Analytic and Decision Support Tools Adaptable to Assess and Evaluate Peace Support Operations

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Karl Bertsche is a project leader and has completed a study for the German army engineers considering explosive demolition in a Peace-Keeping Mission in the military OR-Section of Dornier (a company of Daimler Chrysler-Aerospace). He has written object-oriented Programs concerning minefield effectiveness, and an analysis tool for the sustainability of German forces as well as a dynamic infantry combat model (AMIRIS). His most recent work has been the development of an analysis tool for the development of Anti Submarine Warfare Screens (ASW) for the Fleet Command of the German Navy. He was previously a nuclear engineer at Babcock & Wilcox in Virginia, U.S.A. He has a Masters of Engineering degree in nuclear engineering from New York University.

ABSTRACT

In order for the German forces to fulfill the expanded task spectrum, they must be adequately trained and equipped for the special mission objectives which they have been committed to by our German Federal Government. The most recent German military involvement has been the participation within NATO – SFOR and NATO – KFOR missions.

In the past several years a number of studies concerning sustainability and survivability of German forces in a peace support mission have been analyzed. The objective of these studies were to identify and to resolve the force structures and material requirements for such peace support missions. Basically an objective assessment of the situation within the area of engagement is required. In performing the studies several analysis tools (computer programs) were developed to rapidly perform these analysis tasks.

Another fundamental analysis aspect is the area of 3 dimensional simulations. This class of simulation is already used in aircraft and various ground vehicle simulators. In recent years 3D simulation has also been used to analyze the combat situations of dismounted infantry. The advantage of this type of simulation is the visualization of spatial effects and views, that the individual dismounted soldier sees of the battle field. Not only classic combat can be modeled but also peace enforcement scenarios are possible.

This paper will identify several of these tools and their basic functions and show how these analysis instruments could be converted into mission training tools or possibly to decision support tools to assess and evaluate encountered situations in a host nation.

In addition future trends in unmanned reconnaissance technology using unmanned aerial vehicles (UAV's) and remote-autonomously operated vehicles (RAOV's) will be identified. The implementation of such UAV's and RAOV's in peace support operations is another area of ongoing investigations.

In conclusion, this paper will also show the future trends in analysis which includes the use of agent-based modeling technology to analyze peace keeping missions.

INTRODUCTION

This presentation will show the analytic approaches that Dornier GmbH developed over the past years for the German army in particular. Five major points of interests will be addressed:

- What are the expanded mission spectrum of the Germany forces in the future?
- Which studies have been carried out Dornier GmbH to investigate the tasks associated within this new tasks spectrum of the German army?
- What models have been developed as a result of those studies?
- What new equipment is being developed to more effectively assist the army in fulfilling their new tasks?
- During the presentation we will identify the challenges that still exist in fulfilling this requirement.

First the main objectives is to identify what the expanded task spectrum of the German forces entails. Here the tasks will be broken down in more detail and the associated challenges identified.

Another important point is to identify the different fields of investigations, the solutions obtained and computer models developed in order to help analyze the different tasks. We feel that some of theses computerized tools can be further developed and used to assess and evaluate specific engineer missions.

Later, the preparation measures will be discussed, whereby mission preparation can be facilitated with computer generated maps. Training and stress prevention is an area where virtual reality models can be implemented.

The paper will conclude by showing the latest technology in robotic vehicles as a tool for the soldiers to fulfill their tasks more efficiently with lesser risk.

EXPANDED MISSION SPECTRUM OF THE NEW GERMAN ARMY

The expanded mission spectrum of the new German forces should have the following characteristics:

- The ability to carry out missions over a large distance as part of a multinational force (UN/NATO) without supporting troops or available logistics from the host nation.

- The ability to sustain a foreign engagement for time periods longer than two years.

- The size of the ground forces should be small but with access to appreciably more fire power in particular supported with long range artillery and air strikes from distant air bases.

- Information superiority is also an essential attribute, which can be achieved through continuous battle space surveillance, information warfare capability and through satellite observation.

- Superiority in outer space.

- Robust combat management and C4ISR.

- Effective counter measures in case where weapons of mass destruction have been employed.

- An adequate air- and ballistic missile defense system is to be developed.

- The capability of special forces operations have been acquired through special training and procured equipment.

- The logistical support is more flexible, better distributed and requires less forces than previously required by our conventional force.

INVESTIGATIONS FOR THE NEW GERMAN ARMY

Dornier has carried out many OR-Studies/Investigations for the German forces in the past. These studies were primarily aimed for the German army and navy. Some of these studies for the German army had different aspects of peace support operations as their objectives. The army branches for which the analyses were performed was for the army engineers and the army's dismounted infantry. For these analyses various computerized analytic tools were developed to help perform these studies. These analytic tools could very easily be converted to and implemented as mission support tools and could in a further steps also be implemented as mission assessment tools.

As a mission assessment tools, the assessment will concentrate on the evaluation of the performance of the tasks identified based on time and date of completion.

The following OR-Studies/investigations were carried out for the German army to obtain basic requirements for different army branches about peace support missions.

The most recent OR-Study was entitled: Restraining of Enemy Mobility. The aim of the study is to determine the new requirements for restraining enemy mobility considering the new situation where Germany has relinquished the use of anti personnel mines. Anti personnel mines have been used to hinder dismounted enemy troops in clearing of anti tank mine barriers and to harden fortification against an enemy assault of dismounted infantry. New non lethal weapon systems are being considered as an alternative to anti personnel mines. In addition new strategies of barrier and fortification protection are being developed, which do not rely on the use of anti personnel mines or substitutes.

One major OR study, which was carried out for the army engineers has been the study of Sustainability of Crisis Reaction Forces. The important aspects in this study were the required tasks spectrum to restore and maintain adequate living conditions within a designated area of the host nation. In addition, requirements for the engineers to restore damaged or destroyed infrastructure were identified.

In a more detailed OR study for the army engineers, the implementation of explosive demolition in a Peace support operation was investigated. The use of explosive demolition can rapidly demolish dangerously weakened structures, which pose a danger to the local population. In order to perform proper explosive demolition, the composition of the structure is required.

An important OR study for the dismounted infantry has been the study: “Implementation of Light Forces”. For this study the 3 dimensional simulation model IRIS was used. Among the many scenarios analyzed were:

- Convoy protection.
- Checkpoint operations.
- Object protection.

A totally new area of analysis, which the German army is presently funding is Agent Based Modeling (ABM). This has been an area of investigation of the U.S. army and of the U.S. Marine Corps for the past several years. The emphasis of the analysis for the German army is oriented to answers questions about peace enforcement, peace keeping and peace enhancement. In addition influence of non-tangible parameters such as courage, fear, compassion, cultural background, religious background and others are to be determined at some time in the future.

STUDY 1: RESTRAINING ENEMY MOBILITY

We are now review the study of Restraining Enemy Mobility more closely. The major objective of this study is to determine what new requirements are necessary for the German army in particular for the army engineers to fulfill one of their primary tasks of restraining enemy mobility. The use of barriers and explosives within this context can only be implemented very restrictively in a peace support operation. The only conceivable mission where German forces would build anti tank mine barriers would be in a multinational peace enforcement operation under NATO or UN Command. In such an operation the multinational

force would be confronted with a heavily armed enemy equipped with sizeable armored units. If such a situation would exist, one of the tasks the German army engineers would be to delay and channel the armored enemy attack by using anti tank mine barriers. In an unavoidable counter attack the army engineers my again implement anti tank mine barriers as flank protection against a potential flank attack by enemy armored units.

Since Germany has relinquished the use of antipersonnel mines, the situation on the battlefield will change appreciably. Anti tank mine barriers must now be guarded more closely by armored units or by tank units depending on the type of terrain present. The application of such combat support weapons systems (antitank mines) will be difficult because of political pressures. The fear of politician, that innocent civilian could be become victims, will put enormous pressures on their military commanders to minimize the use of minefields even for defensive and tactical purposes.

In order to use even anti tank mines, certain requirements must be met. These requirements are that they efficiently support all engagement options, pose no significant danger to the population after hostilities have seized. The amount of collateral damage is minimized by using shape charges.

Germany is presently using the shape charge AT2 mines (scattered, deployed by mine launcher system Scorpion) and the shape charge DM31 deployed by mine laying device above or below the surface. In addition, for roads and paths the army uses camouflaged shape charges on tripods which are activated by the passing of armored vehicle.

Another objective of the study is to investigate the possible use of non lethal weapon systems (for example: flares, acoustics charges) as intruder signals and for example: barbed wire and camouflaged trenches to secure fortifications against an immediate attack of dismounted infantry. In the future more than in the past, a combined effort of different army branches will be required to secure fortifications against armored and dismounted infantry units.

In order to perform the analysis for this study, Dornier has chosen to use its own developed Model for combat called DIAMANT (Figure 1). The acronym DIAMANT stands for the Dornier Interactive Model for Application of new Tactics. The model consists of a 2-dimensional combat simulation model for the combat of combined arms up to Brigade/Division-Level. One of the major characteristics is the terrain resolution and associated mobility map. The model was specifically developed for the army engineer specific tasks. One of the tasks being the deployment of mine barriers.

The Model system DIAMANT runs under Windows NT and uses MS-Access as a data base. One of the special characteristics of DIAMANT is it's terrain model. The terrain model is used to finally compute the mobility of vehicles on the specified terrain. There are three classifications which influence mobility: These are terrain characteristics, vehicle characteristic and weather. The modeled terrain characteristics are: SOIL, Grade, Embankments, Forests meadows, crop fields, towns, streets, rubble, dams, water ways, and lakes.

The soil is characterized according to the 6 classification modes specified in the Cross Country Map (CCM) data. Mobility does not only depend on the above characteristics but also depends on the type of vehicle formation crossing the terrain. The mobility model

differentiates between wheeled and treaded vehicles. A difference in mobility is affected if the vehicles are single vehicles or are traveling in a formation. In addition weather conditions also play a significant role. There are three different situations considered: dry, moist, and wet. Mobility is significantly affected if vehicles are traveling off-road. There are only minor affects for wet roads. The terrain mobility map is actually a map of mobility resistance. By using these resistances DIAMANT can generate isochronal maps (maps that show areas which can be reached with in the same time span).

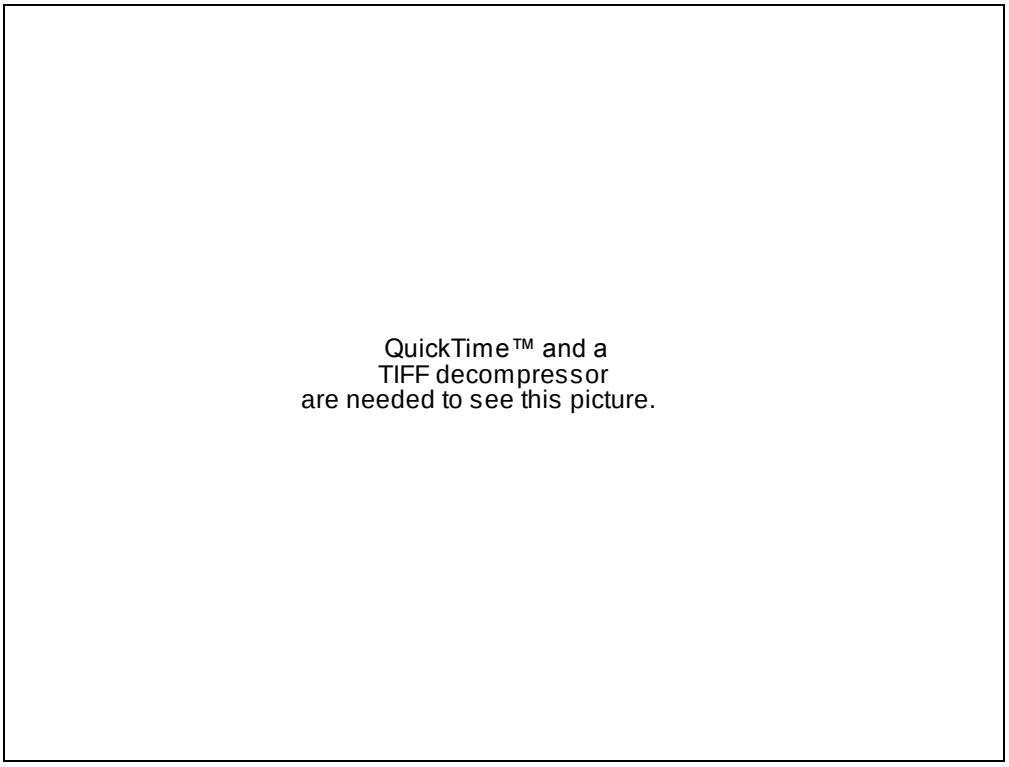

Figure 1: Model DIAMANT.

The map in Figure 2 is such an illustration of such a computation of DIAMANT. A similar approach to terrain mobility was used to determine the endangerment map of helicopters. The primary input parameters for the helicopters are: flight elevation, radar position, and range of enemy weapon systems. In addition combat troops were also considered. Here geography, visibility, and maximum range of enemy directly aimed fire arms were considered.

As the four components pictures in Figure 3 indicate, the light gray areas show regions of high danger, whereby dark regions are safe zones for flying helicopters. Flying at lower altitudes may be much safer for helicopters than flying at higher ones.

Another important tool which is used to determine the time and logistic requirements for mine field deployment is DIOPTER. DIOPTER is an interactive Optimization Tool for Engagement and Control of army engineer tasks in preparation of combat. Primarily this tool computes the time and resource requirements for mine barrier planning in restraining enemy mobility and it also analyses bridging requirements and bridging schedules to enhance the mobility of own forces.

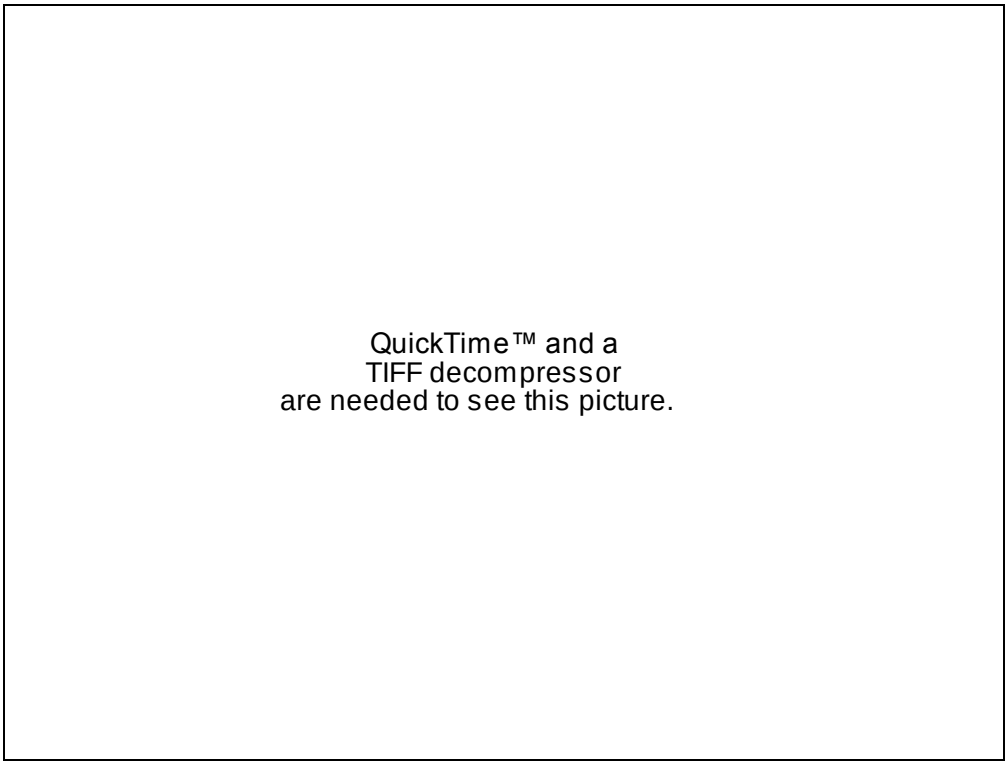

Figure 2: Isochronal Map, Distance-Time.

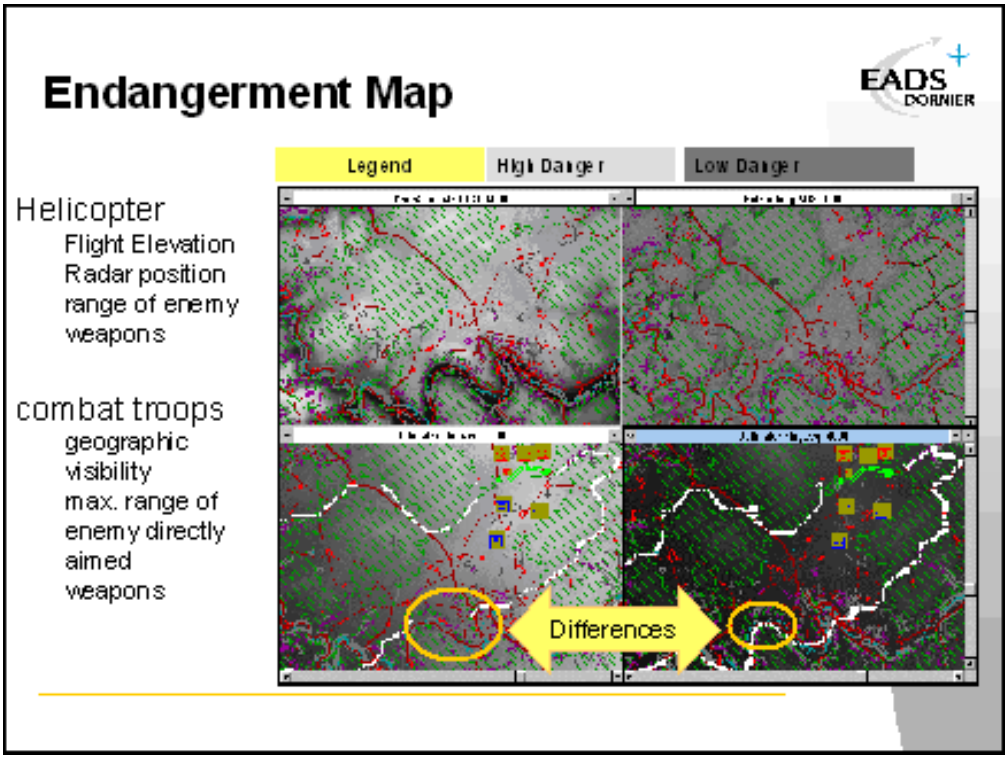

Figure 3: The Endangerment Map.

One major advantage of DIOPTER is that force structure and materiel requirements for the engineers can be determined well in advance, through analysis of different combat scenarios. The development was performed under the authoring software TOOLBOOK,

which allowed a the rapid development of an analysis tool. By using TOOLBOOK other software such as MS-Project were incorporated to generate the work schedules for the engineers.

A direction for further development of this tool would be in the area as a mission support tool. The concepts developed have been already incorporated in the first phase of the SPIA Software, which is planned to become the army engineer command and control instrument to coordinate the army engineer tasks and reporting during an engagement.

DIOPTER runs under the operating system Windows (NT, 95, 98, 2000) and it relies on the Microsoft products MS-ACCESS and MS-PROJECT.

STUDY 2: SUSTAINABILITY

Another important study, which was performed for the army engineers was the study of sustainability. The primary purpose of this study was to determine engineer support while deploying forces and creating adequate living conditions in a host nation considering the engineer support for a mission where crisis reaction forces would be deployed.

Based on the short title of the study: Safeguarding of Living Conditions for the Crisis reaction forces we named the analysis tool (SILC) which was developed using the authoring environment TOOLBOOK from Asymetrics (Figure 4).

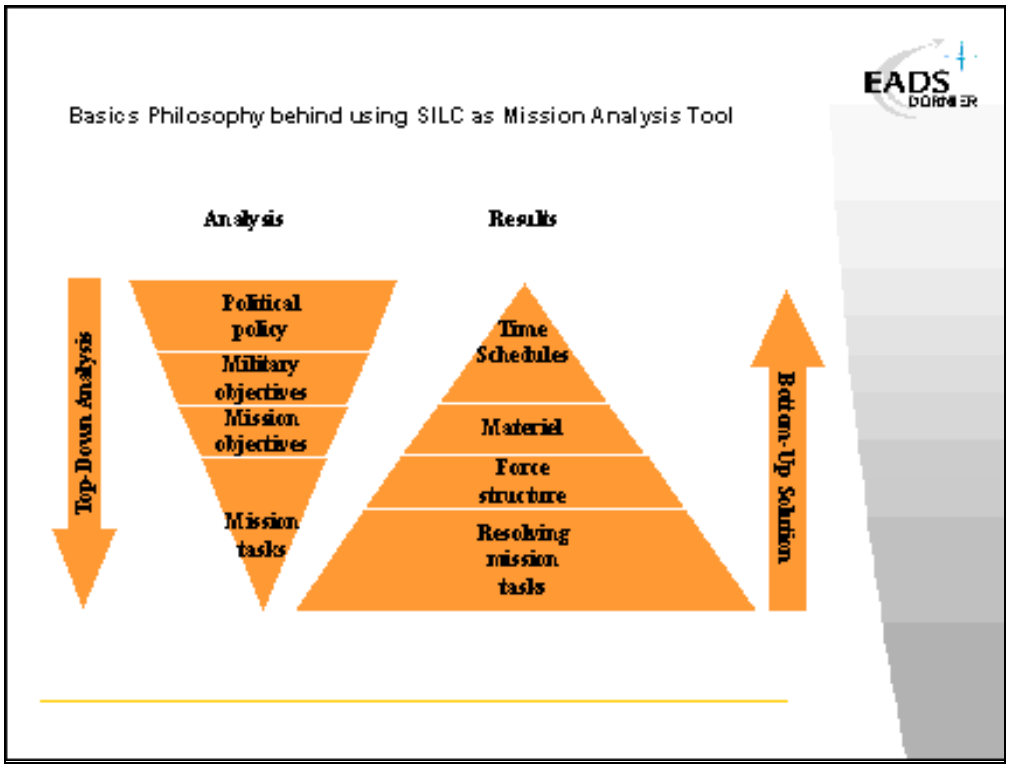

Figure 4: Basic Philosophy behind using SLIC.

The basic philosophy which led to the development of SILC is a top-down analysis and a bottom-up solution approach. Basically, it is an analysis of a mission where we first start with a political policy which states that Germany will assist both NATO and the United Nations in multinational peace operations. Such operations require German military support. In order to fulfill such international commitment a mission is planned for every such international commitment.

Therefore, mission objectives must be formulated by the politicians and from there, military objectives are defined. These objectives are broken down into a large number of military tasks and every military task can be further broken down into an a number of subtasks. Once the number of subtasks have been identified, the detailed analysis can be carried out. The results from the detailed analysis of each task are the required forces and materiel and the time required to fulfill the planned task. Once this analysis has been carried out for all subtasks, they can be aggregated over all tasks of a mission. This bottom-up solution will yield the proper force structure and required materiel. An additional result are detailed schedules of all tasks and subtasks to successfully complete the mission objectives.

In order to fulfill these requirements, SILC was conceived as a modular development base, where a number of smaller applications, which perform dedicated tasks were outsourced as an independent application (Figure 5). This modular approach proved to be a very efficient programming approach. Every module was tested before it was allowed to be called up by the main program SILC.

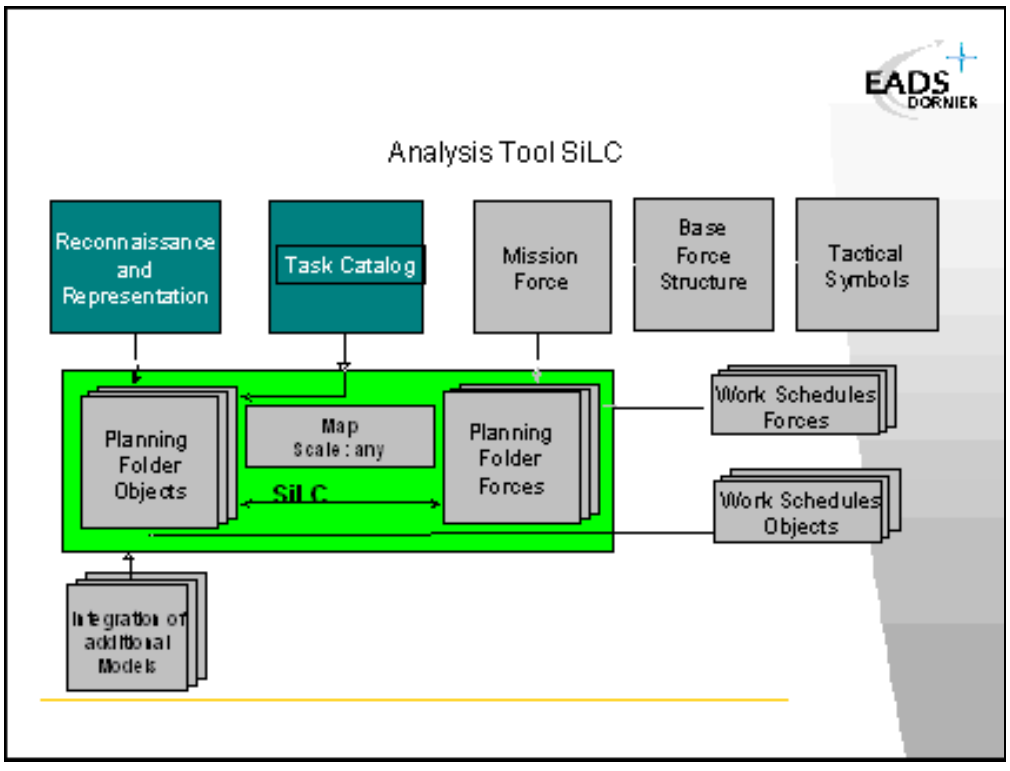

Figure 5: Structure of the Analysis Tool SILC.

The bright green frame represents the main SILC module. It relies on a number of separate external modules to perform its main function. The module itself uses a map of any scale as background for the intended planning and analysis. Since the map is scaled in SILC distances between any specified points of the map can be determined.

The external module Reconnaissance and Representation Catalog is used to generate transparent overlay objects on the planning surface of SILC. The external task catalog contains all specific tasks and subtasks in form of equations that can to be performed in the host nation. In addition a force generator is available which allows the user to generate a force structure starting with the external catalog containing tactical symbols of the various units, platoons, squads, and teams, which will be performing the work. Once a substantial force has been developed Base force structure catalog, a mission force can be copied into the Mission Force catalog. In addition other planning modules can be called up to compute further technical requirements.

By introducing objects onto the planning surface of SILC, additional planning folders for these objects are generated. Within each planning folder are a number of record fields which can be filled with diverse data (such as reconnaissance information, safety information, task information, a summary of all tasks, required material and forces).

The task catalog contains the algorithms of a number of predetermined tasks. These standard equations for tasks can be dragged and dropped into the object planning folder of SILC(Figure 6). There the argument list of the equations are filled in and are than ready to be evaluated. Based on the evaluation materiel and base force requirements are the result. At the beginning of the planning all task related information resides in the object catalog. Once forces are dropped into the planning surface additional record fields are assigned to these units. The tasks (represented by equations) can now be dragged and dropped into the planning catalog of the units. Based on the unit strength. The computed time requirement will be adjusted accordingly.

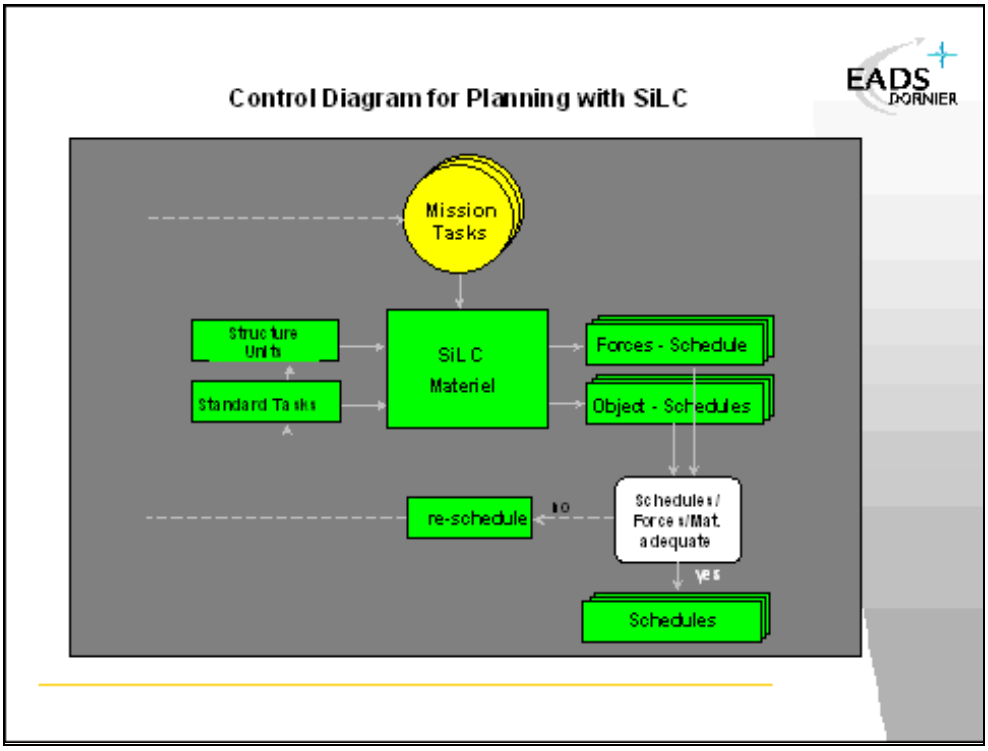

Figure 6: Control Diagram for Planning with SILC.

As a result the schedule can now be viewed from a mission object point of view, where a number of teams and squads have been assigned, or the schedule can be viewed form the

forces point of view, where a squad or teams are deployed to various different mission objects.

By using SILC a control procedure can be implemented by the planning staff to decide which mission tasks can be performed with the available forces and resources. The results produced by SILC are schedules for the tasks to be performed on the different mission objects identified. The resources and schedules are then compared to the intended mission objectives and checked if they are adequate or not. If the resources and schedules prove to be inadequate the tasks can either be reduced or the forces increased in order to fulfill the mission objectives.

The tasks which cannot be performed must of course be carried out either by a partner of the coalition force or from the host nation itself. If funds are limited such an analysis is essential in order to avoid unpredicted cost overruns.

In order to demonstrate the functionality of SILC the following five mission tasks were analyzed.

- Building of a base camp.
- Construction of a new aircraft landing strip.
- Building and repairing a Bridge.
- Construction and repairing of roads.
- Safeguarding of water supplies and septic facilities.

STUDY 3: EXPLOSIVE DEMOLITION IN THE NEW ARMY WITH NEW TASKS

Another study where the development environment ToolBook was used, was for the study Explosive Demolition in the new army with new tasks. Explosive demolition is used to rapidly and cost-effectively demolish structurally dangerous and unwanted structures. These structures are: bridges, buildings, chimneys, and various steel structures that are frequently demolished using explosive demolition methods.

The model DOSIS, Dornier Simulation Model for Explosive Demolition, was developed, similar to the SILC model (Figure 7). The primary component of this model is a planning area, which is comprised of a scaled map (any scale) on the background. Similar to SILC it uses an external module a Reconnaissance and Representation Catalog to generate transparent overlay objects on the planning surface of DOSIS. Similarly, the external Task Catalog contains all specific demolition tasks and subtasks in form of equations. By evaluating these equations the amount of explosives and geometric distribution of the explosives are the results.

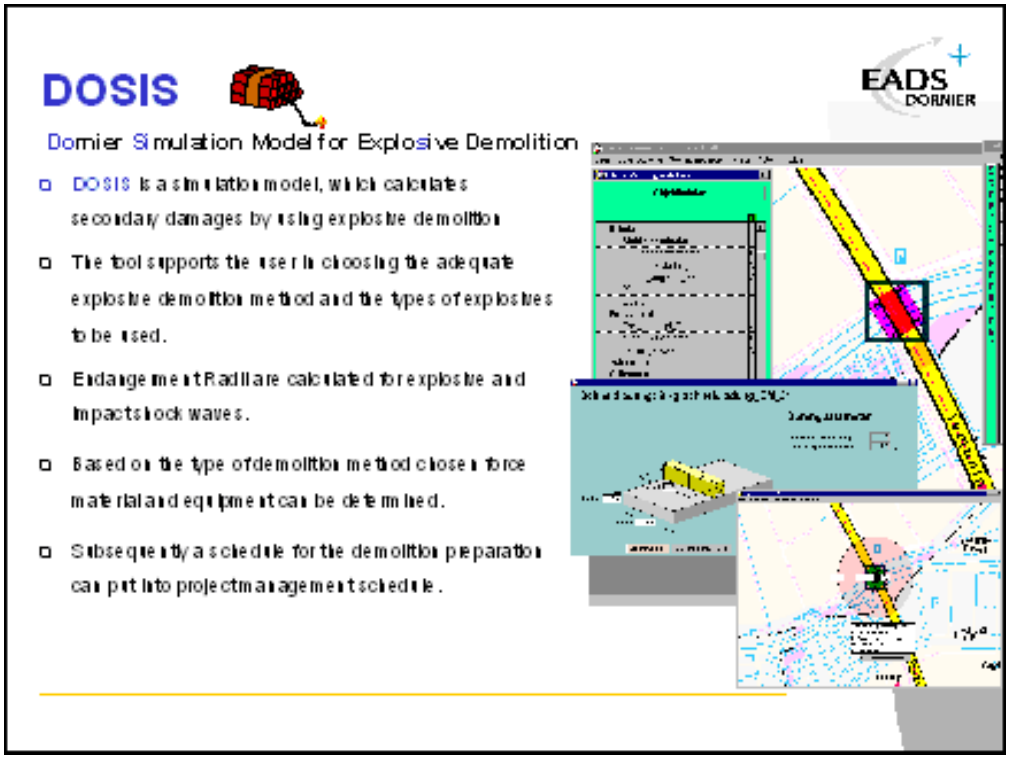

Figure 7: Model DOSIS.

It must be noted that primary overlay objects defined on the primary map may not be detailed demolition objects but may refer to another map of that particular region which then contains the demolition object/objects. If such an object is double clicked another viewer is opened having the same functions as the primary planning area with in DOSIS.

The primary functions of DOSIS are to generate objects on the planning surface. By generating an overlay object on the planning surface of DOSIS an additional planning catalog is generated for those Objects. The structure of the Planning catalog of DOSIS is similar to that of SILC, which has previously been explained earlier in this paper. The primary characteristic being the dragging and dropping of predefined explosive demolition task from the task catalog into the task field of the object catalog.

Once the function has been dropped into the object planning catalog, values for the input parameters must be entered. By double clicking on the equation a schematic diagram of the explosive demolition method is opened in a separate viewer. Here the input fields are made available and graphically show which inputs should be entered. Once the input fields have been filled with data, the "calculate" button can be pressed. The result is the geometric distribution of the explosives and the amount of explosives required for each charge and the total number of charges required.

Based on this information the army engineers can now perform all the necessary preparations tasks such as drilling holes according to the hole pattern calculated by DOSIS. In addition DOSIS calculates demolition and impact shockwave, and computes and visualizes the various endangerment zones due to the amount of explosives detonated and the amount of mass of material from a particular elevation which will impact the surface at a single moment. Endangerment zones due to pressure waves are also computed, in order to determine minimum distance of personnel from a detonating charge.

The results of this study have shown that commercial demolition methods generate a minimum amount of collateral damage when compared with the previous military demolition methods employed by the army engineers.

STUDY 4: MISSION OF LIGHT FORCES

Another Study where Dornier has been involved with, has been the study of light forces. Dornier is using a 3-dimensional analysis tools in order to identify adequate reconnaissance and combat equipment for dismounted infantry. The main areas of study for Mission of Light Forces are the following influences on the performance of the individual soldiers.

- Influence of intelligent reconnaissance equipment which will lead to greater transparency of the field of engagement.
- Influence of new technological equipment (communication, reconnaissance, combat).
- Influence of the media.
- Influence of the political situation in the field of engagement.
- Influence of the general population.
- Influence of different ethnic groups.
- Influence of Intangible factors such as fear, pride, hate, anger, and other factors.

These are some of the global factors that the dismounted infantry will be confronted with in a peace support operation.

Within this study the following scenarios were considered:

- Operation of a mobile check point.
- Convoy protection.
- A search of farm buildings for armed individuals.
- Protection of a depot from enemy militia.
- Confrontation with an angry crowd.

In order to perform the 3-dimensional analysis, the Dornier 3-dimensional visualization tool, IRIS, was implemented (Figure 8). With IRIS different types of terrain can be modeled. For example open regions like a depot or pastures but also buildings inside and outside can be modeled. Even large built up areas such as towns can be accurately visualized.

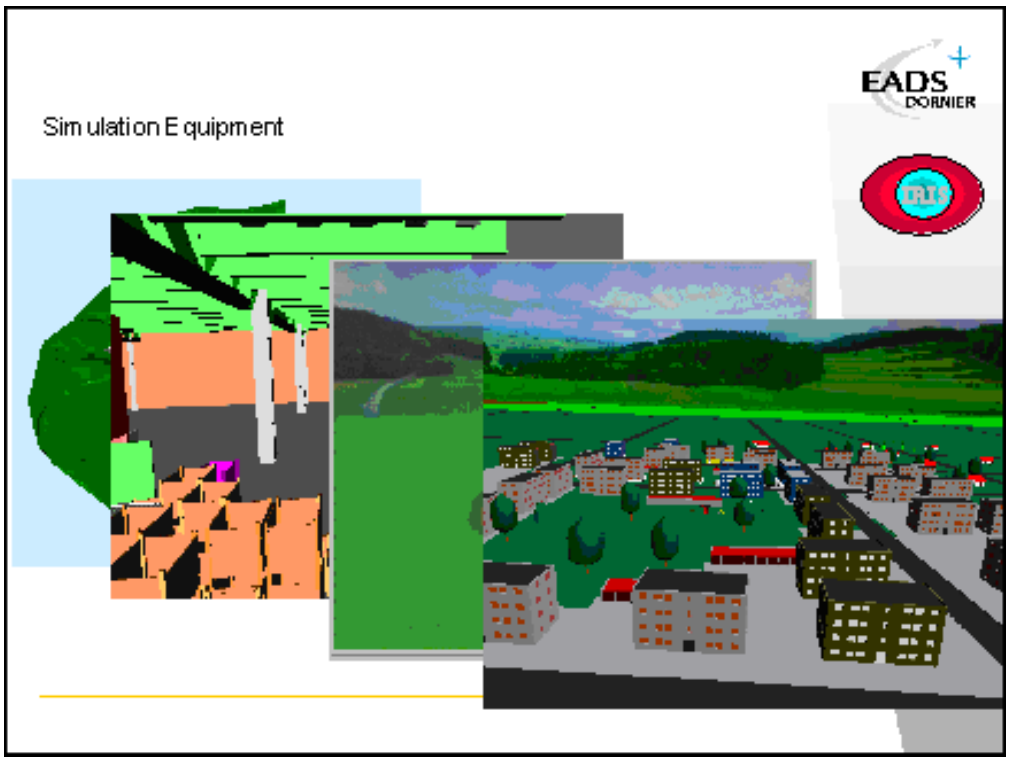

Figure 8: The Dornier 3-dimensional visualization simulation software IRIS.

While patrolling the streets dismounted infantry will have close contact with the population. The population may be very friendly to the soldiers, if they perceive the soldiers as a protecting force. However if the population feels oppressed, the soldiers may be provoked or even directly attacked by the population.

The purpose of the simulation is to convey a 3-dimensional world, where the individuals only see a very limited view of the total picture. Thus giving the various scenarios a much higher degree of realism than what a 2-dimensional view can convey. Examples of the different possibilities are such that persons can hide behind objects or crawl underneath objects (trucks). Or from the top of the truck view the surrounding terrain from a higher elevation. All views have a perspective view, which makes it much more difficult to identify objects or persons at larger distances. By using IRIS the problem of friend/foe identification is illustrated quite clearly through the 3-dimensional visualization.

Not only the open terrain can be visualized but also buildings from the outside and inside. The visualization allows the analyst to view his surroundings walk up stairs and move about the different rooms and hallways. By performing interference checks, possible motions can be checked by the analyst to determine if these intended motions are even possible. This can be valuable for the analyst in order to determine what hand-held weapons or other pieces of equipment are beat suited for a particular environment.

Another type of terrain which can be modeled quite impressively is wooded areas. Here the possibilities of enemy cover and camouflage are quite substantial. The visualization helps the dismounted infantry to become aware of the different tasks of reconnaissance which is required to safely enter such an area. Because of the versatility and possibilities which IRIS offers, can make this tool a valuable training instrument for team, squad, and possible platoon

leaders. One problem which has not yet been satisfactorily solved is the rapid terrain generation with the appropriate structures and agricultural ground cover.

Different scenarios can be visualized by an experienced analyst according to the customers request. This could be the stopping of a convoy by youths running across the road. And stopping in front of a truck. In such situations the accompanying soldiers must force the civilians to free the road. This is just an example of this type of visualization which gives insights concerning how a convoy can be protected more effectively from a crowd attempting to halt it and steal its contents (Figure 9).

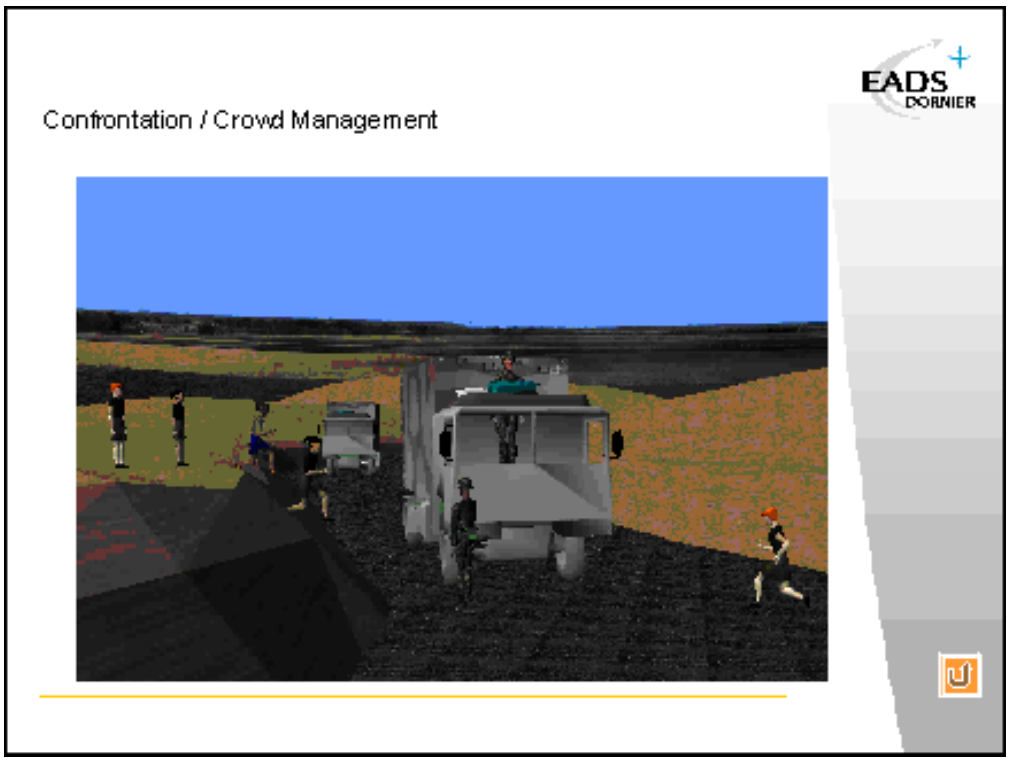

Figure 9: Confrontation/Crowd Management.

Different views inside farm buildings or modern industrialized areas have already been successfully demonstrated. In such an environment different combat scenarios have been visually analyzed and possible casualties computed based on the different fields of view the participating combatants have of one another. The type of available weapons system was considered in the analytical results.

An important scenario of light forces is the protection of different types of military depots. Such depots may contain water, food, fuel, trucks, automobiles, weapons and ammunition. Such facilities must be heavily guarded by light forces. The contained resources of these depots guarantees the sustainability of the forces present. With IRIS the depot is generated within a terrain cell. Once the cell has been generated. The analysis begins by looking at the terrain surrounding the generated site of the depot. Fortifications can now be added to the depot, based on the given terrain.

The results of the visualization analysis of the mission of light forces came up with 16 recommendations for additional equipment for the dismounted infantry. The five most significant recommendations are as follows:

- Light forces are to be equipped with sensors, detecting approaching persons and/or vehicles.

- Sniper detection sensor.

- High precision fire support (non lethal, lethal) to neutralize enemy forces in and out of built up areas (in- and outside of buildings and trenches/foxholes.

- Enhanced communication equipment for voice data, picture and video transmission capability with secure connection within urban areas.

- Light forces are to be equipped with a "mother ship," which can serve as the following: equipment transporter, weapon carrier, supply base, and personnel carrier.

STUDY 5: APPLICATION OF AGENT-BASED MODELING IN A PEACE SUPPORT OPERATION

A relatively new analytic method is being investigated for the German army. This new analytic approach is the application of agent based modeling. By using this methods new insights influences of such non tangible factors such as fear, stress, fatigue and a number of other non tangible factors are expected to be quantitatively assessed.

Basically the questions to be answered can only be achieved with a new type of analytical model with new concepts. The main effort of the study is to investigate non tangible factors and non linear relations in peace support missions, where the traditional operation research models of combat attrition cannot be implemented.

Here agent based modeling offers new hopes. This new method computes emergent adaptive behavior of all the modeled agents within the scenario environment. Each agent is modeled through a number of control loops governing its individual behavior based on needs which must be satisfied and duties which it has committed to perform. Based on the scenario the individual agents acts and reacts to the individual situation. In addition there are a number of threshold values triggering different actions.

In order to obtain reliable results and to determine the influence of different input parameters. The analysis is repeated many thousands of times in order to determine the sensitivity of emergent behavior on the varying initial conditions. In order to obtain results in a reasonable amount of time, data farming methods are implemented, which use ridge analysis methodology to determine maximum and minima of those parameters with highest and lowest significance.

The analysis may also show that slight changes in initial conditions may result in large deviations of the emergent behavior. In such cases the reason for those deviations are extremely important to determine. It either shows severe model deficiencies or it may indicate weak spots of the basic plans of actions and contingency planning within the scenario.

One of the important factors in the area of agent based modeling is the ability of the agents to adapt to an ever changing environment. By implementing the control loops into the agents behavior module, allows the agent to change his actions according to the conditions it encountered.

One major reason for agent based modeling is to determine the influence of intangible factors on the success of a mission (Figure 10). Such factors can be separated into classes such as human factors, where physical and psychological states determine the performance of the agents. Other factors which influence a mission would be the duration of an operation, intensity of the operation, Religion, culture, infrastructure and more. In order adequately model each factor requires that a control loop is developed for that particular characteristic. For each modeled factor/characteristic an initial states and threshold values must be assigned. The significance of some factors must only be reduced with measures taken but should also decay with time with time.

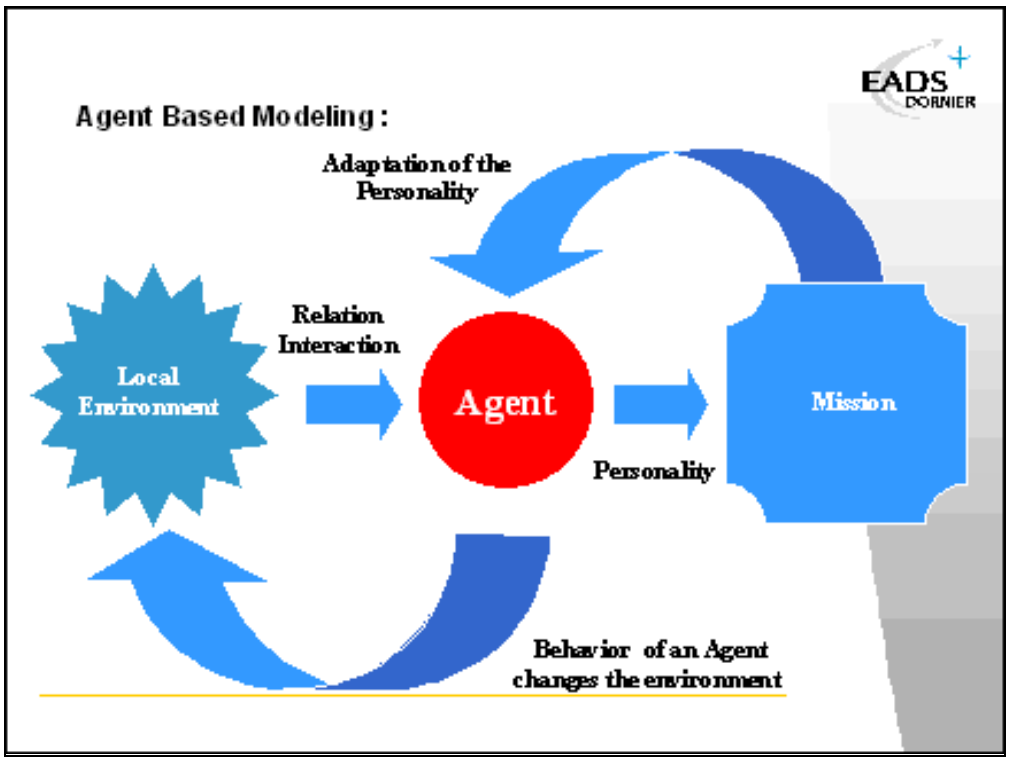

Figure 10: Adaptive Behavior Model of an Agent.

Here is a list of human factors which can be modeled: Leadership, Morale, Training, Combat Experience, Health, Endurance, Fatigue, Courage, Stress, Trust, Aggressiveness, and a number of more factors influencing human behavior.

A general question which arises in any military operation is the following: What are the effects of decisions made by a commander not having complete information of the enemy and his intended operation? By using agent based modeling and by implementing the evaluation methodology of co-evolving landscapes will be able to answers such a posed question.

In the new project which the German army has contracted agent based modeling will be applied using a question based methodology in an attempt to answer the following questions concerning peace support operations.

- What factors impact the stability/instability of an environment in which PSO may occur?

- What is the interaction between the "global" and "local" actors in PSO?

- How do we identify and deal with escalating/ deescalating factors within a PSO (factors would include cultural, religious, political, economic, psychological, issues etc.)?

- How is the force package structured based on the specifics of the mission?

- How should the force package change as the PSO evolves?

Ever since 1994 the US Marine Corps has used agent based modeling to effectively model combat of combined arms. The main effort has been in the area of analysis. This methodology is always used in combination or to augment the traditional combat models. The aim of the US-Marine Corps is to develop a decision support instrument to primarily investigate the following phenomena:

- Non linearity.

- Adaptive behavior.

- Intangibles.

- Co-evolving landscapes.

This planned tool should be constructed in such a fashion, that a commander of any level of command can get the supporting information prepared according to his/her military function.

PREPARATION MEASURES AND NEW DEVELOPMENTS

In order to enhance the performance of soldiers engaging in a new mission, a major factor is the adequate preparation for the mission. One very important factor for the soldier is to become familiar with the terrain, where he will be stationed to perform his duties. If the soldier knows what he can expect form the terrain a number of anxieties are removed and he will be able to concentrate more on his duties which he is expected to perform.

In order to protect the lives of the soldiers more effectively, a number of robotic reconnaissance systems (ground based and aerial vehicles) are presently being developed to reduce the endangerment of own troops. This situation is especially valid for regions where a large number of mines (anti tank/ anti personnel mines) have been deployed for tactical or terrorist purposes in the previous conflict. These vehicles can detect and report such dangerous areas, well in advance of troops reaching the area. In case where the vehicle inadvertently triggers a mine, the robotic vehicle may be lost but without any casualties.

MISSION PLANNING/ENGAGEMENT PREPARATION WITH COMPUTER

One of the main preparation efforts for a military mission in a host nation is for commanders and officers to familiarize themselves with the area of engagement (Figure 11). Very important orientation documents are maps. Maps give the user a good indication of the general distances from one place to another but usually do a poor job in giving an adequate 3-dimensional representation of the terrain.

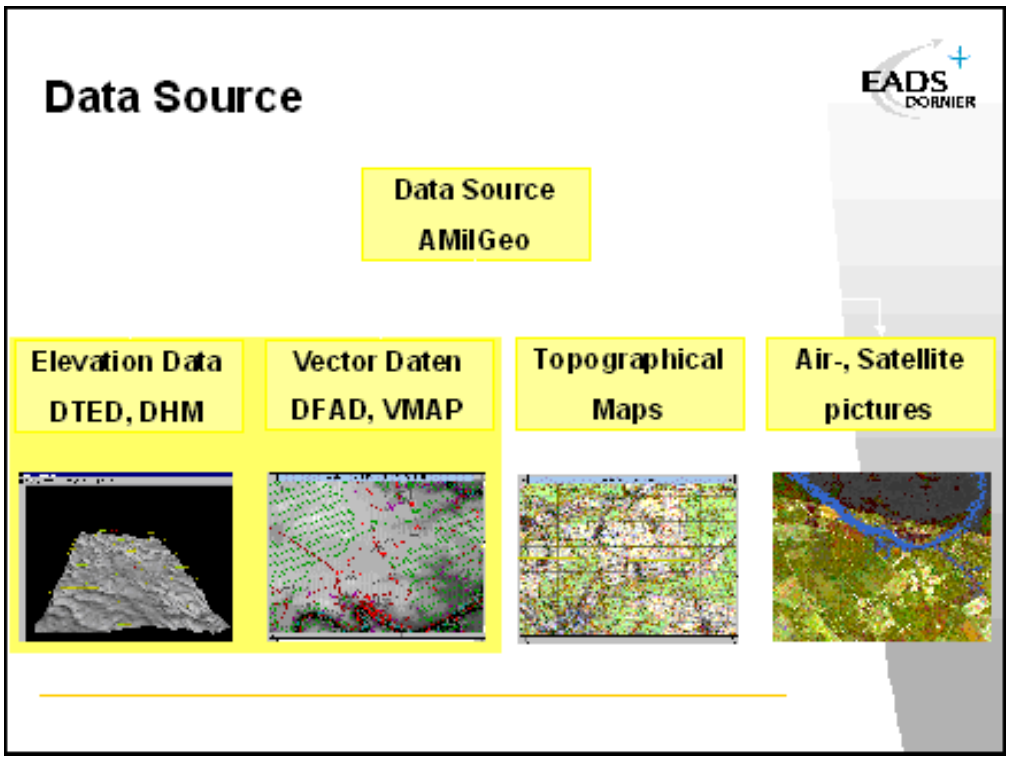

Figure 11: Data Sources for Military Geography.

Lack of knowledge of the terrain can have a significant impact on the planning parameters such as food, water, fuel and clothing. In order to perform such mission planning. A three-dimensional representation can conveys a birds eye view of the region.

One way for the soldier to minimize his/her anxiety is to familiarize him/herself with the terrain, where he or she will be stationed. Here the best data source for such information is the German Office of Military Geography. By using elevation and vector data as well as topographical maps and aerial photos and satellite pictures, a three dimensional view of the terrain can be generated.

Such three-dimensional views can help pilots to orient themselves for missions within the host nation well in advance of the actual deployment by viewing the terrain at different elevations. Army officers can better evaluate the terrain in order to find areas to construct their fortifications.

However, the more detailed the terrain description is the more detailed the planning can be carried out in advance. Such detailed knowledge of the terrain is extremely important in case of a mission to free hostages or free imprisoned troops.

In such situations even more detailed knowledge of the buildings and their interior structure must be known be fore a plan of action can be developed. In any case the more detailed the knowledge about the terrain is known, the more precise the planning can be carried out and therefore the chances of success are appreciably improved.

TASKS OF MILITARY ROBOTIC VEHICLES

In the past most reconnaissance operations have been carried out with advanced observers deployed within the area of operations. This type of operation has always been a very dangerous assignment. Where many of such forward observers have been captured or killed in the line of duty. Despite these risks the insatiable gathering of intelligence information of the enemy will always remain. The next section will considers remotely or autonomously operate vehicles to gather valuable information about the enemy (Figure 12).

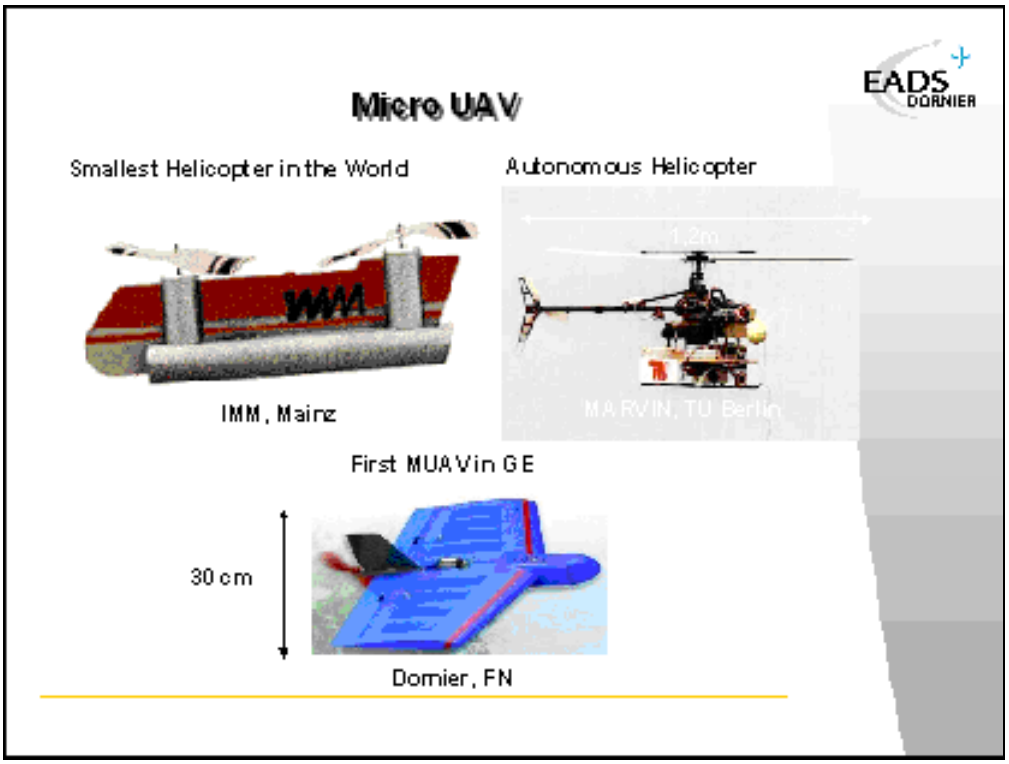

Figure 12: Micro UAV.

The implementation of unmanned mobile land systems (UMLS) by the military is to continuously supply information about the area of operations. The use of such systems is being tested and its goal is to act as a force multiplier, by supplying much more and more detailed information with a smaller number of personnel at lower risks.

Costs are being saved by the use of specialized functions implemented in the vehicle. This technology could conceivably be implemented in main battle tanks to reduce the number of personnel required to operate the functions of the tank.

The detailed tasks of such unmanned land vehicles are as follows:

- Advanced forward observer, Performing reconnaissance.
- Mine search and detection vehicle, Performing mine clearing.
- Guarding and securing, Implemented as convoy protection.
- ABC Reconnaissance, Implemented as Supply and Transport vehicle.

The use of micro unmanned aerial vehicles is gaining world-wide interest. The reason to use such technology is to perform airborne reconnaissance at low risk and low costs. The type of vehicles being investigated are unmanned micro helicopters and micro fixed wing aircraft. All such vehicles are equipped with optical sensors to perform the reconnaissance operation.