Netherlands Army Long Range Anti Armour Study
Status report

Contribution to the Twenty-Eighth US Army
Operations Research Symposium, 11-12 October 1989

by

Drs. P.A.B. van Schagen

Physics and Electronics Laboratory TNO
P.O. box 96864, the Hague
The Netherlands

Abstract

At the end of the nineties the munition for the TOW weapon system in use at the Netherlands army, has to be replaced. The Life Of Type of the TOW carrier ends in 2005. The long range anti armour study is to gain insight into the possibilities and limitations for the Netherlands army to deploy future (time period 1995-2000) weapon systems in the long range anti armour battle. The first study results are expected at the end of 1989. The study is sponsored by the Netherlands army and is carried out by the three National Defense Research Organization Laboratories: the Physics and Electronics Laboratory TNO, the Prins Maurits Laboratory TNO and the Institute for Perception TNO.

The study considers two categories of candidate weapon systems namely line of sight and non line of sight weapon systems. The Operations Research effort within this study is mainly focussed on analyzing and comparing the effectiveness of the different weapon system options. Therefore wargaming, terrain analysis and combat simulation techniques are used.

In the paper these techniques will be presented and some results will be shown.

1 Introduction

1.1 Study definition

In the nineties the long range Anti Tank Guided Weapon (ATGW) system TOW, currently in use by the Royal Netherlands Army (RNLA), will have to be replaced. Due to the technological developments the TOW system will not necessarily have to be replaced by a same type of weapon system in the same quantities.

For this reason an operations research study has been defined to gain insight in the possibilities and limitations on future alternatives for the (long range) anti armour combat. The study is focussed on the 1995-2000 time period. The study is performed by the three Netherlands National Defense Research Organization Laboratories: the Physics and Electronics Laboratory TNO (FEL-TNO), the Prins Maurits Laboratory TNO (PML-TNO) and the Institute for perception TNO (IZF-TNO).

1.2 Study set up

The anti armour study is divided into three phases. In the first phase an inventarisation of the possible alternatives for the TOW replacement has been made. Helicopters and 'static' anti armour means as minefields deliberately were not taken into account as an alternative for the TOW replacement.

In the second phase the combat simulation model 'Force Structure Model FSM' of the Physics and Electronics Laboratory TNO will be adjusted to the specific study goals. Also technical and tactical simulations at the weapon system level will be performed in order to get a first feeling of the effectiveness of the different weapon systems. Finally, a special substudy to the operator behaviour for Fiber Optic Guided Missiles is performed on the simulator table of the institute for perception.

In the third and final phase a break-even point for several mixes on battalion level and higher will be searched for in one or more pre-defined combat scenarios.

Since during the past decade a lot of studies within the same scope have been performed by the different nations, I will focus this paper on those aspects in the study that were mostly new and have not extensively been studied before.

The current state of the project is that phase 2 is almost completed and phase 3 has just been started. Therefore only results from and techniques used in the second phase will be presented.

It is important to mention at this point that during the definition phase of this project, another project was set up to gain technological knowledge of the Fiber Optic Guided Missile (FOGM) system. This 'National Technology Project Fiber Optic Guided Missiles (NTP-FOGM)' has to prepare both the participating Netherlands Industries and the Netherlands Laboratories to be able to participate in future international developments on this type of weapon system. Since the FOGM is one of the alternatives to be considered in the anti armour study, this study profits from the results of the NTP-FOGM. Therefore I will also mention a few aspects of the NTP-FOGM study that bear direct relevance to the anti armour study.

2 Phase 1: Possible Anti Armour Systems

Performing a study with such a broad scope as defined above, one knows beforehand that the study cannot address all the different weapon systems that could contribute for the solution of the problem. Instead some categories of weapon systems, in relation to the problem, that have some specific characteristics, will have to be defined. Having done that one or two (generic) representatives of that category are taken in order to study that particular category.

2.1 Categories of anti armour combat

During the definition phase of the study two main categories of anti armour combat have been identified: anti armour combat within the Line-Of-Sight and anti armour combat beyond the Line-Of-Sight. The second category has initially been subdivided into a category non line of sight systems with a restricted range (<10 km) and a category of systems with a range beyond 10 km.
First a few remarks on the categories defined.

- the category of Line-Of-Sight weapon systems
  Since the Line Of Sight systems need a Line Of Sight with their target they principally can also be seen by the target, which makes LOS systems principally vulnerable for direct and indirect fire of enemy weapon systems. An advantage of these type of systems is that targets are relatively easy to identify since they can be seen. For the LOS weapon systems the position from which detection takes place and the ammunition is fired is very important. A special group of weapon systems within this category are the elevated platforms. These platforms make it possible to position the system at other (more) locations then with non elevated platforms, (more or less) having the same line of sight.
  Although combat helicopters belong to this category, they are not taken into account in this study.
  The ammunition used can be either a chemical energy munitions, guided (new TOW) or fire and forget (HELLFIRE or TRIGAT), or it can be kinetic energy munitions such as the Hyper Velocity Missile or all other kinds of ballistic projectiles.

- the category of Non Line-Of-Sight (NLOS) weapon systems
  The non line of sight systems can be positioned (depending on the range of the ammunition) almost anywhere in the terrain. This feature makes them only vulnerable for indirect fire. On the other hand it is harder to identify targets for the ammunition. To get an acceptable hit/kill probability for the NLOS category of weapon systems one has to either shoot a lot of ammunition in a certain area (area fire), or to perform a way of guidance of the ammunition, which makes the system more expensive.
  Weapon systems belonging to the guided NLOS category with a limited (<10 km) range are the Fiber Optic Guided Missile FOGM and the chemical energy, terminal guided Mortar Anti Tank MORAT system.
  Weapon systems of the NLOS category with a long range (>10 km) are the Autonomous Precision Guided Munitions APGM for the artillery systems and the conventional artillery such as the MLRS (unguided).

3 Phase 2: Getting acquainted with the weapon systems

The goal of the second phase of the study is to get acquainted with the weapon systems taken into account during the study. For this purpose both technical and tactical data of these weapon systems have to be gathered.

In the Netherlands a national database of weapon system data is available. In this database technical information on both national, NATO and potential adversary vehicles is stored. The data for the database have been gathered over the years by the PML-TNO and are based both upon real life firing tests and on vulnerability models. The technical data of the weapon systems taken into account during the study, and not currently represented in the database, have been gathered in this phase.

Beside the technical information also tactical information about the ways of deployment and usage of the weapon systems is required. These tactical data are for a great part stored in a knowledge based system that drives the combat simulation model 'Force Structure Model' of the FEL-TNO. The tactical rules and doctrines are dictated by army representatives.

However, no tactical rules or ways of deployment for systems like the elevated platform and the fiber optic guided missile FOGM existed thus far in the RNLA. So, in the anti armour study a 'deployment' philosophy for the elevated platforms was defined. Within the National Technology Project FOGM a substudy was performed in defining possible targets for the FOGM. The next part of the paper will focus on these two substudies.

3.1 Elevated platforms

3.1.1 Positioning the elevated platform

In order to determine the possible locations of elevated platforms a terrain analysis in the corps area of the 1st Netherlands corps (1(NL)LK) has been performed. The line of sight conditions for observer heights of 2 and 12 meter have been determined with the aid of a digitization of the Northern German Plane. We divided the corps area into three subareas. In the first area the LOS conditions were relatively bad (<1000 meter), in the second area the LOS conditions were average (1000-1500 meter) and in the third area the LOS conditions were good (>1500 meter). It showed that in the area with good line of sight conditions the elevation of the sight from 2 to 12 meter height improved the situation even further to an average line of sight of over 2500 meter. In the area with bad LOS conditions elevation hardly made any difference.
The calculations described above were made based upon viewpoints that were chosen for ground-based observers. In order to get a feeling on the number of extra positions possible when elevating the eye, we calculated the number of positions from which a target could be seen for an observer height of both 2 and 12 meter. These calculations made it clear that an increase of 50-100% on average (relative to the number of positions for a viewer height of 2 meter) is achieved by elevating the viewer height to 12 meter.

In order to get a feeling on the validity of the computer calculations a terrain reconnaissance in the corps area was made. With a helicopter the lines of sight in a lot of positions, previously being calculated by the computer model, were checked. It showed that, due to the digitisation of

the terrain in 100 meter square grids, the LOS calculations were somewhat optimistic, but on average the resemblance was good.
As a result of the 'real' terrain analysis we now also have digitised the tree lanes and other screen elements in the terrain that influence directly the line of sight, thus getting an even more accurate computer calculation.

3.1.2 Tactical deployment of elevated platforms

To gain insight into the tactical use of elevated platforms a two days wargame session was conducted at the Physics and Electronics laboratory TNO.

In general it can be said that such a session can be seen as a controlled experiment to force doctrine development and raise discussions on crucial parameters and performance estimates. The aim of the wargame thereby is to generate a set of (time evolving) situations in which one or more decisions ought to be taken by the participating army officers. During the decision making process discussions among the participants will take place. Since military people from different parts of the military organization (cavalry, infantry, artillery, engineers, army staff and intelligence) take part in such a session, these discussions will take into account the problems related to the cooperation and communication between these different parts. The monitoring of such a session (i.e. leading and steering the discussions) is the responsibility of the operations research group involved.

From earlier studies (Helicopter study and Scatterable Mines) it had already become clear that such a session could contribute significantly in the formation of a military doctrine in using new kinds of weapon systems.

For this session the Netherlands wargame KIBOWI was used. KIBOWI is a fully interactive, user-friendly, real time wargame that is excellently suitable for such a session. Both own and enemy forces are played by military people.

During the two days a total of six different team (company) scenarios were played in two different terrain areas, one with bad line of sight conditions and one with average line of sight conditions. In three of the six simulations each blue team had one platoon with four elevated platforms each at their disposal. Mounted on the elevated platform were 12 TOW-like missiles with a maximum range of 5 km.

From the session it became clear (as we already knew after the terrain analysis) that more locations were available to the elevated platforms in order to gain control over the enemy route. Due to the increase of possible locations the long range of the system could often be used, whereas the non elevated, long range, weapon systems could not fully exploit their range.

The elevated platforms were deployed by the military either on a 'stand alone' basis or in groups of two systems.

In the terrain with average line of sight conditions it became clear that some relation must be made between the obstacle plan and the (effective and useful) long range of the elevated platform. One of the questions raised was whether we also have to put our minefields further away because of the range of the elevated platform, risking a higher chance that the enemy circumvents the minefield or that we lay our minefields as close to the

defensive line as we used to do, risking that the enemy will not reach it, or that we should search for positions for the elevated platforms further in the depth of the blue team.

Finally the session showed that by elevating the sight tactical important terrain areas as river crossings, which mostly lie in the deeper parts of the terrain, can be kept both under surveillance and under direct fire from great distances whereas this could not be done by non elevated sights.

3.2 Fiber Optic Guided Missiles

3.2.1 Defining FOGM targets in a brain storm session

The problem that had to be addressed for the NTP-FOGM study (and also for the anti armour study) was to define the operational environment for a Fiber Optic Guided Missile.
Since the FOGM has a number of important aspects that makes it different from other weapon systems, the (possible) use of such systems in a battle field is not at all trivial.

In order to define specific FOGM scenarios a two days brain storming session was organised. In total 25 people participated in this session: 8 army officers, 7 people from industry and 10 people from the defense laboratories.

3.2.1.1 Organization of the session

Twenty-one people were divided into four task groups, the remaining four people formed the special FEL-study team that controlled the session and took care of on-line documentation. In each task group were representatives from the army, industry and the laboratories. During the two days each task group had to study a number of characteristic enemy situations and to identify the possibilities for FOGM to attack the enemy in that situation.

The session was organised in such a way that in a limited time period a large number of different study tasks could be addressed by the task groups.

The session was divided into five main parts. In the first four parts of 2.5 hours each, each task group had to work out a specific FOGM topic (1.5 hours). In the remaining hour the task groups had to present the results from their mini-study and discuss these with the other groups. In the fifth and final part the experiences could be 'tested' in a wargame (KIBOWI) that included FOGM systems.

3.2.1.2 The task of the task groups

As it has been stated before, a task group had to address a specific topic concerning the (possible) use of FOGM. For this they were given a simple description of a characteristic situation of the enemy and, based upon that description, they had to identify the possibilities for FOGM to attack the enemy. The task groups were urged to address at least the next subtopics:

- targets

identify the number, types, formation and (expected) statuses of the enemy structure.

- threat
  analyze both the direct and the indirect threat for the FOGM system related to the enemy behaviour and structure.

- FOGM tasks
  identify how FOGM could be used to decrease the enemy threat.

- information
  identify how the FOGM station gets its information and how accurate and recent the information should be.

- target acquisition
  identify how the targets can be acquired by FOGM based upon the available information. Also identify whether special demands for information accuracy or for the controlling system of FOGM (flying speed, navigational aids, seekers etc.) exist.

- effectiveness needed
  identify how the goal of the FOGM attack could be reached.

- alternatives
  identify the available alternatives to reach the effect as identified for the FOGM. If alternatives exist, identify the advantages and disadvantages of using FOGM.

- mission description
  Based upon the previous items, give a short description of the FOGM mission.

3.2.1.3 Results of the session

The results after two days of hard labour were extreemingly good. All participants had gained a lot of insight into possible FOGM usage. As a result of the session six different FOGM scenarios are defined. The NTP-FOGM study will use the scenarios to define the (hardware) requirements for such a system and the anti armour study will use the doctrine adopted in this session.

3.2.2 Operating a FOGM

One of the important aspects of FOGM is the man in the loop. To get a feeling of the requirements, possibilities and constraints enforced by this feature a study to the operator performance is performed by the Institute for perception TNO (IZF-TNO).

On a large table a scale model of a part of the Netherlands corps area has been built. On this modle enemy vehicles and helicopters can be positioned. Above the scale model a small camera, representing a FOGM, can be manipulated. In a special FOGM operator control unit with video monitors, FOGM control yokes etc., a human operator can 'fly' his FOGM and try to find enemy targets. A model of the flight behaviour of the FOGM is incorporated in the system.

For the anti armour study simulations (with TOW gunners as FOGM operators) have been performed in order to investigate the possibility of FOGM finding its target in relation to:

- the available information on target positions,
- the type of terrain and
- the type of the targets.

Currently the results of these simulations are being analyzed.

4 Phase 3: comparing the different weapon systems

In the third and final phase of the study the different weapon systems that could replace the TOW systems will be compared with each other. This comparison will be done by performing combat simulations with the combat simulation model Force Structure Model FSM available at FEL-TNO.
A set of different options will be defined and simulated. The results of these simulations will be compared with the simulated results of a predefined reference case.

4.1 Features of the Force Structure Model

The Force Structure Model FSM is a closed, stochastic combat simulation model. In FSM the lowest level of representation of friendly and enemy forces can be either the single vehicle level or the platoon level. In both cases the combat evaluation takes the single weapon systems into account. Principally there is no upper limit at which the FSM can run, but due to practical constraints (required computer power) the highest level that can be simulated is the brigade level. FSM is played on a digitisation of the Netherlands corps area.
The combat units in a simulation are driven by a scenario. The scenario is partly stored in a knowledge based system. The other part of the rules and doctrines are set for the simulation scenario by the study team. In a FSM simulation the complete hierarchical structure is represented, thus being able to take into account command and control features (e.g. the delay times it takes to translate and transfer an order from a battalion commander eventually to all subordinate platoons).

4.2 Choosing the operating area

The choice of the operation area is of great importance within the study. The line of sight weapon systems can exploit their specific characteristics only in a terrain area with line of sight conditions over 2000 meter. Although NLOS weapon systems can also be used in this terrain, they will mainly be used beyond the line of sight (i.e. attacking enemy units in depth or from positions further away from the FEBA).
To study the effects of both categories of weapon systems simultaneously a operating area with LOS conditions ranging from 1000-2500 meters has been chosen.

4.3 Levels to be simulated

The smallest combat unit (of combined arms) that fights independently is the team (company). Therefore the effects of the long range anti armour systems can at best be measured relative to the team combat. The reference case will be the situation as it exists at the moment, simulated in the two types of terrain described above.
However, the effects of the non line of sight weapon systems on the team combat will be indirect and therefore only be measurable in a later phase of combat. Because of this the effect will influence the combat of the (next) higher levels battalion and brigade.
Due to the specific characteristics of the NLOS weapon systems these systems will be incorporated on battalion or brigade level. Thus it is necessary to simulate combat at that level.

4.4 Simulation options

At first only the LOS weapon systems will be evaluated. Next also the NLOS weapon systems with a range less then 10 km will be evaluated. The long range (>10 km) NLOS weapon systems will be taken into account by means of two options:

- no such systems are available and thus the enemy will not suffer any harm from these systems and
- these systems are available and their effects on the enemy will be represented as a parametric variation of the enemy strength.

The first results of the simulations with the line of sight weapon systems are expected at the end of this year.

5 Conclusions and remarks

From the current state of the study it can be concluded that elevated platforms make it possible to attack the enemy at a greater distance, from points in the terrain that cannot be used by non-elevated platforms. Elevated platforms make it possible to overview deep parts of the terrain that cannot be seen by non elevated platforms.

Wargaming and brain storming have proven to be very useful techniques to gain tactical information on the use and deployment of new weapon systems. Sessions based upon these techniques should be well prepared. The tight time schedule enforced on the participants of the brain storm session proved to overcome standard reactions and revealed more inventive thinking.

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION USA Operational Test & Evaluation Agency 6b. OFFICE SYMBOL (If applicable) CSTE-ZT	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) 4501 Ford Ave, Alexandria, VA 22302-1458	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION HQDA, ODCSOPS 8b. OFFICE SYMBOL (If applicable) DAMO-ZDS	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20310-0400	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Proceedings: Twenty Eighth Annual US Army Operations Research Symposium Volume I, 10-12 October 1989; UNCLASSIFIED

12. PERSONAL AUTHOR(S)
Varied

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Proceedings	FROM 10/10/89 TO 10/12/89	7 Dec 89	716

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Readiness, Sustainability, Testing, Field Experiments, Command and Control, Computers, Intelligence, System Effectiveness, Survivability, Operations Research, Force Design, Manpower and

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
This document is a collection of technical papers and speeches presented to the Twenty-eighth annual Army Operations Research Symposium (AORS XXVIII). The purpose of each AORS is to foster communication, exchange information, and recognize high quality work within the Army analytical community. The theme of this year's symposium was "Maximizing Army Effectiveness." General subject areas were: A. Readiness, Sustainability & Support to Forces in the Field; B. Testing, Field Experiments & Training; C. Command, Control, Communications, Computers, Intelligence on the Battlefield; D. System Effectiveness and Survivability on the Realistic Battlefield; E. Recent Advances in OR Methodology, Evaluation Techniques and Other Selected Topics; F. Force Design Planning, Programming & Modernization; G. Manpower and Personnel Analyses; H. Joint Forces and Strategic Operations; I. Cost Estimating and Analysis; J. Military Engineering. The PROCEEDINGS are printed in two volumes; Volume I contains all papers with unlimited distribution, and abstracts of others; Volume II contains papers with distribution limited to DoD components only.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION	
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL LTC Neal R. Jensen	22b. TELEPHONE (Include Area Code) (703)756-2367	22c. OFFICE SYMBOL CSTE-ZC

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE