Roke

Part of the Chemring Group

Value for money from wicked problems

The inclusion of an increased number of factors such as training and procurement methods into the analysis of candidate solutions has resulted in complex multi-dimensional problems within the defence domain. Morphological Analysis (MA) is a technique well suited to taming such problems, aiding decision making through the reduction of the problem space to more manageable proportions. Roke have worked with Polaris Consulting to examine how the Roke SERAPH Morphological Analysis tool and the Polaris proven cost modelling process can be integrated in order to deliver Value for Money (VfM) when assessing wicked problems.

WHAT ARE WICKED PROBLEMS?

The defence domain contains a large number of wicked problems containing a wide range of hard and soft factors for consideration. Wicked problems are often characterised by[1]:

- There is no definitive formulation
- There is no stopping rule
- Solutions are not true or false but good or bad
- Every solution is a 'one-shot operation'
- Every problem is essentially unique

These complex systems of variables are not always well suited to numeric analysis, which may require significant effort and cost to consider all options.

WHAT IS MORPHOLOGICAL ANALYSIS MA?

Morphological Analysis is a method for structuring, analysing and inter-relating complex systems of variables, which are not meaningfully quantifiable. This process was generalised by Fritz Zwicky in 1948[2], with work being undertaken by Tom Ritchey from 1995 to present day[3]. For greater detail please see the presentation by Dr P Hiscock.

ADDING WHOLE LIFE COSTING (WLC) TO MA

Polaris Consulting and Roke have identified that a standard cost modelling approach could be integrated with Morphological Analysis. Once the initial structuring of the problem space has been undertaken, a proven and well established costing method can be used taking account of the variation in possible costs over the lifetime of the combinations through Monte Carlo analysis. An explanation of how costing is undertaken can be seen in Figure 2.

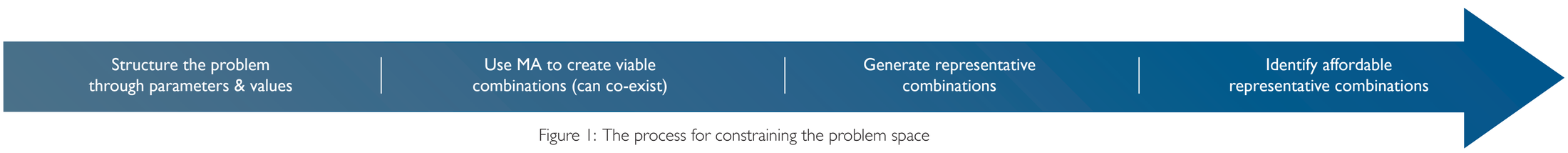

Figure 1: The process for constraining the problem space

IDENTIFYING VALUE FOR MONEY (VFM)

There are four ways in which VfM can be delivered through our proposed linkage of MA and WLC:

1. The MA process will reduce the size of problem spaces to a set of viable options (e.g. characteristics that can co-exist in physical , legal, policy and ethical terms). Any cost and effectiveness modelling is then only applied to this constrained solution space, thus avoiding unnecessary spend.
2. The SERAPH tool enables a subset of representative options to be identified, from the overall viable space, allowed further opportunities for focusing assessment spend.
3. Cost modelling of these representative options can also be used to identify those which are affordable, in advance of any effectiveness modelling.
4. The use of a thorough audit trail and a structured analysis tool such as SERAPH enables quick inspection of the option space in advance of a more detailed analysis.

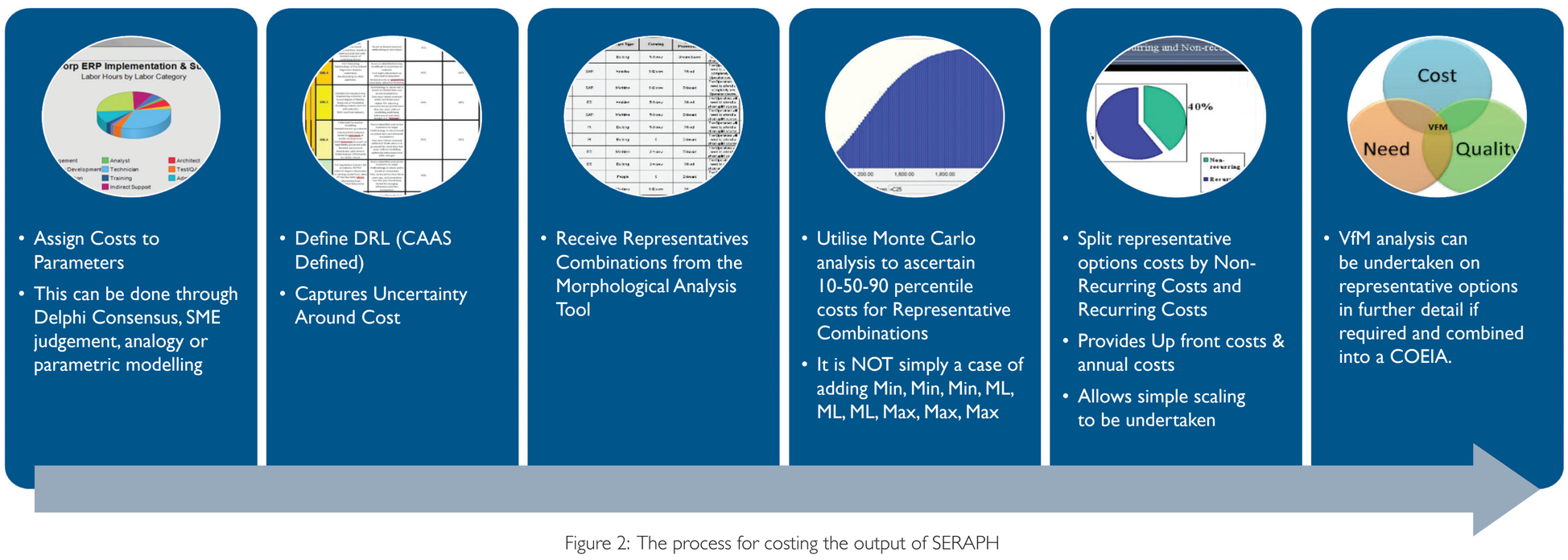

Figure 2: The process for costing the output of SERAPH

VALUE FOR MONEY EXAMPLE

- This table contains the a set of representative combinations from the SERAPH tool for an example ISTAR platform
- The overall potential solution space encompassed 41,472 options which SERAPH reduced to 2,526 viable and subsequently 20 representative options
- The Polaris costing method was then used to estimate aggregated costs for a 30 year WLC at 50% confidence
- For a £300M budget, in this example it can be seen that whilst options 4 & 19 are viable and representative, they are unaffordable

Combination Number	Platform	Mission Range (nm)	Sensor Type & Integration	Target Type	Crewing	Data Processing	NRC (£M)			Annual RC (£M)			30 Year WLC (£M) (50%)
							10	50	90	10	50	90	
1	Small TurboProp	up to 1000	IR	Building	5-8 crew	Ground based	25.0	30.0	37.5	1.2	1.5	2.7	75.0
2	Large Turboprop	1000-2000	SAR	Vehicles	9-12 crew	Mixed	75.0	100.0	175.0	5.0	5.7	7.0	272.5
3	Large Turboprop	>3000	SAR	Maritime	9-12 crew	Onboard	85.0	105.0	185.0	5.7	6.5	7.2	300.0
4	Large Jet	1000-2000	EO	Vehicles	5-8 crew	Mixed	150.0	195.0	245.0	6.0	6.7	7.7	397.5
⋮													
18	Small Jet	1000-2000	IR	Building	2-4 crew	Ground based	30.0	38.5	45.0	2.5	3.0	3.2	128.5
19	Large Turboprop	1000-2000	EO	Building	2-4 crew	Onboard	145.0	187.5	225.0	5.5	6.0	6.7	367.5
20	Small Jet	1000-2000	EO	Building	2-4 crew	Onboard	35.0	45.0	60.0	2.5	3.0	3.2	135.0

Table 1: Output of the costing process for a set of representative combinations for an ISTAR example

REFERENCES

1. Rittel, Horst WJ and Webber, Melvin M (1973) *Dilemmas in a General Theory of Planning*, Policy Sciences 4 (2): 55-169.
2. Zwicky, F (1969) *Discovery, Invention, Research – Through the Morphological Approach, Toronto*, The Macmillan Company.
3. Ritchey, Tom (2011) *Wicked Problems – Social Messes: Decision Support Modelling with Morphological Analysis*. Vol 17. Springer Science & Business Media.

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