CAPABILITIES AND RISKS IN THE MEDIUM AND LONG TERM PLANNING IN THE AIR FORCE - METRICS AND METHODS

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1. INTRODUCTION

The first objective of the current Romanian defense budget, as in other NATO and EU member states, is to provide a portfolio of capabilities to meet the future uncertainty spectrum of the security environment. In this regard, since 2008, the Air Force conducted an evaluation of capacity and programming purposes resizing grounding on this principle.

Despite some progress, many limitations remain and persist in discontinuities between the assessments of capabilities and programming process at the level of the services programs. One of these deficiencies is that the capabilities-based *assessments remain anchored, unrepeatable in subjective judgments*. A second weakness is that there is a *discrepancy between the capabilities set and resources* to be allocated: financial and manpower. Planners of these services face great difficulties in terms of how to adapt programming, following an assessment in excess or shortfall of capability, especially if the relationship between the capabilities and the resources available remains obscure. A third weakness is that capabilities *assessments are* currently *performed* compared with *a single plausible future* and not the spectrum of *possible security environment*. *Uncertainty of the future* of the security environment – a central theme-based planning capabilities - *is not*, therefore, *caught in the current assessments* of capabilities and, respectively, of risks.

From this perspective, it is necessary to present a methodology for revise and how it can be implemented, based on the limitations of planning capabilities, and introduction of a new definition of capability and also current measures to implement them, to keep factors programming decision.

The *objectives* are metrics those new capabilities because:

• describe the direct relationship with the objectives set out in national planning;

• relate to program elements, definable parts of the program elements, or groups of elements of the program;

• are applicable, generally in a range of programs.

To this end, the practice of strategic planning capabilities set is defined, *first*, against the necessary resources to perform a specified level of operational activity in the defence planning scenarios. For example, the set of resources required to execute a major operation (MCO[1]) would constitute a set of capabilities, and where a number of a particular type of helicopters may be needed to MCO, then they constitute MCO capabilities.

Similar metrics can be defined for a number of means for a particular type of operations, including crisis or humanitarian operations, aid them and the state-building operations (such as banning drugs and non-combatant evacuation operations) which would involve additional funding. In this definition, the resource is not fixed, but may vary in relation to a given operational scenario. For example, a certain type of middle, designed for a particular MCO may constitute only 0.8% of the resource, compared to 2.3% as it was for an emergency operation on a

[1] MCO – Major Combat Operation

small scale. This definition of the capabilities assigns them naturally to the NAP[2], respectively, the operational objectives.

The *second step* is to quantify the resources required for each implementation of planning scenarios. We therefore have developed a prototype tool to highlight the resources required for implementation based on the amount and types of aircraft that can be deployed in each basic rule out in-flight, and some general features of basic infrastructure. These features include how the billeting are available, if available a direct supply of fuel through underground pipelines, and the degree to which the base is exposed to a high, medium or low risk, or conventional or unconventional attacks. The creation of these tools is suitable for determining implementation requirements necessary programming and also useful in the implementation phase. However, for use in regular programming, the instrument must be checked formally implemented and regularly maintained by the Air Force.

Thirdly, it is necessary to develop *algorithms for optimal allocation* of resources, both for procurement and for support. These algorithms may consider either a single programming scenario or to develop a robust program, rooted in a wide range of scenarios. Robust optimization maximizes capability sets reported to a number of scenarios, subject to budgetary constraints. Research shows (RANDOM[3]), two optimizations for scenario-based planning, using a single-set of scenarios, both recommending optimizing the allocation of costs between acquisition and support. The *first* determines the minimum cost for which all requirements specified in a set of planning scenarios, subject to the constraint that expenditure does not change more than a certain percentage from year to year. *Second*, maximize the ability to set single-scenario, given a fixed budget for each year specified.

As a result, the Romanian specialists in planning and programming (two concepts which, in the Romanian Armed Forces did not found a clear delimitation in terms of structural and organizational) should provide the analytical foundation for the development and evaluation - the defence planning scenarios. Clearly, the program aims to link planning and programming implications, expressed in terms of national objectives at the operational level tasks, rather than a single category of armed forces - in the concrete case now, the Air Force. Methodology would not only include an effective assessment program linked to a plausible future alone, but would give also the necessary robustness for a wide range of possible aspects of a future security environment.

Trends in military spending in Europe

• Total estimated total military spending in Europe in 2009 was 386 billion dollars (60 billion dollars in Eastern Europe and 326 billion dollars in Western and Central Europe).
• Expenditure increased by 2.7% in real terms compared to 2008 (2.6% in Eastern Europe and 2.8% in Western and Central Europe) and by 16% compared to 2000 (108% in Europe East and 6.6% in Western and Central Europe).
• Growth in Eastern Europe was much lower than in previous years, largely because of economic crisis.
• The largest absolute increase (in 2008 constant prices) were in the United Kingdom (3.7 billion dollars), Turkey (2.9 billion) and Russia (2.7 billion U.S. dollars)

Arithmetic of Defence Policy[4]

The campaign in Kosovo, in 1999, clearly showed the weakness of European military forces. Recognition of the consequences of this lack of capacity put into effect a new European debate on the issue of defence. However, the decline in military capability is systemic in each European country. Helsinki goals will do anything to address this decline, a fact demonstrated by the decline in national defence budgets in the last 15 years[5] (Figure 1), which have declined in

[2] National Action Plan

[3] Don Snyder, Patrick Mills, Adam C. Resnick, Brent D. Fulton , *Assessing Capabilities and Risks in Air Force Programming - Framework, Metrics, and Methods*, Published 2009 by the RAND Corporation

[4] Alexander, Michael; Garden, Timothy, *The arithmetic of defence policy*, International Affairs, volumul 77, nr. 3, iulie2001 , pg. 509-529(21)

[5] When we speak about the smaller countries, without any ambitions of power and, more importantly, lack of resources and creditworthiness to support such a large budget deficits, many have reduced their military spending in 2009, particularly in Central and East Europe. Among countries that have made deep cuts in the 2009 crisis are Bulgaria (7.6% in real terms), Croatia (8.3%), Estonia (9.1%), Lithuania (11%), Romania (13 %), Serbia (5.8%), Slovakia (6.7%) and Ukraine (11%). Largest reductions were in Europe in

real terms. While aspirations to maintain current levels of military spending were to be made, the decline in capabilities would continue.

Military equipment and personnel costs rise faster than inflation and, therefore, reduced weapons systems and personnel can be affordable each year, and the perspective shows that *there is no future* of significant growth in defence budgets of the European Member States, despite recognition of the need for a range of capabilities that allow the execution of costly post-Cold War operations.

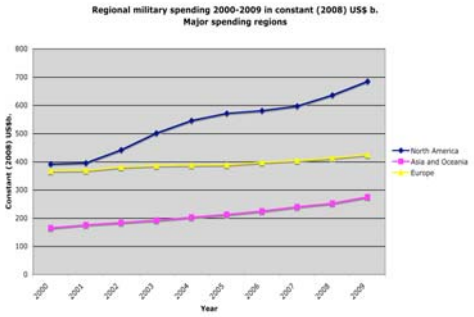
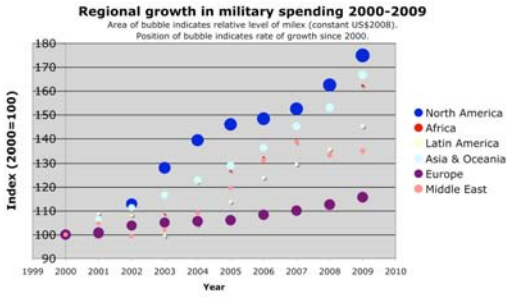


Figure 1 The level of regional military expenditure growth

Source: SIPRI Yearbook 2010, Table 5A

The meaning of studies (RANDOM) it is unlikely if palliative measures, now in testing, don't have major impact (Figure 2), the only option for European nations remaining a progressive integration of their forces to achieve efficiency savings which would allow to be maintained. There are opportunities for initiatives that would produce short-term consequences, but despite the severe political difficulties in terms of a long term plan for integration, the alternative is worse: *trying to maintain sovereignty in defence provision will mean that European nations will be ultimately unable to meet the most modest security needs, or to exercise any influence over security and defence policy at the global level* (mainly U.S. security and defence policy).



Regional growths in military spending 2000-2009

Source: SIPRI Yearbook 2010, Table

Current Air Force Planning and Programming

Each year, the Air Force[6] in all NATO and EU member states set their priorities and budgets for programs that form the basis of infrastructure, equipping and training them. The same process takes place in the Romanian Air Force too, whose size and complexity of activity give rise to a complex budget process, which runs continuously and employs a large staff of the General Staff, Air Staff and other Air Force basic structures and aimed inclusion and balance of the programs in its budget, and response to risk[7] taking for national defence.

The current system is PPBE, which divides the building budget process in four stages:

• *planning*, which provides guidance for developing the concept;

• *strategies* to meet the nation's defense needs, expressed as military objectives;

• *programming*, which translates the objectives of planning in sub-packages of resources allocated to specific;

• *budgeting*, which gives the best estimates of the costs for executing subprograms that are spending their money to complete.

Various specific structures send, on a regular basis, the objectives to the structures responsible (services, central structures, commands) for planning and programming in

Moldova (25%) and Montenegro (19%); Source: SIPRI Yearbook 2010-MILITARY EXPENDITURE, pg 2 (http://www.sipri.org/media/media/pressreleases/pressreleasetranslations/storypackage_milex)

[6] Air Force defines capacity as *"combined capacity of personnel, materials, equipment, and information in measured quantities, under specific conditions, which, acting together in a prescribed set of activities can be used to achieve a desired power"* (Air Force Instruction 10-604, 2006, p. 3).

[7] The term risk refers to the ability to hold / unrealize operational activities of the Defence Planning Scenario.

the PPBE system such as: CSA [8] (by The National Security Strategy); the Ministry of National Defense (by Defense Planning Guidance); chief of General Staff (by the Military Strategy and The Strategy of Armed Forces Transformation[9]). All these documents describe the planning environment, which in present had changed fundamentally, because in the recent past planning objectives revolved around the operational plans developed to address specific threats from opponents and reflected the uncertainties of security environment, while now they must focus on maintaining a portfolio of capabilities. This does not mean that the specific threat assessment was removed from the planning process, a variety of threats and unforeseen factors determining the nature and balance of required capabilities yet. It is a change of emphasis, from an optimal set of capabilities on a robust set, in which:

- planning to achieve optimal capability focuses on specific threats;
- planning for a robust set of capabilities is focused on ensuring the effectiveness of a range of conflicts.

This change of perspective in planning has direct consequences for programming. In the current PPBE process, Staff of the Air Force, with assistance from the General Staff, is responsible for submitting resource allocation decisions in response to and in accordance with Defence Planning Guidance, which focus on the needs for a six years period. In accordance with financial constrains, Air Force Staff is developing a set of program elements and a level of funding for these items, enabling the organization, training and equip forces to achieve the overall objectives of planning. The Air Staff orientation should be based, in large part, on commanders requests, which came in the form of integrated priority lists (IPLs[10]) and guidelines provided by defence minister through the Defense Planning Guidance[11], as I presented above. To monitor the implementation of the decisions, the Air Force Staff should organized the decision making in a corporate structure in on four levels, in

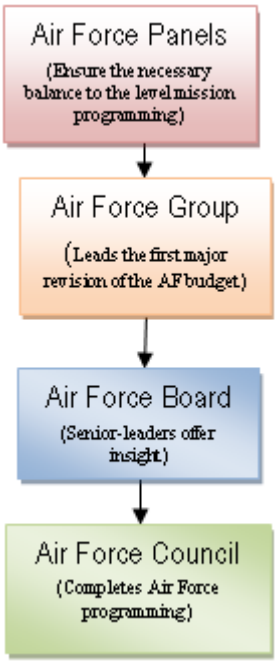


Figure 2 Implementation of programming and budget decisions in the USAF

accordance with the requirements governing the management of the projects in NATO and EU States Member's economies (Figure 2 – a variant).

Therefore, the previous scheduling decisions strongly influence current decision making process. Political problems and competition between suppliers also play an important role, as a strong factor is the inevitable subjective judgments of experts and leaders, and relatively persuasive skills of those who have supported programs and have made clear their benefits. Some of these subjectivities and rivalries are inevitable and probably in some cases, even beneficial.

However, a variety of arguments emphasizes the value of quantitative

[8] Homeland Security Supreme Council

[9] The Romanian current defence planning system does not include the *Strategic Defence Review*

[10] Integrated Priority List

[11] The ending product of the programming process are the resource allocation decisions on major sub-year program within the sub-major program the Air Force, making in accordance with Strategic Planning Guidance, provided by the Chief of General Staff.

assessments, objectives, capabilities the Air Force in the PPBE process, including:

- need to decide between competing programs;

- need to provide a robust set of capabilities (and minimum risk) to a specific, finite budget;

- desire to be balanced between these capabilities and functional areas need to provide a quantitative expression, objective consequences programming decisions MoD and where the Legislature approved.

In part to address these problems, the Air Force in all EU and NATO member states conducted a review and risk assessment capabilities process (CRRA[12]) process, which, I believe, will have to become *an immediate goal* and in Romanian Armed Forces.

Current Capabilities Review and Risk Assessment

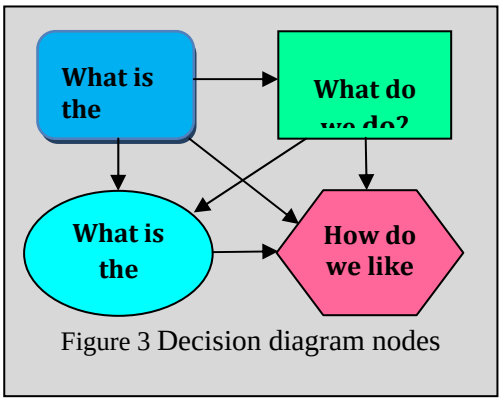


Figure 3 Decision diagram nodes

CRRA use MCL[13] as a starting point for an analysis of capacity and risk. These valuations have evolved and matured over the past years, now the central element is a set of Process Sequence Models (PSMs[14]). PSMs are maps showing the interrelationships of process activities that constitute the mission area, such as opening and base. They are essentially examples of decision networks[15] or influence diagrams[16] (Fig. 3). Nodes in the network are activities or tasks that must be completed for the mission. They assigned probabilities of success, indicating their simulations on the most important and most common areas of failure. These models, coupled with the current structure of CONOPS, binds and MCL. For example, in an agile combat support CONOPS, there are ten PSMs that do not reach other areas CONOPS, but linking the elements of MCL. In addition to these reasons, the PSM's entries include the probability of success and probability of occurrence for each node. Also included in the evaluation of functional and operational results desired, which derived from defense planning scenarios which, naturally, should be developed and managed by the Force Structure and Resources Directory of General Staff – J8. The analysis must be conducted on current and future capabilities, specified in the Air Force Program.

Finality of the analysis must indicate the node with the largest effect on operational results. In this way, limited resources are linked to indicate competence or adequacy of capabilities in a network. From this point of view, an F-16, for example, is not in itself a capability. Rather, the aircraft support equipment, necessary information for an assignment, and all other items necessary to perform the mission shape the general form of the capability. Only when all these elements are operational, those are available and the increasing of the level of available capabilities request to invest in the limiting element. This is the way to understand the efforts to provide

[12] Capabilities Review and Risk Assessment

[13] Master Capabilities Library

[14] *Assessing Capabilities and Risks in Air Force Programming*, published in 2009 by RAND Corporation
Process Sequence Models *allows* an organization:
- to *determine* what happens now is predictable and why;
- to *measure* how the process works efficiently;
- to *collect* information to understand what is useless and inefficient and their impact on the mission;
- to *develop* new improved processes to reduce or eliminate inefficiency.
(http://www.cps.gov.uk/publications/finance/process_mapping.html#a03).

[15] Examples: *Markov Decision Networks* [http://arno.unimaas.nl/show.cgi?fid=116]; *Bayesian network*.

[16] An *influence diagram* is a simple visual representation of *decision problems*. Influence diagrams offer an intuitive way to identify and display the essential elements, including decisions, uncertainties, and objectives and how they influence each other. This simple diagram describes the influence of the situation, a variable decision *"What do we do?"*, a variable chance *"What is the result?"* and our final assessment of *"How do we like it?"*. These four types of nodes are the *building blocks of decision problems*. Influence diagram (Fig. 3) gives a high-level conceptual basis of which an analyst could construct a detailed quantitative model.

a capability to review compliance with environmental requirements and risk assessment capabilities (CRRA).

Correlation programming decisions with capabilities assessments

„The keystone to satisfying these goals lies in how capabilities are defined and

Capability metrics should relate directly to plans or relating to the program, groups of program elements or subsets defined by elements of the program and is wide enough to allow their application in a series of programs. Methodology should aim to address their development to approach the programming in the agile combat support - for example, *do the funding levels of medical support and civil emergency programs provide comparable levels of capabilities?*[17] Or, *depending* on how increase (or decrease) the levels of fuel supply programs funding, *is changing* capabilities provided to civil emergencies? Are sufficient supported investments in all assets acquired? What levels of resources can be organized to best meet the uncertainties in the future security environment? Further, I propose to focus in particular on an assessment capabilities for agile combat support. However, many of the basic principles apply more broadly and should help in structuring the Air Force based on capabilities programming decisions.

Define programming capabilities

Hallmarks of good measures of capabilities are that it is intuitive and easy to understand, namely, that they meet the objectives described above. In this regard, proposing to use the capabilities definition as the *set of resources required to perform an operational level activity*. For example, the set of resources to perform a major combat operation (MCO), which refer to MCO-1, would become an MCO-1 capability. For example, where 17 helicopters of a type are considered necessary for an emergency MCO-1, then they constitute a MCO capability.

Similar metrics can be defined for a number of emergency operations - including the operations of small amplitude - removed contingencies for humanitarian aid operations and the of steady-state deployment, such as the prohibition of drug trafficking and disposal of non-combatants - might not amount to an additional level of funding. Resource capabilities are not fixed its value only in relation to an operational scenario. In this respect, two refueling planes may be 0.8 for a particular MCO, but may be 2.3 for a special event unexpectedly small. This principle is reflected in CJSOR[18] applied by NATO (SHAPE) for each Contingency Plan, respectively, for each CONOPS developed for ongoing operations and which contains the capabilities required by planning scenario developed.

This definition is somewhat elastic term use of capability, but it makes the analogy expresses the Air Force capabilities at the unit level , as the unit type cods (UTCs[19]) that specifies a capability needed by a statement of capabilities-mission. By this, a pilot unit is designated to determine what personnel and what equipment are needed to achieve the specified capability. In this way, a set of capacity and resources are equated, UTC is sometimes used as a benchmark for capability, or other resources. In the same spirit, we use the term *capability metrics* to refer both to the operational *capability of a set of resources* and the *resources determined in the context requires.*

This is why, programming with a set of scenarios, called the defence planning, is the solution most appropriate to implement this method. They are composed of homeland defense scenarios and scenarios for MCOs, unexpected, small, and steady-state deployment scenarios during post conflict period. Each of these scenarios is a unit of the developed planning capability catalogue. For each of these scenarios, it is the set of

[17] Don Snyder, Patrick Mills, Adam C. Resnick, Brent D. Fulton, *Assessing Risks in Air Force Capabilities Programming*, published in 2009 by the RAND Corporation, p. 10.11.

[18] *Combined Joint Statement of Requirements*

[19] Unit Type Codes

resources required executing and in this context, the set of resources is equivalent to the capacity of conducting operation[20].

This capabilities definition meets the above requirements, because the capability definition in operational terms measure the relationship between the availability of natural resources and operational results desired. By connecting resources capabilities, capabilities are also naturally related costs, both in value, expressing movement in the currency of calculation program and as a necessary dimension of human force to be employed. To address the uncertainty of future threats, capabilities analysis should take into account not just a set of scenarios in a given period of time, but the whole spectrum of scenarios defined in the defence planning scenarios.

Before we dwell on this point, it is instructive to compare these measures with some similar capabilities, currently used in the Air Force. To be more indicative of that allocation, the experts propose RANDOM us consider, for example, common metric, often used to measure combat support capabilities necessary resources to bring the operation: the number of free bases that can be opened and respectively operationalized. Using this metric, they say in another context, not surprising extent of the objectives included in the planning and analysis that follows and the average amount of fuel, and support elements in air bases used in recent operations three areas: Operation Enduring Freedom (OEF) Operation Iraqi Freedom (OIF) and Operation Allied Force (OAF).

At this stage it is not important to know the specific function of each activity, the emphasis here is the great variation in requirements for these resources (for each base), for different operations, which occurs mainly from two factors: *the use of the base* and *existing basic infrastructure*. Figure 4 shows the large variation in use, expressed in terms of types and numbers of aircraft. The figure describes the 30 locations where U.S. Air Force were recently used in support of OIF and OEF, whose intrinsic characteristics are the existence of a mixture of aircraft types and the fact that a large part of in site supports a number of aircraft from other services and coalition partners. Furthermore, it is surprising that there are a limited number of "typical" bases or sites with a number / similar types of aircraft, practically each base is unique in.

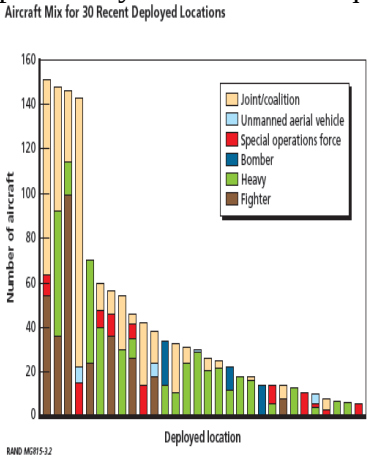


Figure 4 Variations in Use

Source: RAND MG815-32

The quantity and quality of combat support infrastructure varies considerably, not only from base to base in a theater, but also to the theater, the theater. The final effect can be seen clearly in Figure 5. OEF and OIF were held in mmand area of responsibility of the United States, an area with numerous austere bases and without a substantial U.S. presence permanent. Therefore, there is no basis on which to perform typical air force, the number that can be supported varies depending on the type of commitment and location. These observations suggest a metric that focuses on *operational issues* rather than on considerations at the grassroots level. For example, the capability may be expressed in the way as much as, say, can help as a resource, operations in OIF. Where capabilities are expressed in such terms, rather than metrics with smaller field of application capabilities as diverse as medical support, engineer support in the field of civilian objects and actions to neutralize / suppress enemy defense inflatable can be examined and traded on a comparable basis, which directly relates to the planning target level.The challenge is then to determine what

[20] We believe that a resource is only when capacity is able of mission. Solving the problem of ensuring support costs for both sets of maintenance resources and the capabilities, it will last.

resources are needed to perform these operations of defense planning scenario, principally those in the specialized field known as the implementation requirements (represent the resources needed to perform one of the scenarios.) Returning again to Figure 4, we see the need to calculate the necessary resources for each of the different bases represented, having regard to infrastructure and other operational requirements.Note that only the deployment requirements to achieve all desired results, alone, are often insufficient, because some resources will be, at some point, inevitably, in the reconstruction, while others are set aside for training or staging bases, to be carried out only as a last resort. And these additional resources must be scheduled. The amount and ongoing requirements necessary to cover any disruption and training needs are called scheduled requirements.

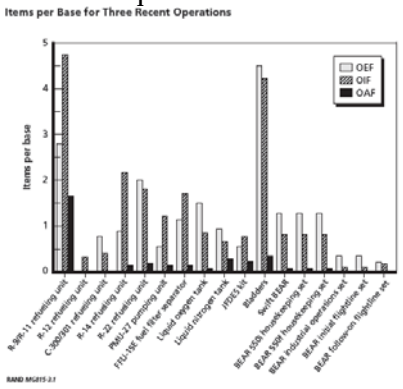


Figure 5 - USAF elements on a layout for the last three operations in the Middle East

Concordance between resources and capabilities

Now I want to propose to return to the core problem - *determining the necessary resources* to provide a fixed level of capacity. Implementation requirements for agile combat support resources can be determined in three ways. *First*, we can reunite the necessary experts in the field of programming / planning to interact with experts in operation, to create *the list of stages for UTCs*[21], called the *force data*, on Source: RAND MG815-32 implementation (TPFDD[22]). TPFDD are very expensive (in terms of time and work) to be produced. You may need about 60 experts to be assembled, whose activity is repeated over weeks or months to reach a viable solution. Part of the difficulty is the fact that the requirements for a functional area often depend on other factors. For example, in areas such as health care and civil engineering, they require knowledge about the population as a basic input for determining their requirements, but they can only be determined by summing all the requirements of all functional areas. This approach is probably the most accurate way to estimate the requirements for implementation, but it is inoperable for examining possible scenarios portfolio based programming capabilities for an uncertain future security environment.

A *second approach* is a step towards rectifying this problem. Over recent years, the Air Force in the armies of NATO member states with big technological advance led to a high UTCs sets the time and steps needed to support operational activities at an austere location. These groups are called *modules forces UTCs*. They direct the efforts already made by experts in the field, alleviating them duplicating the same analysis each time. However, as shown in Figure 4, not only that more operations are performed non austere bases, but there is a base type for all. Modules of force must be tailored to each location, and to do that, must be provided a set of experts. Although some time savings are realized, again this effort goes beyond what is possible for a flexible treatment of a scenarios portfolio.

There is *the third way*, the experts[23] advocate: *establishing a set of rules for the resources needed to implement the algorithm capabilities and keeping them current*. This is the approach developed by RAND as a strategic tool for assessing the requirements of Transport (START)[24] (Fig. 6). The tool calculates a set of UTCs needed to support operations from a location where forces were deployed and used aircraft characteristics and location, as input. For aircraft, the entries are

[21] Unit Type Code

[22] Time-Phased Force Deployment Data

[23] Conclusions of the RANDOM study - *"Assessing Risks in Air Force Capabilities and Programming - Framework, Metrics, and Methods";* Editor RAND Corporation, 2009.

[24] See too Snyder and Mills, 2004

the number of aircraft type and location, if they are stacked or used as locations a turnover stations, the rate of output, and respectively, the type of mission. For location, inputs are conventional and unconventional threat level faced by the (large, medium, or low) and some aspects of infrastructure, such as how much is available billeting, if available fuels hydrant system, and so on. With this input from the air battle order, a list of UTCs to support such operations can occur rapidly, as a tool used to determine the resources necessary to meet the full set of requirements revealed by the defense planning scenarios.

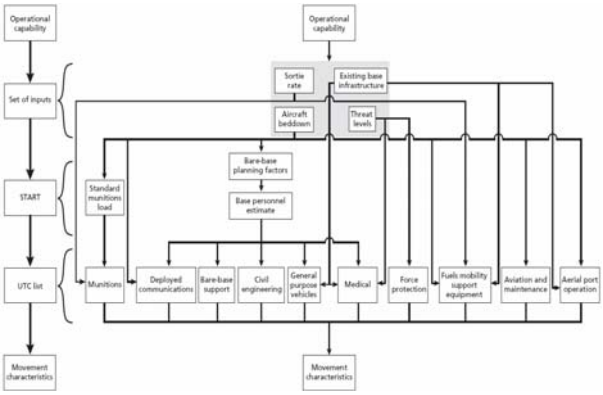


Figure 6 – Relations between functional model inputs and outputs

The difficulty in resource allocation on capabilities, required to be taken into account several considerations. In most cases, resources and capabilities are not permanently associated and therefore specialists[25] proposed to be taken into account the following four options.*First*, we must keep in mind that *a resource* or *a set of resources* can provide *a unique capability* and that *this capability* can be *achieved* only by *one single* resource or *a set* of resources. From the mathematical point of view, this is a *"one-to-one"* (or bijective) in the resource allocation capabilities. Because there are usually several ways to do this assignment, cases by this kind, strictly bijective, there are few. An example of this might be services for the deployment of a mine clearance. *Secondly, a resource* may be able to provide *several distinct capabilities*. An example might be an F-16CJ, which can annihilate the enemy air defence or combat air patrol. *Thirdly, a capability* can be provided *more resources*. For example, referring to the Air Force, a recognition capability could be achieved by a crew of by a U-2 aircraft, an unmanned aircraft Global Hawk RQ-4A, or spatial means. Another example is providing fuel, which can be supplied through tankers or pipeline system. And because the Air Force uses, often, locations, jointly with other groups working of the armed forces or other coalition nations, historically, some capabilities are not provided by Air Force organic resources. The Air Policy mission of Romanian Military Aviation, in the Baltic countries[26], was a clear example in this respect.

Fourthly, the relationship between capabilities and resources could be a mix of any of these three types. Many relations between resources and capabilities enter in the third category: the required capability can be provided by a number or different sets of resources. This situation is frequent and deliberate, giving Air Force a low risk and greater flexibility. Therefore, I believe that the planning process based on multiple assessments of capabilities and resources must consider these relationships - especially the third. The models developed show the *essence of the problems* involved in programming and are *the starting point* for modeling other complex cases. These, though they may be nonlinear, it should still be treated with standard optimization methods. If it is desirable to develop more complicated models, it depends on how much it would help in making an appointment scheduler wiser. Broader scope of a metric capability is, most probably, that a specific capability is provided by more than one resource.

It also shows a preference for operational capabilities in the PPBE programming. For example, if the capabilities were narrow metrics such as the fuel pump to a base, could create an ambiguity during programming in the terms of adequate fuel mixed with both tankers, and from hydrants. If the metric by capability at the operational level is specified, then this mixed is inherently

[25] Ibidem 23

[26] August - November 2007

specified (which has crept in the OPP as CJSOR[27]). In this sense, different operations will require not only different levels of the refueling capabilities, but also a different joint. Both this and the need to examine the usefulness of future uncertainties show the programmer to examine a range of operational metrics capabilities.

A capabilities-based programming methodology

As I pointed that the provision of capabilities is based on the Defense Planning Guidance. The programming goals are established on the basis of portfolio of planning scenarios that define of capabilities at the operational level metrics. Resources are linked to such *scenarios* by assigning a UTC approach that are necessary, from the entry level of air operations order, which, *linking* capabilities with the resources, *correlates* ipso facto programmable units, and costs arising both from need of acquire new assets and the need of sustain existing assets. Procurement costs arising from implementation requirements, recovery circuits and current stock levels. Support costs arising, also, from the frequency of use specified in the of defense planning scenarios and of attrition rates, determined empirically. Factors leading to these support costs cause also reconstituted channels - the only way all these ingredients interact each other in a complex system programming.

The challenge for the programmer is to clarify and balance all these factors, not only within a particular element to the program, but also a complete set to program elements that constitute to budget proposals (objectives, priorities, resources) which category to forces, in the our case the Air Force, subject to yearly approval by Chief of General Staff and later by defence minister. In this section, algorithms will be presented succinctly summarizes these ingredients in the draft program based on capabilities. They can be also used to assess how a proposal can be based on a set of desired capabilities (sets of operational scenarios). In this respect we developed *three approaches*, each providing a different insight into programming decisions, which are distinguished by how they treat and planning future goals, respectively, by the way that minimizes costs and maximizes capability.

The *first approach* minimizes costs (procurement and maintenance expenses), in circumstances they ensure the necessary capabilities of a set of planning scenarios, subject to constraints caused by fluctuations in expenditures from year to year. In this case, the planning objectives set include some subsets of defense-planning scenarios that are a possible future in which a state could prepare their defense.

The *second approach* maximizes the capabilities defined by the set to planning scenarios that are subject to fiscal constraints. In this case, spending limits can cause failure in achieving all the desired capabilities or costs could be high, which could lead to a glut in the capabilities, as defined by the objectives of planning. Both approaches build a future based on a deterministic program, while providing some important insights, especially if used repeatedly with different sets to planning scenarios. These approaches are not surprising, but the whole essence a robust planning, medium term security for an uncertain future and are known as *approaches a set to scenarios*[28].

A *third approach* develops robust program of an uncertain future. Since the latter maximizes the capabilities for one future alternative, the third case provides a simultaneous approach for a portfolio[29] of alternative future, subject to fiscal constraints. This method is known in the literature in the field as a *robust approach*.

[27] Combined Joint Statement of Requirements

[28] Ibidem 23

[29] Analysis which evaluates alternative investment options to various quantitative and qualitative objectives, including risk reduction. The analysis contributes to the "swinging" in an investment portfolio, i.e. a mixture of instruments. The intention is to address all the objectives and mitigate all risks, but at varying degrees, depending on priorities, budgets and achieving opportunities. http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG662.pdf)

Modelling Approach

> *"To apply a rule to the letter, rigidly, unquestioningly, in cases where it fits and in cases where it does not fit, is pedantry"*
>
> George Polya, 1957, pg. 148

Each of the presented approaches involves the need to seek simultaneous values, minimum or maximum of several variables subject to constraints. Such problems lend themselves at analytical optimization techniques. The dual nature of the objectives suggest *two optimization modes*: one that *minimizes* the net-present value of the costs subject itself to all the performance requirements expected capabilities and other that *maximize* the global minimum capabilities (in time and resources), subject to budgetary constraints (e.g. budgets set; constraints on annual changes in the budgets of programs).

For all modes of optimization capabilities expected to be specified. Having regard that the unexpected is expressed in the types, probable locations and time, they will be kept as inputs in the programming, which will be specified separately by each user (program directors), depending on capability metrics, obtained either from defense planning scenarios or through an exploratory analysis of past events (e.g., OIF[30]). This flexibility allows the programmer to explore the implications of various assumptions on the process of program planning and vice versa.

In current practice, is used linear programming (LP) to find the optimal method by choice of purchasing decisions of capabilities, based on a predetermined set of contingencies. Solving a deterministic optimization and application forms are suitable for LP quick solutions to problems on an industrial scale. Thus, LP satisfies our desire to look into a wide range of resources and offers the programmer a quick review. It is flexible enough to allow confrontation with intrinsic and nonlinear components of the problem by using linear constraints, in the particular, feedback of the decisions by procurement and pricing examples resulting from procurement over time, which may affect the status of planning base.

Experience showed, however, maintain that the advantages outweigh any benefits linearity mathematics that can accumulate through the introduction of nonlinear pricing. The pricing problem can still be addressed by adjusting linear parameters, such as establishing a purchase price constraint (for example, forcing a certain minimum level of purchase at any time) and another price for acquisitions without restrictions (e.g. allowing of public to vary at zero at any value in the general budget constraints). This allows the programmer to exploit the variable effects of prices due to industrial base status, but maintains and enormous benefits of linearity.

Using in the analysis

George Polya (1887-1985)[31], one of the leading figures of mathematicians' prominent XXth century, of the issues addressed in his studies and general principles, based, as was natural, from the underlying mathematical problem-solving. The spirit of his advice is equally applicable in programming from the Air Force to analyze of the capabilities of any model. Together, these considerations require the use of a programmer trial. In addition, the programmer needs the perspective of the impact of programming decisions on the Air Force capabilities in development planning objectives and their budgetary priorities, and assesses the risk they might incur.

Cases based on a single scenario

First, we will review, briefly, the algorithms use a single scenario: (a) *to minimize costs* (on a state on a single scenario) and (2) to *maximize capabilities*, as defined by a scenario, subject to budgetary constraints. We start with minimizing costs. Figure 7

[30] Operation Iraqi Freedom

[31] **George Pólya** was a Hungarian mathematician. He is most noted for his work in heuristics and mathematics education, publishing several books on the subject, the most famous of which is the celebrated *How to Solve It: A New Aspect of Mathematical Method.* http://en.wikipedia.org/wiki/George_P%C3%B3lya

shows the optimal connection, depending on of time of the set of capabilities and resources at this type of programming. They (resources) may cover one or more program elements, programming all the requirements of a single fictitious scenario set at minimum cost subject, under the constraint that costs do not vary from year to year, with more than a certain percentage. The The ordinate of the plot show neat capability over of planning period, beyond which additional resources were needed to achieve the scenario set, specified in the plans.

Consequently, when a curve is zero, the resource at that time corresponds exactly to the requirements in scenario planning. If positive, this (plan) has more capabilities than are needed for the scenario set. Since this optimization always meets such requirements, the curves must be non-negative. If the curve was negative, it reflects a lack of resource on at chosen scenario.

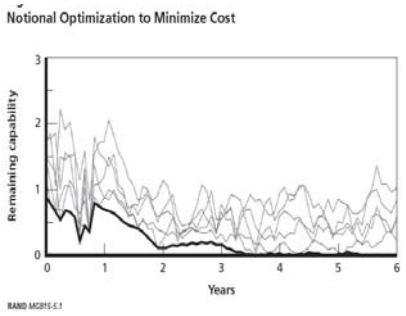


Fig. 7 Theoretical optimization to minimizing costs
Source: RAND MG815-5.1

Ordinate values depend on the choice of metric. Any metric can be selected capability, which may be remaining capability from certain major operation (MCO), emergency, small scale, or humanitarian operation for which requirements are known or can be determined. Note is that the choice of array *will only change the magnitude* of these remaining capabilities. Whether the graph *curves* portions are *positive* (or negative), the *choice* of the metrics is *independent*. Examination of a series of metrics allows the programmer to see the quantitative impact of the proposed program in relation with the different types the contingencies.

For a given set the resources from Figure 7, the limiting form the bottom. Fort his set of the resources, the total capacity is not better than the worst-performing component, so the overall capacity of the set of the resources is given by the thick curve which marks the lower limit. When this thick curve is above zero, many resources are more available than necessary for the specified scenario, set at a particular time. A positive value does not mean, necessarily, an excess of the capabilities, those remaining positive being necessary sometimes to ensure that there will be deficits in the future.

Graphics, as the one shown in the Figure 7, show that resources are in the excess, especially compared to the baseline (have always remaining positive capacity), which are critical (to a moment touching zero). The data set available to of the programmer indicates the balance of investments needed to purchase, reconstruction, and O & M[32]. This not only helps the programmer to determine the appropriate asset and its protection level, but also the possibility of the financial support, ensuring that these assets are real capabilities (able to ensure the mission), and the not remain unavailable because of lack of support. This analysis can be extended to the case of maximizing of the capabilities in relation to with the chosen scenario, a situation which is illustrated in the Figure 8. The elements are the same graph as in Figure 7, except that these curves for each activity are suppressed - only the lower curve is presented. The exact element of this analysis is to explore the risks that could be supported by a cost lower than the optimal values shown in the central chart and to determine additional capabilities, acquired in an additional expense.

[32] Operating and Maintenance

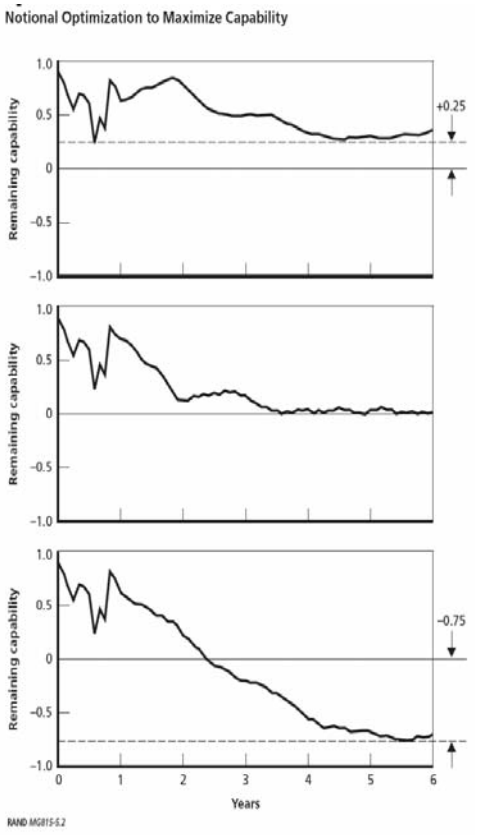


Figure 8 - Theoretical Optimization for minimizing costs (detailed version)

Source: RAND MG815-5.2

It is instructive to consider the addition and the removal of the same amount of money in relation with t presented in the central graph of Figure 8. Upper graph shows the optimal programming solution where some additional money (the example, several millions the dollars) is added in compared with the program presented in the central graph. The graph below shows the optimal scheduling in situations that money are out, say the same million dollars per year listed in the schedule as compared with the program central. Generally, the result will be shown in the figure: the same amount of money, added at an acquisition program ensure *less additional capabilities*, as well as for removal only made money for assuming risk.

The reason for this nonlinear response is to determine the smallest frames and thick curve in the figure, causing the overall capacity of a set of related resources. If a program is non-balancing (i.e., the remaining capabilities of individual resources are spread widely over the lower bounding curve), additional purchasing capacity is relatively inexpensive, since only one or two resources may need to be purchased (or reconstructed) to push up the lower bounding curve. The more capabilities are acquired, the minimum bounding curve moves up, and more resources are grouped in this curve or near the lower limits, which make the overall program is much more balanced, which is good. But pushing the curve further up, you will need to buy a part of almost all the resources and therefore the program becomes more expensive. Put another way, in a program healthy, balanced growth in purchasing power requires a lot of resources, since resources are interdependent. However, in accordance with the principle of funding from a single central resource / base, it can make a whole set of resources inefficiently.

Conclusions

Programming tools described provides a guide and not a solution to the current programming dilemmas. Uncertainty of many input factors and incommensurability - in particular risk - requires the intervention of policy makers. Subjective decisions, singly, are insufficient to build a program that spends money and manpower allocated effectively and efficiently. The approach of the methodology and programming tools, developed through the research in the field of defense planning, provides guidance reproducible, quantitative, to build a program to provide specified capabilities and way in which to assess how will work, in relation to the various challenges of future security environment.

Defining capabilities in this way, we link natural capability to plans. The first recommendation of RAND experts in this regard is that, where possible, define the capabilities to be made under the terms laid down for plans by the guidance of the Minister of Defense, rather than Air Force tasks[33].

Three key elements make this analysis possible. *The first* is *defining* the way of the

[33] RAND Corporation, *Assessing Capabilities and Risks in Air Force Programming*, 2009 edition, p. 66, http://www.rand.org

establishing of the metrics capabilities, so that feature programming decisions. To guide the planning, measurement capability must have several attributes. In a clear manner, reproducible metrics capabilities must be linked to program elements or sub-elements, clearly defined by the program elements. *Second*, metrics *capabilities must be related to planning objectives*, such as plans to set up and model directly programming. And *thirdly*, capability metrics should *link the capabilities* in general terms that apply to programs and not individuals or specific terms that apply to a program or function. Otherwise, the transaction between capabilities and programs is neither reproducible nor quantifiable.

Current metrics capabilities of the Air Force fails, generally, in to capture these attributes, which further indicates that the use of aggregated measures of how a resource provides a minimum contribution to the operational objectives, such as MCOs, crisis response operations and steady-state deployments, to establish a state of equilibrium which constitutes the defence planning scenarios.

From this perspective, the first RAND recommendation[34] *in this area is that, where possible, capability should be defined according to the minister defense planning guidance, rather than Air Force requirements.*

Linking capabilities of programs leads to the following key: *to determine resource requirements to achieve this set of operational capabilities*. In providing agile combat support resource requirements for implementation can be resolved at the level of the air order of battle. To make these calculations quickly, is also necessary a similar procedure to those established for UTCs: how much of each UTC is needed, which is interdependence UTCs to support specific number of aircraft types, which are the rates of exit flight data, and the locations where infrastructure can fly again? RAND research has demonstrated, primarily, the feasibility of such a rule-based tool with a prototype model[35]. To be useful in regular programming and execution of decisions, this model should be formally verified, implemented and regularly maintained.

The second RAND recommendation is "to develop and maintain a rules-based tool for generating TPFDD[36] *requirements that give some order-level inputs for the air battle planning scenarios."*[37]

These first two factors ensure that there ingredients for building cost-capability curves for sets of related resources, which is the foundation for the *third key element*: *a set of algorithms* for (a) assessing the impact of exchange of capabilities and (2) developing a robust commitment capabilities to cope with an uncertain future security environment. A set of resources is not necessarily a capability, unless a sufficiency to support an effort to maintain these resources able to the mission.

A third RAND recommendation is " to develop a robust program across a range of plausible scenario sets that balances asset levels with sustainment investments, in lieu of programming to meet a single challenging scenario set"[38].

Uncertainty abounds in programming. Input data such as life expectancy of resources, potential obsolescence when it might be more rapid modernization, are very difficult to collect. Moreover, the way in which will be this future is impossible to predict. It is tempting to avoid shaping the face before those uncertainties, because the modeler has to commit to decisions on the values of these parameters. However, any programming strategy makes assumptions about the values of these inputs. Assumptions made without a review are simply default and less reproducible, providing a justification for reproducible analysis, measurable targets for the budget aimed at a national level. A combination of skillful and shrewd programming decisions can build a strategy to provide a robust and agile set of capabilities

[34] Ibidem 33

[35] (See Snyder and Mills, 2004)

[36] Time-Phased Force Deployment Data

[37] Ibidem 33

[38] Ibidem 33, pg 67

that will meet the challenges of an uncertain future security environment.

FINAL NOTE

Any defence planning and force development system can be successfully implemented only if there is a more clear and stated government policy to guide planners. But to be clear, "it is folly for any defence planner to wait for such guidance is provided in official documents." Inevitably, planners are left to discern the guidance of a variety of sources, more or less obvious or obscure. For example, these important defenses planning guidance can be found in sources such as the nation's constitution, the defence laws, the officials' speeches, interviews of government and even the press. Indeed, experience leads to the idea that the usefulness of these other sources of guidance and prioritization can far exceed that of public documents, the national policy oriented. Finally, these guidelines and priorities must be promulgated in policy documents from the MoD Defence which inevitably will include principles such as defence of national sovereignty (and, in the context of NATO, respectively, of collective sovereignty), participation in crisis response operations, etc.

Bibliography

1) Don Snyder, Patrick Mills, Adam C. Resnick, Brent D. Fulton, *Assessing Capabilities and Risks in Air Force Programming - Framework, Metrics, and Methods*, Publisher the RAND Corporation, 2009.
2) Dr Gerrard Quille Policy Department European Parliament *The European Security and Defence Policy: from the Helsinki Headline Goal to the EU Battlegroups*, edited by Brussels, European Parliament, 12 September 2006.
3) Ronnie Gori, Pin Chen and Angela Pozgay, *Model-Based Military Scenario Management for Defence Capability Analysis.*
4) Lt Col Nathan Titus, Resource Analyses Directorate, Air Force Studies & Analyses Agency, *Air Force CONOPS & Capabilities Based Planning* *www.dodccrp.org/files/03_19_04_AF%20CONOPS.ppt.*
5) Sam Perlo-Freeman, Olawale Ismail and Carina Solmirano, *Armaments, Disarmament and International Security*, SIPRI Yearbook 2010© SIPRI 2010, *www.sipri.org/yearbook/2010/files/SIPRIYB10summary.pdf*
6) Index of world and regional military spending 2000-2009, SIPRI Yearbook 2010
7) Ashton B. Carter, *Defense Management Challenges in the Post-Bush Era*, *belfercenter.ksg.harvard.edu/files/Carter%20Chapter.pdf*