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Scenario modelling with morphological analysis

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ABSTRACT

Scenarios can serve as points of reference in the future for decisions that we have to make today. Morphological analysis provides a structured method for ensuring consistency and relevance in scenario development. This paper outlines a method for characterizing the entire solution space of future outcomes in a given subject field, and suggests a process for classification of an all-encompassing and mutually exclusive set of scenario classes. The method is illustrated with an example case, taken from Norwegian defense planning, of establishing a scenario set that encompasses all external security challenges to Norway as a security actor. Four parameters are defined – Actor, Goal, Method and Means. Each parameter is defined in terms of an exhaustive set of possible states or values. A Cross Consistency Assessment is conducted to exclude solutions deemed to be impossible on either purely logical grounds (internal consistency) or based on real world assessments (external consistency). Six scenario classes are defined: Strategic Attack, Limited Attack, Coercive Diplomacy, Terrorist Attack, Criminality and Military Peace-time Operations.

1. Introduction

Scenario planners have long dealt with the problem of capturing a complex and uncertain world within the confines of a limited number of scenarios. The problem is fundamental to future oriented studies and planning, and a number of techniques and methods have been proposed to deal with it (Bryant and Lempert, 2010; Postma and Liebl, 2005; Groves and Lempert, 2007; Nguyen and Dunn, 2009; Kwakkel et al., 2013). Although no single approach will ever be able to transcend the gap between scenario models and the real world, this paper suggests that General Morphological Analysis applied to scenario modelling may solve some of the most pressing problems related to established scenario methodology.

This paper looks at the scenario modelling problem from the standpoint of long term defense structure planning. In the defense planning process, scenarios serve vital functions as vehicles for war gaming, simulation, and analysis to support the design of a future force. As an illustrative case and as an example of the morphological process in practice, the paper goes into some detail in explaining the development of a scenario set for Norwegian defense planning.

A scenario can usefully be defined as a description of a possible future state or condition within a subject field. Scenarios are not predictions of future events, and although they sometimes provide probabilities, their main function is to present decision makers with a set of alternative futures against which different courses of action might be measured. The basic criterion for inclusion of a scenario in a scenario set, thus, is not the probability that it will eventually happen, but the fact that it *might* happen given certain assumptions about the surrounding world. Schwartz (1996 p. 4) consequently defines scenarios as "tool [s] for ordering one's perceptions about alternative future environments in which one's decisions might be played out".

In order to provide a useful tool for thinking about the future, scenarios have to relate to established knowledge about the outside world, and to a certain conception of what might actually happen in the future. In that vein, van der Heijden (2005 p. 225) posits that scenarios must conform to the principles of *plausibility* – scenarios must build on a logically derived cause-and-effect relationship between and within real world phenomena; *consistency* – scenarios must build on assumptions that are not mutually exclusive; and *relevance* – a scenario must contain sufficient high quality information to make it useful for its purpose. As an additional admonition, he states that the number of scenarios should be restricted to two, three or – at the most – four, since that is the maximum number decision makers are able to relate to in a systematic way.

A number of schools and traditions have dealt with, and proposed their own solutions to the complexities of scenario writing. Bradfield et al. (2005) identifies three dominant schools in scenario building: The French *La Prospective* school; the *Probabilistic Modified Trends* school associated with RAND; and the *Intuitive Logics* school. The *Intuitive Logics* approach, associated with the oil company Royal Dutch Shell and the Global Business Network, is perhaps the best known among them (Bryant and Lempert, 2010). Being extensively applied for a wide

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variety of purposes, it has become something of a convention for scenario and planning purposes.

Wack (1985) describes how the Intuitive Logics method was developed by analysts at the Shell oil company during the 1970s in a situation with deep uncertainty about the future development in the international energy market. The key element to the intuitive approach is a firm grip on what constitutes the forces driving the system, and awareness that there are some outcomes that are *predetermined* – events that have occurred, but whose consequences have yet to materialize, and some that are fundamentally *uncertain*. Uncertainty in this context stems from different sources, some purely random, as when an accident causes a halt in the oil production, but also some that are related to choices made by social entities – the actors making up the system. Under this particular type of uncertainty, outcomes are determined by multiple, interacting self-interested actors (Blanken, 2012). Hence, scenarios have to incorporate not only probabilistic uncertainties, but also uncertainties of a *strategic* nature.

By measuring the uncertain factors to the range of possibilities provided by the predetermined factors, some outcomes can be excluded from the scenario selection, while confidence in others is strengthened. As an example, Wack shows that by 1972 analysis of the oil market had established that demand for oil was outstripping supply by a large margin, and that ten years of low economic growth would be required to fit demand to supply. Hence, rising oil prices were seen as predetermined and a balanced oil market with stable, low prices over the long term could effectively be excluded from the company's scenario portfolio (Wack 1985 p. 82).

This approach is well suited to reduce a potentially vast scenario set down to manageable proportions. Moreover, one of the attractions of conventional scenario methodologies is their focus on causality. However, application of a particular causal chain to scenario development might be extremely difficult given the non-linear properties that characterize systems governed by human behavior. Misplaced causality, therefore, is a major source of bias in scenario building, and restricts the prospect of fitting discontinuities that cannot readily be framed in cause-and-effect terms, to the scenario set.

Consequently, according to Kwakkel et al. (2013 p. 1), conventional scenario approaches struggle when dealing with rare events and cases where there are a multiplicity of possible futures. In defense planning, in particular, uncertainties related to political shifts and revolutions, misperceptions and accidents characteristically overwhelm the predetermined elements. To put the matter bluntly, it is impossible to explain war as an incremental and entirely logical process based on observable trends. Or, in a more academic phrasing, conventional scenario building tends to break down when confronted with possible futures that combine extremely low probabilities with potentially disastrous consequences.

This point is borne out by new research that indicates that interstate conflict follows a power law logic where the size and the likelihood of events, including wars, are affected by mechanisms linking micro-level actions to macro-level outcomes in a strongly nonlinear fashion (Cederman et al., 2011 p. 621). Conflicts thus may turn into wars, and small wars into large wars through the operation of highly unstable escalation processes governed by positive feedback loops between the interacting agents.

These dynamics are not easily integrated into scenario methodologies that rest on forward looking causal reasoning. Referring to crisis management, Wright and Goodwin (2009 p. 16) claim that the requirement to incorporate rare and extreme outlier scenarios to the scenario set stands in stark contrast to the Intuitive Logics method since "… the range of focal scenarios is likely to be constrained by components of the construction methodology".

Framing the challenges posed by an exceedingly complex political and military environment therefore requires a radically different approach. Wright and Goodwin (2009) propose to apply a "backward logic" to the Intuitive Logics method in order to create a range of more extreme scenarios (see also Wright et al., 2013). The backward logic works by imagining that rare, high impact events have in fact occurred, and then work backwards by disclosing which conditions would have to be in place for that particular event to materialize.

Intuitive Logics with its recent enhancements go a long way in remedying the shortcomings of forward causal thinking, still the focus on causal chains tends to unnecessarily restrict and complicate the scenario process. This paper, therefore, proposes a shift of focus towards modelling non-reducible, complex problem spaces through the application of General Morphological Analysis.

The remainder of this paper will briefly describe the use of scenarios in long term defense planning. It goes on to flesh out some of the fundamental aspects of General Morphological Analysis. It furthermore suggests a process for classification of future outcomes in the context of long term defense planning. Lastly, it provides an example case where the method is applied to develop scenario classes for defense planning purposes in Norway.

2. The use of scenarios in defense planning

Scenarios are basic to planning of military capabilities. A NATO study (Campbell, 2010) observed that all of the nine nations contributing to the study used scenarios in some way or other for defining future force requirements.

Long term defense planning can be defined as "*the process of defining long-term defense objectives and a strategy for their fulfilment*" (Stojkovic and Dahl, 2007 p. 9). Thus defined, the planning process must consider politically determined objectives as well as technically defined force requirements. The process aims to outline a future force that can support the achievement of strategic objectives. Furthermore, defense planning usually takes place in a resource restricted environment. Hence, the final purpose of the planning process is to create a force plan that conforms to budgetary restrictions at the same time as political and military requirements are fulfilled. Consequently, what the planner is looking for is the most *cost-effective* solution to the force structure problem.

Considering the complexities involved, it seems obvious that the planning problem does not easily lend itself to simple calculation. In reality, the only reasonably reliable method is to execute a systematic search among predefined force structure alternatives which are then tested against a relevant scenario set.

The process may be – and usually is – implemented in two stages (Birkemo, 2013). In the first stage, the force structure alternatives are analyzed with respect to their inherent capabilities and costs. In the second stage, military scenarios are applied as testbeds to derive capability requirements. Scenario analysis may involve war gaming, the use of simulation models and/or considerations of national doctrine. In the final analysis force structure capabilities are compared to capability requirements in order to expose gaps and to direct the development of future force plans.

Capability based planning is sometimes set in contrast to threat based planning. This, however, is misleading, because, as Davis (2002) points out, capability based planning is also very much concerned with threats Davis (2002 p. 8). What it is not, however, is concerned with one specific threat and one specific scenario.[1] Instead, a diverse scenario portfolio is required for an adequate representation of the security environment.

Scenario based analysis for long term defense planning is considered best practice among NATO nations (NATO, 2003). The *NATO Handbook on Long Term Defence Planning* (2003) also stresses that an adequate diversity of scenarios must be applied in order for the scenario set to be

[1] In the NATO context, the shift from Threat Based Planning to Capability Based Planning came as a result of the collapse of the Soviet Union and the need to prepare for a wider spectrum of challenges.