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Research Article

European Conflict Analysis Project (ECAP)

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ABSTRACT:

With this report I am describing a US-German project that was worked on from 1983-1992 and which, from today's point of view, seems to be worth revisiting in its essential points. The general goal of the project was to provide analytical support to decisions on the conventional defense capability of the NATO armed forces in Central Europe and the political-strategic debate on deploying medium-range nuclear missiles. An important aspect was the consideration of the paradoxical situation of a possible use of tactical-nuclear battlefield weapons with the associated escalation risks and the hoped-for deterrent effect in the strategic area. One of the foundations was the analytical use of quantitative simulation models and methods that were already relatively mature at the time for the reproducible calculation of a conventionally conducted attack of the Warsaw Pact with a likely focus on Central Europe. The main results were the type of cooperation and the structure of the analyses, the evidence of the usefulness of simulation models and, last but not least, the development of common goals, especially in phases of great upheaval such as the end of the Soviet system.

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Introduction

The topics of this report were highly sensitive in the period from 1983-1992 for various obvious reasons, in particular with regard to the ongoing public debate

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on armaments, including the deployment of nuclear missiles in Europe,[1] as well as the security classification of the data and concepts used. It can therefore be understood that practically no, or as few as absolutely necessary, written documents were prepared. The results of the analyses and simulations were presented directly at management level in the relevant ministries (Federal Ministry of Defense in Germany, Department of Energy and Department of Defense in USA). Since the implementing institutions were basically funded, it was possible to formulate the respective order for the implementation of the work in a simple and direct way and to make it dependent on the progress of the analyses. The coordination between German and US participants took place on the basis of general "Terms of Reference." The institutions on the German side were the "Stiftung Wissenschaft und Politik" based in Ebenhausen under the direction of Dr. Uwe Nerlich and the Wargaming Center of Industrieanlagen Betriebsgesellschaft mbH (IABG) based in Ottobrunn under the direction of Klaus Niemeyer and, on the US side, the National Laboratories (Sandia and Lawrence Livermore) and some basic financed analysis facilities such as KAMAN, RAND, IDA, etc. under the direction of Dr. Robert Rinne and Dr. Richard Wagner. Other experts were called in on specific topics on a case-by-case basis.

In recent years, Russia has demonstrated the tendency towards strong conventional armaments and threats to the Baltic states and has shown an aggressiveness, especially towards Ukraine, that the Western States of Europe and North America will not accept.[2] At the same time, the US demand for a more equitable distribution of the burden is being controversially discussed within the NATO countries and which is only judged on the basis of the percentage of GDP (Gross Domestic Product) spent on defense is not convincing.[3]

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[1] This concerns particularly the Intermediate Range Nuclear Forces (INF). The INF treaty on medium-range nuclear systems refers to a bundle of bilateral treaties and agreements between the USA and the USSR/Russia on the destruction of all ground/ land-based missiles with medium and short range (between 500 and 5500 kilometers). The treaty was signed on December 8, 1987 and, after ratification, entered into force on June 1, 1988. It has been suspended since August 2, 2019.

[2] The Russian threat on NATO's eastern flank can be countered by a variety of means, which work in international isolation and the economy as well as in diplomatic and military escalation. The philosophy of deterrence is also significant again. See for example the articles by Darrell W. Driver, Todor Tagarev, and Velizar Shalamanov, Pavel Anastasov, and Georgi Tsvetkov in the special issue of *Connections: The Quarterly Journal* on the current practice of deterrence, Winter-Spring 2019, https://doi.org/10.11610/Connections.18.1-2.

[3] In the security-political discussion in NATO, the US in particular points to the lower military expenditures of the European partners and urges them to make greater efforts. At the NATO summit in Wales 2014, the effort of 2 % of GDP was accepted, although there are considerable doubts about both the singular scale and the value. Huber (2002) provides a justification, but the essence of his article is essentially the conclusion that the European forces are developing into a uniform structure and thus become considerably more cost-effective. At the same time, the cyclical Defense Re-

This article is intended to show possibilities that were dealt with in international working groups during the time NATO was confronted with the Warsaw Pact (WP), trying to find solutions of the partly paradoxical problems of conventional and nuclear deterrence. The setup of joint working can in principle also be applied to the present-day problems as indicated. The possibilities are given by:

- Formation and commissioning of international working groups with experts from diplomatic, military and scientific fields. International is to be understood both within one's own coalition and with the adversary, depending on the problem.[4]
- Use of simulations and calculation experiments from Operations Research for quantitatively verifiable argumentation and finding common positions, in particular for the interface between the more qualitative-thinking political-diplomatic and the rational-military participation. The virtual modeling of possible contingencies opens up a multitude of options for avoiding real disputes with devastating consequences.[5]
- Expansion of the philosophy of deterrence with softer forms of convincing in all areas of mutual confrontation. This includes economic, information, armaments and directly military areas in the pre-phases to a military conflict.[6]

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quirements Review and the Defense Planning Process have been working for decades within the military NATO administration with a great deal of effort and in coordination with all partners to develop the nationally required contribution (cf. Sticz, 2010; European Parliament, 2018; Campbell, 2010). A demand for x % of GDP cannot be derived from this, apparently there is no coordination between political and military, rationally and methodically secured bases. See also the report by the Deutscher Bundestag, Wissenschaftlicher Dienst and the article by Karl-Heinz Kamp, both published in 2019.

4 In this article, in the section "Type of Cooperation." The type of cooperation in mixed political-military-scientific working groups for ECAP is described. The basically same approach was chosen in working groups of the USA, England, France, the Federal Republic of Germany (FRG) and the Soviet Union/ Russia during the period 1989-1993, with a clear contribution to mutual trust-building. See: Wagner, Rinne, Gold, and Sloss, January 1991; Rinne, July 1990; Rinne, July 1991; Nerlich, November 1990; Nerlich, June 1991; Niemeyer, 1990; and Niemeyer, 1993.

5 In the "Cooperative Simulation" section, the type of simulation models used is illustrated using the example of "AGATHA" and important principles of scientific analytical work, such as "peer review," are pointed out in an international context. See: Klaus Niemeyer, October 1989.

6 In the section "Principle of Long Shadow," the foundations and paradigms developed by Gold and Wagner for a soft deterrence and a corresponding armament planning are presented. See: Ted Gold and Richard Wagner, "Long Shadows and Virtual Swords," 1990.

These possibilities are related to a certain extent and should not be viewed as independent of one another. The joint use (development and application) of simulation processes is both the basis of one's own findings and a means of demonstrating catastrophic effects to the detriment of all those involved.

It has been shown, also through the project work described in this article, that projects of this kind pay off and contribute to pacification. This applies both to finding knowledge within one's own coalition and in intellectual discussions with a potential opponent. The project-work in ECAP was terminated by mutual agreement, as from 1989 the security and military boundary conditions changed fundamentally with the end of the Soviet threat and the existence of arms control agreements.[7]

From today's point of view, the results of the analyses are at best historically significant because the general political-military-strategic situation has changed considerably. Nevertheless, given the interpretation by Russia and the termination by the USA of the arms control treaties reached at the time, as well as the continuous threatening by Russia to the eastern countries of Europe, the issue is topical again. In addition, the experience and concepts that have been gathered when applying the analysis methodology are certainly still valid and significant in view of the significantly advanced technology.

Type of Cooperation

Between 1983 and 1992, meetings and conferences of the participants took place twice a year, alternately at the institute's locations in the USA and Germany, as well as in the respective ministries. Basic views, politico-military specifications for the studies and results of the national simulations were presented and exchanged.

Overall, ECAP has not developed any analysis products of its own. The results of the national studies were largely presented by the participants in the conferences and passed on by them to representatives of their respective governments. There were important exceptions, however. In the years 1984-85 the ECAP framework document was developed. In 1987, the exchange for the development and shared use of simulations was expanded. US and German simulations were carried out on the basis of a jointly developed, detailed scenario. In addition, ECAP began core research in 1988. These were studies designed to provide a framework for discussion of a particular area by defining terms and developing taxonomies, including measuring what is known, not known, and recognizable; linking to other areas, determining what the right questions are, etc.

By 1989, the conceptual framework for NATO positions was largely in place. The analysis focused on detailed defense problems. The analysis at the political-

7 The results of the cooperation within the framework of the ECAP agreements show that a continuation of the project would have been important. From today's perspective, a new beginning could and would be of enormous importance for the common goals in the area of NATO, the EU and, last but not least, national security.

strategic level had mainly to do with the political and deterrent effects of INF questions and Soviet options for attacks with very short warning times.

At the beginning, in 1982-1983p it turned out that a discussion and treatment of the topic could be advantageously supported by the use of the already partly existing systems analysis instruments and models. The systematic procedures, however, require a quantitative basis that was only available within the defense administrations of both countries. Since an exchange of data and models is required in a bilateral study, a formal agreement was required to carry out the joint study activities. This agreement was given by the "Terms of Reference" (TOR). A "Studies and Analysis" group (SAG) and a "Model Development and Exchange Group" (MDEG) were formed. The systems analysis work was coordinated, organized and carried out in the model group (MDEG). A control group—"Joint Steering Group" (JSG)—represented the ministries of the US and the FRG and was responsible for defining the tasks, policy coordination, general structure, allocation of resources and results.

In the SAG, contributions from nationally conducted studies were presented and put up for discussion. In these relatively freely organized and structured seminars and the exchange of ideas, joint solutions were developed and presented to the national ministries.[8]

In the MDEG, data was exchanged as far as possible and a network of simulation models was agreed and carried out. In a cooperative simulation application some results, which were also dealt with in the SAG, were worked out quantitatively. Evidence was provided that such simulations make important contributions to decision-making.[9]

Contingency cases and scenarios were developed to combine broad strategic thinking with detailed analysis. The following hierarchy provided a framework for ECAP planning:

- Conceptual framework:
  - geopolitical context, including the political/ military dimension of security challenges
  - NATO objectives
  - NATO strategy
  - deployment of nuclear and conventional forces
  - general purposes of arms limitation
- Development and description:

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[8] A doctrine of armaments planning is seen as an important contribution that is also significant from today's perspective – see Gold and Wagner, "Long Shadows and Virtual Swords," 1990.

[9] The collaborative study was carried out in 1986-1987. The benefits of using simulation models have also been clearly demonstrated with regard to the success of the development of digital computers and are therefore shown in more detail using the example of the "AGATHA" model. See Robert Mahoney, May 1990.

  - scenarios and contingencies
  - conflict phases
- Detailed analyzes, including requirements analyzes, conventional and nuclear concepts in the context of the scenarios:
  - armed forces' structure and deployment
  - total numbers and mixtures
  - detailed properties of individual systems
  - operational doctrine, use of weapons
  - declaratory policy and arms control positions
  - technology and production bases.

This broad analytical scope was a characteristic feature of ECAP. Within this wide range of analyzes, collaboration was carried out to develop and use large, detailed computer-based conflict simulations.

With developments from 1989 onwards, it became necessary to examine problems from a much broader perspective of the entire security environment, to take into account the greater uncertainty in this environment and also to try to use the newly offered possibilities. ECAP has always dealt mainly with issues related to a somewhat more distant future and only carefully selected current issues with current political implications. But the breakdown of the old conceptual framework required and allowed ECAP to look more closely at the political context: Some aspects became irrelevant or wrong. What was longer term became short term, and there were closer links across the analytical hierarchy.

So, under the new circumstances it became necessary to pay much more attention to the political boundary conditions. Accordingly, in the years that followed, ECAP carried out a number of activities related to understanding the emerging security environment and its political foundations, as well as dealing with the undoubtedly large remaining uncertainties. Some of the main themes were:

- the changing nature of relations with the Soviet Union, with greater prospects for cooperation
- lengthening the times for major conflicts to develop in Central Europe
- the changing nature of nuclear deterrence and the changing relationships between conventional and nuclear armaments
- the need to reformulate NATO's strategy in light of these and other factors.

General Results

The following basically atypical principles were agreed for the work and analyses; they have proven to be outstanding:

- The exchange of information took place relatively freely, but in compliance with the existing regulations on confidentiality and security

- The exchange of information was not mandatory, although it was possible for each official side to choose what it would find useful
- The analyses and discussions were exploratory, but within the framework of the agreed objectives
- Some studies were carried out bilaterally with the aim of promoting coordination between the United States and Germany as well as within NATO
- Participation was given by both official government agencies and institutes that were not part of the government
- A large and varied expertise from politics, the military, industry and science was covered, but with pragmatic compliance with financial and personnel limits
- The analyses were based on a comprehensive approach to the use of conventional and nuclear weapons technology
- The integration of conceptual and quantitative system analyses was aimed at.
- The use of ongoing studies was made possible.

Within the limits set, this has served to:

- broaden knowledge
- explain the respective national positions
- test new ideas
- identify emerging problems
- develop new concepts
- evaluate study results
- find integrated solutions to fragmented problems
- to build up better forms of agreement, and
- strengthen information networks.

In different ways, the analyses also dealt with how a change in the boundary conditions would affect defense issues in NATO. This has made it possible in a unique way to contribute to the understanding of defense issues in the changing political and strategic environment since 1989. Concepts and analysis results generated in ECAP have contributed to the reform of NATO through various channels. This concerned the understanding of:

- the complete Soviet withdrawal from Eastern Europe
- the growing importance of the pre-conflict dynamics
- the requirements for a timely and effective build-up of armed forces
- the interaction with crisis management
- the changing nature of contingencies
- the evolving justification for nuclear deterrence

- the development of potentially complementary relationships between different collective safety organizations, etc.

However, in order to remain useful, the scope and structure of ECAP should have been adapted to the new circumstances and needs.

It was intended that ECAP's collaborative modeling would provide much insight into the properties and use of nuclear weapon systems. However, since the attack scenarios on which the simulation analysis was based were no longer relevant, the detailed work was discontinued at the beginning of 1990. However, all parties have learned a lot about the interface between nuclear and conventional conflict in such simulations.

Cooperative Simulations

The studies to be carried out served to provide general, bilateral assistance for security policy decision-making. The analyses focused primarily on the interactions between conventional and non-conventional weapons for deterrence and defense in Central Europe. This included the evaluation of foreseeable developments regarding the function and effect of future weapon technologies.[10] The effect is to be understood comprehensively, i.e., deterrent, military, synergetic, collateral effect and strategic risks. The studies focused on the AFCENT area, which had the highest global density of WP/NATO military potential, and which was most likely for the deployment or application of future weapon technology. The starting point was the high perceived threat from the WP armed forces, both conventional and non-conventional. The operational and strategic goals of the WP were assumed as very threatening and persistent as a basis for the analyses.[11] In this situation, the desire and hope for a way out of the dilemma of contradicting security needs became clear: An attempt was made to cover the need for security against the very strong conventional military threat posed by the Warsaw Pact countries through a nuclear escalation risk that the WP considered incalculable, but thereby increased the security deficit in view of a possibly self-inflicted nuclear exchange. The search for ways out, namely to achieve one without risking the other, was the subject of much discussion.

The possible self-deterrence of the use of nuclear weapons makes the deterrence of the opponent from starting a conventional conflict questionable. With a conventional superiority of the WP [12] and the achieved nuclear parity, the considerations on conventional reinforcements had acquired a new meaning. It

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[10] An important starting point for the discussions was the doctrine of Follow-on Forces Attack (FOFA), Deep Strike, or interdiction of the forces of the second echelons of the Warsaw Pact (interdiction). See: Albert Wohlstetter, 1984; Philip Karber, 1984; Klaus Niemeyer, 1983.

[11] The evaluation of military planning documents of the German People's Army in the context of German reunification showed that the assumptions were very justified. See: H. Nielsen, June 1994.

[12] For a discussion of the conventional balance of power see Philip Karber, 1984.

seemed necessary to be able to prevent an attacker from achieving his strategic goals, even conventionally. From a strategic point of view, a conventional stalemate was basically a losing battle for the WP. In this sense, conventional improvements were conceivable in various ways, for example:

- fight in the depths
- reinforcement of the fight at the FLOT (Forward Line of Own Troops)
- area defense
- reinforcement of the reaction options on focal points.

The "Fight in the depths" was only one possibility, and it could not be ruled out that other concepts might ultimately be more effective. The replacement of nuclear weapons with conventional weapons, which were both aimed at the same target and were intended to achieve a corresponding militarily-relevant effect, and a calculation of the effect was therefore an objective of the detailed simulations.

Methodological Basis

The simulation method with the "AGATHA" model is described here as an essential basis.[13] This model was developed in the area of the Simulation and Wargame Center of the IABG for investigations on behalf of the Federal Ministry of Defense of Germany and used for analyses and studies of the defense capability in the AFCENT area.

The methods of system analysis have proven useful with the development of the possibilities of computer science and data processing for the support of decision making and planning and can also be used for analyses in the area of security policy problems. The simulation techniques and planning games are particularly suitable for this. It could be shown that the previous, largely qualitative studies, could be expanded to include essential quantitative aspects. The core of the system-analytical approach consists in the development and application of models that can be explicitly formulated and operated on computer systems. These models allow reproducible results at any time in so-called calculation experiments under a variety of changing assumptions and boundary conditions, and are therefore always accessible for discussion and change. They are made up of mathematical and logical relationships based on technical, physical or social knowledge and theories. A model can be seen as a virtual reality and is a representation of an existing, perceivable system or as a preliminary formation of a system that is to be planned and foreseeable in the future. The model allows the simulation of the system under consideration and the analysis of parameters, assumptions and arguments; it enables knowledge about sensitivity, trends and interrelationships of variables that are considered important. A

[13] AGATHA was developed and operated under the responsibility of the author. See: Niemeyer, "Preparing Defense Decisions by Battle Simulation and War Gaming," 1989.

model can thus allow new insights to be gained, but it must always be noted that it can never be better than the sum of all skills, experience and knowledge of the developers and users. Since empirical comparisons on real systems are also excluded in principle for models of the future, every opportunity should be used to check such models. An important possibility is the controlled but redundant development of models and data. Redundancy means the independent processing of the same model in different teams in different institutes, whereby competition from an economic point of view is excluded from the outset, but scientific competition is fully maintained. By control we mean that regular comparisons of the models are organized. Although redundancy leads to duplication of work and thus initially appears to be twice as expensive, on the other hand the probability of using a false or incorrect model is significantly reduced if both models, developed independently of one another, lead to the same or similar results under the same conditions. If the comparisons of results show differences, the cause can be investigated intensively and with a good chance of success. This leads to the elimination of the errors. In the end, redundant work on the models is cheaper and safer, especially given the importance of the issues considered here. In fact, this is the general philosophy of work in the sciences of nature.

The bilateral processing of the models in the USA and in the Federal Republic of Germany allowed the redundant approach, since a large number of suitable models were developed on behalf of the defense administration of both partners. In addition, it could be assumed that there was no economic competition, but that scientific competition was fully effective. The control was ensured by the joint organization of studies in the working groups (Fig. 1).

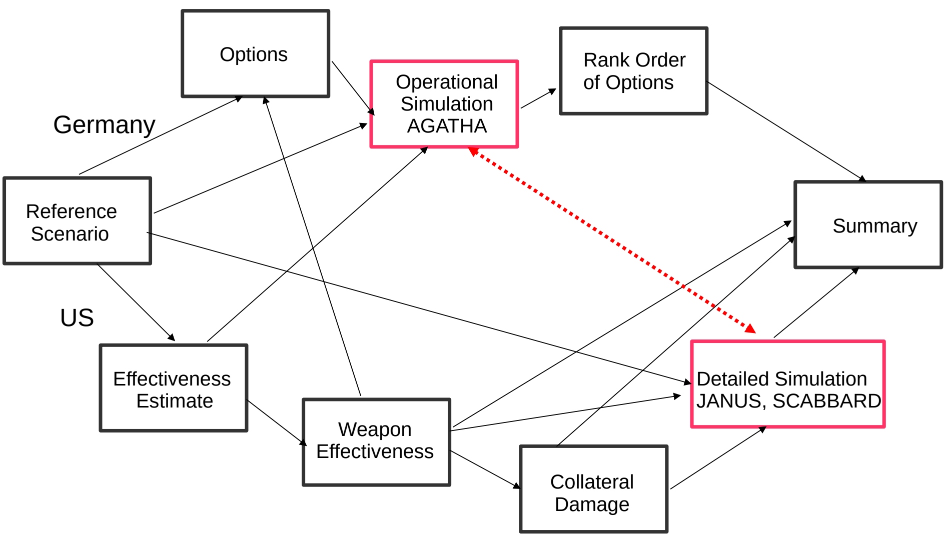

Figure 1: Dataflow Cooperative Simulation.

In addition, an exchange of data and models could be agreed in those areas in which the partner had gaps in data and models. The choice of models could bring a broad understanding of the most important elements, due to the use of complementary models in terms of resolution, database, methodology and measures of effectiveness, and could provide an overlapping and self-reinforcing framework that provided significantly greater insights than the exclusive use of a single model.

Objectives and essential elements

An initial objective for a system-analytical study within the framework of ECAP was defined in such a way that it led to initial results within a period of approximately 1-2 years based on the existing organizational, personal and financial circumstances. Furthermore, models that already existed or were already planned to be completed during this period were assumed (Fig. 1). The objective of the study was essentially determined by the agreed range of requirements and assumptions (scenario) and the number of questions to be answered.

The studies were generally characterized by a number of limitations resulting from the time and personnel available as well as from existing models and data. For this reason, from the possible and theoretically investigatable sub-questions and sub-problems, the most important ones in the assumed scenario were dealt with priority.

The scenario is the set of the most important assumptions and boundary conditions on which all model calculations are based:[14]

- The time horizon was 1992-1994. The time horizon should not go any further into the future, as both the assumptions about the threat and the technical development were too difficult to define. A shorter horizon would have made the results appear less relevant to planning.
- The geographical area was defined by Central Europe, i.e., the military area of responsibility of NATO, i.e., AFCENT/COMLANDJUT. The simulations were limited in the north by the coastline, in the south by the northern edge of the Alps, in the east and west by the respective ranges of possible weapon effects (depending on the type of weapon system). It was also possible to work with greater detail in some sectors, e.g., Elbe crossings, Fulda region, etc..
- The threat posed by the WP was also assumed for 1992-94 and updated accordingly. It was assumed that a WP/NATO political situation would develop which would lead to the WP's decision to attack NATO in an initially conventional manner in Central Europe with a focus on reaching the Rhine with the 1st Strategic Echelon. A tension period of several weeks would be clearly noticeable.
- The system-analytical work began with the start of the deployment of the WP armed forces. This led to the development of the military scenario. The

[14] This scenario was developed in 1986-1987 and intensively simulated in the study.

simulation calculations began in the context of the present study with the beginning of the first combat operations by the WP armed forces (D-day). The simulation was ended at a predetermined point in time, i.e. when a termination criterion occurred. The maximum time window, calculated from the start of the conflict (D day), was assumed to be 30 days (D + 30).

- The armed forces considered in the scenario or in the simulation included air and land forces of NATO and the WP. Naval forces were initially only considered insofar as they would have a direct effect on the fighting on land.
- The NATO armed forces were deployed in accordance with the current peace deployment and a possible general defense plan (GDP) for the target year. The forces were armed with conventional weapons and valid structures. Future weapons that were planned to be available by the target year were used as the basis for the simulations.
- The situation on the flanks of the conflict area under consideration was assumed but not simulated. The forces of the neutral states in the considered conflict area were taken into account.
- Movement and supplies to the armed forces have not been restricted due to civil traffic, subversive actions, and the like. The logistics were not explicitly represented in the simulation.
- For the simulation it was assumed that a very frequent meteorological situation was present. This was expressed in the weather with average temperatures, good visibility and the same day and night time durations (e.g. late summer).
- For the deployment of the armed forces, the following benchmarks of the scenario (short warning time) were assumed:
  - "simple alert" at D-48 hours (i.e. military warning time) [15]
  - "reinforced alert" at D-30 hours
  - "border crossing authority" for the air forces at D-0 hours.
- In the simulation, the communication between the command facilities was not explicitly shown.
- The NATO reinforcement forces from the USA and UK were introduced as quickly as possible. They were explicitly shown in the simulation if they appeared noticeably in the conflict area. The same applied to the reserves of the WP (2nd strategic echelon).

This basic scenario has been extensively tested and played. This resulted in a number of partial scenarios that built on one another over time and were therefore consistent in themselves.

[15] D means the time when military combat operations begin by the WP.

Assuming that the models of the AGATHA model family used in the simulation already allowed a closed simulation of up to six hours of conflict, then analyses could be carried out for 10 partial scenarios (with 60 hours of total conflict). Since these sub-scenarios were still subdivided into NORTH and SOUTH (II./IV. ATAF or NORTHAG/CENTAG), up to 20 scenarios emerged that could be used as a basis for further investigations. In a first step, these scenarios were viewed, assessed and selected with regard to their relevance for the ECAP questions so that they could be used as a basis for further analyzes.

The following important analysis elements could be defined, for example:

- Evaluation of events and decisions with regard to importance, inevitability, consequences, etc. For this, criteria were established and quantified.
- Use of possible, future conventional weapons. Did they have any measurable military effects? Which risks had to be taken into account? Which synergetic effects were observed?
- In connection with the NATO concept of "Combat in depth," a priority list of the target-types of the WP had to be drawn up, taking into account different time windows. The military effect of the target-destruction with regard to the effect in the immediate combat zone was to be taken as a basis.

The AGATHA Model

In the context of the studies, both in the USA and in the Federal Republic of Germany, models and data were used partly redundantly to one another, partly as a supplement. In the following, only the essential model parts in connection with the AGATHA model that were used are described. The type of model defined the quantitative values that could serve as a measure of the effectiveness of the various assumptions, variations and measures. Since the models were mutually checked, or should complement each other, a data flow had to be organized between the models and the institutes that operated the models. The data interfaces had to be defined and agreed. On the basis of the model calculations and the simulation experiments, it was then possible to assign the essential elements of the analysis to the parameters and the simulation experiments. A joint interpretation and documentation of the results was agreed.

The AGATHA (Aggregated Ground Air THeatre Level Assessment) model made it possible to map air and land warfare within the AFCENT/AAFCE framework. AGATHA made the following tasks possible:

- simulation of the interactions of combat between air and land forces in an appropriate resolution
- adoption of the given operational plans for six hours and determination of the resulting course of the conflict for six hours
- provision of all data and information in order to be able to assess the new situation
- preparation of the results for evaluation and presentation.

Some of the measurement parameters are listed below. In the course of the analyses and evaluations, they could be supplemented or combined with one another:

- strength of the land forces over time (number of essential weapon systems, division equivalents)
- strength of the land forces over the depth of the battlefield at certain critical points
- strength of the land forces over the width of the battlefield at certain critical times
- ratio of forces NATO/WP over the time, depth and width of the battlefield
- active proportion of forces over the time, depth and width of the battlefield
- ratio of forces NATO/WP of the combat active parts over time, depth and width of the battlefield
- force densities over time, depth and width of the battlefield (division equivalent / km^2)
- lost or gained area over time and the width of the battlefield (km^2)
- course of the FLOT (Forward Line of Own Troops) at certain critical points in time
- time duration between certain critical events
- strength of air forces over time (potential) number of essential weapons of certain categories, air attack equivalents
- strength of air forces over time, width and depth (numbers, air defense equivalents systems)
- availability of air attack forces over time (due to technical reasons)
- generated air attacks over time (tactical reasons)
- generated effect of air attack operations over time, depth and width of the battlefield
- generated effect of the air attack operations over the time and width of the battlefield (integration over the depth, i.e., effect on the FLOT).
- generated effect of the air defense forces over the time, depth and width of the battlefield.

The data flow was characterized by the alternating use of the models in the course of the analyses. In some cases, for pragmatic reasons, the models were used in parallel, and in some cases in sequence (Fig. 1). The following data interfaces resulted:

- sub-scenarios for SCABBARD [16] from the overall scenario; the Fulda area and the Elbe area were used for this

[16] The SCABBARD and JANUS models were developed and implemented by the US institutes.

- various sub-scenarios for JANUS from the overall scenario
- the results of the SCABBARD calculations had to be aggregated in such a way that they could be used as input data for AGATHA
- results of the AGATHA simulations were specifically evaluated for the models SCABBARD and JANUS.

The variation of a number of assumptions were to be further specified in the course of the analyses. The following variations were planned (only in the context of the relevant sub-scenarios):

- change of the decision points in the sub-scenarios
- availability of new (conventional) weapons, e.g., for combat in depth
- change of basic operational assumptions, e.g., amount and location of the focal areas of the land forces, or focus of the air force on certain types of operations, etc.

These variations were no longer implemented, however, as the security policy situation had changed fundamentally in the meantime and the assumptions made for the basic scenario were no longer valid.

Some Results of the Simulation Experiments

The main conclusion of the evaluation was that in all variants of the base scenario examined, the number and mix of weapons deployed had significant beneficial military effects. In particular, the breakthrough that occurred in the base case simulation was prevented by defeating the forces of the first echelon and re-establishing the initial FLOT before contact was made by the second echelon. The air performance of four ATAFs was retained on all excursions examined. Much of this success was due to the timing of the operations, carried out at a time when NATO still had sufficient combat capabilities to allow a coherent defense.

Target priorities in the investigated cases were air force bases, second echelon forces and first echelon forces. These priorities are necessarily scenario dependent.

Additional findings that emerged from the analysis were:

- Synergy effects were decisive for the success of the simulated options. The success of counter-attacks by NATO land forces depended on operations against air bases and armed forces of the second echelon. Lockdown operations reached the required level of casualties and delays in the WP armed forces.
- There were opportunities for accurate targeting to reduce and largely avoid collateral damage.

The focus of the discussion was on two facets of the collaborative study:

- the variety of inputs and resources used in the study efforts

- the use of effectiveness metrics that measure the military effectiveness of options (i.e., their impact on the conduct of simulated operations) as opposed to the more common counts of the number of targets destroyed.

In order to discuss the relevance of study results for a future planning environment, several suggestions were developed:

- With a lower density of forces, target acquisition, command and control capabilities can be of significantly greater importance.
- If Soviet forces have to travel considerable distances before coming into contact, new logistical systems (with new types of interlocking facilities) are required.
- With a lower density of forces, the mobility of the defense forces becomes considerably more important, since the defense forces have to be quickly brought into counter-concentration.

Ultimately, the study team concluded that a foundation was created for future collaborative modeling efforts. The first cooperative ECAP study led to a common understanding of the modeling strengths and limitations of each participating national organization. The participants recommended encouraging and supporting further collaborative analysis.

Principle of the "Long Shadow"

With the elimination of the direct conventional-military confrontation in Central Europe after 1989, a completely new situation arose for the analyses within the framework of ECAP. In the military-political considerations in particular, fundamentally new approaches had to be found, some of which were used in NATO for the definition of new objectives, planning and structural adjustments. An important contribution was the proposal, known as "Long Shadow," which is briefly presented here in its essential cornerstones.[17]

A Paradigm Shift

In general, the defense planning was largely based on the view that the future would be very similar to the recent past (Fig. 2). This perspective of defense planning created a large amount of standing and possibly deployable forces with the ultimate goal of deterrence. Research and development of the weapon systems was at the beginning of this process and the results were ultimately the fully implemented systems at the other end. A common perception has been that the value of research and development only increases when fully implemented systems are available. The financial resources available for research and development were much less than the resources used for the acquisition, maintenance and operation of personnel and equipment.

The history of war has shown time and again that the results and successful concepts of the previous period have been adopted. However, when new tech-

[17] Gold and Wagner, "Long Shadows and Virtual Swords," 1990.

nologies have been adopted by adversaries, these concepts have often proven to be disadvantageous.

During the Cold War decades, NATO defense planning was based, sometimes explicitly, on the view that the future would be very similar to the recent past. The constant was a Soviet Union that supported their position with large standing forces and used them often enough that a threat was always perceived.

Of course, the weapon systems procurement process must be efficient in order to provide the required systems on site. However, it is widely believed and used as the basis for decisions that the procurement process should lead linearly to the amount of systems deemed necessary for defense. This tendency seems to be as widespread among the public as it is among the responsible departments. A common perception has therefore been that the value of research and development only exists when fully implemented systems are available. Funds spent on systems that have not been provisioned are often viewed as wasted. Programs that do not go from production to deployment are considered errors. This perspective of procurement in the sense of a follow-up process has also distorted the view of the provision of funds itself.

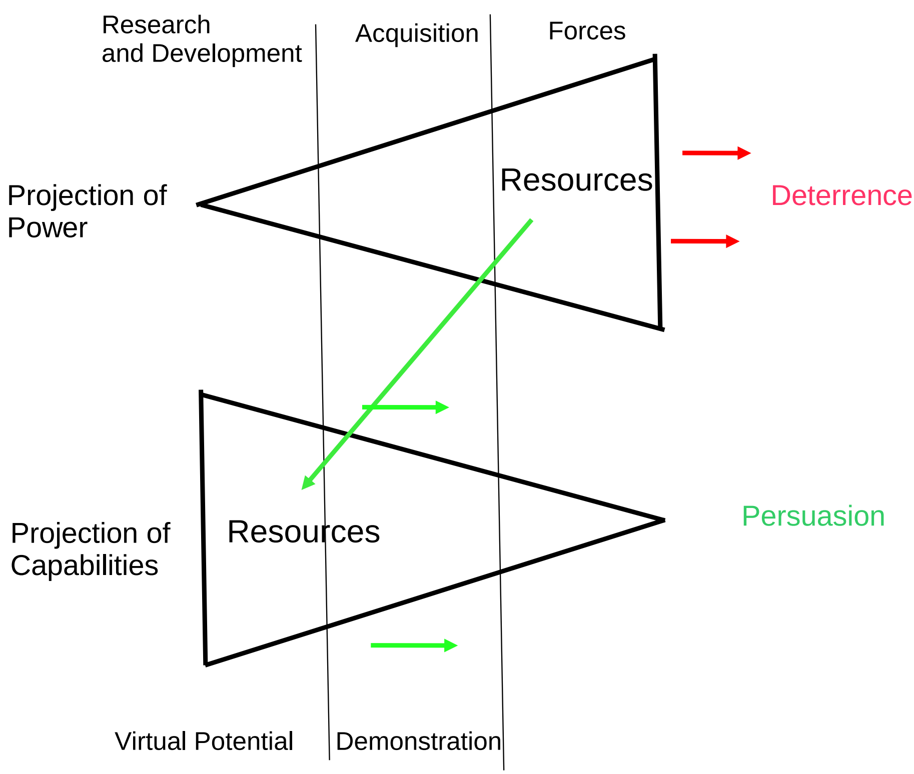

Figure 2: Paradigm Shift.

The defense acquisition process, which is dominated by this classic approach, is not well suited to dealing with the larger uncertainties. Nor is it well suited to meeting the needs arising from the importance of arms control as an element of the security situation. Verification and protection measures play an essential role in managing the risks associated with arms control agreements. Both of these functions help prevent non-compliance. Protective measures also mitigate the effects of fraud and contract termination. Safeguards include maintaining the ability to design, test, manufacture, or deploy certain systems, both as a deterrent and as a safeguard.

On the other hand, research and development creates value in and of itself before any production or procurement. A developed and proven potential for the production of certain systems is an independent product and can offer options and safeguards against an unknown future and mitigate the consequences of surprises. In addition, there is a growing gap between what is technologically available and the technologies that are actually included or required in deployed armed forces.

There are also essential values and results of research and development as well as technology and the industrial base that go beyond the provision of the systems. In addition, there are diverse results and products that arise in the civil sector and that can be used directly without great effort.

Knowledge is an independent product that offers options and safeguards against an unknown future and mitigates the consequences of surprises. Knowing this, the potential of a future deployment can influence the behavior of possible opponents: creating incentives for arms control, advising against fraud and breach of treaty and convincing them now or at a later point in time that they would have nothing to gain by resuming or developing a military structure and threat. In fact, research and development casts a long shadow forward in terms of time, the influence of which is noticeable long in advance.

The increased emphasis on strategies dealing with greater uncertainty of the future, as well as the need to project military potential, lead to concepts that could be characterized as virtual deployment of forces. Virtual procurement can be perceived as a skill by potential opponents long before it is actually implemented. It can include all phases of development, demonstration, prototyping, and limited production. In the future, military armaments can be characterized more by the development and maintenance of such options, which are provided virtually, than by the use of real systems. Virtual deployment, closely related to the growing gap between civil and military technology, will add to an already existing trend, dependency, and need for artificial experience, modeling and simulation.

Growing environmental concerns, smaller budgets, and availability of funds have already sparked great interest in simulation techniques and capabilities. The interactions of new technologies that are embedded in future military structures and their countermeasures are thus better understood. Realized systems can often no longer be tested in a real environment. Simulation and training techniques, used not only for deployed systems, but also to assess the interoperability of potential developments and virtual procurements, will increasingly be the tools of military planning and training.

A nation's military potential is its ability to develop actual military forces at a later date. Many ingredients can contribute to the military potential: trained and trainable personnel, natural and material resources, technology and production bases as well as a military infrastructure that can accommodate an expansion in a timely manner.

In the existing security environment—with fewer immediate major military threats, but relatively great uncertainty about the future—the dependence on standing forces can be reduced and the military potential can be given a correspondingly larger role. Such a strategy not only protects against uncertainty, but can also help to shape and stabilize the future by influencing possible opponents and advising against incalculable adventures.

A Possible Realization

Two properties are necessary for the long shadow to work: Rationality and long-time horizons. The first is essential to an object of any deterrent strategy; the second shows that there should be no time problems to enable the realization of potential.

The military paradigm of the Cold War years, which was anchored in the high concentration of troops, could be described as the "attack paradigm."[18] It is characterized by large standing forces that can attack or defend in days or weeks. A "mobilization paradigm" is a concept of smaller standing forces, most of which are less operational, and which takes several months to prepare for very large offensive operations. A "rearmament paradigm" is a concept in which there are even fewer standing armed forces and which takes years to produce equipment and mobilize the armed forces necessary for larger offensive military operations. Together with the extended preparation times and smaller forces, there may be shifts in the direction of military forces with properties that are less suitable for large-scale offensive actions.

Such a long-term development of forces can be seen when political relations deteriorate. This seems desirable, although risks remain. Longer periods of preparation for conflict do not guarantee peace. Likewise, longer warning times do not guarantee that the warning notices are observed. Dealing with such uncertainties remains an inescapable responsibility of defense planning. In a rearmament paradigm, however, a highly developed economic base could greatly benefit nations if signs are responded to in a timely manner.

An armaments strategy with a small armed force would lead to a policy which, at a later date, could achieve a considerably higher level of military capability. A reconstitution policy embodying such a strategy would have several components: technological and production bases, natural, material and financial resources, trained and trainable personnel, and a military infrastructure

[18] Gold and Wagner, "Long Shadows and Virtual Swords," 1990; Wagner, Richard, „A Path to Enduring Improvements, 1990.

that can accommodate expansion in good time. It would also require strong information gathering and clever information analysis capabilities. One criterion for the success of a reconstitution strategy would be its ability to prevent the mobilization or rearming of potential opponents through the prospect that a competitive reconstitution cannot fail.

Another element is a growing difference between what is technologically available and the technologies that are actually included in the force structure deployed. This divergence was smallest at the end of World War II, when virtually everything that could be done in military technology was done. The difference has increased steadily over the past few decades.

A "virtual armament" is therefore a function that is activated some time before an actual procurement—months to several years—and then archived in order to be retained in this (or a time-varying) state of future feasibility.

Virtual procurement could take several forms. In some cases, it may be appropriate to maintain a development and demonstration program over time and to introduce new technologies into an evolving architecture over time. Some systems could go through several generations in their development, with each generation moving from concept development to a phase without full production and real procurement. The production of prototypes would also play an important role in learning about manufacturing problems and / or providing some systems. The resulting practical experience would have an impact on later development as well as on changes in education, training, roles or tasks. In some cases, a data package with production specifications could be prepared but archived.

The virtual procurements would be used to define the scenario, where your own virtual procurements can block or channel a potential adversary's procurements. The ensembles of actual and virtual procurements would have a complex deterring interaction. A deterrent would not only be the deterrence of the armed conflict, but also the deterrence of mobilizations or certain operations.

Not only must new technologies and concepts continue to be developed, but also skills to convert concepts into specifications and specifications into real systems and to bring these systems into operation.

The ability to assess the military potential of global technology is also required. Assessing the technology will be particularly important and increasingly challenging as in-house research and development is only a small fraction of the global total. In particular, the reconnaissance must enable the mapping and analysis of the capabilities of other nations to project military potential, including their basic and applied research, as well as the early stages of system development. Some of the information needed is certainly available in the published literature, but further efforts are needed to examine the awareness gap, the interval between published research and the time when systems development projects reach observable test stages.

Of course, virtual procurements cannot be tested in a real conflict. Simulation and training techniques, which can be used not only for deployed systems, but also to evaluate the interaction of potential developments and virtual procurements, will increasingly play an important role in the military economy.[19]

Maintaining capacity in times of reduced forces will be more of a challenge. One key to achieving this is for the defense administration to make much greater use of commercial products and capabilities. This implies a significant change in procurement practices to bring them closer to those of the commercial sector. In some areas (e.g., communications and electronics, certain aircraft, software, logistics, etc.) the commercial sector is able to provide much of the skills required. For direct combat systems (warplanes, submarines, tanks) – there are no skills in the commercial sector. Even with this, however, commercial products and functions can be used more at the subsystem and component level.

Conclusion

In this article it is shown that a project like ECAP can contribute in several respects to the solution of today's international problems in common interest and can be used meaningfully. International cooperation, incorporating modern information processing techniques through simulation, models and quantitative methods of operations research, in addition to qualitative assessment in diplomatic processes, can lead to new approaches to conflict resolution and pacification. In the ECAP project it was shown that an intensive discussion of all aspects in the form of joint "brainstorms," detached from national administrative restrictions, can open up new paths. In addition, the use of quantitative, rationally justified techniques leads to common knowledge and forms a good basis for trust and a starting point for legitimate agreements. The example of an armament concept, as described in the section under "long shadow," could lead to an overall more stable military security and avoidance of arms races, especially with the help of simulations in the sense of a virtual soft deterrent strategy.

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[19] The use of simulation processes and models in joint analyzes with potential opponents can make a significant contribution to building trust and making the assessment of the situation more rational. Joint simulations were carried out with representatives of the military-political staff of the US / UK / GE and the USSR in Joint Simulation Conferences (JOSIM) in the period 1990-1992 and should have contributed to building confidence in the upheaval that took place at the same time. See: Klaus Niemeyer, "A Note on Joint NATO/WP Gaming: No Longer a Utopian Proposal?"

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About the Author

Klaus **Niemeyer** was born in Bremen, Germany, in 1941. He 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.