TRANSFORMATION: MILITARY AND SCIENCE

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Abstract: Military and science have been complementary throughout history. Military capability has always been built on the advances in science and technology and at the same time it has provided motivation and goals for new technologies and applied science. If technologies and scientific approaches advance the military options, strategies and tactics need to adjust and transform accordingly. In this sense transformation of military is triggered by the advances in science and technology. At the same time, specific scientific disciplines, such as operations analysis, provides the techniques and tools for a pragmatic and effective transformation of military affairs.

Keywords: Transformation, military, science, security system, scenarios, operations analysis.

The transformation of the security system originated from the need to adjust to fundamental changes in the objectives of the security sector and to major developments in information and sensor technologies. The objectives changed from the rather fixed and stable situation of massive balance of power and deterrence in the Cold War period to missions in different locations all over the world for peace support, humanitarian aid and protection of human rights. In addition, the fight against terror became a major motivation. At the same time, the technology of information systems, in particular the world wide net of computers and advanced sensors, opens completely new approaches and options for the strategy, structure and operation of military forces.

As a consequence and based on the first steps in a new direction of some nations, in particular the US, NATO decided to adjust its structures and objectives to the new conditions. The two supreme commands of NATO, SACLANT and SHAPE, reformed into ACT, Allied Command Transformation, and ACO, Allied Command Operation. The very fact of this fundamental and high level change in the command structure indicates the high importance of the need for transformation within all NATO nations.

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Transformation

Transformation means instead of only re-shaping something existing (just modernization and reform) the establishment of a permanent and future-oriented process of change and adaptation to new challenges. The goal is the creation of something new as well as the increase of effectiveness of military forces. Transformation has many dimensions:

- The security policy dimension is related to the wide scope of many possible scenarios although with high uncertainty and low predictability, which requires robust solutions in terms of force structures and strategies.
- The societal dimension needs to consider training and education for the use of high technology and the integration and status of military forces within the overall society of a nation.
- The technological and scientific dimension is the utilization of the new advances for the increase of military effectiveness.
- The innovative dimension requires a permanent search for and creation of new options in strategies, operations and tactics in order to reduce the risk of ignoring and omitting the most promising and powerful solutions.
- The mental dimension incorporates the permanent need for questioning the own position and the scientific approach for reproducibility, transparency, and falsification of wrong and bad solutions.

In NATO, transformation is seen as an effects-based approach. Capable future forces are built on the transformation goals of achieving coherent effects, decision superiority, and joint deployment and sustainability. These goals are conditional on each other and cannot be seen in isolation. They are determined commonly based on classical defense planning, as well as on the new approach of concept development and experimentation. More specifically, the transformation objectives are:

- Effective engagements, joint maneuvers and enhanced civil-military cooperation for the achievement of coherent effects;
- Information superiority and network-enabled capability for the achievement of decision superiority; and
- Expeditionary operations and integrated logistics for the achievement of joint deployment and sustainability.

Military and Science

Military and science have a long historical relation to each other. The oldest known and recorded war philosopher Sun Tzu wrote approximately 2300-2500 years ago in *The Art of War*:

> "The rules of the military are five: measurement, assessment, calculation, comparison, and victory. The ground gives rise to measurements, measurements give rise to assessments, assessments give rise to calculations, calculations give rise to comparisons, and comparisons give rise to victories."[1]

or

> "Measurement owes its existence to Earth; Estimation of quantity to Measurement; Calculation to Estimation of quantity; Balancing of chances to Calculation; and Victory to Balancing of chances."[2]

Today our interpretation of this statement can read as follows. Based on the perception of reality the disciplines of natural sciences as mathematics or physics are developed; with the methodologies of science, models are constructed; the application of models results in simulations; simulations are important foundations of operations analysis; and operations analysis is required for success. In this context, many nations and their military organizations have created and maintained military-scientific institutions to perform operations analysis.

Operations Analysis or Operations Research was defined as a scientific discipline among researchers of the Alliance during the Second World War in support of the armed forces. This definition reads as:

> "Operations research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control."[3]

Although the techniques and methods of operations research have earlier been used in industrial, governmental, and military activities—sometimes under different names—

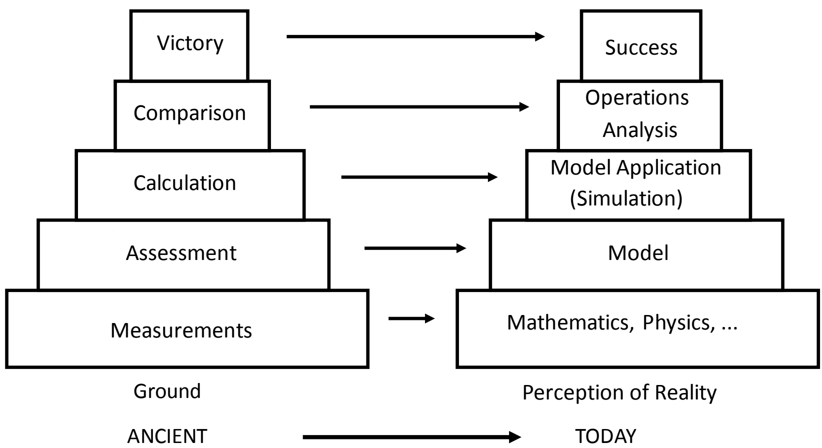

Figure 1: Sun Tzu and Scientific Support.

its systematic application have been predominantly military. However, the techniques and methodologies of operations analysis and simulation can be of help in arriving at executive decisions concerning operations in any field—industrial, governmental, commercial, ecological, environmental—as well as in military.

In NATO, the problem areas supported by operations analysis approaches have been focused on the following two basic questions:

- For given resources, budget and political guidance what is the best composition or structure of military forces?
- For given military forces and mission what is the best employment in order to optimize the available resources, e.g. minimize the own losses?

The first question is very closely related to long-term defense planning, while the second question considers short-term operational planning of given forces.

In defense planning, the objectives are the creation of forces that are able to provide the capability to handle a multitude of possible or likely, though uncertain, scenarios or planning situations and that are robust in their structure for successful operations under many conditions. Important constraints have to be considered, such as available economic budgets, demographic developments, social national conditions, technology and scientific advances, industrial and logistical base, and last but not least the overall political guidance.

In operational planning, the objectives are best employment of forces, which are able to accomplish a well-defined military mission with minimum losses. Important constraints are the geographic and environmental conditions, the opponent and his options, strength of own forces, reserves, etc.

Planning Situations

Planning is closely linked with the definition of situations that can serve as basis for testing the effectiveness of structures, systems, plans, concepts of operation, etc. If such situations cover a set of future most likely possibilities, it is safe to assume that structures and concepts based on these situations provide robust solutions. From an analysis perspective, given or planned solutions should be tested against these planning situations seen as benchmarks.

Considering the analysis of crises, a number of common factors, which are relevant to generic planning situations, emerge. These basic components of military planning identify the common issues confronting planners in each situation. From these common factors detailed checklists of generic planning tasks can be identified that also reflect the guidance on generic planning.

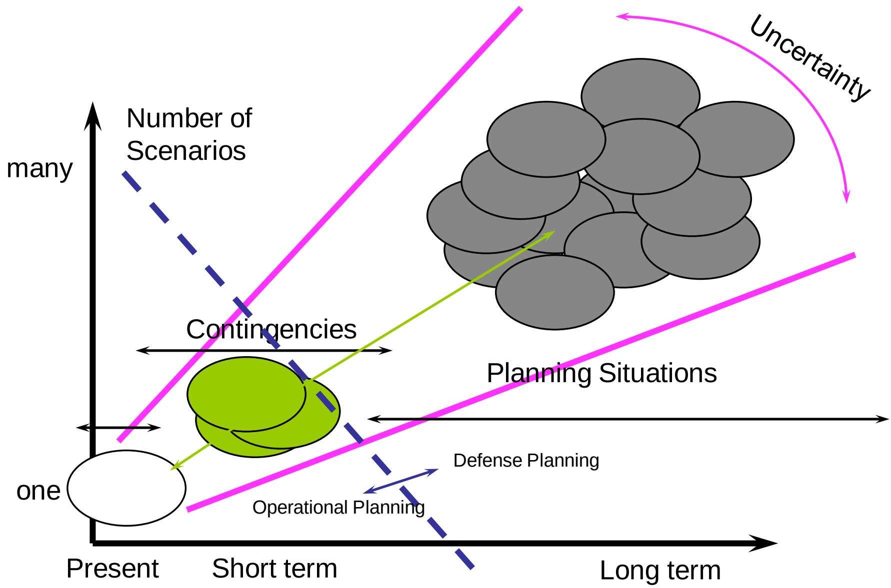

Figure 2: Uncertainty of Scenarios.

The challenge that planners face nowadays is the uncertainty of potential scenarios on the background of the new space of missions. The number of scenarios, which has to be considered, increases with the time horizon for planning. At any given time, only one or two real-life operations are important. For short-term planning, the given forces have to be employed most effectively. For long-term planning, many planning situations with increasing uncertainties have to be analyzed. For long-term planning, the structure should be as robust as possible in order to be able to cover worst-case scenarios. In general, the set of scenarios should be as consistent as possible.

Defense Planning

The main element considered in a deduction process for generation of force requirements is the transparency of the process. Everyone involved, including the political leadership, the democratic control, and the military should be able to understand the deduction in principle. This leads to scientific approaches of reproducibility of results, rigor in methodology and logical reasoning. The task is to determine military requirements from analysis of military missions, taking into account the political guidance for defense planning, the predicted security environment and any lessons learned from operational planning or real-world experience.

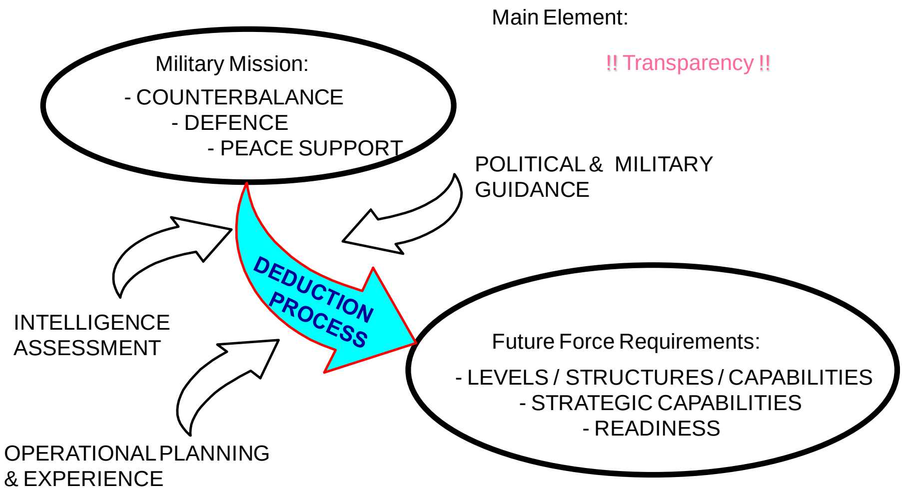

Figure 3: Defense Planning.

The requirements are expressed in terms of force levels, force structures, force capabilities, force readiness and strategic capabilities. The latter are military capabilities, not directly referable to a single service, that enable military commands to effectively deploy and employ assigned forces and that are essential to ensuring successful mission accomplishment.

In NATO, the results of this Defense Requirements Review (DRR) process form the major input to the NATO Biennial Force Planning process and the generation of Force Proposals for each NATO nation. These proposals are then discussed with the nations concerned and agreed Force Goals for each nation are established – this is a commitment by the nation to deliver capability. The main purpose of the DRR is thus to give a sound military rationale for the military requirements and capabilities in order to provide a solid basis for negotiations for the agreement of Force Goals and input to other defense planning developments.

The requirements for each planning situation are established using analysis approaches at different levels of complexity. All planning situations are initially analyzed using relatively simple static analysis methods. Static analysis methods are used to cover the wide range of variations that have to be considered. It should be kept in mind that DRR is concerned with possible future planning situations and certainly there are many uncertainties associated with these situations. The static methods are used to arrive at an initial view on robust defense requirements. Robust in the sense that the forces proposed are required to be capable of dealing with a wide range of circumstances. In certain cases, these requirements are then refined using more com-

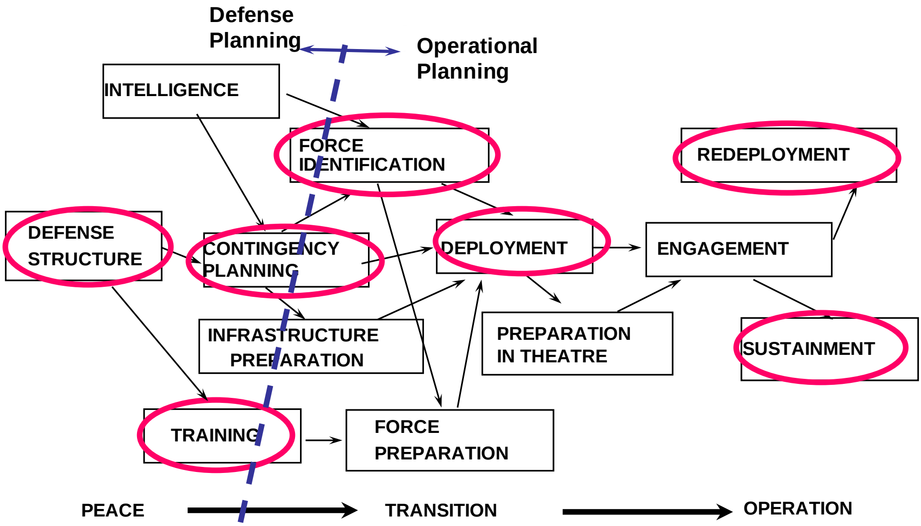

Figure 4: Wide Scope of Processes.

plex methods based on more sophisticated and detailed simulations. The basic requirements for each situation are expressed in terms of required force levels and the force build-up required in the geographic area concerned.

One of the required outputs from the DRR is a recommendation with respect to the required readiness of NATO forces. In order to do this, it is necessary to examine whether the predicted future national force contributions to NATO can meet the requirements resulting from the combination of planning situations. This requires an assessment of which national forces might contribute to each planning situation. This in turn makes it possible to estimate national force movement times. With this information, and the required in-theatre build-up profile, it is possible to estimate the force readiness requirements. Obviously, this is a complex process requiring several iterations. The resulting force allocations, and any shortfalls or excesses compared to the basic requirements, are then inputted into the Force Proposal process.

Support in Operations

Military operations can be regarded as groups of processes occurring simultaneously or in sequence. There is a wide range of processes involved in planning and executing military operations, both for generic peacetime planning and for contingency operational planning. They interact in complex ways and require stringent management.

Intelligence in the military sense is concerned with identifying threats and stimulating political decision-making processes. In peacetime, generic plans are made to ensure readiness for operational planning if a crisis situation arises. Outcomes of operational planning form inputs for political decision-making and govern military deployment to crisis areas. Deployment of well-trained forces and subsequent preparation for their possible future employment may deter a potential aggressor. If deterrence works, no further employment of forces may be required. Re-deployment of forces may subsequently be possible.

Operations Analysis and simulation can be used with regard to any of these processes, to arrive at optimal solutions. Use of simulation is especially valuable in deriving such solutions in the face of frequently changing circumstances. The marked areas in the diagram presented in Figure 4 show successful application of the Operations Analysis methodology in real operational planning.

During real operations many direct and indirect supporting activities for the deployed headquarters have been accomplished, e.g. scientists deployed as part of the assessment cells of the headquarters. Some experience for the use of Operations Analysis has been summarized and the following observations during these deployments have been made:

- An important area of work is the collection of data, lessons learned and material, which could later serve as a ground for analysis and model building. Here major contributions are possible in the areas of Force Generation, Deployment, Logistics, and Command and Control.
- Lessons learned activities need to be extensively organized, controlled and analyzed.
- Data collection, archiving and data management are key tasks requiring better planning and coordination; a data collection plan should be integrated into the staff planning process.
- The Operations Analysis scientists have provided contributions of high value to the deployed headquarters. Experience reaffirms that Operations Analysis has a place as an integral part of military decision-making. It is necessary for the Operations Analysis teams to train and exercise together with the military staff.
- Integration of the military staff work and the scientific support is very important in order to react in a timely manner, to understand the problems and to define the option, which has to be analyzed.
- Operations Analysis teams in military headquarters should be small, of mixed disciplines, with a broad range of experience. They should be headed

by independent civilian scientists reporting to senior level. Members of the team should possess good information technology skills.

- Simple, transparent and easy to use tools and models are needed since the time for analysis is often limited.
- A good and direct link and network to scientists and organizations at home locations is essential for back-up support, rotation of personnel, retrieval of data and methodology, etc. This network should be established in advance.
- Measures of effectiveness are required to provide commanders and staff with a measure of mission success, which is difficult for peace support operations as they need to be developed before the operation.

A typical cycle of actions takes place in the command and control process. This so called decision cycle is established more or less on all levels and within all forces and headquarters.

In general, the procedural elements of this classical decision process are:

- Situation Assessment;
- Objectives;
- Strategies/ Options for Actions/ Decisions;
- Detailed Planning;
- Implementation.

Any military staff or crisis management team carries out the five elements of this process repeatedly during its activities. Situation assessment encompasses all activities related to finding out and describing what is going on, understanding the motivation of the principal actors, establishing the basic causes of events and the relevant drivers of processes, updating the assessments, disseminating the assessments to others as required, etc.

The process begins with definition of the desired objective. The status of own and opposing forces and the environmental circumstances in which they will eventually have to operate need to be established. The potential of forces can be compared using simulations. Environmental conditions, scenarios and planning situations can be changed in the simulations. Operational options can be developed from the results of comparisons. The likely effects of the adoption of options can be assessed using simulations. The best option can be selected as a basis for decision-making and further planning. Again, the marked areas in the diagram in Figure 5 show successful application of Operations Analysis methodology in real operational decision cycles.

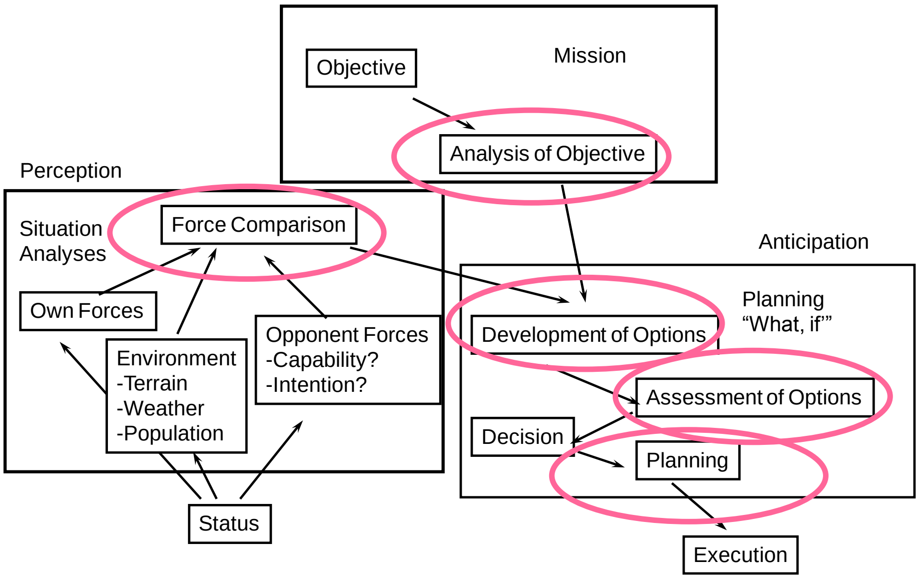

Figure 5: Decision Cycle.

Military-Scientific Co-operation

The defense system like any other complex living system or organism requires continuous adaptation. To this end, potential improvement options need to be continuously tested and compared with a view to their feasibility, effectiveness and robustness in a wide range of possible scenarios and taking into account all of the sensitive factors and their inter-dependence. However, as the human brain may only consider a limited number of system entities and interrelations simultaneously, modeling and simulation tools and methods are needed to support the planning, structuring and employment of forces. Since models permit account to be taken of the complex interactions of modern day combined arms combat and its synergistic weapon effects, simulation approaches do provide the required basic instruments. Yet, it must be borne in mind that any analysis does have its limitations due to very practical reasons such as, for example, the availability of data, time, and skilled personnel.

The Operations Analysis methodology, models and simulations are evolutionary in nature. The benefits of an evolutionary approach are many. Extensive involvement of users from the outset results in rapid design and introduction of a significant pilot capability. Collaboration with users in relation to design and testing and participation of users in games and experiments allow the Operations Analysis team to become familiar with functional-area activities. On the basis of continuous scientific research in

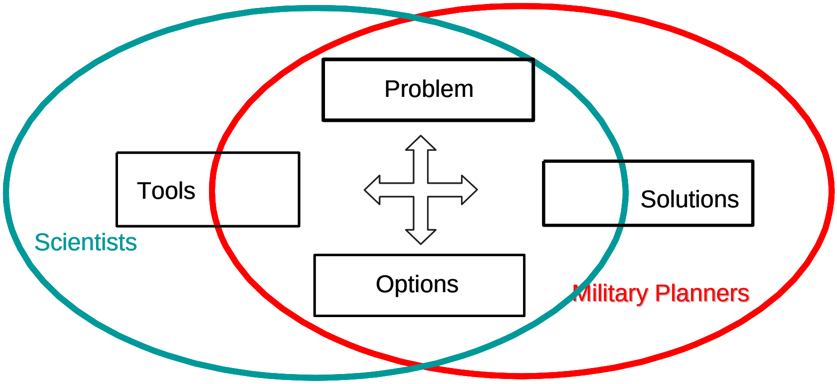

Figure 6: Joint Analysis.

operations, it is possible to develop a set of planning and simulation models. The interaction of these models with each other, using a common database, is the essence of the first demonstrated prototypes of model confederates, which can be used in games involving planners from the military, in experimental settings.

Planners who use models in operational environments require training. Model-assisted exercises need to be organized for this purpose and finally models can be used in connection with real-life operations.

All such uses of the methodology have resulted in fresh insights and identification of possible areas of improvement. These led to new versions of models and simulations.

The development and evolution should be handled by a single team consisting of military professionals and scientists, using basic Operations Analysis techniques. This has been important in providing the continuity needed to ensure progress. The most important conclusion to be drawn from this experience is that collaboration between military personnel and scientists is vital for the successful application of any model. Collaboration is most efficient when it takes place in the context of an interactive feedback loop that supports decision-making.

Transformation: A Vision

Many successful Operations Analysis tools and their application provide evidence that the rational, logical, quantitative consideration of facts results in better understanding of the phenomena of war and in improved operations and strategies.

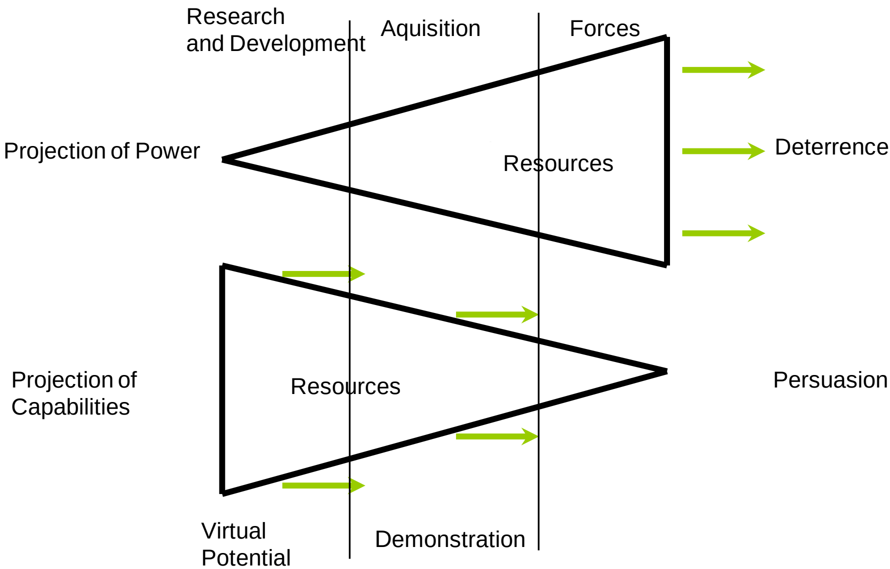

Figure 7: Deterrence-Persuasion.

In the past, defense planning was based, sometimes explicitly, on the view that the future would be much like the recent past. This perspective of the defense planning process caused the projection of power with the ultimate goal of deterrence and a huge amount of standing and deployed forces. Research and development are poured into one end and eventually their results appear as fully deployed systems at the other end. A common perception was that the value of research and development accrues only if and when fully deployed systems materialize. The amount of resources available for research and development were much smaller than the resources spent for the acquisition, maintenance and peacetime operation of manpower and equipment.

On the other hand, research and development creates value in and of themselves before any production or deployment. A developed and demonstrated potential to produce or deploy certain systems is a product in its own right and can provide options and hedges against an unknown future and mitigate the consequences of surprise. Also, the potential of future deployment can influence possible adversary's behavior. In effect, research and development cast a long shadow forward, its influence felt long before any deployment. In addition, there is a growing difference between what is technologically available and technologies actually embodied or required in deployed force structures.

In any case, these effects should be of interest for future defense planning and detailed quantitative analysis utilizing operations analysis methodology, modeling and simulation.

The increased emphasis on strategies, which deal with greater uncertainty of the future, as well as the need for projecting military potential leads to concepts, which could be characterized as virtual deployment of forces. The virtual deployment can be perceived by potential adversaries as capability long time before any actual deployment is taking place. It could include various stages of development, demonstration, prototyping and limited production. In the future, military competitions may be characterized more by development and by maintenance of such virtual deployed options than by deployed real systems. The virtual deployment in close relation to the growing gap between civil technology and deployed military technology will magnify an already existing trend, the reliance on and need for artificial experience, modeling and simulation.

Increased environmental concerns, smaller budgets and resource constraints have already motivated great interest in simulation techniques and capabilities. The interactions of new technologies embedded in future forces and of their counter- and counter-counter-measures, will not be well understood. Virtually deployments cannot be actually tested on the field. High fidelity simulation and training techniques used not only for deployed systems but to assess the interoperability of potential developments and virtual deployments, will increasingly be the tools of military planning and education.

In summary and quoting the war philosopher Sun Tzu:

> "To win without fighting is best."

Notes:

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[1] Sun Tzu, *The Art of War*, Translation and Interpretation by Thomas Cleary (Boston: Shambhala, 1988).

[2] Sun Tzu on *The Art of War*: An Intelligent Guide to Life Strategies and Wisdom, The Oldest Military Treatise in the World Translated from the Chinese by Lionel Giles, M.A. (1910).

[3] Philip M. Morse and George E. Kimball, *Methods of Operations Research* (1950).

KLAUS NIEMEYER was born in Bremen, Germany, in 1941. He left Gymnasium in 1958 and studied at the Physikalisch-Technische Lehranstalt in Lübeck and Hamburg, graduating as Diplom-Ingenieur in Technical Physics in 1963. During this period he worked also in industry, primarily with Entwicklungsring Süd, in the computing field. On graduation, Mr. Niemeyer moved to Boelkow Entwicklungen KG in Ottobrunn, near Munich, where he worked as system analyst in a team of U.S. and German scientists that initiated the German Operations Research activities for the German Ministry of Defense.

Mr. Niemeyer has had a long and distinguished career in Military Operations Research, Simulation and Computer Applications. In 1965, he joined the Industrieanlagen Betriebsgesellschaft mbH (IABG) in Ottobrunn with other German members of the above-mentioned team, and helped in establishing the Systems Analysis area at IABG. In 1966, he was assigned to US/GE advanced V/STOL-fighter assessment at the Wright Patterson Air Force Base in Ohio. As Project Leader he evaluated and analyzed airborne and airbase systems.

In 1969, Mr. Niemeyer was appointed head of a group working on optimal air force structures. In this role he developed and operated the first German computer-assisted exercise in 1970. This formed the basis for establishment of the IABG Wargaming Centre, of which Mr. Niemeyer was appointed Chief in 1972. In this position, he initiated the development of several concepts, models, approaches and solutions to assessment and evaluation of force structures, and helped in initiating international programs such as the US/German European Conflict Analysis Program (ECAP), and the Joint Simulation (JOSIM) Project. He has been responsible for many national and international studies in the areas of weapon system assessments, air and army structures, command and control, force effectiveness comparisons, arms control, conflict research, operational support, long-term defense planning, logistics planning, war gaming, exercises, and information systems support.

Mr. Niemeyer became Chief Scientist and Head of the Operations Research Division at the SHAPE Technical Centre (now NATO Consultation, Command and Control Agency) in May 1992. In this position he was the principal advisor on scientific matters and military operations analyses that affect SHAPE and Allied Command Europe. Among other projects, the Allied Deployment and Movement System (ADAMS), the methodology for the Defense Requirements Review (DRR) and the High Level Exercises have been developed in his area of responsibility. Mr. Niemeyer initiated and co-chaired the Steering Group on Modeling and Simulation and represented his organization in several other panels and committees within NATO.

Mr. Niemeyer retired from NATO in April 1999 and now he works as a consultant.