# Annex B – SELECTIVE LIST OF 'SOFT' OA METHODS

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As an example of 'soft' methods in use in a defence environment, the table below lists the 'soft' methods most commonly used within Dstl, the UK Defence Science and Technology Laboratory [1]. The table also indicates the types of analytic activities to which they are most suited. More details are given in the following sections, taken from [1] (but textually slightly adapted). Another useful source of recommendations and techniques for defence analysis, including 'soft' analysis, is [2].

**Table B-1: Some 'Soft' OA Methods and Their Uses.**

| No. | Method | Analytic Activities |
|---|---|---|
| 1 | Benefits modelling (matrix method) | Option selection |
| 2 | Benefits modelling (map-based) | Problem structuring / Option generation / Option selection |
| 3 | Cognitive mapping | Problem structuring |
| 4 | Causal mapping | Problem structuring |
| 5 | Influence diagrams | Problem structuring |
| 6 | Decision Trees | Problem structuring / Option generation / Option selection |
| 7 | SODA (Strategic Options Development and Analysis) | Problem structuring / Option generation |
| 8 | Strategic Choice Analysis | Problem structuring / Option generation |
| 9 | SSM (Soft Systems Methodology) | Problem structuring |
| 10 | SAST (Strategic Assumptions Surfacing and Testing) | Problem structuring |
| 11 | SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis | Problem structuring |
| 12 | PESTLEM analysis (Political, Economic, Social, Technological, Legal, Environmental, Military) | Problem structuring |
| 13 | Scenario building/planning | Problem structuring / Option generation |
| 14 | Interactive Planning | Problem structuring / Gap analysis / Concept formulation |
| 15 | Robustness analysis | Option generation and selection |
| 16 | Hypergames | Problem definition / Scenario generation |
| 17 | Delphi | Prioritisation of issues / Option selection |
| 18 | AHP (Analytic Hierarchy Process) | Prioritisation of issues / Option selection |
| 19 | Drama theory / Confrontation analysis | Scenario generation |
| 20 | Viable systems model | Problem structuring / Option generation |
| 21 | Total systems intervention | Problem structuring / Planning the analysis |

There are several other 'soft' methods that have not been mentioned in [1] and Table B-1 but may be useful as well, including: Morphological analysis (for problem structuring, option generation, scenario building), (qualitative) System Dynamics, (for problem structuring, time-dependent multiple perspective analysis, option generation and selection), brainstorming using group support systems (for problem structuring, option generation), several other (qualitative) multiple criteria methods (for option selection).

## B.1 BENEFITS MODELLING (MATRIX METHOD)

Benefits modelling is a flexible technique by which the improvements in an enabling technology (such as CIS) can be systematically and quantifiably related to improvements in the overall effectiveness of the organisation which the technology supports. The key philosophy behind the approach is to decompose the problem into a number of distinct steps, each of which represents a concept that can be directly related to the real world. Decomposition of the problem in this way to form a 'benefits chain' has many advantages as it allows individual aspects of the problem to be considered separately. However, the benefits chain forms a static model which does not allow any form of feedback to earlier stages.

Benefits modelling is a multi-criteria analysis technique, in that multiple measures can be used at each stage of the benefits chain, including the final measures of effectiveness. Traditionally the data needed to populate a benefits model have been obtained from technical and military judgement. The use of a benefits chain facilitates the use of judgmental techniques in situations where a wide range of types of experience is required. However, the benefits model technique is not restricted to using judgmental data. Data could be derived from the results of lower-level objective models. Note that judgements are used directly in the model to quantify improvements; this is in contrast to techniques such as the Analytical Hierarchy Process (AHP) where judgements are used to derive weights through some form of pair-wise comparison.

The benefits chain is constructed from a series of dependency matrices each of which represents the relationship between one set of concepts (often referred to as an axis) and those relevant to the next step in the chain. The matrix transitions typically relate CIS system performance, through intermediate measures (such as measures of C2I function performance), to high-level measures of effectiveness which quantify how well warfare (and OOTW) functions can be performed. A generic structure might have five axes as follows:

- **Investments** – Meaningful units of investment in some aspect of the system-of-systems, including equipment and training.
- **System Functions and Attributes** – Primarily related to the performance of technical elements of the system, but could include human skills if the investment is in training.
- **Organisation Activities and Attributes** – Related to the combined socio-technical system, and covering activities such as information processing and attributes such as flexibility.
- **Military Capabilities and Attributes** – The outputs of the organisation; the activities or attributes that are necessary for achieving a valuable outcome.
- **Value System** – Those concepts that define a successful campaign.

## B.2 BENEFITS MODELLING (MAP-BASED)

Benefits analysis is a technique which arose in the 1990s, combining elements of Multi-Criterion Decision Analysis (MCDA) and causal mapping. It aims to model the consequences of investment decisions in terms of their impact on operational effectiveness.

The construction of the causal map often (but not invariably) starts with the identification of the desired end benefit of the programme. The map is laid out so that the means precede the end – so, for each effect,

all possible causes of that effect must be identified. This process is iterated until no further decomposition of causality can be achieved; the final causes are the inputs to the model, against which (in this case) investment options are to be scored. This mapping process can be very helpful in establishing in broad terms whether all aspects impacting on capability have been covered by a requirements document.

Once the causal map has been developed, and a stable state reached, it can be used as the basis for MCDA analysis. In generic terms, the most fundamental level in the causal map will need to be measured numerically and scored, and then the mathematical relationships between each layer of the map formalised and weighted. This will permit the maps to be used in quantitative analysis.

## B.3 COGNITIVE MAPPING

This technique maps the vision of a system, issue or event from the point of view of an individual ('group map' or 'concept map' is the term usually used when reflecting the views of a group of people). It captures the interpretation of how concepts relating to the area of interest interact. The cognitive map can be used to analyse the knowledge and opinions of the stakeholder(s).

Generally, cognitive maps used in 'soft' OA are constrained to be causal maps, representing cause and effect between the various concepts in the problem space. The process of developing the map will generally start with a less formal structure and the map will be refined over the course of the workshop.

The language used in a cognitive map is chosen carefully. For example, in the SODA approach concepts are phrased as imperatives (commands to carry out an action). In general, the manner of phrasing a concept should be consistent throughout the finished map. However, during the mapping process, facilitators should be observant of the language used by stakeholders to express the concepts, which can be significant.

Cognitive mapping is a way of improving understanding of a problem area, and can be particularly useful in teasing out the different viewpoints of various stakeholders. It is particularly useful at the scoping phase of a study.

## B.4 CAUSAL MAPPING

This is a variant of cognitive mapping, which imposes the discipline that the elements on the map must form a causal sequence. Causal maps can be used as the basis for a benefits model by representing the impacts of study interventions on operational effectiveness.

Causal maps can be constructed top-down or bottom-up. There are advantages to each method, depending on how well the problem is understood. The top-down approach requires the goal to be clearly defined, and imposes a strict discipline; at each stage the question "HOW does this concept cause the next?" must be asked.

Where the map is representing a well-understood system, the inputs (variables or interventions) can be used as the starting point and the consequences inferred. Whichever method is used to construct the map, it is important to cross-check using the alternative route – for each concept asking "HOW might this be achieved?" and "WHAT are the consequences of this?"

## B.5 INFLUENCE DIAGRAMS

Influence diagrams are simple representations of problems, including decisions, uncertainties and aims and how they influence each other. They are particularly useful in the early phases of structuring big and complex problems, as they enable the relationships between the main elements of the problem to be identified. They are often used together with decision trees.

## B.6 DECISION TREES

Decision trees are used to provide a diagrammatic representation of a problem, setting out possible courses of action and their consequences. They show the details of a problem and can provide a means of quantifying and evaluating options.

## B.7 STRATEGIC OPTIONS DEVELOPMENT AND ANALYSIS (SODA) (RENAMED TO: JOURNEY MAKING)

SODA is most suited to complex, ill-defined problems with multiple stakeholders with differing views of the problem space. It captures the various views and provides the opportunity for the stakeholders to reach a shared understanding of the problem.

SODA uses individual and group Cognitive Maps (see above) to explore a problem space. This leads to the identification and negotiation of possible solution options in facilitated workshops using the Oval Mapping technique. The technique aims to create a causal map with a "teardrop" shape, with one or a small number of goals, supported by a greater number of issues or strategies which are in turn supported by more, detailed options.

A successful outcome from SODA would be the achievement of consensus among the stakeholders on a set of possible viable courses of action. It would not seek to define the optimal solution, but could be used as a precursor for MCDA.

## B.8 STRATEGIC CHOICE ANALYSIS (SCA)

This method is related to interactive planning. It sets out to establish and manage the areas of uncertainty in a problem, through collaboration between stakeholders. It considers all the decisions involved in a particular situation in parallel, rather than taking them according to perceived priority or timescale, which permits the impacts of immediate actions of future decisions to be explored.

Three key areas of analysis are used to structure the problem:

- The decision area, where alternative courses of action are being considered.
- The comparison area, where the alternatives are assessed and ranked.
- The uncertainty areas, where the following issues are investigated:
  - Working environment;
  - Guiding values (policies); and
  - Related agendas (other perspectives).

Four complementary areas of decision making are considered in SCA:

- Shaping, where the problem structure and linkages are considered;
- Designing, where potential courses of action are explored;
- Comparing, where the criteria for assessing courses of action are decided; and
- Choosing.

The key to this approach is in the consideration of the whole problem space, which ensures that options generated for different parts of the problem will be compatible. The effectiveness of SCA is heavily dependent on the skill of the facilitator.

## B.9 SOFT SYSTEMS METHODOLOGY (SSM)

Soft Systems Methodology helps to structure complex problems where there may be divergent views about the nature and definition of the problem. It is particularly useful for requirements capture. It uses 'real-world' descriptions and systems engineering terms to ensure both that the problem is fully described and that it can be rigorously modelled.

The main elements of SSM are as follows:

- Through facilitated workshops and interviews with the problem stakeholders, a "rich picture" is created, using "real-world" terms which encourages the issues to be explored creatively and ensures that all relevant factors are considered.
- Using the rich picture, the analyst derives the root definition of the problem using the mnemonic "CATWOE" (see below) to ensure that all relevant aspects of the problem are included:

  C – Customer;

  A – Actor;

  T – Transformation;

  W – World view (Weltanschauung);

  O – Owner; and

  E – Environmental constraints.
- The root definitions are used to create conceptual models of the activities implied by the root definition.
- These models are then compared with the real world.
- Potential interventions and their likely impacts can then be defined.

## B.10 STRATEGIC ASSUMPTIONS SURFACING AND TESTING (SAST)

Strategic Assumptions Surfacing and Testing is a method used to bring consensus to a group of stakeholders where differing views are preventing them from making progress in dealing with a problem. As the name suggests, it draws out the underlying assumptions held by the stakeholders and clarifies the common and opposing issues.

It is a five-stage process; the stages are described below.

- **Group Formation** – The stakeholders are formed into mixed groups (chosen to provide a range of roles and experiences but also to minimise conflict) and each group is given a "viewpoint" from which to address the issue.
- **Assumption Surfacing** – Each group brainstorms the issue from their specific viewpoint and identifies the relevant assumptions.
- **Intra-group Dialectic Debate** – At this stage each assumption is tested for importance by examining its opposite, and for certainty according to the group's best estimate. Assumptions that are deemed to be neither certain nor important are dropped at this stage; those which are both certain and important are retained and the others ranked within the group (importance is generally rated more highly than certainty).
- **Inter-group Dialectic Debate** – Each group presents its findings before a whole group discussion is held. The output of this stage is a set of agreed assumptions (which will be taken as underpinning principles on which to proceed) and a list of those requiring further debate.

- **Final Synthesis** – The whole group works on the outstanding controversial issues to achieve consensus. The final output is a prioritised list of the most important issues, an assessment of the status of potential solutions to the issues and a proposal for the next steps.

This method is particularly useful in developing plans from a high-level strategy.

## B.11 SWOT (STRENGTHS, WEAKNESSES, OPPORTUNITIES, THREATS) ANALYSIS

This method provides a structure for brainstorming a problem in its early stages. It is particularly helpful in generating solution options. The TOWS technique extends this by pairing the individual elements.

## B.12 PESTLEM ANALYSIS (POLITICAL, ECONOMIC, SOCIAL, TECHNOLOGICAL, LEGAL, ENVIRONMENTAL, MILITARY)

Again, this method provides a structure for brainstorming workshops, in this case examining the system constraints and operating environment.

## B.13 SCENARIO BUILDING/PLANNING

This method is intended to achieve a better understanding of the future environment. It is a group process which draws out an understanding of the key issues affecting the future. The aim is to produce a number of diverging stories by extrapolating the main driving forces. This should:

- Increase the knowledge and understanding of the problem environment; and
- Widen the perception of possible future events.

The method involves a 5-step process:

- Identify the key issue;
- Identify the primary driving forces affecting the issue at present (using the PEST categories);
- Identify the predetermined, fixed elements of these driving forces;
- Identify the critical uncertainties and cluster them so that two orthogonal axes of uncertainty are defined, and create a matrix defining four quadrants of uncertainty. Each of these quadrants can then define a possible future scenario; and
- Use the main drivers to flesh out the scenarios defined by the four quadrants.

This method provides a set of four contrasting potential future scenarios against which future plans can be tested.

## B.14 INTERACTIVE PLANNING

This technique is associated with process change programmes, where an organisation needs to evolve. It is a three-step method:

- **Mess Formulation** – Where multiple interdependent problems exist, the first stage is to focus on the current business situation and analyse the function, structure and critical processes of the organisation. This analysis will help to identify the current obstacles to meeting the organisation's goals, from which a reference scenario can be generated describing the worst-case consequences of retaining the status quo.

- **Design Process** – This step requires blue-skies thinking to create an unconstrained vision of the future organisation, which can then be iteratively refined so that the vision, mission, structure and process can be defined. The reference scenario is used to check the design to ensure that the obstacles and problems identified in the first stage can be handled.
- **Means Planning** – Where the strategy and tactics to achieve the new organisation are developed.

The strength of Interactive Planning is the clearly structured process which starts with the identification of the current barriers to success before attempting to design the new organisation.

## B.15 ROBUSTNESS ANALYSIS

Robustness analysis looks at decision-making in conditions of considerable uncertainty. It requires the analyst to acknowledge that it is not possible to predict the future, or event to estimate the possibilities of future events, but instead one should use decision trees to look at all possible futures and consider their desirability.

This technique uses only the most reliable information about the decision tree – the number of branches at any point – and does not look at the probabilities of any of the events; effectively, it considers all futures as equally likely. The robustness of a decision option is defined as the number of acceptable futures at the planning horizon with which the option is compatible (as a percentage of the total number of acceptable futures at the planning horizon).

## B.16 HYPERGAMES

Hypergames build on classical game theory to give a method of more practical use by recognising that the players (two or more) have different perceptions of the game being played. This representation of different perceptions is important in judging the value of different strategies to different players, and hence this approach can be used to define (and subsequently refine) a solution space for a complex problem. Because of the increased complexity of hypergames compared with classical gaming methods, families of decision trees rather than matrices are used.

## B.17 DELPHI

Delphi is a term applied to the collection of expert judgements from a group of people. In particular, the information is not attributable to any individual; it is collected anonymously and discussed without reference to individual opinions. Usually the data gathering will involve the use of questionnaires and secret voting, followed by generalised feedback and discussion sessions before iterating the process. The aim is to generate consensus without direct influence or coercion by any individual.

Numerous methods of implementing this method have been developed, and in particular, where the aim is to rank or score decision options a number of different scoring systems exist.

## B.18 ANALYTICAL HIERARCHY PROCESS (AHP OR SAATY METHOD)

AHP is a multi-criteria decision making method widely used in support to defence acquisition. It is designed to assist in ranking solutions to complex problems. The process can be broken into four stages:

- Problem structuring as a hierarchy of criteria and options;
- Criteria weighting;

- Option scoring; and
- Sensitivity analysis.

The first stage identifies the evaluation criteria; the attributes by which the solution options will be judged. In more complex problems, these criteria can be subdivided and a hierarchical structure of criteria will ensue.

The next stage is to weight these criteria in importance and thus prioritise issues. These weightings are subjective; a number of techniques exist for deriving these weights. One of the more commonly used methods is pair-wise comparison, carried out at each node of the hierarchy. More detail on this can be found in the references of [1].

The third stage is to score each solution option against each criterion. Some criteria can be scored objectively, with measurable data; some criteria are subjective. It is possible to quantify subjective judgements using the same numerical scale as for objectively derived scores. Again, this is explained in detail in the references of [1].

Finally, sensitivity analysis should be carried out. This is important in hierarchical models. The impact on the results of small variations in the input data (scores and weights) must be investigated to assess the robustness of the model.

## B.19 DRAMA THEORY (ALSO KNOWN AS CONFRONTATION ANALYSIS)

Confrontation analysis also has its basis in game theory. This technique is less formal than hypergaming; it focuses on the tactical, political and psychological relationships between the players, and looks at the players' beliefs about the other players' intentions.

The first stage in the process is to define the present situation, the predicted future situation that would arise if current plans were implemented, each player's preferred outcome and potential areas for conflict and compromise. The next stage involves the analysis of threats and promises; how one player's impression of another player's intentions affect his plans. The culmination of this process is a strategic map which sets out all players' possible courses of action to reach their preferred endpoint. This can then be used to identify courses which lead to a desired outcome.

## B.20 VIABLE SYSTEMS MODEL

This model is applicable to organisational change programmes. It proposes five necessary functions which must exist for an organisation to be viable:

- Primary activities;
- Coordination between the primary activities;
- Control;
- Intelligence; and
- Policy.

The application of this model involves the critical examination of each of these functions by the key stakeholders. Workshops are held and the current status and future goals are established. When the gaps have been identified, plans to realise the goals can be generated.

## B.21 TOTAL SYSTEMS INTERVENTION

This is a method for characterising problems and mapping them to appropriate analysis methodologies. It is a three-phased approach, starting with data gathering from a wide range of stakeholders, then classifying the problem type and finally implementing the appropriate methodology for its solution.

## B.22 REFERENCES

[1] Handley, A., "Guidance on the use of subjective Operational Analysis methods in support of acquisition decisions", DSTL/CR43706, March 2010. © Crown copyright 2010.

[2] NATO Joint Analysis and Lessons Learned Centre (Lisbon, Portugal; www.jalcc.nato.int), "Joint Analysis Handbook", 3rd Ed., 2007.