THE POTENTIAL OF SERIOUS GAMES FOR TRAINING OF URBAN OPERATIONS

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ABSTRACT

With the push of civilian commercial technology development and the emergence of a vast military gaming community, military gaming technology undergoes an extremely rapid evolution. At present US Marines and Army, GBR, NLD, Canadian and Australian Armies have adopted Serious Games (SG) as essential training platforms for small infantry units and combined arms training. This Dutch study reports on extensive field testing combined with a broad literature analysis to reveal what presently does and does not work in training with military gaming technology for urban warfare. Besides kinetic operations, we explored the lower spectrum of force, considering tasks such as reconnaissance, social patrol, road blocking, knock, talk and search.
This paper will discuss the main conclusions and recommendations of the Dutch study regarding the potential of SG for urban operation training.

1.0 INTRODUCTION

Focus of deployment of military force has shifted rapidly towards urban, usually highly populated areas, with mainly an irregular opponent. Since then, Urban Warfare training sites have been created, and additionally simulations and games are being developed for aspects that can hardly be trained live, e.g. operations amongst vast numbers of civilians or the use of (close) air support or e.g. artillery.
'Urban terrain is among the most complex of military environments and urban combat skills remain the most difficult to train' [1,2]. Since the terrain and its inhabitants are such important factors in urban operations, simulating urban environments is an important part of creating a valuable training experience. However, the representation of the synthetic natural (and man-made) environment has been an on-going challenge for military modelling and simulation.
Compared to the open terrains of the 'green battle', urban fight requires dense environments with a variety of buildings and other physical structures. Those buildings must represent the building and cultural styles of all those different operation areas. Specifically, in designing a virtual environment (VE) for UO, a number of environmental cues essential for these teams must be considered to ensure that the resulting scenario allows the practice of critical skills. To define the requirements specific to training for Urban Operations we'll start with outlining the specifics of such operations.

2.0 URBAN OPERATIONS

Urban Operations (UO) are defined as all operations on, or against objectives within an urban area, a terrain where man-made structures and the presence of non-combatants are the dominant features. Although UO are not considered a specific type of operation, they do require an entirely different set of Tactics Techniques and Procedures, because of the inherent challenges of this environment. The following factors define the complexity of planning and execution of military activities in UO [3].

1) The *population* is by far the most complex aspect of UO. Locals may support or oppose the military units and as current missions are more and more aimed towards stability, the success of the mission depends on winning the hearts and minds of the locals. This requires an understanding of their culture and makes UO more than battle-only.
2) The *physical characteristics* of the environment: it limits situation awareness and movement, making virtually every room a potential threat and requiring thinking in 3D.
3) The *urban systems* present require knowledge of such things as construction and material, as these influence vulnerability and weapon effects among others. Additionally, these systems support the functioning of an urban area – it is essential to keep vital systems operational for the own troops and the local population (in the context of winning hearts and minds), while denying it to the opposing force.
4) The *urban threat* is often an irregular threat, making it hard to recognize friend from foe. This complicates the operation, as a mistake may either endanger the own troops or making civilian casualties.

The urban component brings about a limited situation awareness of the higher level units who are not on site. The troops also have restricted visibility and canalized movement on site. As a result, UO are considered the domain of the small combined arms units, the domain of the *junior leaders*, creating much responsibility with the squad and platoon leaders, which consequently are the main focus of this paper. They need to be able to perform all kinds of tasks in various levels of force and be able to switch between them (the Three Block War principle).

3.0 SERIOUS GAMING FOR URBAN OPERATIONS

SG hold promises as a means for education and training for UO, as the 3D virtual environments facilitate the use of a great variety of different urban structures and objects. In addition, when sufficiently realistic civilian behaviour can be modelled, it should be possible to train amongst (large numbers of) civilians, perform operations in the lower spectrum of force, and train for the *three block war*. Similarly, when destructive effects are modelled realistically it will be possible to actually train breaching tactics and how to cope with disintegrated structures. As such, SGs may support training that is hard or even impossible to do as a live exercise.
However, it is important to keep in mind that there are limits with respect to the positive effects of games. Not all ‘serious gaming’ will have a positive transfer to the operational situation.

4.0 Study Approach

The study reported on here sets out to answer the question to which extent Urban Operations can be trained using currently available commercial off-the-shelf military games. This should also uncover which improvements of games are needed to increase applicability.
To gain a clearer understanding of the requirements for training UO, we developed some 20 scenarios for group and platoon and field tested about 15 of these scenario’s with trainees from dismounted and mechanized infantry and combined arms units. Typical tasks on these levels are breaking in, clearing and releasing an object; reacting to a missing person in an object; do an object reconnaissance; performing a

knock, talk & search; and performing a social patrol. Within these tasks we aimed for training NCOs and officers on tactics (both planning and in situ) and C2, as previous experiences and evidence suggests this can be trained effectively in serious games [4, 5, 6]. Within the scenario's, we varied several settings such as time of day (day versus night), visibility and the density of population. We also tested destructive measures, tested different types of weapons and ammunitions and IEDs as well as various air-borne and
During the course of this project, we also developed scenarios and ran comparable tests for Counter-Improvised Explosive Devices [7] and for Public Order Management (POM) [8]. Finally, we studied current commercial and scientific developments within the military serious gaming community.
To scope this study, the analyses were done using Virtual Battlespace 2 (VBS2), as this is the predominant platform for infantry training amongst western coalition forces. Also, as previous experiences [4], supported by many international studies (e.g. [9]) showed that effective application of serious games is presently limited to the cognitive domain. Therefore, we limited our analysis to the use of games for tactics and command & control.

4.1 Field testing

A first two series of 2 day tests (in Weert and Oostdorp) were mainly technical- and feasibility tests to see whether the scenarios functioned technically and worked as intended. The second series of tests were more 'effect' oriented, these series aimed at finding out whether the scenarios were adequate to achieve the learning objectives. We started out with two squad test sessions of two days each; first a session with 3 squads from an air assault squad from Assen and second a session with 4 squads from a (remedial) platoon in Amersfoort. Subsequently, we ran a 3-day session with an operational mechanized infantry platoon from Havelte.

Figure 1: Dutch military operate in a UO scenario in a SG

Additionally, 3 one day test sessions in intermediate search (addressing C-IED) were conducted in Reek and Oirschot and in 4 one day test sessions in Apeldoorn and Soesterberg with Public Order Management
While running the tests, we consistently applied the didactic approach 'Job Oriented Training'[10,4], in this discovery learning approach, the students are provided with the experiences to help them construct tactical knowledge and C2 skills themselves rather than going through formal instruction.

5.0 FINDINGS

5.1 Analysis and planning

One of the outstanding aspects of Serious Gaming is the use of virtual environments for analysis and planning. Several test sessions in Amersfoort (planning of infantry operations), Reek and Oirschot (planning of intermediate search (C-IED)) and in Apeldoorn (planning of Public Order Management) revealed the value of the detailed 3D visualisations of terrains during analysis and planning [7,8].
The 3D visualisation of the terrain provides means for (detailed) terrain analysis and allows for (virtual) reconnaissance. In addition, the Real-Time Editor (RTE) enables to experiment in advance with elements of planning. Both students and instructors voiced seeing evident advantages over a traditional TOOK (Tactical exercise on a map). Therefore, we see significant added value for analysis and planning.

5.2 Execution

5.2.1 Skills and drills

Desktop PC games are not the right means to train skills and drills at the individual level. For such individual skills and drills, live training is definitely superior. Psychomotor tasks, that is, mainly the skills and drills at the individual level, cannot be trained effectively in serious games on a desktop PC with only a keyboard and mouse as input devices. As argued, such input devices limit the execution of psychomotor skills largely, as these require unnatural actions to e.g. open a door or breach a window. In addition, VBS2 in itself limits psychomotor actions. Some skills and drills just cannot be performed virtually. E.g. most of the 2 and 4 man drills require individuals to stand closely together and e.g. tapping the shoulder of a neighbour to indicate that one is ready to continue the task, which is just not possible due to collision avoidance, preventing persons to get so close and to touch one another. Breaching tasks are also limited, as it is functionally impossible to breach a door with a hooligan tool or using other mechanical techniques.
One may expect substantial improvement of input devices within a period of 3-5 years and this will make skills and drills somewhat more realistic- but interaction will remain limited. Besides, live environments are perfectly well equipped to allow the training of individuals skills and drills, one may practice (non-destructively) those skills and drills in any building available, hence training means are abundant.
As indicated above, due to limitations with regard to skills and drills, we advise the use of VBS for tactics and C2 only for students that are sufficiently familiar with the basic individual and 2- and 4 man skills and drills.

5.2.2 Command and Control

Before going into detail with respect to the separate task types, special attention should be given to command and control (C2). The experiences with training C2 are positive. While performing the tactical exercises mentioned above, instructors role-played higher command and other units, while the students communicated within their unit. This created a rather realistic and sometimes very hectic communication. Within the reflections, we noticed that issues in command and control were discussed quite frequently and generally, we saw an evident improvement of the quality of C2 over the course of scenarios [5].

5.2.3 Tactics and C2 – Task-Types:

- Patrol in urban environments. The tactical aspects of (combat and satellite) patrol in urban environments can be trained in SG, certainly operations in extended areas such as satellite patrol at platoon level. The virtual environments offer a larger variety in urbanisations and terrain (elevation, infrastructure) and allow operations in a populated environment.
  At squad level, due to limits of psycho-motor skill performance and limitations in (social) interaction with local population, training value of patrol is presently limited. At platoon level, however, the

training value becomes evident. In tests of the satellite patrol, we experienced the added training value of use of SG. Operating in an extensive urbanised area makes such an operation rather challenging, both with regard to tactics and to command and control. In addition, the 2D and 3D overview gives the instructors an exceptionally good insight in the progression of the squads and it enables close control of the events in the scenario.
When it comes to fire-contact, SG provides a live firing environment to a certain extent, where people get injured and killed and units will have to deal with lesser numbers of troops and have to handle the injured and the dead. Whether the training of TiCs is equally adequate as training in instrumented environments (such as MCTC) can be doubted, again due to limitations in performance of skills and drills.
In conclusion, for patrol, live exercises have an evident advantage due to the natural way people can walk, kneel, lie down, gesture and handle their weapons. Other than that, patrol tasks in SG appear to have additional value over the live ones that can be done in the exercise villages presently available: the virtual environments offer more variety in urbanisations and terrain (e.g. elevation, infrastructure) and more frequently allow operations in a (densely) populated environment. In addition, an SG allows better control over scenario settings such as time of day, visibility and weather parameters and allows better monitoring and control by exercise staff.

- Object assault. With object assault we refer to the break-in to an object and clearing that object. For basic object-assault training at squad level, the conclusions of our research are not clear cut. For basic object assault exercises at the individual and squad level, live training shall generally lead to better results than gaming as such operation rely heavily on a proper execution of skills and drills. In SGs these skills and drills are performed in a rather artificial way due to limitations of the MMI. In contrast, in more complex exercises where smoke and fire support is used, and overview and a high level of control of enemy actions is demanded, gaming may be a valuable addition to live exercises.
  For platoon level and higher SG has advantages, as part of the operation that has little training value can easily be simulated, see small unit exercises in context. Also for advanced training on non standard buildings SG will have additional value. Games offer a greater and growing variety in types of buildings, although the more complex buildings need more realistic modelling. In all cases, if live training facilities are rare, it may be a valid option to practise the tactics and C2 of assault before training at the UO facilities.

- Defence. SG allows relatively good practice opportunities for defence. In UO, the defence/offence rate is at least 1/10, which means that huge numbers of opponents are needed to make a defence exercise realistic. In this situation, SG allows good opportunities to act with partly played and partly simulated opponents. The behaviour of simulated opponents during an assault is not very realistic, but acceptable when partially coordinated by scenario management. Also, relatively realistic smoke and fire support can be provided.

- Knock, Talk and Search The knock, talk, entry and securing the search team could well be performed. Interaction with a search team, however, is at present artificial. The search task itself cannot be performed adequately due to lack of simulation of search equipment.

5.3 Other Fields of Application

Still limited to tactics and command and control.

- Combined Arms Operations
  Integrated training of manoeuvre units with combat support and combat service support units is

not yet possible. Games currently lack tools for search, engineering, maintenance, recovery, medical support and logistics, as well as the interaction of these tools upon the environment.
On the other hand, the effects of most capabilities can be simulated in VBS2. When the cooperation becomes more tight, however, the capabilities will be more visible to the infantry foot soldiers and the requirements become hard to meet.

- Lower spectrum of force: operations amongst civilians
  In lower spectrum of force tactical exercises, verbal and non-verbal interaction is needed to gain information e.g. about local threats, IED networks and to gain insight in the adversities amongst non-combatants. Verbal interaction is also needed to be able to influence and interact with the population, e.g. in Information Operations. Two social features are at least essential to allow meaningful operations amongst population: behavioural cueing by the population and possibilities to interact with the local population. The latter is presently possible only by means of role play. Behavioural cueing can be improved substantially, this, however, demands substantial investment. Hence, present feasibility for lower spectrum of force is limited, but one may expect substantial improvement within a 3-5 years period of time.

- Mission preparation
  Serious games may be used for mission preparation, allowing military to virtually prepare for a planned operation. When a terrain database of the operation theatre is available and the virtual environment sufficiently reflects the real-life situation, this may allow the military to pre-test their plans and undergo the problems that may occur during the operation in an interactive way. Using serious gaming in this manner requires a high level of fidelity on all aspects of the environment, since the users may base their applied tactics on the feedback they get from execution in the virtual world. Any deviation of the game from reality can have serious consequences.

6.0 POTENTIAL

Before discussing limitations: In general, we see a number of a very positive aspect for tactics and C2 training in SG:

- The variety of terrains and buildings available. The OU live training facilities are usually quite limited with respect to terrain variety and types of buildings. Games such as VBS2 provide an extensive collection of different terrains and buildings and the collection is growing. We have made extensive use of the variety offered to provide learners with different terrain related tactical cueing.
- Possibility to have large numbers of civilians available. Simulated civilians can be used to populate an urbanisation. Yet, it should be noted that a lot of work needs to be done to make the behaviour of simulated civilians and opponents sufficiently realistic.
- Operations in context. Attaining more efficiency and providing more context by embedding squad and platoon level exercises in higher level operations by simulating part of the own troops.
- Manipulability of circumstances. Within gaming scenarios, circumstances in terms of lighting conditions, weather, as well as effects such as fire and gasses can be controlled at will.
- Better monitoring and control of scenarios. All movements and actions can be monitored and controlled from the scenario management facilities (2D and 3D real-time editor). As a result, instructors have more insight in and control over the course of scenarios.
- Better after action review facilities. AAR facilities can be used to go back to critical actions and review these.

7.0 Limitations

We'll end with three limitations that hold for all tactics training:

- The realism of features of vehicles, weapons and ammunition is still limited. In general, many

objects and most behaviour is modelled with a sufficient level of realism. Still, the full report lists several aspects of models and behaviour that have been simulated insufficiently [11].

- A limitation for all tactical training is the lack of proper vulnerability/damage modelling. With regard to vulnerability modelling, the options for cover do not sufficiently reflect reality. The vulnerability of a wooden fence is the same as that of a one meter thick stone wall. In addition, ammunition type does not affect the nature of damage caused, and there is no simulation of differences in the structural integrity of buildings (e.g. resulting in effects such as collapse of weak buildings when landing a helicopter on a roof, collapse of building due to demolition). There is no realistic modelling of the amount of debris. In the same regard, the simulation does not yet allow realistic degradation of vegetation. The above mentioned limitations currently still reduces the effects of tactical training as students are not forced to take into regard the effects of differences in cover, structural integrity and weapon and ammunition type used.
- The artificial intelligence (AI) of simulated persons in games such as VSB2 is limited and not designed for use in urban environments. Available features are path finding, collision avoidance, detection of opposing forces by visual or audible means and automated reactions (shooting in case of military, fleeing in case of civilians). However, inadequacies in the behaviour of simulated persons limit the usability of these features in an urban environment, e.g. path finding generally does not work well within buildings, on balconies and on roofs. Additionally, some basic natural behaviour is missing; for example, simulated persons do not step aside when in the way of a nearing vehicle, do not react when spoken to, do not flee when under visible threat.

8.0 CONCLUSIONS

Reflecting upon the experiences with the development of scenarios, tests and studies of international developments, we came up with the following general observations about the potential and current limits of the use of serious games. Main finding of this study is that the testing revealed that many of the aspects of pre-operation analysis and planning and tactics and C2 of the operations phase can properly be trained on SGs.

The games as we use them today are low cost PC based. Being based on standard PC technology limits man-machine interaction to the use of mouse/joystick and keyboard. Due to this limitation, psychomotor tasks, found mainly in the skills and drills at the individual level (level 1), cannot be trained effectively in serious games. This hampers the execution of tactical scenarios. Due to these limitations with regard to skills and drills, we advise the use of VBS for tactics and C2 only for students that are sufficiently familiar with the basic individual and 2- and 4 man skills and drills. Improvement of the MMI is needed to support the psychomotor motor elements of task performance, in particular handling objects (doors, ladders, gurneys), moving in confined spaces (including stairs) and making gestures.

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