped into pieces, but those pieces would not actually occur separately in reality. The tasks that are described above are not (artificial) part-tasks in the sense that they do still represent a realistic integrated task. A single movement task can very well be a
complete mission as they would be encountered in operational countries such as Iraq or Afghanistan. In other words, the different tasks presented in this section maintain their realistic context and can therefore still be considered integral tasks.

The five different tasks described above should all be included in the curriculum, with no exception, for the simple reason that students are required to learn these (Ministerie Van Defensie, 2005). The remaining question is how to place the different tasks in a curriculum. There are roughly two options to deal with this issue.

6.1.1 Randomizing tasks
The first option is to completely randomize the tasks in the curriculum meaning that it does not matter what task is trained at what point of time in the curriculum. This means that it could be possible that the curriculum starts with an offensive action, which is the hardest task to learn, followed for example by a movement, which is the easiest and most basic task. Literature on cognitive skills actually supports this. Bjork (2002) calls this concept of randomly mixing tasks ‘random practice training’. This concept is the direct opposite of ‘blocked practice training’, which he also mentions, where the student trains the same task until he reaches some kind of mastery and then moves to the next task. He did various experiments with both blocked and random practice training. He then analyzed both short- and long-term performance on the tasks that were trained. The results were remarkable; the short-term performance was better on blocked practice training while the long-term performance was better on random practice training. In other words, the retention of training in the case of random practice training was better.

However, there are various reasons that indicate this option is not suitable for military JOT.

1. Some tasks are building blocks for other tasks. This was already mentioned previously. An offensive task requires knowledge on both displacement and reconnaissance tasks. An offensive task can therefore never be trained before the other (conditional) tasks have been trained.

2. One of the most important principles of JOT training is the fact that students should learn from their mistakes. This means that if they make mistakes in a particular scenario which involves a certain task, you want them to be able to do it correctly the next time. If you continue with a completely different task this possibility to learn from mistakes and do it correctly the next time is missed.

3. An important side effect of random practice training is that students have the feeling that their performance during the training is remarkably low (Bjork, 2002) i.e. their success
experience was quite low. Precisely this success experience proved to be very important for the performance and motivation in subsequent training sessions.

4. The tasks involved in the various experiments of Bjork (2002) were mainly basic, easy tasks such as motor skills, knowledge memorization and the acquiring of procedural skills. The task trained in military JOT training is far from easy and procedural (see chapter three). It can therefore be questioned whether this random practice training method is suitable for military Job Oriented Training.

6.1.2 Blocked training
The second, and most preferred, option is to start the curriculum with the basic tasks and end with the most complex tasks that integrate the more basic tasks. You create certain ‘training blocks’ with each block representing a certain task. It very much resembles Bjork’s (2002) blocked training concept. The conditional training blocks – the ones that are required for succeeding tasks – should be trained first. The following figure illustrates this.

6.2 Scenario progression
Once the training blocks have been identified the following issue is how to fill and arrange those training blocks. Ideally you want to train the same task in different settings and with different complexity levels. There should be a certain advancement in scenarios and their complexity, which I will call scenario progression. The main reason for choosing an increasing complexity within training blocks is based on the assumption of educational sciences that training/education should start

Guiding principle “C.1 CONDITIONAL TASKS FIRST”
- Arrange a curriculum in such a way that the training blocks which are prerequisites for other training blocks are trained first. In the case of infantry training this would be the following order: Movement, Reconnaissance, Patrol, Defensive action, Offensive actions.

18 Interview A.H. van der Hulst, June 2008
simple and gradually increase in complexity (Gauthier & Dembele, 2004; Härtel, 2000). One of the advantages of using a simple to complex progression is that it helps students in introducing an unknown field and this hopefully leads to early learning success (Härtel, 2000). For the design of a training block this would mean that one should start with an easy scenario and make every succeeding scenario within the same block more complex. However, there are two other reasons why there should be a certain scenario progression: an educational and a motivational reason.

1. The key issue in having a successful learning experience is that students should learn from their mistakes. They should be able to link the (negative) consequences of their behaviour with the behaviour itself. Only then, students can identify that their behaviour was inadequate and that they should perform differently the next time they are in the same situation. This (cognitive) process is rather easy when they do not make many mistakes. This is normally the case in a basic scenario where no extra complexity dimensions are added. Confronting students with a scenario that is too complex though, can result in the student making too many mistakes while being confronted with too many different elements. The consequence is that the students are not able to link their behaviour to possible consequences of that behaviour simply because there are too many things to be taken into account i.e. the learning experience is missed. A scenario progression where each successive scenario builds upon the previous one in terms of complexity counteracts this because students will gradually be confronted with their mistakes.

2. The second reason is a motivational reason. An essential aspect of Job Oriented Training is the presence of a challenge for students. Without this challenge, students can easily get distracted and their creativity and ability to apply effective strategies can be reduced. It is therefore essential that each scenario matches the competency level of the students i.e. a scenario should not be too complex nor too easy. After executing each scenario the competency level of students will increase, meaning that the successive scenario should be more complex. This also justifies the use of a scenario progression from simple to complex.

### 6.3 Dimensions of complexity

Before one can actually tweak the different complexity levels of scenarios it is necessary to determine what the term 'complexity' actually means. This will be done by dismantling scenario complexity in its various dimensions. The dimensions described below are adapted from Phillips et al. (2001) and TNO (2009).

**6.3.1 Civilian presence**

Adding civilians to scenarios can substantially increase complexity. Especially in the current Urban Operations there is a big chance that civilians are in the area where the operation takes place. When they are in midst of the operation they can hinder the soldiers in their task execution. It can also be
difficult to distinguish civilians from opposing forces. Bearing the Rules of Engagement in mind, this can be extra challenging.

6.3.2 Threat level

Executing a certain task in a setting with a high amount and intensity of threat is a lot harder than doing this in a friendly setting because:

1. You have to be more careful; every corner has to be checked.
2. There is increased stress level because you know the consequences of failures can be severe, resulting in early fatigue symptoms.

Diversity of threat is another factor that can make a scenario more complex because there is a lot more uncertainty about what to expect.

6.3.3 Interaction with other entities

More interactions with other entities require more actions, more coordination and more processing done by the decision maker. Other organizations may include, but are not limited to, other friendly units in the area (varying from other groups to a whole platoon/division), relief organizations and local police. There are different aggregation levels for military actions in Urban Operations which are labeled as level one till five as displayed below (Ministerie van Defensie, 2005). Note that the scenarios that are currently being designed are mostly level two (squad) and some level three (platoon)19.

I. Individual level
II. Squad level
III. Platoon level
IV. Company level
V. Battalion level

19 Defensive and offensive actions are usually done on platoon level. This is another reason why these are more complex tasks.
6.3.4 Information complexity
Completeness, intensity, reliability and complexity of the information provided to the student during the scenario all influence the complexity of the scenario. If necessary information about the task is missing the student will have to reconstruct the information himself and make a decision based on 'educated guesses', which is more complex. If information intensity is high it is difficult for the student to distinguish useful information from less useful information and this might eventually lead to an information overload. Less reliable or conflicting information will also make it more complex to make a decision because first it must be determined which information is the most reliable. Finally, very straightforward information that is directly related to the situation is easier to handle than complex, extensive information which is hard to interpret, e.g. the historical background of the conflict.

6.3.5 Available resources
During a mission various resources are being used that range from materialistic resources such as bullets, vehicles and communication means to more complicated resources such as the skills and experience of team members. The availability of resources puts constraints to the execution of the mission. When there are limited resources, effort has to be put in conserving and managing those resources which adds another task to the already complex task of reaching the mission’s goal.

6.3.6 Time pressure
Time pressure is closely related to information load mentioned earlier. In the case of time pressure there is no time to extensively study and assess the information at hand. This results in decisions that have to be made on information that is far from complete. Not all alternatives for a certain decision can be generated so it could happen that a less effective decision is made. Study by Mann & Tan has shown that time-pressured students actually generate fewer objectives and alternatives and considered fewer consequences than students who were not time-pressured (Mann & Tan, 1993). One of the reasons Mann & Tan give for this 'hassled decision making' is the disruptive effects of
psychological stress. Stress generated by perceived time pressure – time pressure does not have to be real, as long as the decision maker perceives the pressure – thus makes decision making harder.

6.3.7 Subtlety of cues
Chapter four described cues as the perceptual elements of the environment that influence challenging decisions. In order to make decisions, the cues related to that decision have to be perceived and processed by the decision maker. In a scenario, direct cues that are clearly visible to the student are easier to notice and interpret than indirect, not so clearly visible cues. The presentation of each cue can be different, be it visual or auditory, but each can be presented in a more or less clear way. An indirect cue (a cue related to another cue that is the actual ‘decision making cue’) is for example harder to notice and interpret than a direct cue. Consider the cue in the market place scenario “Civilians suddenly run away from a certain point” for example (see Appendix B). This cue indicates that threat might occur in the opposite direction of where the civilians are running. It is quite a subtle cue because during test sessions, few students actually noticed it or failed to connect the cue to its meaning. This increases the complexity of this particular scenario.

6.3.8 Number of unexpected events
Various sayings and quotes stress the importance of preparation, for example “To be prepared is half the victory”\footnote{Miguel De Cervantes} and “Luck favors the mind that is prepared”\footnote{Louis Pasteur}. However, you cannot prepare for the unexpected. Unexpected events – such as casualties, equipment malfunctions or bad weather – therefore require on-the-spot thinking and, again, a good situational awareness. A scenario with a lot of unexpected events is a lot more complex than a scenario with only events that were prepared for.
6.4 Application of the dimensions.

The dimensions of complexity alone are not enough to successfully design a scenario curriculum. You must at least know how to apply these dimensions on scenarios in the curriculum. Questions that arise are: How many of the dimensions have to be tweaked in every scenario? How difficult should the starting scenario be? How should scenario complexity progress within the training blocks?

Unfortunately there are no guidelines for the application of complexity dimensions, for reasons that will be described below. The goal of this part of research is thus not to give prescriptive guidelines on the use of complexity dimensions such as ‘only change at maximum two dimensions for each successive scenario’. It merely gives the reader (and scenario designer) some information about what type of complexity dimensions can be used to change the complexity level of a scenario. The application of the dimensions is strongly dependent on the specific task that is trained. Some dimensions are even inherent to the task; an offensive or defensive action almost always has a higher threat level than a reconnaissance task for example and a patrol is characterized by more information complexity.

It is therefore advisable to always discuss with a domain expert:

1. The task that is trained in the scenario, along with the learning goals corresponding with that task.
2. The possibilities with regard to the complexity dimensions.

Guiding principle “C.3 DISCUSS COMPLEXITY WITH SME”

- Within the task building blocks, there should be a number of scenarios concerning the same task but having an increasing complexity level. The required complexity changes are strongly dependent on the task at hand. It is advised to discuss the options with the SME.

An essential aspect that should be discussed in such a discussion is the reality aspect. What changes in complexity are realistic and could happen in actual missions in current countries of operation? An example: during a discussion for the design of a house clearing scenario (offensive action), the subject matter expert mentioned that operating during the night instead of during the day is a very common event but it also makes the mission significantly more complex. Based on this statement a
scenario was made within the ‘offensive action’ training block which involves clearing a house during the night. This scenario was placed at the end of the training block because it was so complex.

6.5 Task independent competencies

Besides the task dependent learning goals (all competencies related to movement, reconnaissance etc.) there are also task independent learning goals or competencies. Examples of such learning goals are CoVo & the OTVOEM analysis, as described in chapter three. They will return in every single scenario in the curriculum because they are needed for every task. The expectation is that the competency level of students on these independent learning goals will increase over time only because they are confronted with them in each scenario. However, in order to reach a certain competency level at the end of the curriculum there are roughly two options:

- Demand an increasing quality level on the OTVOEM and CoVo learning goals by
  1) expecting more OTVOEM elements to be present in the analysis and to increasingly expect students to make correct, or at least justifiable situation assessments and
  2) expecting better CoVo as can be observed by students exhibiting increasingly clear command and increasingly better control with respect to predefined (situational) standards. These standards have been defined in the conceptual design of scenarios (the right or wrong decisions with regard to the ‘critical decisions’, see section 5.2).

- Gradually increase the time pressure on the OTVOEM analysis. E.g. give the students fifteen minutes for their OTVOEM analysis in the first scenario of the curriculum and only five minutes for the same analysis in the last scenario of the curriculum.

This means that the students should be required to deliver increasing quality on these learning goals in every succeeding scenario and to be able perform on those learning goals in a shorter amount of time.

Guiding principle “C.4 INCREASING DEMANDS”

- In every single scenario, attention should be paid to the task independent learning goals such as OTVOEM and CoVo. Gradually increase the time pressure and demands on the OTVOEM analyses and the CoVo performance.

6.6 Short or long cyclic scenarios?

As was mentioned in chapter two, there are two types of scenarios: short- and long cyclic. The former targets specific tasks and are usually shorter in their time duration. They are placed directly in the context of a real mission, but do not cover the whole operation. A long cyclic scenario on the other

22 According to A.H. van der Hulst
hand, as you might expect, does train the whole integrated mission and can therefore last for up to 4 hours.

Because the curriculum to be designed for the Royal Netherlands Army should initially fit in a three-day training course, it is not possible to train every learning goal in a long cyclic scenario because this simply consumes too much time. However, this is not the only reason why short cyclic scenarios are used. It is sometimes also more efficient because very basic tasks, such as movement tasks, which were done multiple times in previous scenarios, do not have to be done over and over again.

**Example**

When you want to clear a certain object you usually do a movement to the object and a reconnaissance around it before you actually engage in clearing. A long cyclic scenario will usually combine the displacement, reconnaissance and clearing tasks. In a short cyclic scenario only the clearing is trained.

6.6.1 Information on preceded tasks

In order for short cyclic scenarios to be realistic and to give the right cues to the students, information about the preceded tasks (e.g. movement and reconnaissance in the above mentioned example) should always be provided beforehand. The purpose of such tasks in a real operation is to gather information about the location and surroundings of the object(s) and/or about human presence (this information thus includes cues). Based on this information the commander makes decisions as to the next task in the operation (in my example on how to clear a certain object). Without that information the commander can not make proper decisions simply because the necessary cues are missing. Therefore it is absolutely vital that such information is included in the mission order of a short cyclic scenario. Of course, one can deviate from this principle to increase the scenario’s complexity level (due to less subtle cues and incomplete information). However, it is highly unlikely that this will happen during a real operation and, with regard to a relevant reality, this is not advised.

**Guiding principle “C.5 SHORT CYCLIC SHORTNESS”**

- If you want to train a specific task in a short cyclic scenario which is usually preceded by other tasks, always give the necessary information normally extracted from those tasks.

---

23 Within the pilot and test phase the Royal Netherlands Army is currently in; its goal is to give students a scenario based JOT training of three days.
6.6.2 A good start

Experiences drawn from workshops that were done with soldiers in order to test existing scenarios indicated that it is important to get the students’ attention right from the beginning. People with little experience with serious gaming – which is often the case as it is a quite innovative way of training at the Royal Netherlands Army – sometimes find it hard to take the game seriously. As a scenario designer one runs a risk that the students who do not take the game serious enough just play around and don’t reach the learning goals of the scenario. In order to counter this effect it is important that, right from the beginning of the training, students should experience ‘immersion’. Recent studies show the importance of immersiveness in serious gaming. Immersion is referred to as “the state of mind where a person is completely absorbed in what they are doing” (Bateman, 2007). When a player is properly immersed in a game, the real world ceases to exist and the game world becomes their reality. There are different techniques to design an immersive game such as proper game mechanics and a good game narrative. Scenario design also influences the immersion of students in the game by providing a certain context in a scenario where all the aspects of a real life mission are present. The ideal world would be that every scenario is like this. Unfortunately, due to the lack of time as described before, this is not possible. However, the starting scenario is very important as this sends the students along with a certain ‘serious’ mind set which will be used in the successive scenarios. In general, a long cyclic scenario provides more context than a short cyclic scenario, simply because more aspects of a real mission are present.

There are two more reasons for implementing a long cyclic scenario in the beginning of a curriculum.

1. Making the student sensitive to the various relevant aspects of his job. A risk of a curriculum where only subtasks are trained in short cyclic scenarios is that the student is unable to relate the subtasks to each other and to the bigger picture. For each subtasks, the student will question: what do I need this subtask for? As opposed to a short cyclic scenario, a long cyclic scenario will train an integrated mission where different subtasks are integrated. This will make the relation between tasks clear and it will clarify the usefulness of the different subtasks. As such, the long cyclic scenario provides a solid base for the rest of the curriculum.

2. Making the student feel incompetent. A long cyclic scenario is generally quite complex. For the student it can be an overwhelming scenario where relatively many mistakes are made. The student will notice that he is not competent enough to successfully perform in this scenario. He will feel incompetent but at the same time he generates a strong motivation to learn the various aspects that made him fail in this first scenario.

24 Interview Dennis Coetsier 18 November 2008; Rogier van der Hee 19 November 2008.
25 Interview Dennis Coetsier 18 November 2008. NOTE: This is only applicable on the first scenario in the curriculum. In the rest of the curriculum the student needs success experiences to sustain his motivation
Guiding principle “C.6 A GOOD START”
- The first scenario in a curriculum should always be a rather complex long cyclic scenario which includes all the relevant aspects of the job and is as close to a real mission as possible.

6.6.3 Long cyclic scenarios to keep the context clear
Having a long cyclic scenario at the start of the curriculum is good. But it has been observed that also during the curriculum, long cyclic scenarios are necessary to keep the context of the job alive. Once a few training blocks – each targeting a different subtask – have been done, it can occur that the relation between those tasks, and consequently the context of those tasks, fade. A long cyclic scenario deployed after a few training blocks can help to keep the context of the subtasks visible to students. On the other hand, it can also function as simple memory refreshment for the tasks that have been done some time ago.

Guiding principle “C.7 KEEPING THE CONTEXT CLEAR”
- In between task building blocks there should be long cyclic scenarios that integrate the preceded tasks.

6.7 Conclusions
Seven important guiding principles for the design of a scenario curriculum have been identified in this chapter. The second part of Appendix I gives an overview of these guiding principles and relates the guiding principles to the three aspects of curriculum design for which guiding principles were needed: task arrangement, complexity progression and the balance between short- and long cyclic scenarios. If the guiding principles for curriculum design are incorporated in a curriculum design, a general implementation of a military JOT scenario curriculum would look like this:

![Figure 15. A general JOT training curriculum](image)
Reminder: This is a general implementation model. The exact realization of the curriculum depends on the tasks. The placement of long cyclic scenario in the curriculum is subject to change (except the first one). The same applies to the prerequisite relations between training blocks. However, the concepts used in this model can be used in any training program that aims at increasing the competencies of students.
CHAPTER 7 – VALIDATION

An important step in the complete process of formulating a collection of guiding principles for the design of a scenario and a curriculum consists of validating the guiding principles. Validating the guiding principles is aimed at assessing the impact of applying the guiding principles on the aspects for which they were designed. By validating the guiding principles – i.e. assessing whether or not they do what they intend to do – one reduces the risk of the guiding principles unintentionally influencing the design process in a negative way. In this particular case the guiding principles were designed to:

“...assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming.”

From this statement two important validation questions can be extracted. The first deals with the consistency of the guiding principles with the JOT concept. The question that relates to this issue is: Are the guiding principles for scenario and curriculum design actually JOT consistent and do they therefore aim at acquiring competencies? The second important aspect, one that is actually inherent to all design guidelines, is the usability aspect. In the end, the target group of the guiding principles – inexperienced scenario designers - should be able to design singular scenarios and scenario curricula by means of these principles i.e. they should be usable and should contribute to the design process. The second validation question is therefore: Are the guiding principles usable by scenario designers and do they have a valuable contribution to the design process? Summarized, the two validation questions are:

1. Are the guiding principles for scenario and curriculum design actually JOT consistent and do they therefore aim at acquiring competencies?
2. Are the guiding principles usable by scenario designers and do they have a valuable contribution to the design process?

Both of these validation questions will be key aspects in the validation process presented in the next sections. Meanwhile, there are various other reasons to validate a set of guiding principles.

1. Eliminate or at least detect conflicting principles. Some guiding principles can be completely contradictory in which case the scenario designer will be uncertain about which one to apply. For example, a guiding principle “Start the curriculum with the most easy tasks and
end with the hardest tasks” conflicts with “The first scenario in a curriculum should always be a rather complex long cyclic scenario which is as close to a real mission as possible”. The first principle can be interpreted in such a way that it states that a curriculum should start easy, while the second states that the curriculum should start rather complex. It is necessary to identify these types of conflicting statements. A possible solution to conflicting principles can be to let one of them overrule another (this should be clearly pointed out in the documentation of the guiding principles).

2. The guiding principles are not based on well established theories or proved principles which could reduce the need for validation. There are currently very few theories on the design of scenarios within serious gaming. Therefore, most of the guiding principles presented in this thesis are based on experience and common thoughts.

3. And last but not least; validation is used to increase support of the guiding principles. Non validated guiding principles may lack support by its intended users because they are not certain about the usefulness and correctness of the guiding principles.

The next section describes the validation method that was used to validate the guiding principles with regard to the above mentioned issues. It describes the validation process in detail, including its strengths and weaknesses.

7.1 Validation method

Choosing a validation method should be primarily based on the characteristics and goal of the to-be-validated content. A quantitative model that generates realistic data should for example be validated by comparing the outcome of the model to already existing empirical data. However, a second very important factor that needs to be considered when choosing a certain validation method is the resources, i.e. the means (e.g. time, money and people) available to conduct the validation. In the case of my guiding principles the lack of available resources was very obvious, as will be described later.

As was mentioned in the previous section, the objective of the guiding principles is to help (inexperienced) scenario designers with designing JOT consistent scenarios. Two main validation questions were formulated; one that deals with JOT consistency and the other that deals with the usability of the guiding principles. Two validation methods were chosen based on these research questions: experimental validation and face validation. These methods, including the motivation for choosing them, are described below.

7.1.1 Experimental validation

A proper and valid method for validating the guiding principles is to let their end user – inexperienced scenario designers – design a number of scenarios and curricula while using these
principles and to check whether or not the scenario designers indeed found the principles valuable and useful.

The first step in the validation process presented here is thus to have a rather inexperienced scenario designer (hereafter "experimental subject") – however, with basic knowledge on the domain and educational aspects of scenario design – design a single scenario and a scenario curriculum, based on a set of learning goals provided beforehand. In the first phase this is done without the guiding principles presented in this report. The experimental subject will have to rely on his own intuition and knowledge on the subject. In the second phase, he will again design a scenario and scenario curriculum (based on the same learning goals), but this time with the guiding principles. The results of this process will be two scenarios and two scenario curricula where the hypothesis is that the second scenario and curriculum are more consistent with the JOT concept, i.e. where the focus lies on acquiring competencies instead of the application of knowledge. Two suitable experimental subjects were identified within the TNO organization. They both work for TNO Defense, Security & Safety in The Hague and are in the Urban Operations program where they will have to deal with scenario design very soon (2009). They have a solid knowledge on the military domain (one has been a commanding officer in the Royal Netherlands Army before) as well as basic knowledge on how to train soldiers with scenarios.

Ideally you want to have a larger group of experimental subjects in order to have multiple measurements and therefore a more solid validation. Unfortunately, gathering suitable experimental subjects is hard because they have to have enough knowledge on the subject. For this thesis research, it was (logistically) not possible to have more than the two experimental subjects described above and due to time limitations they were only able to design one scenario and one curriculum. It is an inevitable weakness of this validation process.

The design of the scenario and curriculum was a conceptual design, i.e. a design on paper with the basic ideas elaborated. Designing an implemented scenario and curriculum is out of reach for this thesis research because it is a very time consuming activity. Designing a single curriculum that includes all the required scenarios (which can be a large number) can easily take a couple of months or even up to a year, especially when the iterative model presented in paragraph 5.5 is used (with all the testing and refinements). I therefore chose to have the experimental subjects design a conceptual scenario and curriculum on paper which they were able to do in a limited time span of one full day.

Both experimental subjects did the conceptual design individually. After their individual, basic ideas were elaborated, they had the opportunity to discuss these together. I was present at this discussion because valuable insights could be gathered, especially in the choices a scenario designer has to face.

---

26 Nathalie Vink and Koen Alderliesten
After this discussion, they had the time to finalize their conceptual designs. Once this was done, I questioned them about the usability of the guiding principles and whether or not they were valuable to them in the design process. The questions asked hold a subjective, open and qualitative character. This seems appropriate since the validation questionnaire is aimed at collecting the users’ opinion (hence, subjective) that is representative (hence, open) about the guiding principles (hence, qualitative). The results of this questionnaire can be found in appendix G.

7.1.2 Face validation

In addition to the above mentioned validation method I also used face validation. Essentially, face validation is “the process of determining whether a model (or guideline, or design tool) seems reasonable to people who are knowledgeable about the system under study” (Illgen & Gledhill, 1999). This means that experts – in this case with extensive knowledge on both educational (JOT) as well as military related subjects – evaluate the guiding principles to determine if they are correct and reasonable for their purpose. Face validation is especially suited for early development phases as it provides an informal review on the usefulness and correctness of the conceptual model. It is a qualitative method that quickly identifies gross problems.

Two very knowledgeable experts within the TNO organization27 - who actually took part in founding the JOT concept - were addressed to assess the consistency of the guiding principles with the JOT concept. They had to evaluate the guiding principles based on a questionnaire I drafted. As JOT co-founders, they were pre-eminently suitable to assess the guiding principles based on these questions. The results of this questionnaire can be found in appendix H.

7.2 Validation results

7.2.1 Experimental validation

The experimental validation consisted of two phases: one for the curriculum principles and one for the scenario principles. The results of the validation in both phases will now be described.

Curriculum design: WITHOUT guiding principles

The experimental subjects declared after the design of a curriculum without any guiding principles that their design process was rather unstructured. They continuously came up with new elements to be added on the basis of “hey, this could be added too”. The most remarkable observation in the curriculum design without guiding principles was the fact that both subjects already used some of the concepts presented in the guiding principles. One for example, started the curriculum with a long cyclic scenario – even though he did not mention it like that – that included all the core aspects of an Urban Operations mission, in order to give the students a good view on all those important aspects.

---

27 Dennis Coetsier, Rogier van der Hee
The other more or less introduced the blocked-training principle. First, she identified all unique sub-tasks and started the curriculum with small exercises training those separate sub-tasks. Then, with the acquired skills on the sub-tasks, the main tasks were trained. These main tasks mainly consisted of any combination of the separate sub-tasks, and possible one or more new element(s) which acted as a surprise element. The other experimental subject did not do this; he only used integrated missions, each taking care of a main task.

Both subjects arranged the various tasks in the curriculum on the basis of the sequential elements of an actual mission (e.g. first the displacement, then the reconnaissance, then the offensive action etc.). An interesting side-note is that they also identified this as going from easy to complex. The more complex tasks, which had more freedom of action and more choices, were placed in the end of the curriculum.

Curriculum design: WITH guiding principles

After reading the guiding principles on curriculum design both curricula of the experimental subjects were much more consistent compared to their first versions. They both had a long cyclic scenario in the beginning of the curriculum to create the right mindset for the rest of the curriculum. One also identified sub-tasks and trained these in short-cyclic scenarios.

Something that was missing in both curricula without the guiding principles was repetition. Especially in the curriculum of one experimental subject, each task was only trained once. Now, both subjects added long cyclic scenarios after a number of short-cyclic scenarios. These long cyclic scenarios integrated the different tasks trained in the short-cyclic scenarios. The curricula designed after reading the guiding principles much more resembled the general JOT training curriculum presented in figure 15.

Remarks made by the experimental subjects:

1. The guiding principles on curriculum design are also usable for non serious gaming scenario curricula (in this area they have more experience).
2. In some cases, there are no prerequisite tasks. In this case the sequence of the actual mission will give support in the arrangement of the different tasks in a curriculum.
3. Sometimes (especially on a higher level of operations) it is hard to dissemble an integrated task into one or more sub-tasks to be trained in short cyclic scenarios because there is no clear boundary.
4. Some guiding principles were too detailed to be used in the experimental validation. Due to time limitations in the validation process these levels of detail were not possible to implement.
Scenario design: WITHOUT guiding principles
What happened during the curriculum design – using concepts presented in the guiding principles without having read them – did not happen here. The concept of cueing (the most important part of scenario design) was not used. The conceptual scenario designs made by the experimental subjects remained on a rather high level; the actual elements of the scenario were not described. Much attention was paid to the story behind the scenario; the mission order. However, they did not formulate any particular cues in the mission order. In the scenario description a lot of focus was placed on what students should do and not on what students should not do. There was also no linking between the learning goals (which were provided beforehand) and the elements of the scenario (cues).

Scenario design: WITH guiding principles
Both experimental subjects stated that the guiding principles on scenario design were very valuable and gave lots of insights in the scenario design process. The linkage between learning goals, decisions, typical mistakes and cues provided a valuable tool to get working. Their support for the guiding principles was reflected in their second design attempt which was now much more focused on cues. They actually tried to follow the design framework presented in figure 11. Unfortunately they also experienced the time consuming habit of scenario design; there was not enough time to finish the conceptual design. Nevertheless, both experimental subjects were of the opinion that the guiding principles on scenario design provided a solid basis to be incorporated in their scenario design activities in the next year(s).

7.2.2 Face validation
Besides the experimental validation, I also conducted a face validation with two JOT experts who have a lot of experience in using JOT for military training. The questionnaire I proposed to them can be found in appendix H. I also held interviews with both experts to gather the necessary in-depth information; the questionnaire served merely as a guide for the interview. In the questionnaire and interview I focused on two things:

1. Recognition & JOT consistency of the concepts mentioned in the guiding principles.
2. Usability for inexperienced scenario designers (from their view).

A major issue that was brought up in the face validation was the fact that sometimes, especially on a higher level of operation (platoon and up), you can not speak of right and wrong behaviour. Most of the learning goals are to the extent of identifying opportunities and mitigating threats. The experts also declared though, that on a lower level of operation (squad and sometimes platoon) you can indeed speak of right and wrong behaviour. This suggests that the guiding principles are mainly useful for squad commander training. Although this research was mainly done in the context of
squad commander training, I also want the guiding principles to be useful for scenarios for higher levels of operations. I therefore slightly adapted the guiding principles, in particular the typical mistake parts, to make them suitable for higher level scenarios. No fundamental changes were needed because ‘not identifying important opportunities’ and ‘neglecting threats’ can also be seen as mistakes. I therefore made the description of a typical mistake less strict and broadened its definition.

A second issue that was brought up by the experts was the fact that it is not the displayed behaviour that matters, but the assessment and decision making process that precedes the behaviour. If the assessment was good but the performance of actions (the results of the displayed behaviour) was bad, the student still did a good job. The main reason for this is the fact that the performance of actions is dependent on various circumstances and is therefore subject to coincidence. Even though the assessment was good, its resulting behaviour can turn out to be more or less effective, depending on the situation. In the beginning of chapter five I referred to this issue. I stated that it can be hard to determine whether or not the assessment was good i.e. the behaviour is visible while the assessment is not. However, an experienced domain expert (usually the instructor) should be able to determine this. The guiding principle ‘Responsive flexibility’ (section 5.6) facilitates this. Inadequate behaviour will not automatically be punished if the domain expert recognizes that the assessment was good. Because this issue was brought up by the experts, this guiding principle was probably not clear enough. I therefore reformulated the guiding principle and its description to make it more clear.

Finally, regarding the usability for (inexperienced) scenario designers, it was hard for the experts to put themselves in the place of an inexperienced scenario designer. However, the guiding principles seemed valuable to them because they give an inexperienced scenario designer a set of tools which forms the basis of their work: “Eventually these guiding principles can help them to become expert scenario designers.”

7.3 Validation conclusions

The overall conclusion of the validation process was positive. The two main validation questions were:

1. Are the guiding principles for scenario and curriculum design actually JOT consistent and do they therefore aim at acquiring competencies?
2. Are the guiding principles usable by inexperienced scenario designers and do they have a valuable contribution to the design process?

28 Dennis Coetsier
The experimental validation mainly focused on the usability of the guiding principles for inexperienced scenario designers, the second validation question. The two experimental subjects declared that the guiding principles were very useful and provided them with a solid basis for their future work. The fact that they used concepts presented in the guiding principles, without reading the guiding principles, only strengthens the outcome. One could question the value of the guiding principles, if scenario designers with absolutely no experience can come up with the same concepts as presented in the guiding principles. However, it can be explained by the fact that both experimental subjects did have some experience; they were neither experts nor absolutely inexperienced. Based on the experimental validation I did not change anything in the guiding principles.

The face validation focused on the JOT consistency of the guiding principles. As the interviewed experts were JOT experts, they were able to determine whether or not the guiding principles were actually consistent with the JOT principles. Two major issues were brought up and I solved these issues as described in section 7.2.2. There were also some small comments on some of the guiding principles, mostly regarding the sharpness of their formulation.

As a result of the total validation process, some guiding principles were slightly sharpened in their formulation. All in all, it can be concluded that the set of (adapted) guiding principles for scenario and curriculum design are JOT consistent and useful for inexperienced scenario designers.
CHAPTER 8 – CONCLUSIONS

The use of serious gaming in military training is an area that seems very promising. Serious games such as Virtual BattleSpace provide a reliable and realistic environment in which soldiers can be trained and be prepared for their job. This job is crucial in the didactical concept used at the Royal Netherlands Army. In cooperation with TNO they train commanders with the Job Oriented Training concept. However, the current state of scenario and curriculum development in serious games, based on Job Oriented Training is still in its infancy. Guiding principles were needed that would help inexperienced scenario designers to design JOT consistent scenarios and curricula. The main research question in this thesis research was:

“What guiding principles will assist inexperienced scenario designers in applying Job Oriented Training on scenario and curriculum design for serious gaming?”

The first step in this research was to identify the learning goals of the Job Oriented Training sessions. What do students have to learn while executing a scenario in the serious game? The most important learning goal in the serious gaming sessions with JOT is the acquisition of competencies, which are defined as a combination of knowledge, skills and attitude. The basic knowledge needed to perform the various tasks is mainly taught in either the Royal Military School or the Royal Military Academy the students attended before coming to the JOT sessions (KMS/KMA). On the other hand, it was assumed that the knowledge and attitude parts of competencies are also acquired automatically when the student is continuously confronted with new situations in which they have to make decisions. This research therefore mainly focused on acquiring the decision making skills needed to adequately perform the job.

In order to stimulate decision making skills and to create a profession attitude, the scenario in the serious game should provide the conditions that are relevant for the job that is performed. These conditions are called cues. Cues provide the valuable information based on which people make decisions. This means that by offering (trigger) cues in the scenario, students are stimulated to make a situation assessment and a subsequent decision. Feedback on this process is a vital part of Job Oriented Training. By giving feedback on the (situation assessment and) behaviour of students, they will have the learning experience they need. This especially concerns feed back on mistakes. Response cues can be implemented in the scenario to give ‘live’ feedback to students on their behaviour.
8.1 Guiding principles for scenario design

Based on these findings (which were done in chapter three and four) a number of guiding principles have been formulated that will help scenario designers to create scenarios that are consistent with the JOT concept. According to chapter two, these guiding principles should provide guidelines on two aspects of scenario design: the translation of learning goals (in this case the competencies) into a scenario and on the design process itself. The guiding principles are presented below:

S.1 DOMAIN EXPERT IS VITAL
The design of a scenario should always be done in close cooperation with a subject matter expert.

S.2 CONCEPTUAL DESIGN
Based upon the learning goals, formulate the high level decisions and their corresponding critical decisions, the typical mistakes a student is likely to make, the trigger cues that provoke the critical decisions and the response cues that give feedback on the performance. This is the conceptual design of the scenario, which can look like the table presented in Appendix C.

S.3 THREAT AND EFFECTIVENESS
Trigger cues will be either threat related or effectiveness related; it depends on the learning goals in which category the cues belong. To implement trigger cues that are threat related, the list in Appendix F can be used. To implement trigger cues that are effectiveness related, the mission should be thoroughly analyzed together with a SME, to identify the effectiveness related cues corresponding to the mission.

S.4 NOT A ONE MAN EFFORT
A scenario should reflect three perspectives: an educational, a technical and a domain perspective. The elements in the final scenario should consequently be 1) of educational value, 2) technically feasible and 3) realistic.

S.5 AGILE DEVELOPMENT
The Agile Scenario Development model was drawn up to facilitate the design process, involving the three perspectives, in which a conceptual design is continuously refined into an implemented, final version.

S.6 FLEXIBLE FEEDBACK
Avoid the use of automatic response cues, instead work with optional response cues (whether it be by built-in options in to the scenario or a cue presented by the instructor himself).
S.7 GUIDE THE INSTRUCTOR
Document the scenario for the instructor in terms of the decision requirements, typical mistakes and possible cues the instructor can use to react on these mistakes. The format presented in appendix B and E can be used.

8.2 Guiding principles for curriculum design
Besides guiding principles for scenario design, there was also a need for guiding principles on curriculum design. A scenario will most likely never be independent, but will always be part of a collection of scenarios in which different learning goals are addressed. Formulating the guiding principles for curriculum design proved to be an independent research activity; other concepts where used to formulate them. Here, I focused more on task arrangement, complexity progression and the balance between short- and long cyclic scenarios. The guiding principles for curriculum design that were formulated in this research are:

C.1 CONDITIONAL TASKS FIRST
Arrange a curriculum in such a way that the training blocks which are prerequisites for other training blocks are trained first. In the case of infantry training this would be the following order: Movement, Reconnaissance, Patrol, Defensive action, Offensive actions.

C.2 DIMENSION OF COMPLEXITY
A scenario can be made more complex by tweaking the different dimensions of complexity, presented in section 6.3 of this report.

C.3 DISCUSS COMPLEXITY WITH SME
Within the task building blocks, there should be a number of scenarios concerning the same task but having an increasing complexity level. The required complexity changes are strongly dependent on the task at hand. It is advised to discuss the options with the SME.

C.4 INCREASING DEMANDS
In every single scenario, attention should be paid to the task independent learning goals such as OTVOEM and CoVo. Gradually increase the time pressure on OTVOEM analysis and higher demands on students' CoVo performance.

C.5 SHORT CYCLIC SHORTNESS
If you want to train a specific task in a short cyclic scenario that is usually preceded by other tasks, always give the necessary information that is normally extracted from those tasks.
C.6 A GOOD START
The first scenario in a curriculum should always be a rather complex long cyclic scenario which includes all the relevant aspects of the job and is as close to a real mission as possible.

C.7 KEEPING THE CONTEXT CLEAR
In between task building blocks there should be long cyclic scenarios that integrate the preceded tasks.

8.3 Validity
The validation of the guiding principles was an important part of this research. Do the guiding principles actually do what they intend to do? Based on the main research question presented earlier, two important validation criteria could be deduced:
- Usability for an inexperienced scenario designer
- JOT consistency

A validation process was designed that covers both validation criteria. An experimental validation was held with two inexperienced scenario designers. The aim of this experimental validation was to determine the usefulness of the guiding principles to inexperienced scenario designers. They used the guiding principles for the design of a scenario and curriculum, after which I interviewed them. From the experimental validation I concluded that the guiding principles where indeed useful and were in close congruence with the job of a scenario designer. However, as the experimental subjects were not JOT experts and were therefore not able to judge whether or not the guiding principles where consistent with the JOT concept an additional validation method has been conducted. Besides the experimental validation, a face validation was held to cover this. I interviewed two experts that are very knowledgeable on Job Oriented Training and on how to implement this concept in (military) training programs. Apart from a few minor issues they had with some of the statements made in this report (which I consequently adjusted in the report), the general conclusion was that the guiding principles were consistent with the JOT concept. The scenarios and curricula that will be designed by means of the guiding principles presented in this report will therefore train students to become military commanders with the necessary competencies to successfully perform their job.

8.4 Reflection
8.4.1 Common design practice
I started this research with a lot of uncertainty about the way the research should be conducted and how I should retrieve the necessary information in order to be able to formulate the guiding principles. Being part of the serious gaming project team, for me, was essential in the success of this research. Literature on scenario and curriculum design for serious gaming was scarce and therefore being able to observe the experts in doing their job proved to be very valuable. A lot of the findings in
this report were the result of the, sometimes, endless discussions I had with members of the project team. By asking the right questions I was able to extract the information from the experts’ experiences and knowledge. As such, the guiding principles in this report can also be seen as the expression of a common design practice. While some of the findings were also very new to the project team, the guiding principles in this report reflect the way scenario design experts at TNO currently work.

8.4.2 Negative transfer

The way cueing should be used to stimulate decision making skills and creating a professional attitude is considered a very, if not the most, important finding in this report. However, as was identified in section 5.3.2 the design and implementation of cues is a delicate effort. To be able to design cues which are realistic and which provide the right conditions for the student to learn in, one needs a very good understanding of the represented environment as it exists in reality and the way cues in this environment influence decision making by students. An inherent risk of training in virtual environments is that of negative transfer. Negative transfer occurs when learning from one situation interferes with learning in another situation (Vockell, 2008). In the context of this report this essentially means that the skills acquired in the virtual environment interfere with the skills that are needed in real life. This can happen when the conditions (cues) in the virtual environment do not represent those in reality. The student assumes that the world created in the virtual environment is real and consequently uses the decision making skills acquired in the virtual environment (which were based on the wrong cues) in reality. This might result in inadequate decision making on the battlefield, which can have major consequences.

A major part of this risk is mitigated by the guiding principle which states that a subject matter expert should always be involved in the scenario design process. The subject matter expert is able to judge whether or not the virtual environment and its cues represent those existing in reality. However, the risk of negative transfer should always be considered when designing scenarios.

8.4.3 Usability in other domains

The guiding principles in this report were formulated in the context of military Job Oriented Training with serious gaming. This means that they are mainly useful in this domain. But they could also be useful in other domains as long as the learning goals are consistent with the Job Oriented Training concept; they should be focused at acquiring the competencies needed for the job that has to be performed. The guiding principles presented here are not really suitable to create scenarios and curricula which train motor skills or procedural skills. I would be very interested how these guiding principles would function in other settings, such as training in relief and crisis management organizations. This could be subject to future research.
8.5 Recommendations

The guiding principles presented in this report are based on theory and some experience in applying them during the research. This means that they have not yet been tested extensively. Considering the available resources, the validation process conducted in this research was an adequate method to quickly validate the guiding principles. However, besides the two validation criteria that were used in the validation process – usability and consistency - there may be other criteria that are important, such as completeness and preservability. These criteria were not included in the validation process due to the limited available resources as mentioned before. Therefore, the real validation will take place in the constant application of the guiding principles in scenario and curriculum design activities. Only then, one can identify all flaws and/or missing elements and is one able to make statements on other important criteria such as completeness and preservability.

I therefore want to recommend TNO Defense, Security & Safety to disseminate the guiding principles among the people they were designed for (inexperienced scenario designers) as much as possible. This especially concerns the instructors of The Netherlands Royal Army, since eventually; they will have to design the scenarios and curricula. The guiding principles presented here function as a knowledge base that will allow the instructors to rapid apply the knowledge and get to work. By doing this, the guiding principles will be applied as many times as possible, eventually making them even more robust.
GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLUEFOR</td>
<td>Blue forces</td>
</tr>
<tr>
<td>OPFOR</td>
<td>Opposing forces</td>
</tr>
<tr>
<td>UO</td>
<td>Urban Operations</td>
</tr>
<tr>
<td>IED</td>
<td>Improvised Explosive Device</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>JOT</td>
<td>Job Oriented Training</td>
</tr>
<tr>
<td>COVO</td>
<td>Command and control</td>
</tr>
<tr>
<td>OTVOEM</td>
<td>Analysis in the decision making process (Task, Terrain &amp; weather, Enemy &amp; other organizations, Remaining aspects, Own resources, Possibilities)</td>
</tr>
</tbody>
</table>

In Dutch:

<table>
<thead>
<tr>
<th>Letter</th>
<th>Dutch Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Opdracht die is ontvangen (is de opdracht begrepen?)</td>
</tr>
<tr>
<td>T</td>
<td>Terrein &amp; Weer (zie H.N.B.W.V)</td>
</tr>
<tr>
<td>V</td>
<td>Vijand &amp; Partijen (wie, wat, waar, wanneer, hoe, met welke middelen?)</td>
</tr>
<tr>
<td>O</td>
<td>Overige aspecten (tijd &amp; ruimte) en groeperingen</td>
</tr>
<tr>
<td>E</td>
<td>Eigen middelen (organieke middelen, onderbevelstellingen, steunende eenheden, toegewezen extra materieel)</td>
</tr>
<tr>
<td>M</td>
<td>Mogelijke wijzen van optreden vaststellen en de beste kiezen (wat zijn de feiten?)</td>
</tr>
</tbody>
</table>

HNBWV   = Analysis of the T(errain) part of OTVOEM. (Obstacles natural and artificial, approach possibilities, important and essential areas from a tactical point of view, Observation possibilities & fields of fire, Fire & observation cover)

In Dutch:

<table>
<thead>
<tr>
<th>Letter</th>
<th>Dutch Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Hindernissen, natuurlijke en kunstmatige</td>
</tr>
<tr>
<td>N</td>
<td>Naderingsmogelijkheden</td>
</tr>
<tr>
<td>B</td>
<td>Belangrijke en essentiele gebieden uit tactisch oogpunt</td>
</tr>
<tr>
<td>W</td>
<td>Waarnemingsmogelijkheden en schootsvelden</td>
</tr>
<tr>
<td>V</td>
<td>Vuur- en zichtdekking</td>
</tr>
</tbody>
</table>
LITERATURE


PHILLIPS, J. et al. (2001). *Decision-centered MOUT training for small unit leaders*. U.S. Army research institute for the behavioural and social sciences. Fort Benning GA.


APPENDIX A: MOTIVATION FOR THIS RESEARCH

Below an e-mail is presented which includes the motivation for this research. This e-mail was distributed among the Serious Gaming project team at TNO Defense, Security & Safety (dd. May 2008).

“Een didactiek voor SG zou in essentie moeten bestaan uit tenminste de volgende sets van prescripties:

I Prescripties over de overall procesgang: (zie verder in je JOT stuk: dus)

1. [situatieschets en] opdrachtsuitgave;
2. opdrachtsanalyse door de student;
3. experimentatie/uitvoering van de oplossing door de student;
4. groepsreflectie over de oplossingen door de studenten;
5. expertvisie, waarbij de docent feedback geeft en de discussie met de studenten aangaat.

II Prescripties over de setting
Hierin staan bijvoorbeeld voorschriften als 'er wordt geleerd in syndicaten’

III Prescripties over de rol/houding van de instructeur/expert:
(van die prescripties als 'tijdens de reflectie fysiek afstand nemen’- zie onze JOT rapporten etc.

IV Prescripties over de inrichting van de game Hierin doe je bijv. uitspraken over bijv. de vereiste aspecten van (enhanced) natuurgetrouwheid van de virtuele omgeving. Let wel, je stelt bijv. niet dat alleen dat de omgeving 'veilig', 'uitdagend' etc moet zijn, maar je geeft vooral aan wat dat concreet betekent in virtuele omgevingen.

V Prescripties over de inrichting van scenario's Dat betekent dat je bijv. uitspraken doet over wanneer kort-cyclische wanneer langcyclische scenario's. Dat betekent dat je uitspraken doet over de aard van scenario-ingredienten die je nodig hebt voor specifieke taaktypes- voor tactiek andere elementen dan voor bijv. procedureel. (NB daar zijn we nog niet ver mee).

VI Prescripties over curriculumopbouw.
En dit gaat verder dan bijvoorbeeld uitspraken als 'in complexiteit toenemend'.

Ik denk dat we I, II en III al goed genoeg begrijpen om deze goed in een didactiek onder te kunnen brengen. IV, V en VI zijn heikle punten- waar we meer van moeten gaan begrijpen. Het lijkt me zinvol om discussies over SGD langs deze lijnen te laten verlopen. Onderbouwing kun je dan ook koppelen aan concrete prescripties.”

Dr, A.H. van der Hulst (project leader SG)
APPENDIX B: COURSE “MARKET PLACE” SCENARIO

Leerdoelen: orientatie op bediening, op optreden in virtuele omgeving, op rollenspel. 
Oppikken cues uit gedrag bevolking.
Inhoudelijk: sociale patrouille, omgaan met lokale bevolking, inschatten gedrag lokale bevolking, anti IED tactics. (zuivering optioneel).

Bevel PC (korte versie)

U bevindt zich in de provincie Helmand in het oord Sangin. Sangin is een jaar geleden in handen van de Taliban gevallen en pas recent na zware gevechten wordt het oord weer beheerst door westerse troepen.
Er heerst veel wantrouwen onder de bevolking jegens de westerse troepen en men is angstig weer overrompeld te worden door Taliban. De bevolking wordt gemanipuleerd om niet mee te werken met welke westerse troepen dan ook. Talibanstrijders zijn niet makkelijk te onderscheiden en zullen proberen ons verliezen toe te brengen waar dat zij dat mogelijk achtten.

Actuele situatie: Voor de tweede week is er weer een weekmarkt op de bazar van het dorp. Deze weekmarkt heeft een belangrijke regiofunctie. Dit betekent dat er veel mensen in het oord zullen zijn.

Opdracht
U bent commandant van de Alpha groep en uw opdracht is de aanwezigheid van westerse troepen zichtbaar te maken - showing the force/flag.

Extractie richting is Oost, hier zult u ter hoogte van de watertoren opgepikt worden door een Bushmaster. Indien u contact krijgt met de vijand en het verkeerde gebied zsm contact opnemen met OPS en overgaan op de door u geleerde drills.

RoE
Tracht vuurcontact te vermijden.

Intel:
Voor zover bekend is er geen Taliban meer aanwezig in het oord.
Er zijn geruchten dat er een IED facilitator in het oord aanwezig is geweest.

[disclaimer:
1) Normaliter deze operatie in groter verband- niet als groep
2) ivm demo- veel minder tijd dan normaal voor voorbereiding en uitvoering van zo’n operatie]

Gedacht verloop scenario

- Bluefor staat bij Bushmaster. Spelers oefenen bediening, schieten.
- [PC]: over 2 minuten aanvang verplaatsing.
- GC stelt formatie vast en geeft sein vertrekken.

[regie 1] Kinderen spelen rond Bluefor, vragen om ‘chocolat’ en ‘pien’ (cue:situatie is rustig). cue voor: (Kritische beslissing: met welke mindset de markt naderen)
  o Juiste reactie: Laag dreigingsniveau mindset -> wapens omlaag, rustig lopen
  o Foute reactie: Hoog dreigingsniveau mindset -> wapens richten, agressief

[regie 2]: Burgers worden agressief (zet een paar ‘angries’ neer)
• Verplaatsing naar markt, kinderen blijven meelopen.
• Stoppen zo’n 200 meter voor markt, waarnemen.
• [PC]: Verzoek verslag uit te brengen van aantal pax op de markt en mogelijke aanwezigheid gewapende pax.

[AI] 3 man met geweren lopen over markt. Bevolking reageert hier niet op (cue geen Taliban).

cue voor: (Kritische beslissing: onderscheiden van combatants en non-combatants)
  o Juiste reactie: Melden aan PC. Deze mannen rustig benaderen
  o Foute reactie: Man met geweer = Taliban = schieten


• Onderling overleg, eventueel ruggespraak met PC.
• Verplaatsing naar markt, start sociale patrouille.

[regie 2] Niet-Engels sprekende man met geweer (lokale politie) gaat provocerend voor een van de spelers staan. cue voor: (Kritische beslissing: hoe om te gaan met provocatie gewapende non-combatants)
  o Foute reactie: Agressie

[regie 2]: Man richt geweer en schreeuwt.

• Na eerste ronde over markt: PC: ‘S2 meldt dat het lokale stamhoofd op de markt aanwezig moet zijn, dit is een wat oudere man met een witte baard, gekleed in een vaal wit gewaad. Neem contact op en vraag naar recente aanwezigheid Taliban.’
• GC zoekt stamhoofd en spreekt hem aan.

[regie 1] als stamhoofd (ga gesprek aan, wees wantrouwend, maar geef informatie af dat er recent twee man taliban is gesignaleerd).

cue voor nieuwe intel, verhoogd dreigingsrisico: (Kritische beslissing: hoe om te gaan met conflicterende info)
  o Juiste reactie: Melding aan eigen mensen dat er Taliban dreiging is, hergroeperen
  o Foute reactie: geen actie.

[regie 1]: Bij TIC (zie onder) gericht schieten en 1 man bluefor uitschakelen

• Hervatting patrouille

[regie 2] Burgers beginnen opeens weg te lopen van markt richting noordwest (cue: dreiging in zuidelijke richting) Let op: Eerste groep die wegloopt is de groep op Zuid Oost bij hoekhuis. cue voor (Kritische beslissing: herkennen van eventuele dreiging)
  o Juiste reactie: Herkennen van mogelijke dreiging uit zuidelijke richting.
    Hergroeperen, dekking zoeken
  o Foute reactie: Niet herkennen en dus geen dekking zoeken

[regie 1]: Neerschieten bij de TIC (hieronder) van een lid van de eenheid.
- Alsnog dekking zoeken en waarnemen waarvandaan de dreiging komt.

**[regie 1]** Taliban (1 man) grijpt aan uit hoekhuis (zuidoostelijke richting). **cue voor:** (Kritische beslissing: zuiveren of niet, of eerst versterking vragen)
  - **Juiste reactie:** GC neemt contact op PC. Meldt situatie en vraagt eventueel om versterking
  - **Foute reactie:** Geen contact opnemen met PC. Gelijk besluiten te zuiveren. Is immers beslissing van de PC.

**[PC]:** We horen hier schoten, kunt u terugmelden wat de situatie is?

- Indien GC vraagt om versterking: PC. Het leveren van versterking is op dit moment niet mogelijk omdat de Echo en Bravo groep op dit moment ook in vuurgevecht verwikkeld zijn.

**[regie 2]** Zorg dat er enkele burgers in het zicht rondlopen.

**[regie 1]** Taliban schiet een burger neer (duidelijk in het zicht van Bluefor). **cue voor:** dreiging voor burgers neemt toe (Kritische beslissing: zuiveren of niet)
  - **Juiste reactie:** GC neemt opnieuw contact op met PC. Meldt situatie en overlegt over situatie.
  - **Foute reactie:** Geen contact opnemen met PC. Gelijk besluiten te zuiveren. Is immers beslissing van de PC.

**[PC]:** Indien uw inschatting is dat er maar een man Taliban is dan heeft u hierbij toestemming.
  - **Juiste reactie:** Geen contact opnemen met PC. Gelijk besluiten te zuiveren. Is immers beslissing van de PC.
  - **Foute reactie:** Geen contact opnemen met PC. Gelijk besluiten te zuiveren. Is immers beslissing van de PC.

**[PC]:** Indien GC zonder overleg met PC begint aan een zuivering: PC: Vanuit overwatch zien we dat u een zuivering aan het verrichten bent. Ik vind dit niet verantwoord, verzoek zo snel mogelijk terug te trekken.

- Indien toestemming PC: Zuiveren huis.
- **PC:** extractie in oostelijke richting, een Bushmaster zal uw kant opkomen om u op te pikken.

**[regie 2/AI]** geen burgers meer in het gebied, er staan alleen nog burgers bij een vuilnisbelt en autowrakken te klooien en deze rennen weg zodra ze Bluefor in zicht krijgen. **cue voor:** (Kritische beslissing: Herkenning van eventuele dreiging (specifiek IED dreiging))

**[regie 1]** Bushmaster meldt: ‘ik heb visual op u en kom uw kant op.’
  - **Juiste reactie:** GC neemt contact op met Bushmaster en meldt niet die kant op te komen en te omtrekken.
  - **Foute reactie:** Laat Bushmaster zijn kant op komen.

**[regie 1]**: Bushmaster rijdt op IED.

**[regie 1]** Afbreken

**Uitleg lettertypegebruik**

Gebeurtenissen die het verloop van het scenario schetsen
Tekst rollenspel door PC

Leermoment met:
**Trigger cue**
**Kritische beslissing**
**Juiste/Foute reactie/Regie reactie**
### APPENDIX C: CONCEPTUAL DESIGN “CORDON & SEARCH” SCENARIO

<table>
<thead>
<tr>
<th>Decision Requirements</th>
<th>Critical Decisions</th>
<th>Typical mistakes</th>
<th>Trigger cue</th>
<th>Response cue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SECURE THE PERIMETER</strong></td>
<td>Determine how to seal off the area (Outer Cordon)</td>
<td>* Not all feeder roads secured</td>
<td>Number and location of feeder roads</td>
<td>Enemy forces resupply</td>
</tr>
<tr>
<td></td>
<td>Determine how to commence security assets (Inner Cordon)</td>
<td>* Inner cordon not placed correctly (too far or too close)</td>
<td>Concealment opportunities around object, flee paths</td>
<td>Enemy/target flees through inner cordon</td>
</tr>
<tr>
<td></td>
<td>* Inner cordon not free of non-combatants</td>
<td>Civilian casualties, Civilians hindering operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Poor timing with entry group (forming the inner cordon too early or too late)</td>
<td></td>
<td>?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine the safety of the direct environment of the object</td>
<td>* Ignore objects of interest such as surrounding buildings</td>
<td>Presence of objects of interests</td>
<td>Combatant that is out of sight engages</td>
</tr>
<tr>
<td></td>
<td>* Wrong assessment on possible threat from other buildings</td>
<td>Distance of other buildings to object</td>
<td>Reduced security/threat from these buildings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine the need for and application of support fire</td>
<td>* Blue on blue</td>
<td>Receiving fire from the object</td>
<td>Wounded or killed friendly forces</td>
</tr>
<tr>
<td></td>
<td>Determine the route to the object</td>
<td>* Dangerous/slow route chosen</td>
<td>Various elements of the environment such as intersections, tunnels, bushes, buildings but also the perceived amount of time pressure (in which case the shortest route must be chosen)</td>
<td>Reduced security/expose BLUEFOR to danger</td>
</tr>
</tbody>
</table>

92
<table>
<thead>
<tr>
<th><strong>ENTER THE OBJECT</strong></th>
<th><strong>Determine where to enter object</strong></th>
<th><strong>Determine how to enter object</strong></th>
<th><strong>SNATCH THE TARGET</strong></th>
<th><strong>Determine occupation of object</strong></th>
<th><strong>Determine how to conduct the snatch</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* Dangerous entry point chosen</td>
<td>* Red entry method when green should be used and vice versa</td>
<td>* Under/over-estimate the amount of resistance</td>
<td>* Ignore the possibility of civilian presence inside</td>
<td>* Not clearing dangerous areas/rooms in the object</td>
</tr>
<tr>
<td></td>
<td>Multiple entry points with different threat lvls (doors, windows, holes)</td>
<td>Multiple entry points with different speed lvls (doors, windows, holes)</td>
<td>Intel on object occupation, observations</td>
<td>Intel on object occupation, observations</td>
<td>Rooms lay-out</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Already encountered resistance/threat</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Expose danger from these areas/rooms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EVACUATE</td>
<td>Determine how to handle non-combatants</td>
<td>* Unguarded, uncuffed non-combatants</td>
<td>Presence of (non)hostile non-combatants</td>
<td>Non-combatants turn into combatants when unguarded. Non-combatants hindering the mission</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine the extraction point and route</td>
<td>* Evacuate in an unsafe situation</td>
<td>Location of security elements outside (inner cordon). Other (cleared) buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determine the evacuation method</td>
<td>* Not the fastest method chosen</td>
<td>Available means (transport such as chopper or vehicle)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENERAL</td>
<td>Managing personnel assets</td>
<td>* Not calling for back-up when needed</td>
<td>Amount of resistance. Unforeseen event (such as being shot at from another building or the detection of an IED)</td>
<td>Mission failure, BLUEFOR casualties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Not retreating when situation asks for it</td>
<td>Amount of resistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RoE</td>
<td>* RoE wrongly applied</td>
<td>Given RoE from commander. Presence of civilians. Behaviour of combatants (hostile acts, hostile intents)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing</td>
<td>* Timing is not right</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D: IMPLEMENTED “CORDON & SEARCH” SCENARIO

This appendix shows how the initial conceptual design framework (appendix B) is implemented in the game Virtual BattleSpace2. Special attention will be paid to the critical decisions, typical mistakes and how they were triggered by the cues implemented in the scenario.

1

<table>
<thead>
<tr>
<th>Critical Decision:</th>
<th>Determine how to seal off the area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical mistake:</td>
<td>Not all feeder roads secured</td>
</tr>
<tr>
<td>Trigger cue:</td>
<td>Number and location of feeder roads</td>
</tr>
</tbody>
</table>

In order to trigger the critical decision “determine how to seal off the area” there are a few feeder roads placed in the scenario. The blue icons in figure X represent the feeder roads (the student can not see these icons) which should be sealed off. We chose to search for an already existing terrain instead of designing a whole new terrain with roads etc. because the latter is one of the most time consuming activities there is. Fortunately, it is not very hard to find a setting in which some important feeder roads exist. They terrain chosen is actually a suburb of Baghdad, Iraq.
The group that is responsible for securing the direct environment of the target building should always clear the inner cordon of non-combatants and anyone who is not supposed to be there. In order to trigger this decision (and possibly the typical mistake) we therefore added a few children who are playing and running around the house. The security group should recognize this and send them away or hold them until the operation is finished.

The environment of the target building should always be thoroughly analyzed for possible threats or opportunities. In the scenario, nearby the target building, we placed a small market place where civilian men are walking around. We placed it there so that the students can recognize it as an object of interest; the civilians on that market can always come to the target building to hinder the operation. It is essential that this market is continuously observed for any irregularities.
Figure 18. Market place with target building not far behind.

**Critical Decision:** Determine how to enter the object

**Typical mistake:** Not using dual entry method when this is appropriate

**Trigger cue:** Building layout, fleeing possibilities
The initial house we used had a rooftop which could only be reached from inside the house. In order to give the student the option to use the dual entry method (entry from both lower and top floor simultaneously) we added a ladder to the side of the building. In fact, considering the speed the mission requires plus the possibility for the high value individual (target) to escape through the rooftop, the dual entry method is actually appropriate here.

<table>
<thead>
<tr>
<th>5</th>
<th>Critical Decision: Determine how to handle non-combatants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical mistake: Unguarded, un-cuffed non-combatants</td>
</tr>
<tr>
<td></td>
<td>Trigger cue: Presence of (non)hostile non-combatants</td>
</tr>
</tbody>
</table>

In order to trigger the student to make a decision about what they should do when they encounter non-combatants inside the building and how to handle them, we added a woman in the kitchen and two children playing inside the house (who represent the HVI’s family). The general procedure is to gather them and set them apart in a different room, whether cuffed or un-cuffed. If this is not done, and they still wander around the house, they could possibly hinder the operation.
APPENDIX E: COURSE “CORDON & SEARCH” SCENARIO

Leerdoelen: Coordinatie tussen peletons, met snelheid opereren, omgaan met non-combatants
Inhoudelijk: afgrendelen van het gebied, beveiligen van directe omgeving object, oppakken van HVI

Bevel PC (korte versie)

U bevindt zich in een buitenwijk van de stad Baghdad. Er is intel binnengekomen over een IED facilitator die zich mogelijk ophoudt in deze buitenwijk. Hij bevindt zich voornamelijk in een woning, die is geïdentificeerd als zijn woonhuis. De betreffende buitenwijk is redelijk rustig nadat de meeste Iraakse strijders zijn verdreven. Alle overgebleven mogelijke IED facilitators worden door zogenaamde cordon & search acties opgespoord en aangehouden. U gaat zo’n cordon & search operatie uitvoeren.

Actuele situatie: Het is zeer waarschijnlijk dat hij zich op dit moment schuilhoudt in zijn woning. Hij wordt continue in het oog gehouden door onze troepen, dus mocht hij zich mogelijk verplaatsen hoort u dit zo spoedig mogelijk.

Opdracht
Beveiling (inner cordon) PC:
U bent commandant van het Alpha peleton en uw opdracht binnen het uitvoeren van de cordon & search operatie is het beveiligen van het object. Het Alpha peleton bestaat uit 2 groepen van 8 manschappen en is dus verantwoordelijk voor de directe beveiliging van het object. Het Beta peleton is verantwoordelijk voor instap van het object. Goede coordinatie tussen het Alpha en Beta peleton is dus noodzakelijk.

Instap PC:
U bent commandant van het Beta peleton en uw opdracht binnen het uitvoeren van de cordon & search operatie is de instap van het object. Het Beta peleton bestaat uit 2 groepen van 8 manschappen en dient zorg te dragen voor de instap en het aanhouden van de HVI. Het Alpha peleton is verantwoordelijk voor de directe beveiliging van het object. Goede coordinatie tussen het Alpha en Beta peleton is dus noodzakelijk.

Startpositie van zowel het Alpha als het Beta peleton is ten westen van het object. U dient zich ingestegen, met behulp van de 4 bushmasters, te verplaatsen in oostelijke richting. Het Charlie peleton is verantwoordelijk voor de afgrendeling van het gebied. U zult hen op een gegeven moment passeren. Het is absoluit essentieel dat de verdachte niet ontsnapt. Snelheid en overrompeling van de HVI is erg belangrijk tijdens de hele operatie. Als de HVI eenmaal is aangehouden dient hij te worden geëvacueerd naar het extractiepunt.

RoE
Tracht vuurcontact te vermijden.

Intel:
Voor zover bekend zijn er geen Iraakse strijders meer aanwezig in het oord. De IED facilitator bevindt zich momenteel in object X.
Gedacht verloop scenario

- Bluefor staat bij Bushmaster ten westen van het object, buiten het afgrendelingsgebied.
- [CC]: over 2 minuten aanvang verplaatsing.
- Beide PC's maken hun eenheid gereed om in te stappen.
- Verplaatsing in oostelijke richting.

**[AI]** Belangrijke toegangsweg is niet afgegrendeld door Charlie peleton cue voor: (Kritische beslissing: bepalen van de veiligheid rondom het object)
  - **Juiste reactie:** Melden aan CC dat er een gat in de afgrendeling is
  - **Foute reactie:** Niet opmerken van het gat in de afgrendeling

**[regie 2]** Tijdens verloop scenario vijandelijk voertuig het gebied binnen laten rijden via de niet afgegrendelde toegangsweg.

- Bluefor doorkruist het afgrendelingsgebied en daarmee het Charlie peleton.
- Met enige vaart richting het huis. Stoppen vlakbij het huis, uitsappen.
- PC Beveiligingspeleton neemt posities in.
- [CC]: Verzoek verslag uit te brengen van de situatie in en rondom het object.

**[AI]** Markt in de buurt van object waar mensen lopen. cue voor: (Kritische beslissing: bepalen van de veiligheid rondom het object)
  - **Juiste reactie:** Markt wordt continue onder waarneming gehouden door beveiligings peleton
  - **Foute reactie:** Markt wordt genegeerd

**[regie 2]** Vanuit markt burgers richting het object laten lopen, agressief laten gedragen.

**[regie 1]** Kinderen rennen en spelen rondom het huis. cue voor: (Kritische beslissing: bepalen hoe de beveilig rondom het object in te zetten)
  - **Juiste reactie:** Kinderen aanspreken en indien mogelijk wegiagen/apart zetten
  - **Foute reactie:** Kinderen rond laten blijven rennen

**[regie 2]** Kinderen heel irritant tussen de eenheid laten lopen, proberen de operatie te hinderen.

- Onderling overleg tussen PC's, eventueel ruggespraak met CC.
- Instap peleton doorkruist het beveiligingspeleton. (Opmerking: dit moet gecoördineerd worden, bijvoorbeeld door ruimte open te laten in de beveiliging waar de instap ploeg door naar binnen kan. Indien dit niet gebeurd terug laten komen in de reflectie)

**[AI]** Trap aan de zijkant van gebouw cue voor: (Kritische beslissing: hoe het object binnen te gaan)
  - **Juiste reactie:** Identificeren van de trap plus dak als zijnde een mogelijke vluchtroute voor HVI. Dual entry methode gebruiken.
  - **Foute reactie:** Negeren van de trap.

**[regie 1]** Tijdens het binnendringen van het huis door de instap ploeg, proberen de HVI te laten ontsnappen via het dak
(Deel van) het instap peleton gaat via tuin en voordeur naar binnen.

<table>
<thead>
<tr>
<th>[AI]</th>
<th>Vrouw en kinderen staan in het huis, cue voor (Kritische beslissing: hoe om te gaan met non-combatants)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Juiste reactie:</strong> Enkele leden van de eenheid verantwoordelijk maken voor het bij elkaar zetten van de gezinsleden in een aparte ruimte.</td>
</tr>
<tr>
<td></td>
<td><strong>Foute reactie:</strong> Vrouw en kinderen alleen laten in het huis.</td>
</tr>
</tbody>
</table>

[regie 1]: Vrouw en kinderen raken in paniek en rennen naar hun vader (de HVI) en hinderen de missie

Instap peleton doorzoekt het huis, vindt in een kamer de HVI. Als dit te lang duurt is het verassingelement weg en heeft de HVI tijd om eventueel te ontsnappen.

<table>
<thead>
<tr>
<th>[AI]</th>
<th>Aanwezigheid van Bushmaster, cue voor: (Kritische beslissing: bepalen van de extractiemethode)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Juiste reactie:</strong> Snelheid van evacuatie is essentieel (HVI mag maar bepaalde tijd vastgehouden worden), snelste methode (mits veilig) geniet daarom de voorkeur. Bushmaster moet dus dichtbij het object gezet worden en de HVI moet er snel ingezet worden.</td>
</tr>
<tr>
<td></td>
<td><strong>Foute reactie:</strong> Langzame extractiemethode, bijvoorbeeld door eerst een stuk te lopen met HVI.</td>
</tr>
</tbody>
</table>

[regie 1]: Stap als HVI zijnde in de Bushmaster

[CC]: Waar blijft de HVI?

[regie 1] Afbreken

**Uitleg lettertypegebruik**

Gebeurtenissen die het verloop van het scenario schetsen

**Tekst rollenspel door PC**

Leermoment met:

Trigger cue

Kritische beslissing

Juiste/Foute reactie/Regie reactie
APPENDIX F: CUES AND THEIR MEANING

The Content of this appendix is classified in the public version of this report.
APPENDIX G: QUESTIONNAIRE EXPERIMENTAL SUBJECTS

<table>
<thead>
<tr>
<th>Questionnaire experimental validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the guiding principles you have been given useful?</td>
</tr>
<tr>
<td>Yes most of the guiding principles were very useful.</td>
</tr>
<tr>
<td>N. Some guiding principles where not really relevant for this small exercise. For example the principles on CoVo, OTVOEM and the complexity variation within building blocks. This is mainly a time issue. These principles would have required a more detailed design. We were stuck on a somewhat higher level and did not dive into complexity variation. It was however very nice to have an overview of the possible tweaks you have available to change a scenario’s complexity level.</td>
</tr>
<tr>
<td>K. Yes they were very useful. Some of the design trade-offs and guiding principles were already somewhere in my mind. However, I was unaware of this and it was very valuable to have them made explicit on paper. Some guidelines where very new to me, such as the training block concept and the focus on cueing, especially response cueing. Since I will be designing scenarios and a curriculum for my own project in the beginning of 2009, I will certainly use the concepts presented in your guidelines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which adjustments have you made to the curriculum after reading the guiding principles?</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. In my first curriculum, I more or less already identified unique sub-tasks which could serve as a basis for other more integrated tasks. So in that sense I did not radically change anything. What I did do was tighten up the sub-tasks. Also, in the first curriculum I implemented the sub tasks as simple ‘exercises’. After reading the guiding principles I noticed that more elaborated, so called short-cyclic scenarios could be designed for those tasks. After a number of short-cyclic scenarios, dealing with the sub-tasks, I added a long cyclic scenario which integrated them.</td>
</tr>
<tr>
<td>K. I tried to identify blocks of sub-tasks which could function as building blocks for other tasks. Sometimes it was quite difficult to distinguish different sub-tasks in an integrated task. Especially on platoon level (the level we designed on) it can be hard to pull apart certain tasks because they are intertwined more then on group level. I also made the first scenario a long cyclic scenario. It was already a longer scenario, but I made it more comprehensive and complete to set a certain tone for the remaining scenarios.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Where these curriculum adjustments actually improvements? And why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>N./K. Yes, I think the adjustments were improvements. By implementing long cyclic scenarios after the short-cyclic scenarios dealing with the sub-tasks, the students get the opportunity to redo the things they've done wrong in the short-cyclic scenarios. The initial long cyclic scenario is indeed very important for the mindset of students.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Which adjustments have you made to scenario after reading the guiding principles?</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. I found it quite hard to specify cueing. This could be due to the fact that I have seen some scenarios already and I followed the principles used there. I did therefore not make a lot of changes.</td>
</tr>
<tr>
<td>K. I actually started the scenario design from the core by using the conceptual design table presented in the guiding principles. I took the learning goals and translated them to critical decisions, each having a typical mistake etc. etc. Especially the response cues were interesting. In the first version of my scenario no attention was paid to responses on possible mistakes. In the second scenario I tried to make up some realistic responses a soldier could be confronted with if they would make a mistake.</td>
</tr>
</tbody>
</table>
Where these scenario adjustments actually improvements? And why?
N./K. Although I was not able to finish the conceptual design, your proposed method of designing scenarios seems very helpful and certainly gives structure to the design process. It is a good way to come from learning goals to the implementation of a scenario. I will certainly use the guiding principles when I will design scenarios myself.

Do you miss any guiding principles, if so which ones?
N. No I don't miss any guiding principles.
K. No I don't miss any guiding principles. Maybe one point of interest is the translation of the conceptual design to the implemented design. This was not entirely clear to me. How to implement the cues you have designed.
APPENDIX H: QUESTIONNAIRE SME

<table>
<thead>
<tr>
<th>Questionnaire SME’s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VRAGEN OVER DE SCENARIO RICHTLIJNEN</strong></td>
</tr>
<tr>
<td><strong>Is the design framework, as presented in figure 8, a good method to translate the initial learning goals into the implementation of a JOT scenario?</strong></td>
</tr>
<tr>
<td>D. In principle it is. A marginal comment is that you can not always speak of typical mistakes. Especially on a higher level of operation (platoon and higher) it is not as black/white as in right/wrong behaviour. On that level it is more about the identification of risks and opportunities. The argumentation that is used by the commander is very important. If a certain strategy or tactic does not work out well in a situation it does not necessarily mean that the strategy/tactic was not good. As long as the argumentation was good. This is a grey area. On squad level your statements are totally true.</td>
</tr>
<tr>
<td>R. Learning goals are too small to start the design of a scenario with. Training soldiers with JOT is also about concept development. The situation assessment preceding the decision is more important than the behaviour that is shown by the student. Good behaviour does not necessarily mean that the assessment was good and vice versa.</td>
</tr>
<tr>
<td><strong>Would you, as an SME, use the same method? To which extent are the concepts used familiar?</strong></td>
</tr>
<tr>
<td>D. In the training programs I facilitate, feedback on behaviour is also very important. The response cues, as you call them, will always return in scenarios.</td>
</tr>
<tr>
<td>R. I would focus more on concept development and situation assessments and less on behaviour.</td>
</tr>
<tr>
<td><strong>Determine for each guiding principle if you would apply it in the design of a JOT scenario and to what extent you agree with the guiding principle.</strong></td>
</tr>
<tr>
<td>The conceptual design should be done in close cooperation with a SME.</td>
</tr>
<tr>
<td>R. Very true and very important. An SME can intercept on any unrealistic cues and or learning goals.</td>
</tr>
<tr>
<td>Trigger cues will be either threat related or effectiveness related. It depends on the learning goals which category of cues is relevant for the particular scenario (incl the table with threat cues).</td>
</tr>
<tr>
<td>The 3-way iterative design model, presented in figure 9, including the view on the three perspectives.</td>
</tr>
<tr>
<td>R. (with regard to realism of the scenario) Augmented cueing can sometimes be valuable for concept development. Make the invisible visible! It is one of the strengths of virtual environments.</td>
</tr>
</tbody>
</table>
Avoid the use of automatic response cues, instead work with optional response cues in order to increase the flexibility of the scenario.

D. I triggered on this guiding principle because what do you and do you not automate in a scenario? Automation is layered. All things inherent to the course of the scenario, such as movements of AI, should be automated. The instructor should not be bothered by these aspects. However, feedback on mistakes is sometimes you do not want to automate. I think this is what you mean, but you should formulate it a little better.

Document the scenario for the instructor in terms of the decision requirements, typical mistakes and possible cues the instructor can use to react on these mistakes.

D./R. No comments. True

Are the guiding principles for scenario design useful for inexperienced scenario designers to design a JOT scenario? If not, which principles are not useful and/or require adaptations?

D. The guiding principles seem certainly useful for inexperienced scenario designers. It is however hard for me, as a SME, to judge to what extent. My view is:
In order to 'train' inexperienced scenario designer to expert scenario designers, the JOT concept can also be used. When an inexperienced scenario designer reads these guiding principles, he may not be triggered by them very much. But when he actually does his job he will encounter the same concepts used in the guiding principles and will therefore think “hey, the guiding principles are very valuable for my work”.
The guiding principles you have formulated give solid handles for inexperienced designer to work from.

**VRAGEN OVER DE CURRICULUM RICHTLIJNEN**

Is the model for a JOT curriculum, as presented in figure 15, a good one? If not, what would you do differently in the design of a JOT curriculum?

D./R. Agreed. No particular comments.

Determine for each guiding principle if you would apply it in the design of a JOT curriculum and to what extent you agree with the guiding principle.

<table>
<thead>
<tr>
<th>Guiding Principle</th>
<th>Applying in JOT curriculum</th>
<th>Degree of Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite tasks should be placed before the subsequent tasks in the curriculum.</td>
<td>D. Yes. Conditional tasks should be trained before their dependent tasks. However, sometimes there are no prerequisite tasks. If this is the case, the natural sequence of work should be followed (logic of the job).</td>
<td>D./R. Agree. No particular comments.</td>
</tr>
<tr>
<td>Within the task building blocks, there should be a number of scenarios training the same task but with an increasing complexity level.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


In every single scenario, attention should be paid to the task independent learning goals such as OTVOEM and CoVo. Gradually increase the time pressure on OTVOEM analysis and place higher demands on students’ CoVo performance.

D./R. The independent learning goals such as OTVOEM and CoVo will return in every scenario. By using them in every scenario students will automatically gain the corresponding skills. Your principle of gradually increasing the demands on these skills is a good way to build up the curriculum.

The various complexity dimensions

D. Very useful! A subtle comment: two dimensions seem to target similar concepts: information complexity and subtlety of cues. Cues also give information and 'more subtle cues' can be seen as the same as incomplete information.
R. Useful.

If you want to train a specific task in a short cyclic scenario that is usually preceded by other tasks, always give the necessary information that is normally extracted from those tasks.

D./R. Of course the short cyclic scenarios should include the information necessary to perform the task.

The first scenario in the curriculum should always be a rather complex long cyclic scenario in order to give the students the right mindset for the rest of the curriculum.

D. Indeed very important. Additional goals of the long cyclic scenario in the beginning are:
- making the student feel incompetent
- familiarize students with the various aspects of the job
- remove playfulness (this is what you mentioned)
R. The first scenario should give an overview of all the relevant aspects of the job.

Are the guiding principles for curriculum design useful for inexperienced scenario designers to design a JOT scenario? If not, which principles are not useful and/or require adaptations?

The same answer as for the scenario guiding principles

D. The guiding principles seem certainly useful for inexperienced scenario designers. It is however hard for me, as a SME, to judge to what extent. My view is:
In order to 'train' inexperienced scenario designer to expert scenario designers, the JOT concept can also be used. When an inexperienced scenario designer reads these guiding principles, he may not be triggered by them very much. But when he actually does his job he will encounter the same concepts used in the guiding principles and will therefore think "hey, the guiding principles are very valuable for my work"
The guiding principles you have formulated give solid handles for inexperienced designer to work from.
APPENDIX I: THE GUIDING PRINCIPLES

This appendix gives an overview of the guiding principles that were identified in this report, including the structure of the guiding principles.

GUIDING PRINCIPLES FOR SCENARIO DESIGN

S.1 DOMAIN EXPERT IS VITAL
The design of a scenario should always be done in close cooperation with a subject matter expert.

S.2 CONCEPTUAL DESIGN
Based upon the learning goals, formulate the high level decisions and their corresponding critical decisions, the typical mistakes a student is likely to make, the trigger cues that provoke the critical decisions and the response cues that give feedback on the performance. This is the conceptual design of the scenario, which can look like the table presented in Appendix C.

S.3 THREAT AND EFFECTIVENESS
Trigger cues will be either threat related or effectiveness related; it depends on the learning goals in which category the cues belong. To implement trigger cues that are threat related, the list in Appendix F can be used. To implement trigger cues that are effectiveness related, the mission should be thoroughly analyzed together with a SME, to identify the effectiveness related cues corresponding to the mission.

S.4 NOT A ONE MAN EFFORT
A scenario should reflect three perspectives: an educational, a technical and a domain perspective. The elements in the final scenario should consequently be 1) of educational value, 2) technically feasible and 3) realistic.

S.5 AGILE DEVELOPMENT
The Agile Scenario Development model was drawn up to facilitate the design process, involving the three perspectives, in which a conceptual design is continuously refined into an implemented, final version.
S.6 FLEXIBLE FEEDBACK
Avoid the use of automatic response cues, instead work with optional response cues (whether it be by built-in options in to the scenario or a cue presented by the instructor himself).

S.7 GUIDE THE INSTRUCTOR
Document the scenario for the instructor in terms of the decision requirements, typical mistakes and possible cues the instructor can use to react on these mistakes. The format presented in appendix B and E can be used.

![Diagram of Guiding principles for scenario design](image)

*Figure 21. Guiding principles for scenario design*

In the problem description in chapter two of this report, I elaborated on scenario design. Two aspects of scenario design were identified for which guiding principles were needed:

1. **Translation of learning goals into a scenario**
   The translation of learning goals into a scenario is the essence of scenario design; you start with a number of learning goals you want the students to reach during the execution of a scenario. The learning goals then have to be translated into scenario elements. Guiding principle “S.2 Conceptual Design” is the main guiding principle that covers this translation.
Guiding principles “S.3 Threat And Effectiveness” and “S.6 Flexible Feedback” are supportive principles but not less important than guiding principle “S.2 Conceptual Design”.

2. Design process

Besides the content related guiding principles mentioned before, there was also need for process related principles that would support the scenario design process. Guiding principles “S.1 Domain Expert Is Vital”, “S.4 Not A One Man Effort”, “S.5 Agile Development” and “S.7 Guide The Instructor” all provide guidelines on the design process. In particular they elaborate on the role of the domain expert and instructor and on the design process itself.

GUIDING PRINCIPLES FOR CURRICULUM DESIGN

C.1 CONDITIONAL TASKS FIRST

Arrange a curriculum in such a way that the training blocks which are prerequisites for other training blocks are trained first. In the case of infantry training this would be the following order: Movement, Reconnaissance, Patrol, Defensive action, Offensive actions.

C.2 DIMENSION OF COMPLEXITY

A scenario can be made more complex by tweaking the different dimensions of complexity, presented in section 6.3 of this report.

C.3 DISCUSS COMPLEXITY WITH SME

Within the task building blocks, there should be a number of scenarios concerning the same task but having an increasing complexity level. The required complexity changes are strongly dependent on the task at hand. It is advised to discuss the options with the SME.

C.4 INCREASING DEMANDS

In every single scenario, attention should be paid to the task independent learning goals such as OTVOEM and CoVo. Gradually increase the time pressure on OTVOEM analysis and higher demands on students' CoVo performance.

C.5 SHORT CYCLIC SHORTNESS

If you want to train a specific task in a short cyclic scenario that is usually preceded by other tasks, always give the necessary information that is normally extracted from those tasks.
C.6 A GOOD START
The first scenario in a curriculum should always be a rather complex long cyclic scenario which includes all the relevant aspects of the job and is as close to a real mission as possible.

C.7 KEEPING THE CONTEXT CLEAR
In between task building blocks there should be long cyclic scenarios that integrate the preceded tasks.

![Diagram of guiding principles for curriculum design]

In the problem description in chapter two of this report, I elaborated on the guiding principles for curriculum design. Three aspects of curriculum design were identified for which guiding principles were needed:

1. Task arrangement

Various tasks are involved in the job of a commander. It is not possible to train all these tasks in one scenario, but in a curriculum this should be possible. The curriculum should be designed in such a way that all tasks are included in the curriculum. However, it was unclear how the various tasks should be arranged in a curriculum. Guiding principle “C.1 Conditional
tasks first” provides guidelines on how to arrange the various tasks in a curriculum, while guiding principle “C.4 Increasing Demands” provides information on how to deal with the task-independent learning goals.

2. Complexity progression

Besides the task arrangement, complexity progression within a curriculum was an aspect for which no information was yet available and was therefore in need for guiding principles. The scenarios in a curriculum should vary in complexity level, but how can this be achieved and what options does one have to increase a scenario’s complexity? Guiding principle “C.2 Dimensions Of Complexity” provides guidelines on the various dimensions that can be used to make a scenario more or less complex. Guiding principles “C.3 Discuss Complexity With SME” subsequently gives guidelines on how to apply the dimensions on the scenarios in a curriculum.

3. Balance between short and long cyclic scenarios

The third and last aspect of curriculum design was the balance between short and long cyclic scenarios. Guiding principles “C.6 A Good Start” and “C.7 Keeping The Context Clear” give guidelines on how to deal with long cyclic scenarios, i.e. how to commence them in a curriculum. Guiding principle “C.5 Short Cycle Shortness” subsequently provides guidelines on what to do when you commence short cyclic scenarios in a curriculum.