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14. ABSTRACT

The Symposium addressed the contribution of analysis to defence transformation. The goal was to provide a forum through which the military may express their transformational needs to the analytical community, highlight the need for analysis in the transformation process, share information amongst analysts, and to stimulate new ideas and initiatives on how analysis can enhance transformation. In particular, the objectives are to:

- Share experience from the implementation methods and tools and latest research results in support of transformation and management in the new security environment

- Enhance the body of knowledge of related concepts, methodologies, methods, and tools

- Promote the implementation of objective, rational decision-making frameworks

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Analytical Support to Defence Transformation

(Le soutien analytique à la transformation de la Défense)

Papers presented at the Systems Analysis and Studies Panel (SAS) Symposium held in Sofia, Bulgaria, 26-28 April 2010.

Published April 2010

The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Technical Evaluation Report

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OVERVIEW

The SAS-081 Symposium on "Analytical Support to Defence Transformation" took place in Sofia, Bulgaria in the period 26-28 April 2010. It brought together 90 participants from 19 NATO and partner countries. The symposium final programme featured 33 presentations, structured around five main themes: General topics; Defence planning; Acquisition; Concept development and experimentation; and Analysis of current operations. 31 of the scheduled presentation, including two keynote presentations were made, each followed by a vigorous discussion.

This Technical Evaluation Report summarises core ideas, identifies trends, good practice and gaps in analytical support of defence transformation. It provides an overview of the discussions and presents recommendations to NATO and national authorities and the leadership of their analytical organisations.

1.0 INTRODUCTION

The symposium addressed the contribution of analysis to defence transformation. It provided a forum for military and civilian officials to express their transformational needs to the analytical community, to share information amongst analysts, and to stimulate new ideas and initiatives on how analysis can enhance transformation. Practitioners and analysts were able to discuss experiences from the implementation methods and tools and latest research results in support of transformation. The symposium facilitated the enhancement of the body of knowledge of related concepts, methodologies, methods, and tools, the implementation of objective, rational decision-making frameworks, and the identification of key implementation challenges and priority research areas.

This report preserves the structure of the symposium programme, with slight reformulation of the main topics to reflect the actual presentations and highlights of the discussion. Thus, the following five sections of the report reflect the themes of the five symposium sessions. Section 2 presents general analysis issues with focus on main transformation areas and their intersections, including the role of partnerships, and the interaction between analysts and decision makers. Section 3 outlines the main challenges in providing analytical support to current and future defence planning. Section 4 treats the analytical challenges in providing for efficient and well coordinated development of main capability components, while Section 5 looks at the advances in concept development and experimentation. Section 6 treats current challenges in providing analytical support to ongoing operations, including the enhancement of lessons learned processes. The final section presents an attempt to formulate some enduring challenges to the provision of analytical support. The report concludes with selected recommendations to leadership of the defence establishments and senior members of the NATO analytical community that, in the opinion of the author of this report, may serve to organise future studies in support of transformation.

2.0 GENERAL ANALYSIS ISSUES

This section presents recent senior views on defence transformation, the main transformation areas and linkages among them, roles of the analytical community, and some recommendations on shaping OA research programmes.

2.1 Transformation Challenges

There is no single, generally accepted definition of defence transformation. Contributors to the symposium used different definitions, referring to NATO's new missions, operational concepts, capability requirements, organisational structures, training and force development approaches.

The 2010 edition of the NATO Glossary of Terms and Definitions defines transformation as a "*continuous and proactive process of developing and integrating innovative concepts, doctrines and capabilities in order to improve the effectiveness and interoperability of military forces*" [1]. In a recent discussion on the new NATO Strategic Concept, Secretary General Rasmussen said that the Alliance transformation is about improving NATO's working methods and preparing better for the future:

> We must face new challenges. Terrorism, proliferation, cyber security or even climate change will oblige us to seek new ways of operating. And in a time of financial and budget constraints, we need to maximise our efficiency within limited resources. [2]

During the same discussion, Dr. Madeleine K. Albright—leader of the group of experts that prepared a report to the North Atlantic Council with analysis and recommendations on the new NATO Strategic Concept—emphasised that NATO must adapt to the changing times:

> NATO can neither slow the pace of change nor ameliorate the quick-silver quality of modern events. But if Allies are truly dedicated to their shared tasks, it can be a reliable and predictable means for coping effectively with unpredictable threats. [2]

Uncertainty is also emphasised by US Secretary of State Hillary Clinton, stating in February 2010 that "we face a new strategic landscape. New technologies, new adversaries, and new ideologies threaten our security. And once again, there is little certainty about the future" [2].

Reviewing some historical examples, Roger Forder emphasised in his plenary report that the current wave of transformation is not as unique as it may seem [P 02]. On many occasions, leaders—utilising new technologies, innovative strategies, or combination of the two—have been able to achieve dramatic improvements in the face of novel threats or to take advantage of emerging opportunities. Accepting that as a historical fact, for the purposes of the current report we emphasise three features of the current wave of defence transformation:

The first feature is *agility*. In the face of uncertainty, alliances, nations and defence establishments have to become more agile, to be able to adapt quickly to changing security requirements and resource constraints, to exploit technological opportunities, to take advantage of new business models. Agility turns into a capability of its own right. Defence establishments face the challenge of introducing capability planning and development processes, resource allocation norms, and organisational culture that enhance the ability of the organisation to adapt to changing circumstances.

The second feature is *efficiency*. It is not enough to demonstrate that military forces are effective, i.e. that they are able to conduct successfully the range of operations envisioned in alliance and national defence policies. Parliaments and the public have to be convinced, that the resources allocated to defence are utilised in the most efficient manner. Defence establishments are under constant pressure to streamline

organisational processes, to introduce novel business models, to benchmark their performance in the development of all capability components to best practice, doing all that in a way that is fully transparent to decision makers in government and parliament. On the other hand, decision making processes in democracies may be rather complex, thus posing an additional challenge to achieving agility of defence establishments, in particular in times of budget cuts as in the current economic and financial crisis.

Third is the role of cooperation and *partnerships*. NATO nations cooperate in various formats, in some cases including also partner nations, in procuring defence capabilities. Also, NATO interacts with partner countries in operations in many hot spots around the globe. Thus, interoperability remains a challenge, and that includes terminology, decision making principles and processes, operating procedures, technical standards, organisational culture, etc. In addition, what matters are not only the operational capabilities, but also the institutional capacity of partners willing to share with NATO the responsibilities for their own security, for enhancing regional security and, in some cases, addressing global security challenges.

2.2 Transformation Areas and Main Analytical Links

NATO nations, as a rule together with partners, are involved in diverse operations. The most prominent among them are the operations to counter terrorist networks, potentially with a global reach. The understanding of these operations evolves, and that is seen in designations like "irregular warfare," counterinsurgency (COIN) operations, "hybrid warfare," Stability, Security, Transition, and Reconstruction (SSTR) operations, etc. Both policy makers and operational planners understand well that the desired end state in such operations cannot be achieved with kinetic effects alone. To be successful, the military forces, cooperating in a network manner with other government agencies, international, non-governmental and business organisations, have to address root causes and provide certain effects on the opponents, their support base, and the population. Hence, two concepts attract the prevailing attention of decision makers and analysts – effects based approach to operations and network enabled capabilities.

Both concepts impact the operations planning process. They also drive the capability planning process, and the capability requirements review in particular. Operational concepts impact—albeit indirectly—the processes of delivering capabilities through coordinated management of organisational structures and processes, people, materiel, infrastructure, and training. Finally, these and other supporting concepts are refined, tested, and eventually validated in the process of Concept Development and Experimentation (CD&E).

All these were addressed by symposium participants as stand alone issues, but also in their interaction. The symposium also addressed the technological aspects of transformation, going beyond the analytical challenges of procurement and R&D management. New technologies are the most frequent driver of defence transformation, although it is not the only one nor is it sufficient. Of particular current interest is the topic of non-lethal weapons (NLW), defined in the 1999 NATO NLW policy as weapons "explicitly designed and developed to incapacitate or repel personnel, with a low probability of fatality or permanent injury, or to disable equipment, with minimal undesired damage or impact on the environment." Analysts agree that the challenges and opportunities created by NLW technologies are most appropriately studied within context change, e.g. through alternative futures analysis, as well as along with relevant changes in concepts, organization or technology, e.g. implementing ideas from trend analysis and game theory [P 28].

2.3 Roles of the Analytical Community and Interactions with End Users

The symposium participants agreed that the field of Operational Analysis (OA) can be considered to include those professionally trained analysts that are experts in applying rigorous, structured, scientific methods to understand complex problems to assist decision-makers within the military domain with independent advice [P 35]. This analytical community has a role in addressing all transformation challenges. It not only supports the respective decision-making processes, but also serves as a pool of

knowledge and experience and a conduit of ideas, critical evaluation and good practice across transformation areas. For example, on the practitioners' side, the communities of operations planners, capability planners, acquisition, infrastructure, programme managers, trainers and experimenters are rather distinct, and the military officers are assigned in respective positions for a relatively short period. On their side, and in addition to traditional decision support roles, analysts are often assigned for longer terms, they are used to exchange information with peers from national OA/OR organisations and internationally, to benchmark experience and facilitate the introduction of best practice.

Notwithstanding these advantages, the interaction with end users—primarily decision makers—is particularly challenging. Often analysts do not have the luxury of intense observation and undisturbed contemplation. Instead, they have to tailor ruthlessly the analysis to the time scales and method of work of the decision maker. And that is particularly important for advice in theatre. Roger Forder calls this 'tyranny of time', noting that the utility of the analytical tool is tied to time. As a result, advice is often sub-optimal. Even so, based on his rich experience he counsels that "a timely advice is better than no advice" [P 02].

For years analysts have been able to learn from the experience of their professional community – what works, what does not, how to interact with decision makers, and so on. One observation from the symposium discussion raises concerns in that respect – recent organisational changes in NATO HQs lead to dispersion of operational analysis and may not guarantee the professional standing and development of adequate OA practices [P 35].

Han de Nijs from ACT emphasises that there is a large and established body of people whose profession is the application of scientific and structured analysis to support decision-making in various fields in defence. NATO and nations can benefit from a well established professional community with the following main goals [P 35]:

- Promote a professional identity that is recognised by customers and self-identified;
- Education, training and professional development;
- Networking;
- Collaboration on a project basis;
- Technical development, to include identification and definition of shared theories and concepts; best practices and setting technical, ethical standards and values; and mechanism to share (and validate) work of common interest to members of the community;
- Identification of issues of future importance;
- Community support to include representation, moral and social support, rewarding and recognising achievement.

2.4 Enhancing NATO Partnerships

The community of analysts within NATO and nations may serve as an efficient conduit of good practice and other know how to more recent NATO members and to willing partner countries. The exchange of information and experience facilitates the increase of interoperability within the alliance and with partners through better understanding of context, terminology, methods, measures, and implementation challenges. That encompasses all main areas of analytical support, including support to operations, lessons learned, capability planning, capability development, concept development and experimentation. Particularly important for new NATO members is the learning experience of how to organise OA research and to provide analytical support.

Interactions of analysts help to set the stage for multinational capability development and R&D projects among NATO and other partner networks, thus increasing efficiencies and alleviating the impact of shrinking defence budgets in the current economic and financial crisis.

Norway provides an example of analysts assisting the establishment of analytical capacity in support to defence planning in partner countries. Such efforts improve communication, contribute to defence institution building in partner countries, and may prove to be a very cost efficient contribution to the increase of interoperability of partner forces and their contribution to NATO operations.

This is just a sample of examples, showing that the analytical community contributes to all main areas of the Alliance transformation.

2.5 Shaping OA Research Programmes

Symposium presentations and the discussion facilitate the understanding of how to shape an OA research programme. One recurring topic was the search for adequate definitions and taxonomies. According to Sue Collins and Simon Purton, NATO definitions are frequently ambiguous and vague, derived through a consensus among parties with different views [P 08]. This has hindered, inter alia, the analysis of requirements for expeditionary operations in the SAS-075 study. The authors of the report have used General Morphological Analysis as a method to structure this 'wicked' problem and to consider potential solutions. They have created an interactive, dynamic tool based on a Morphological Table to capture expert opinion. Then they eliminate non-valid combinations of scalars in the table that may result from logical contradictions, empirical inconsistencies, or normative constraints. Data mining techniques, i.e. a classification tree, and standard statistical analysis software are used to identify predictors and build rule sets that model different problem definitions or solutions to the research question. This method is considered of potentially wide utility within NATO and national capability development domains [P 08], thus increasing the transparency within NATO.

Anton Minkov from Centre for Operational Research and Analysis at Defence Research and Development Canada provided another example of analytical support to increasing transparency of national and Alliance planning [P 05]. The author presented an analytical framework for assessing security and regime stability that is based on a correlation between several demographic stress factors and accounts for GDP per capita and unemployment rates, as well as for the presence of ethnic or sectarian tension. Studying open source data for 15 Middle East countries, the author assesses the probability of demographic growth to result in regime changes or democratic reforms based on a correlation between the strength of the youth cohort and the regimes' ability to retain power [P 05]. This can be seen as an example how rigorous analytics can make planning assumptions and scenarios—planning situations, alternative futures, or both— and thus the defence planning process more transparent.

The symposium discussion increased the understanding of analytical requirements. OA research managers and senior analysts need to understand current and anticipate future requirements in order to shape national OA research programmes. One trend is the increasing demand for soft OA support, addressed briefly in section 7 of this report. In addition, they need to keep a picture of the potential contributions of the analysts *vis a vis* the currently available analytical capabilities [P 02]. Given that demand for analytical support usually exceeds the available capacity, a better understanding of gaps in analytical capability could lead to an increase of the exchange among peers from allied and partner nations and the international cooperation in OA/OR programmes and projects.

3.0 ANALYTICAL SUPPORT TO DEFENCE PLANNING

The presentations and the discussions during the symposium supported the thesis that Capability-Based Planning (CBP) has already turned into a "gold standard" for the defence planners in NATO, NATO

nations, and many of the partner countries. CBP is already solidly situated at the core of national force development processes. In all presented instances, CBP approaches utilise scenarios,[1] or "planning situations" in the official NATO language, attempt to distinguish between capability requirements and respective organisational and/or material solutions, and seek the answers within more or less strict resource constraints framework with understanding of risks. This trend was boosted with the introduction of the new NATO Defence Planning Process (NDPP), its methods, tools, and terminology.[2]

This section of the report draws heavily on Dr. Alan Campbell' report [P 09], summarising the findings of the workshop on the *Analytic Implications of the NATO Defence Planning Process*, conducted by the SAS-081 Specialist Team at the NATO Consultation, Command and Control Agency in The Hague, The Netherlands, 2–4 March 2010.

3.1 The Use of Scenarios

The use of scenarios is already recognised as being indispensible in capability-based planning. Scenarios serve three main purposes.

First, through scenarios defence policy makers and planners make explicit various assumptions underlying national—as well as allied—security and defence policies and high-level guidance. Typically, high-level guidance defines roles and missions of the armed forces and provides broad description of future security environment, without explicitly defining defence planning scenario sets. Scenario sets are developed subsequently to span the spectrum of roles and missions of the armed forces, as defined in high-level policy or guidance [P 09].

Second, the use of scenarios enhances the credibility of the planning effort. It provides a framework that is considered adequate for exercising military judgement, offers a quantification tool, and maximises analytical rigour and traceability [P 09].

Third, scenarios provide a common framework for planning across different defence domains, or capability components, and enhance the understanding of interactions among capabilities. Thus, the use of scenarios is helpful in penetrating organisational boundaries and overcoming service biases.

This feature is potentially important in a broader security setting, and attempts have already been made to utilise it. One application area is the allocation of requisite capabilities and the coordination of capability development among national security sector organisations [5]. Likewise, in operations with the military in a lead role, such as the ongoing operations in Afghanistan, the use of common scenarios in the planning phase provides for better understanding of requirements to and by all contributors involved in the operation, including international organisation, aid and other non-governmental organisations, and private security companies.

Nations with well established defence planning processes recognise the advantage of using generic scenarios to reduce political sensitivity and potential security classification. Nevertheless, the benefits of scenario-based assessments are maximised with the use of real-world scenarios, thus increasing fidelity, avoiding the need to justify fictitious settings and assumptions, and assuring greatest degree of military credibility. That allows also increase in the level of realistic detail in design to a degree that turns planning scenarios into pseudo-operational scenarios [P 09].

[1] The CBP process of France is possibly one notable exception [3].

[2] In particular the transition from "Defence Requirements Review" (DRR) to "Capability Requirements Review" (CRR) process [P 02], [4].

However, even though both the design and the selection of planning scenarios are based on intelligence assessments and foresight, the use of real-world scenarios may fixate the planners on current challenges.

In its origins, the use of scenario sets has been intended to help planners deal with uncertainty. There is a growing understanding that that may not suffice in a force development environment characterised by "deep uncertainty."[3] Therefore some countries investigate a concept with two levels of scenarios – scenarios describing alternative futures at the upper level and one or more 'point case' planning scenarios on the lower level corresponding to each alternative future [7], [P 01], [P 22]. Solid methodological approaches to support the implementation of this concept are still in the making, while it has been reported that in the 2010 Quadrennial Defence Review the US planners have used multiple sets of planning scenarios in order to avoid optimizing for a single future [8]. It is possible to witness a similar impact of the Multiple Futures Project [9] and related developments on the NATO Defence Planning Process.

There is a continuing tension between the scope of the scenario set, i.e., the need to span the problem space, and the constraints on time and effort analysts can afford to spend on the design and the analysis of scenarios. In addition, significant efforts are required to maintain currency of scenario data and assumptions, as well as to trace the potential impacts or consequences of policy options and/or changing policy on the scenario set used in the defence planning process. Therefore, only large national defence establishments and NATO have the capacity to analyse several dozens of planning scenarios.

The identification of a minimum but sufficient scenario set is still a challenge. The main issue in this respect is how to span the envelope of roles and missions of the armed forces without making the costs of analysis prohibitive. Formal analytical techniques to assess the coverage of the scenario set are under development, along with some innovations like the use of 'stressors' in analysing deviations from point scenarios with significant impact on capability requirements. Another enduring challenge is the practical incorporation of low probability events with potentially catastrophic effects in the planning process. As a consequence, nations that endeavour to do capability-based planning, but have limited OA capacity may explore fully only a few scenarios, and rely on NATO and allies for the design and the analysis of common scenarios.

3.2 Derivation of Capability Requirements

As yet, there is no generally agreed definition of capability. Nevertheless, practically all definitions refer to capability as the ability to solve an assigned task under specified conditions. The planning scenarios describe the respective conditions and also serve to derive tasks to be performed within the assigned mission or for the implementation of a specified strategy, and then to identify and quantify the capabilities required to solve the tasks.

Hence, analysts are required first to decompose the assigned mission to tasks, or—in other words—to do "mission-to-task decomposition." The level of formalization in this respect varies across nations [P 09]. While analysts have devised tools to assist this decomposition, it still requires solid military understanding and judgement. The military officer decomposes the mission or the strategy with an explicit or implicit concept of operations in mind. Effects-based operations and network-centric warfare have been the prominent concepts of operations in the current wave of transformation [10]. At this point, their incorporation in the capability-planning process has not been fully formalized. Section 5 of this report provides more detailed examination of advanced concepts of operations.

Capability-based planning is a term that is already soundly established. Nevertheless, reflecting on the impact of novel concepts of operations on the planning process, the type of defence planning currently practiced is more accurately described as *policy-driven, concept-led, scenario-based, capabilities-oriented planning*.

[3] Uncertainty referred to as deep, massive and ubiquitous [6].

In order to formalize the description of capabilities, the nations that practice capability-based planning have designed their own capability partitions, or taxonomies. Two broad approaches have been used to structure the defence capabilities:

- Partitioning along operational environments;
- Partitioning along broad military functions.

Attempts have been made also to structure defence capabilities along supporting technologies and systems. That approach, however, is considered ineffective by default, since it runs counter to the foundations of CBP, i.e. the clear distinction between defining capability requirements first and the follow-on identification of organisational and material solutions.

The first of these approaches better fits the experience and the anticipation of military planners. It allows using existing planning instruments, such as "universal task lists" and, through the task lists provides for smooth interaction between defence planning, operations planning, and training. For example, the U.S. defence establishment uses joint, army, air and naval task lists at four levels – strategic national, strategic theatre, operational, and tactical [11]. Other countries, such as Canada and Australia, use three levels of joint tasks—strategic, operational, and tactical—and the tasks within each level are further disaggregated into two additional layers of sub-tasks, with each layer becoming more detailed and specific [12].

Along with its advantages, this approach has two main drawbacks. First, partitioning—and respective capability requirements—along operational environments almost directly translates to organizational structures, i.e. Land Forces, Air Force and Navy, and thus it does not directly contribute to the resolution of the persisting problems of organisational stovepipes, the related sub-optimal, service specific capability solutions, and the potential interoperability problems. Secondly, the maintenance of coherent sets of task lists, capability partitions and other related methodological tools, as well as the re-use of various products of the planning process, may be very challenging even for nations with mature defence planning arrangements and solid analytical capacities.[4] Countries that attempt to introduce capability-based planning through replication of this approach are often overwhelmed by its analytical and organizational requirements. An attempt to deal with these challenges through a less granular capability taxonomy was presented at the symposium [P 01]. It utilises a single structured list of capabilities (not a hierarchy) that can be visualised at different levels of detail.

The latter of the two approaches is used by the defence planning communities of Canada, The Netherlands, and seemingly France. We are not aware of comparative studies of the effectiveness and the efficiency that can be attributed to one or another partition. Both approaches may benefit from using descriptions of capability categories that are easily translated into effects that a capability can deliver.

All nations implementing CBP then conduct quantitative capability analysis to derive requirements from the planning scenarios. A range of operational analysis techniques are applied to enable quantification. That includes use of simulation modelling, linear programming, spreadsheets and other purpose-built tools, while military expertise and judgement continue to be recognised as a vital component of the analysis [P 09].

The service oriented approach is particularly powerful in capturing command and control (C2) and intelligence, surveillance, and reconnaissance (ISR) capability requirements. It utilises a definition of architectures, describing "how the elements within a system/organization interrelate and interact to perform tasks and hence achieve required objectives and effects" [P14]. It further provides a systematic way to derive a comprehensive set of requirements, can be scaled and adjusted to the problem at hand. It is important to underline that, once designed, architectural models can be used across planning and analytical communities for variety of purposes.

[4] For example, the 2002 U.S. Universal Joint Task List is a 784-page document.

3.3 Meeting Capability Requirements

The design of solutions to capability requirements involves coordination of organisational, doctrinal, human, materiel, and information resources, individual and collective training. Nations use different models to describe capabilities, e.g. the Australian 'Fundamental Inputs to Capability' (FIC) [13], the Canadian PRICIE [P 10], the U.K. TEPID OIL [P 02], etc. This difference is more one of traditions than of substance. The DOTMLPF model, used initially by the U.S. military and then—with the addition of 'I' for Interoperability—adopted by NATO as DOTMLPFI,[5] seems to be adequate in capturing all possible ingredients of a defence capability.

Hence, the issue is not one of standardising capability models, but rather one of paying due attention to all components of defence capabilities, and not focusing on personnel numbers and weapon platforms, as it happens just too often. The report by Phil Guy [P 16], for example, shows how important is the impact of guided munitions stockpiles both on costs and on capability levels. Guy shows that the use of robust numerical methods, combined with scenario analysis, is the most suitable approach to quantitative planning of strategic munitions stockpiles within the overarching capability-based planning framework. He reasons that a strategic munitions planning model has to account for existing stockpiles, munition costs, platform survivability, minimum deployable quantity, target interdependence, target range, platform availability and time constraints, inter-service conflicts, false targets (the limited ability to identify targets correctly, either because of skilful deception or bad weather), other enemy actions, losses onboard lost platforms, the eventual need to expend some munitions to 'zero-in' on targets, logistics allowance, technical failure, environmental factors such as weather, terrain, temperature, humidity, dust, etc., non-doctrinal usage, and geographical location. Guy presents analysis of recent conflict that generally confirms the need to consider all these factors, telling us at the same time that against an ill-defined, militant, non-conventional, regenerating opposing force it is more challenging to define both target lists and criterion for its defeat. Nevertheless, the author still follows a primarily target-oriented methodology. Analysing results, he formulates policy recommendations, related to standardization and multi-national procurement of strategic munitions.

The "capability portfolio" is emerging as a dominant concept in the search of answers to the defence planning task. Implementing the concept of a portfolio, defence planners seek comprehensive solutions, examining all types of required capabilities at one point in the planning process. Planners identify gaps and redundancies in the current set of capabilities, monitor and analyse emerging technologies and their impact, design capability options and seek synergies.

Rigorous prioritization of capability requirements or of capability gaps further assists the identification of solutions that decision makers would find acceptable. A methodology, presented at the symposium [P 15], prioritises capability gaps based on their "relative importance" calculated as an average of their weight, added utility, and urgency. In the calculation of the weight analysts process expert judgements on the relative importance of one scenario *vis a vis* other scenarios in the set of planning scenarios, using a nine degree Saaty scale.[6] Then they calculate coefficients of 'participation' (based on the number of scenarios which require the respective capability), of 'risk' (the potential impact on operational objectives if the capability requirement is not met), and of 'correlation' (to account for the mutual influence among capabilities in an operation). At the next steps analysts use an exponential utility function in processing military assessments of the potential increase of capability levels. The authors provide an example and end with a claim that, compared to the ACT methodology [15], this one adds content and clarity to a commander's strategic vision and enhances the quality of information available to decision makers.

[5] **D**octrine, **O**rganization, **T**raining, **M**ateriel, **L**eadership, **P**ersonnel, **F**acilities, and **I**nteroperability.

[6] That approach differs from the one in the 2004 CBP Guide [14] where the selected set includes plausible scenarios, and no distinction of their relative importance is made.

In this and other studies of prioritization, the definition of priorities includes—either implicitly or explicitly—assessment and understanding of planning risks. By its design, the portfolio approach makes assessment of risks explicit. Practically, in defining the capability portfolio, planners attempt to minimize—with different degree of rigour—some integral criterion of planning risks.[7] Thus, the portfolio approach directly supports the institutionalization of risk management and related frameworks in the defence planning process.

The presentations and the discussions during the symposium outline a trend towards increased coverage of the capability portfolio planners are trying to come up with. First, most planners already include in the portfolio various support capabilities. In Canada, for example, capabilities of supporting defence organisations are included in the portfolio through the "Generate" domain [P 10]. In a second example, Bulgarian analysts envision further expansion of the capability portfolio in an attempt to incorporate efficiently national defence strategies, to capture the full costs of defence capabilities and to be able to match it to anticipated budget levels. Thus, it was suggested to add four domains to the traditional six "operational capabilities."[8] These four domains are [P 01]:

- Generating capabilities and maintaining readiness;
- Strategic management;
- Shaping regional security environment; and
- Strategic adaptability and organizational agility.

A third direction of expansion of the capability portfolio reflects the comprehensive approach to operations and supports the implementation of concepts like 3D (Defence, Diplomacy, Development aid) and Whole-of-Government approach to operations. A variety of organisations and not just the military develop and provide requisite capabilities to operations such as the ISAF operation. Respectively, the planning methodology needs to be adapted, e.g. through expansion of capability portfolios under examination, or adapting the capability taxonomy.

A variation of that expansion relates to the extension of CBP to other security domains. For example, the U.S. Department of Homeland Security (DHS) implements a planning methodology that is almost a direct reflection of the capabilities-oriented methodology used by defence planners. DHS uses a set of planning scenarios, a universal task list, and a target capabilities list, forming "the basis for coordinated federal planning, training, exercises, and grant investments needed to prepare for emergencies of all types" [17].

Eventually, the CBP approach may be applied to support holistic, rigorous and transparent decision making on the development of national security sectors, e.g. in the implementation of concepts of security sector reform or security sector transformation [P 11]. Attempts have already been made to extend the CBP methodology for that purpose [5]. At least in one case, in the Netherlands, the CBP has been applied in a government-wide national security planning process [18]. It may turn out that the challenge is not primarily analytical: the fact that DHS relies on a rather straightforward application of the capability-oriented defence planning methodology indicates that CBP is in fact transferable to other security domains. Most likely, the main challenges lie in the need to coordinate distinct bureaucratic processes and to de-conflict different organisational cultures. The defence analytical community is in position to initiate a study on the applicability and to promote a holistic capability-based planning framework for national security sectors, thus contributing to the effectiveness and the efficiency of the response to security challenges within ever stricter budgetary constraints.

[7] The 2008 defense strategy of the United states calls these risks "Future challenges risks" [16].

[8] NATO and several nations use variations of the following six domains: Effective Engagement; Effective Intelligence; Deployability and Mobility; Command and Control; Logistics Support; Survivability and Force Protection.

Once a realistic portfolio of defence capabilities has been defined, some nations turn to balance of investments studies [19], thus providing a clear linkage between capability requirements and investment decisions, with the respective translation of priorities.

3.4 The Search for End-to-End Solutions

Several presentations and the following discussion during the symposium provide grounds to identify another trend – the search for 'end-to-end' solutions in capability-based planning. J-DARTS [9] is seen as a promising tool to provide such solution on a national level [P 13]. Norway is ahead among NATO nations in adapting J-DARTS to provide efficient support to capability-based planning for the needs of the country's defence establishment.

In order to present and elaborate on plausible execution of defence missions, Norwegian planners and analysts use J-DARTS to develop concrete situations with defined geography, actors and time lines. These situations, or scenarios, are then used to decompose each mission type into objectives, tasks and sub-tasks, and to determine the type and level of capabilities required for each sub-task. Further, Joint Activity Trees and respective 'Capability Assignment Logic' are used to quantify generic, potential solutions to 'Key Tasks'. All capability requirements from all scenarios are aggregated into so called 'benchmarks', corresponding to specified levels of ambition. A Mixed Integer Programme employing the CPLEX optimization algorithm is used to match forces to benchmarks and scenarios and to suggest a future force structure at the lowest possible cost. In addition, J-DARTS serves as repository of data and analysis results, thus allowing re-use and increase in efficiency in follow-up planning cycles.

The tendency to search for and implement end-to-end analytical support tools may be strengthened with the use of J-DARTS in support of the new NATO defence planning process, as well as by attempts of other NATO nations to use J-DARTS to guarantee the transparency of allied planning or for their national defence planning purposes, or both.

While initially used by Norway to support defence reviews, conducted in a four-year cycle,[10] J-DARTS is currently seen as "one of the main tools underpinning the new continuous planning process … implemented by the Norwegian MoD" [P 13]. Mr. Mark Rempel from the Centre for Operational Research and Analysis – Defence Research and Development Canada (DRDC) presented another example of comprehensive analytical support to a *continuous* capability development process [P 10] in support of the finding that "some nations are transitioning from a cyclical to a continuous model for their defence planning" [P 09].

In the second generation strategic decision-making process for the Department of National Defence (DND) and the Canadian Forces (CF), the capability-based planning is an integral part of the Canadian force development process, which in turn is incorporated in the CF/DND strategic decision-making governance structure [P 10], [20]. Planners combine in one phase of the planning process "capability planning, management, and integration" that, in combination, produce two key products: the strategic capability roadmap (or "Defence Capability Plan") and the investment. Through two key feedback loops—between the 'Capability Based Planning' and 'Strategic Guidance' components and between the 'Key Products' and 'Capability Based Planning' components—planers continuously update the key planning products, thus keeping the force development process adequate to the evolving force development environment.

[9] The Joint Defence Planning Analysis and Requirements Tool Set (J-DARTS) has been continuously developed and enhanced by the NATO Consultation, Command and Control Agency (NC3A) since 2001. It has been provided to several NATO nations, willing to use it for national planning purposes.

[10] And the 2007 Defence Study in particular.

To support the planning process, DRDC has developed and supports the implementation of five analytical methods and two subject matter expert analyses (risk outlook and alternative to project mapping) [P 10]. The five methods are:

- The *CATCAM* method is used to evaluate and prioritize the capability framework elements within force planning scenarios through subject matter experts assessing each of six standardized mission effects with respect to their required frequency and the consequence if the effect is not created within each scenario; it produces a numeric score for each capability element across effects;
- The *Scenario Capability/Capacity Requirements Assessment and Outlook Tool* (SC_2RAT) is used to process capability element scores, existing and future programmed operational force structure, and force element rotation ratios and to generate a capability outlook that effectively describes the health of the CF capabilities over time for each force planning scenario;
- The *Concurrency* method is used to investigate the force element requirements of concurrent scenarios;
- The *Optimization* component of the CBP analytical process is used in the exploration of the solution space for non-dominated sets of solutions that best address the identified capability deficiencies; a solution is comprised of a set of capability investment alternatives;
- The *Cost Sensitivity* method is applied to investigate the risk of delivering alternative solutions due to cost risk, assuming a triangular distribution of equivalent annual costs for each alternative.

The work of the analysts from Defence Research and Development Canada provides one example of a planning and force development process that is getting away from the comfortable regularity of review and planning cycles with clear cut delineation of long-, mid- and short term planning horizons. Several other countries are also transitioning to a process of continuously seeking to balance security requirements, defence objectives, capability development plans, and affordability considerations. To this purpose policy makers and planners, supported by analysts, introduce a feedback loop from the assessment of performance and results, i.e. the level of capabilities achieved and the efficiency in utilising limited resources. Lately, this continuous cyclic process has been referred to as "strategic defence management" [19], [P 01].

3.5 Credibility of Defence Planning and Plans

Notwithstanding the level of analytical effort and rigour in designing force structures and proposing force development plans, investment plans, recruitment targets, etc., no analyst would suggest that defence plans represent an objective, scientific 'truth' [P 13]. Nevertheless, analysts are expected to provide a transparent, auditable decision-making process that thoroughly explores solution spaces and allows to deal with uncertainty.

First, the rationale for decisions has to flow transparently through all phases of the decision making process. A decision maker would most probably not be able to follow all details, but needs to maintain a strategic level view throughout the process. DRDC relates to this analytical support challenge as "enhancing the Command View" and lists the design and development of an adequate interface between senior decision-makers and the CBP process among the main development thrusts for the next generation analytical support [P 10].

Second, with a certain increase of the analytical effort, planners can explore both the problem and the solution spaces more systematically. Further methodological efforts are necessary to guarantee that the set of planning scenarios used in CBP span the space of relevant security challenges reasonably well (from the point of view of decision makers), without making the analysis cost prohibitive. Likewise, the solution space needs to be fully explored, with account for capabilities and their respective organizational and

material 'providers' to be maintained and those to be divested. While traditional optimization methods and tools preserve their value, recent advances in the field of genetic algorithms also prove beneficial in increasing the planers' confidence in the quality of the solutions [P 10].

Third, even best efforts in designing and selecting the set planning scenarios represent the planners' understanding of the future world and may prove in error in the face of deeper uncertainty. According to Colin S. Gray, a contemporary strategist, "most efforts to anticipate the future have been seriously in error. There has usually been somebody who got it right enough at the time, but at the time people had no way of knowing who that person was" [21]. Hence, one seemingly promising way to represent such uncertainty is not to anticipate a single vision of the world, but to envision multiple futures, each of which can be represented in the planning process with its own set of scenarios [11] [9]. Attempts to formalize the concept for defence planning purposes have already been made [7], [P 01], but so far the issue of traceability has not been rigorously addressed.

Fourth, planners cannot provide credible solutions if the data they use is not reliable. One apparent area of concern is costing. Reliability of capability costing can be increased with the use of proven cost models [22], including models of life cycle costs [23], systematic accumulation and validation of cost data. Both stochastic and deterministic models of assessing future costs of capability alternatives have been used in capability-based planning [P 10]. Benchmarking studies of both models and costs can further enhance the confidence in national approaches, as well as the understanding among allies of the costing aspects of defence planning.

The analysis of sensitivity of planning solutions to main assumptions and human estimates, albeit heavy in terms of workload, also contributes to the credibility of the analytical work.

Finally, planners and analysts are expected to maintain an audit trail that can be used to trace the flow of the decision making process from the guidance to decisions on capabilities, force structure, and investment projects. The analytical community should avoid trend extrapolation and wishful thinking and try to keep alive a long-term planning and study process, including alternatives, adding to that critical assessment of today's capabilities and assessments by simulation and gaming [P 04].

3.6 On the Efficiency of the Defence Planning Effort

Capability-based planning in its already traditional form [14] is highly analytically demanding, in particular when a higher number of planning scenarios is included in analysis. The demand for analytical support increases radically with the transition to a continuous planning model, the introduction of rigorous sensitivity analysis and the representation of deeper uncertainty through multiple sets of planning scenarios.

The increase of efficiency of analytical support is expected to parallel the increase of analytical demand if we do not want to see the cost of analytical support escalating. One approach to increase efficiency is to seek compatibility and higher degrees of standardization of capability partitions, models, generic units, etc., used by defence analysts of NATO and NATO nations. That will have important side effects in providing compatibility of national defence planning process and increasing the transparency of NDPP. The RTO SAS panel has and will continue to play an important role in that respect through sharing of information, experience, and benchmarking studies.

A complementary trend involves implementation of advanced IT systems and tools. Advanced geographic information systems, database and content management systems increase the efficiency of planning in variety of ways, e.g. allowing for re-use of scenarios designed for different purposes [P 13], re-use of

[11] Obviously, there will be an overlap among the sets of planning scenarios.

analysis results, etc. A drive to implement a CBP knowledge management system is also expected to contribute to the efficiency of analytical support [P 10].

4.0 ANALYTICAL SUPPORT TO THE CAPABILITY DEVELOPMENT PROCESS

Effective and efficient capability delivery is based on coordinated development of human, material, information components, training and interoperability, described in NATO by the DOTMLPFI model. Of these, the symposium discussed the analytical challenges of acquisition and personnel management and touched on logistics issues.

4.1 Analytical Support to Personnel Management

Capabilities cannot be delivered without adequately educated, trained and motivated people. And yet, the number of such people, willing to serve in the armed forces, is subject to policy decisions, often having long-term impact on the process of recruitment and retention. Analysts can contribute to the understanding of trends and drivers, as well as to the definition of "capability-oriented" personnel policy and programmes. The study on personnel attrition rates by Manchun Fang and Paul Bender from the Department of National Defence of Canada, Director General Military Personnel Research and Analysis, is informative in that respect [P 17]. Fang and Bender present a model of quantifying demographic and behaviour effects on changes in attrition rate. The model is applied to identify policy changes—in the process of personnel selection, remuneration, and others—that have caused particular effects on attrition rates. The lessons from the study, as well as the developed model, can be used to support future development of targeted retention initiatives.

4.2 Analytical Support to Acquisition Management and Logistics

Thomas Ekström from FOI took the most comprehensive view to the ongoing transformation of defence procurement and logistics [P 19]. Driven by the post-Cold war changes in security requirements, the opportunities created by new information and communications technologies and the impact of new business concepts, the Revolution in Military Logistics (RML) paralleled the Revolution in Military Affairs (RMA), and now the process of defence transformation. A previously rather straightforward military supply chain turned into an increasingly complex and fragmented supply and support network, with many actors and roles and responsibilities that are not entirely clear. Respectively, during the Cold war analysts focused on scenario techniques, war-gaming, modelling and simulation, cost-effect or cost benefit analysis, and problem structuring methods, such as morphological analysis. Mr. Ekström identifies a number of areas currently in need of analytical studies and support, such as:

- Design and management of supply and support chains and networks;
- Supply and support chain risk management;
- Identification and evaluation of potential business models for defence acquisition and logistics in the entire spectrum from public provision to outright privatization;
- Development of Decision Support Systems (DSS), decision trees, decision mechanisms, and other support to decisions regarding what to make, what to buy, and how to buy;
- Evaluation of efficiency, effectiveness and performance, including definition of measures of effectiveness (MOEs) and measures of performance (MOPs);
- Moral and ethical issues associated with outsourcing, in particular in hostile environment;
- Defence acquisition culture, organisation, and competencies.

Włodzimierz Miszalski and Szymon Mitkow from the Military University of Technology in Warsaw presented an original, comprehensive approach to support the process of defence acquisition, starting from the definition of capability requirements through selection of a material solution all the way to optimization of the respective logistics support [P 18]. The authors use the AHP (Analytic Hierarchal Process) method in solving the multicriteria problem of selecting a capability solution among a number of alternatives. The following criteria are used by decision makers: combat ability, cost, technological feasibility, time (time required for delivery, time in service), availability on the defence equipment market, logistics requirements, and versatility (is the capability applicable across tasks). Once the class of a material solution has been defined, analysts turn to the selection of a product from that class. The authors create a benchmark—an 'ideal' solution having the best features among the features of interest of all available products—and then rank the products according to the distance from the benchmark.[12] Thus, while admitting that political and economic considerations often come into play, the analysts put the product that is closest to the benchmark on top of the list of possible material solutions.

Robert Murphy and Scott D. Beach from Lockheed Martin Aeronautics presented another comprehensive decision-making framework, setting procurement decisions within the strategic planning process, i.e. the top-down process of developing scenarios, defining, developing and deploying a strategy [P 20]. Identification of metrics is part of the step of developing the strategy. Identification of capability solutions and analysis of alternatives, including effectiveness, cost and risk analysis, are all part of the "deploy the strategy" step. The Force Matrix Model ™ (FMM) developed by Lockheed Martin supports rigorous analytical studies of the whole process, including evaluation of effectiveness, cost, and risk of identified solutions by using multi-attribute value theory (MAVT) which includes Analytical Hierarchy Process (AHP) and utility curves. Seen as an alternative to expensive and time consuming modelling and simulation, MAVT uses [P 20]:

- Criteria or Measures of Performance developed for each capability and then prioritised using the AHP process;
- An AHP process that uses a pair-wise comparison of capabilities and then ranks them using an arithmetic or geometric mean;
- Utility curves for determining the value of a solution; using s-curves, FMM mimics the way people make decisions and most often represent this thought process by allowing the decision maker to define the "preference" curve.

The final result is a weighted average (or normalized ranking) of the capabilities rolled up into a single overall value.

5.0 ANALYTICAL SUPPORT TO CONCEPT DEVELOPMENT AND EXPERIMENTATION (CD&E)

The CD&E process affirms its role in the capability development process of NATO, NATO nations and partner countries. Capability development is understood to encompass "strategic analysis, identification of capability requirements, solution identification and solution implementation", while CD&E enables "structured development of creative and innovative ideas into viable solutions" [P 21]. That does not come quickly. CD&E, and innovation in general, involves not only technologies and processes, but also the people in the organisation. A process of continuous learning accelerates innovation, as eloquently summarised by John J. Garstka:

> One factor complicating military transformation is the need to demonstrate the potential operational effectiveness of a new concept. In the case of inter-war carrier aviation and mechanised warfare, the

[12] Including in the 'distance' also a measure of the dispersion of the features.

> initial operational concepts and associated technologies failed to perform as well as existing capabilities. Few appreciated the potential impact that the operational concepts and technologies would have as they matured. In both cases, the ability to conduct a mutually reinforcing series of experiments, exercises and war-games was critical to enabling visionary leaders to accelerate learning rates and obtain evidence to support investing in emerging capabilities. In the case of mechanised warfare, a critical mass of individuals in the German Army was able to learn about how mechanised forces could be employed much faster than their peers in the British, French or Polish armies [24].

This section of the report is structured in three sub-sections, reflecting symposium discussions on recent developments of the CD&E process, the proper understanding of "analytical rigour" in experimentation, and the roles of the analytical community.

5.1 Towards a Common Understanding of CD&E and CD&E Project Management

Recent developments within NATO have contributed to the clarification of the role of CD&E and to the common understanding of the phases of the CD&E process, its financing, tracking, and quality assurance. In September 2009, the NATO Military Committee has approved the Alliance policy for Concept Development and Experimentation [25]. The symposium participants generally agreed that this NATO policy is in line with the "Guide for Understanding and Implementing Defense Experimentation" (GUIDEx), developed by the Joint Systems Analysis Group in the framework of The Technical Cooperation Program, involving defence experimentation experts from Australia, Canada, the United Kingdom and the United States [26].

CD&E plays an important role in finding conceptual solutions to capability shortfalls and gaps that were identified in the processes of defence planning, lessons learned, or as urgent operational requirements. It also contributes to capability development through the introduction of capabilities not anticipated previously. They may result from new ideas, "out of the box" thinking or systematic R&T efforts [P 21].

CD&E is the process of structured development of innovative ideas into viable solutions. This is an iterative process leading, eventually, to an approved concept. Concept development provides the framework within which a solution may be developed, and solutions may (or may not) be refined through experimentation [P 21]. Experimentation reduces uncertainty as to the maturity of the concept or its component parts.

Although CD&E is a concurrent, iterative and spiral process, in which Concept Development and Experimentation are closely interlinked, for project management purposes it is useful to distinguish four phases [P 21]:

a) Preparation, Initiation and Structuring;

b) Concept Development Planning;

c) Concept Development and Refinement; and

d) Assessment and Validation.

Each of these phases poses specific challenges to analysts, which will be examined in more detail below.

While the NATO CD&E policy provides a benchmark for a comprehensive, disciplined management of CD&E projects, it may be beneficial to take a look at the process from a different perspective. Another, "civilian" perspective from the experience of the business world was introduced by Dr. Venelin Georgiev, who drew parallels between the CD&E process and the process of innovation. Sound innovation management supports the decision making process through exploration of the decision space and the use of scenarios, and reduces the associated technical, technological, financial, and planning risks. Georgiev showed how that the decision process becomes more rational, transparent and accountable [P 24].

Another report in the CD&E session addressed organisational effectiveness in coalition HQs conducting non-article 5 crisis response operations, presenting interim results of a RTO HFM study group [P 27]. The authors show that in order to implement the concept of NATO Network Enabled Capabilities (NNEC), the military organisation needs to be agile, flexible, joint and interoperable. Such *organic* organisational structure has the following attributes: it is decentralised; the authority to make important decisions is delegated to persons at all levels of the hierarchy; it stimulates flexibility, so that employees can innovate and quickly adapt to changing circumstances, and take responsibility to make decisions when necessary; roles are loosely defined; organisational members with different functions work together to solve problems and are involved in each other's activities; a high level of integration enables organisational members to share information quickly and easily; rules and norms emerge from the ongoing interaction between organisational members; and interaction between organisational members is horizontal as well as vertical. The study group came up with the following basic characteristics of an effective Coalition HQ:

- Political-military decision making: Able to achieve its goals; Establishing priorities;
- Internal processes management: Learning organisation; Stimulating information sharing; The HQ is willing to adapt its structures to the ever-changing conditions where necessary; Processes improvement strategies implementation to facilitate information sharing, social networking and top leaders' commitment to achieving HQ goals; Making efficient use of the available resources;
- People: Able to take initiative; The leaders are able to make fast and timely decisions; Existing flexible human resources management system to guarantee high motivation, cohesion, organisational and interpersonal trust;
- Cultural differences: Openness to diverse cultures; development of intercultural competences; Using common language and terminology; Using common formats/standardization of different procedures; Using common doctrine and concepts.

They also show that for the NATO HQ to be able to attain its goals of effective and timely sharing of information, quick and timely decision making, and improved shared awareness of tasks and responsibilities, its terminal cultural values must reflect flexibility and agility in its processes, but stability in the organisational structure, and its instrumental cultural values should include trusting each other, being open to diversity, and having an improvement orientation.

5.2 How Rigorous Can Be the Experiment?

Describing Swedish experience in defence transformation, Jan Foghelin underlined the need to take into account new ideas and concepts. At the same time, he emphasised that even if new concepts "are immediately seducing, they should not be a substitute for studies – should be transferred to tangible solutions and then tested in several dimensions …" [P 04]. In his presentation in the CD&E session, Han de Nijs also supported this point, stating that analysis activities along the CD&E process are necessary to accumulate evidence in order to determine and demonstrate the validity of proposed solutions and the increase of effectiveness. Analytical rigour is important to increase confidence in a conceptual solution and reduce the risk involved with its implementation [P 21].

But how rigorous can be an experiment in the context of defence transformation?

There is no simple answer to this question. One needs to delve into the foundation of science to find an adequate answer. Generations of scientists, in particular in the fields of natural sciences and engineering, have been educated in the paradigm of "positivism", where "theory corresponds to the only one, true, objective reality" [P 25]. In studying that reality, e.g. through experimentation, analysts attempt "to be objective," i.e. to "ensure that no bias, subjective influences or value considerations disrupt our view of the true reality" [P 25].

Andy Williams and Simon Purton show that while this scientific method is appropriate in many cases of defence experimentation, it may be counterproductive in experiments that bring together political sensitivities, divergent stakes and viewpoints, and different cultures. In such cases, the paradigm of "constructivism" is more appropriate [P 25]. (The table below outlines the main differences between the two paradigms.) Analysing their experience, that includes an experiment on the newly developed strategic and operational planning process, the authors of the report make several observations that can sharpen the understanding of both analysts and decision-makers of such specific cases:

- "Truth" is a matter consensus among informed and sophisticated constructers (it is not just 'out there');
- "Facts" have no meaning except within some value framework, therefore there cannot be "objectivity";
- "Causes" and "Effects" do not exist except by imputation and all interacting parties are responsible;
- Phenomena can only be understood within the context of study; no generalisation is possible;
- Treatments are not stable; they will be affected as much as the "dependent" variables;
- Experiment analysis produces data in which facts and values are inextricably linked;
- Researchers/analysts are subjective partners with stakeholders/ audience/ customer in the literal creation of data.

Notwithstanding all these features of experimentation, researchers/ analysts still have a special role to play.

Table 1: Competing Paradigms and 'Rigorous' experimentation.

Positivism	Constructivism
What is reality? ("ontology")	
• Objective, independent from the observer	• Subjective, dependent upon the observer
• Only one	• Continuously constructed
How to know reality? ("epistemology")	
• Subject-object duality	• Knowledge is a process of creation between research and the researched
• Exclude values from influencing	
Methodology	
• Control confounding variables and values	• Iterative process
• Converge on truth	• Values, beliefs, biases are included
• Accumulate validity	• Findings 'emerge' from joint construction of reality

5.3 Roles of the Analysts

Thomas Ekström from the Swedish Defence Research Agency (FOI) identifies four types of players in the CD&E process, intentionally exaggerating certain features of some typical attitudes [P 23]:

- "Artistic freedom" of the concept developer, who does not really want a CD&E method, a CD&E process or any other form of CD&E structure, relying instead on creativity and inspiration;
- "Timely order" for the experimenter, who focuses on schedule and resource management, and not on the questions of interest to the concept developer;
- "Military relevance" considerations for the manager of the experimental platform – usually a senior officer who has to make sure that the scarce resources at his or her disposal are being used to develop the concepts in an effective and efficient manner;
- "Analytical structure" considerations for the analyst, who looks that alternatives are explored, the maturity of the concept is tested, that decision makers receive relevant information at regular intervals, that concept developers are given opportunities to create support among colleagues outside the CD&E community through the dialogue that tests like seminars, workshops, and war-gaming.

Han de Nijs examines in detail the respective roles of the analyst along the phases of a CD&E project, with the overall purpose of bringing "structure and rigour in the definition of problems, in methods and in results." This may involve quantitative or qualitative methods. Most importantly, "analysis brings meaning by making better sense of the world," even when dealing with wicked problems [P 21].

De Nijs further suggests that the whole CD&E community, as well as other stake holders, would benefit from a common *concept maturity model*, analogous to the technology readiness levels used currently in R&T management, a proposes a scale with ten grades of concept maturity [P 21].

6.0 ANALYSIS OF CURRENT OPERATIONS

The symposium session on current operations addressed the effects-based approach to operations, intelligence data management requirements, the concept of tribe building, the factors contributing to, or hindering, coalition team performance, and lessons learned—all at least to an extent—in the context of the ongoing operations in Afghanistan.

Analysts continue to address the implementation challenges of the Effects-based Approach to Operations and to develop respective decision support tools. Johan Schubert from FOI presented the Collaboration Synchronization Management Tool (CSMT) used in effects-based planning and continuous evaluation and refinement of the plans [P 33]. A Capability Impact Matrix (CIM) is used to represent the influence of activities of supporting effects, of supporting effects on "decisive conditions", and finally of decisive conditions on military end state. The tool allows evaluating and representing alternatives, as well as the consistency and the stability of each instance of the operations plan. The method takes subjective judgments about the activities as input data and to calculate assessments of all other plan elements. When a piece of evidence lacks credibility, it is 'discounted' in the same analysis framework. Thus, planners are able to identify not only decisive influences from activities, but also to "find any weaknesses and all strengths of the plan as described by the cross impact matrix before the effects-based execution phase" [P 33].

To assess potential effects, however, planners need reliable intelligence. Experienced practitioners insist on revising the intelligence process to support effectively Irregular Warfare (IW) and Stability, Security, Transition, and Reconstruction (SSTR) operations, as well as to reach decision makers [27]. Practitioners' suggestions have been critically examined by analysts and presented to the symposium in a report by Michael J. Baranick and Stuart H. Starr [P 29]. The authors explore the data needs of analysts in support of decision makers and call for a substantial role of the analytical community in the intelligence data management process. That focus is supported by the finding of the US Training and Doctrine Command Analysis Center (TRAC) that 34 of 35 major gaps in analysis support to IW can be attributed to lack of

credible data. Several major questions still wait resolution, and further studies may be required to support the respective decisions:

- How to come to data standards (e.g., metadata) and a structure in transforming qualitative into quantitative data?
- How to provide for a multidisciplinary, 'Whole of Society' discovery when needed data are widely distributed?
- Shall there be a central organisation to take responsibility for the data needed to support analysis and for developing needed ontologies, metadata, and pedigree?
- How to provide efficient verification and validation of data?
- Should a Federated IW Data Repository be mandated?
- What are the suitable Measures of Merit?

While complex adaptive systems define an emerging paradigm in studying irregular warfare and counterinsurgency operations, practitioners need more tangible tools. Nicolas Israël and Thomas Peugeot search for a formalised operational concept drawing from human sciences, and the anthropology in particular. Their studies suggest that tribe building can serve as such concept to enable, inter alia, intelligence collection and data organisation and modelling and simulation efforts [P 30]. Tribe building is seen as a set of practices supporting the smooth growth of modern value spaces endorsed by traditional authorities, and a rejection of totalitarian forces. Such practices should be performed with great care due to the difficulty of knowing a priori which modern space should be developed first, who the traditional authorities are or what the level of endorsement is. In line with the findings of practitioners [28], the authors reason that a successful strategy should be based on stabilization of tribes to enable state legitimization and not the opposite. Studying the interaction between individual and group behaviour and values, they conclude that restoring the traditional fabric of society is the best way to achieve peaceful transitions toward democracy.

Another study, presented at the symposium, addresses team efficiency in coalition settings [P 34]. Applying the PRISM (Performance, Role interdependence, Information Sharing) model, the analysts study the factors influencing information sharing, collaboration, and ultimately the performance of coalition teams. They also draw on the model of Inter-organisational Collaborative Capacity (ICC) [29]. ICC is the capability of organizations (or a set of organizations) to enter into, develop, and sustain inter-organisational systems in pursuit of collective outcomes. ICC provides a framework for understanding individual and organizational factors brought to a newly formed team, and likely to influence team collaboration. The authors apply the model to study the factors influencing the performance of U.S. and Bulgarian teams training together at the Novo Selo range, Bulgaria. The study is expected to enhance the means of assessing coalition team effectiveness, or likelihood of success in future NATO missions. This research could be utilised to develop a method of assessing the readiness of coalition team members prior to beginning a mission and to target training to address areas in need of improvement [P 34].

Two symposium reports presented Lessons Learned (LL) approaches and experience respectively of Bulgaria [P 03] and Norway [P 31]. The LL process benefits strongly from inclusion of analysts in operational units. Lessons learned is seen as a process going beyond absorption of operational experience to encompass lessons from exercises, gaming, and experimentation, as well as from capability development experience. It is recognised that people learn, not "organisations" [P 31]. Therefore, while LL does require the creation of databases and implementation of advanced IT, experts in organisational culture and psychology are also needed for effective and efficient operationalisation of experience.

7.0 MAJOR OA THEMES IN A PROCESS OF CONSOLIDATION

There are several transformation-related analytical themes that cover two or more areas in the symposium programme. Some emerged fairly recently, but are already solidly placed on the agenda of both analysts and users of analytical support. Hence, this section of the report takes another look at effects-based approach to operations, networks, and organisational development under uncertainty.

7.1 Effects-Based Approach to Operations

It is blatantly clear, that it is not possible to achieve the end state in a counter-terrorism or counter-insurgency operation by capturing a country's capital, its territory, or killing a handful of terrorists/ insurgents. We need to be able to tackle the influence, i.e. the "hearts and minds" problem. To that purpose analysts should assist decision makers in relating military resources—and the way in which they are used—to the outcome of peace support and counter-insurgency operations. That requires understanding (modelling) human perception and behaviour and the ways by which they—individuals, crowds, military units, factions, régimes, populations, etc.— can be influenced, keeping in mind that there is an infinite variety of humans with their experience, beliefs, priorities, as well as a wide variety of unobservable contextual variables. In addition, chance events and outcomes also come into play [P 02].

While traditional, or 'hard', OA techniques still have their place, in particular when the problem at hand can be quantified based on physical data or assessment by an adequate number of experts [P 16], we need to enhance the capabilities for 'soft' operational analysis [30]. In the U.K. experience, Dstl Strategic Analysis Group is widening the analytical discipline base by including psychologists, anthropologists, sociologists [P 02]. Further, Roger Forder recommends that the analytical community needs to:

- Keep in touch with possibly applicable theoretical approaches, such as complex adaptive systems;
- Widen the use of historical/ current operational data, including broad conclusions about factors affecting success of counter-terrorism/COIN operations and factors affecting public support, as well as striving to achieve pull-through from current operations;
- Use gaming to provide participants with sufficient 'wrapping' to enable them to play out of their own personality and culture [P 02].

The need to enhance 'soft' analytical power is confirmed by other studies as well. For example, in studying intelligence data gaps, it was concluded that 20 of the 35 identified gaps required at least some "soft science" solutions [P 29].

Such findings are of benefit to the operations planning process, to capabilities-based planning, CD&E, and training among the areas of highest importance to defence transformation.

7.2 Effective Networking

The effect-based approach has to be applied comprehensively in dealing with the opponents, their support base, and contextual factors, as well as own support base. The principle of comprehensiveness applies also to the use of all available means to resolve a particular crisis situation, whether they are 'owned' by military forces, intergovernmental organisations, NGOs, private security companies or other businesses, that act in a theatre as a network.

Comprehensive approach is not just a concept, but a practical challenge that requires design and application of adequate concepts, methodologies and tools. Concepts like 3D (Defence, Diplomacy, Development aid), Whole of Government approach and other, developed by policy experts, are finding a way into the security and defence planning communities. The experience of the U.S. Department of Homeland Security shows that best practice in capability-based planning can be amended and modified to

the needs of other security sector organisations, and the approach has been found of utility by other non-defence actors such as the World for Food Programme [19].

The challenge of transferring effects-based, capability planning and capability delivery models and methods to other actors in the network is not one of hard analytics. Since there is no single planning 'centre,' 'soft' approaches would contribute to finding suitable arrangements in planning the response—both in preparing and maintaining 'capabilities' and in the coordination of in-theatre activities. 'Social media'-type of platforms, accompanied by adequate soft analysis methodologies and tools may prove the usefulness of the analytical community in an inter-agency and broader international setting.

7.3 Organisational Development Under Uncertainty

The third, and final theme addressed in this report is how to manage the evolution of defence organisations, including the military, in the face of uncertainty. One emerging approach calls for making defence organisations agile by design, i.e. to make them responsive and able to adapt quickly to changing threats, new types of operations, technological opportunities, funding levels, shifts in socio-demographic environment, etc. On the other hand, it takes years to fully develop most types of defence capabilities, and the decision making process in NATO and its member nations, being under the scrutiny of parliaments and society, is rather slow compared to the dynamics of change we currently witness. This dilemma of *Stability versus Agility* of defence organisations has yet to be resolved, but some promising ideas are already put forward to the symposium discussion.

8.0 CONCLUSION AND RECOMMENDATIONS

The symposium brought together 90 analysts, decision makers and military officers from 19 NATO and partner countries to discuss the major transformation themes of capability planning, capability development, concept development and experimentation, counter-terrorism/ counter insurgency operations and lessons learned. One important topic, however, was missing from the symposium agenda – the analytical support to advanced training.

A number of other topics were also addressed repeatedly by presenters, as well as during the discussion. The following were among them:

- What are the appropriate roles of the analyst in the current wave of defence transformation?
- What is necessary to make the exchange between analysts and decision makers effective?
- What are the best ways to organise the analytical support?
- How to make alliance and national defence planning processes transparent, traceable, and auditable?
- How to arrive at a common lexicon, e.g. on capability, lines of development, capability taxonomy, task lists, generic units, etc.?
- How to define good measures of effectiveness and efficiency?
- How to make cost- and performance-related benchmarking studies more effective and efficient?
- What are the appropriate methodologies for managing knowledge related to defence transformation?
- How the analytical community can contribute to enhancing integrity and reducing corruption risks in defence?
- How to make defence organisations sufficiently agile in the face of contradicting requirements?
- Are there emerging transformation themes that require new types of analytical expertise?

In addition to the suggestions made throughout the text of this report, we can make several recommendations, the implementation of which would enhance the analytical support to defence transformation. A number of studies may be beneficial in that respect:

- *Organisational development under uncertainty*. How to deal with the contradicting requirements of decision-making processes in democracy and long lead times for defence systems, on one hand, and the need to react quickly to unforeseen changes in the force development environment?
- *Analytical support to training*. How to make joint and multi-agency training more effective and efficient?
- *Taxonomy of OA 'technologies'* (approaches, methods, and tools). What is the spectrum of analytical methods and tools applicable to defence issues? A taxonomy that is commonly used by the NATO analytical community would facilitate benchmarking studies, potential role specialisation among nations (just like the capability specialisation of the armed forces of NATO nations) and cooperation among nations, thus contributing to the efficiency of analytical support to defence transformation.

To contribute effectively to defence transformation and receive recognition, the analytical community of NATO, NATO nations and committed partners needs to focus on providing organisational agility, proving the efficiency of defence organisations, and of analytical support itself, and strengthening partnerships.

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