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# Holistic Complex System Intervention Evaluation – Understanding the nature of defence capability

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# Holistic Complex System Intervention Evaluation – Understanding the nature of defence capability

Chris Jordan and Mike Wilkinson

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Approved for release on behalf of Niteworks by Simon Jewell, Niteworks Managing Director.

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# Introduction

*"While state-versus-state conflict is still possible, contemporary operations are likely to be more complex and adversaries could be more difficult to identify. Increasingly we live in a world of wicked problems, which are so complex that they defy process driven, management or scientific approaches[1]. This does not mean that they are unsolvable, but the approach must be open-minded, agile, flexible and adaptable to work through the complexities."*

*Joint Doctrine Publication JDP 2-00 Understanding and Intelligence Support to Operations*

The current and Future Operating Environment (FOE) for UK Defence forces, based on the Future Character of Conflict (FCoC)[2], is rapidly becoming "Congested, Cluttered, Contested, Connected and Constrained"[3] with state-on-state and insurgency operations taking place alongside peace enforcement and defence engagement activities. Recent events in Europe and the Middle East have highlighted the unpredictability of the operational environment and the challenges facing UK Defence capability to support interventions in such environments.

Analysis in 2012 of a 'Decade of War'[4] has identified that incomplete recognition and inaccurate definition of the operational environment led to mismatches between forces, capabilities, missions and goals. In this case, the operational environment included not only the threat, but the cultural, religious, social, informational and economic elements of the environment. The analysis highlighted that better *understanding* of the operational environment, particularly the human aspects, was important for appreciation of the root causes of conflicts, definition of more appropriate approaches, and anticipation of second order effects.

In relation to Operations and military planning there are promising steps being taken to address the complex operational environment, particularly in relation to holistic critical thinking. According to a recent study by NATO[5], understanding involves exploration and self-critical analysis whilst making sense of the complex system and developing an awareness of the potential for change within the system.

As a key piece of UK Doctrine, JDP2-00 requires the military commander or those providing capability to the front line to think in an agile, flexible, adaptive and innovative way to achieve effect within the operational environment. Headquarters Allied Rapid Reaction Corps (HQ ARRC) has developed the Understanding Techniques Aide

1 The term wicked problem was introduced by Horst W J Rittel in a 1967 lecture, and subsequently elaborated more fully in collaboration with M W Webber in their Dilemmas in a General Theory of Planning, Policy Sciences, Volume 4, 1973, pages 155-169.

2 Future Character of Conflict DCDC 2010.

3 The business world uses the term VUCA – Volatile, Uncertain, Complex and Ambiguous.

4 US Joint and Coalition Operational Analysis, 'A Decade of War', 2012.

5 Dr. C. De Coning discusses Complexity Theory and the implications for measuring peace-building operations. Chapter 10 of Innovation in Operations Research: Recent developments in measuring results in conflict environments. Edited by A. Williams, J. Bexfield, F. F. Farina and J. de Nijs. NATO ACT (2013).

Memoire[6] to support the commander in evaluating the operational environment, using a range of critical thinking tools and techniques, and investigating what might happen if a particular course of action is adopted.

In addition, to engender critical thinking and a flexible approach by the officer community, the Royal Military Academy Sandhurst is introducing wargaming into the curriculum through the Captain's Warfare Course. The long term hope is that the idea of wargaming and critical thinking in general are inculcated into the culture of the Officer cadre.

However, for Force Development, where Force Development is defined as "the process by which policy and requirement are translated into capability and the means by which Defence determines how and with what a military force should operate"[7], the picture is challenging.

Well-established techniques have been employed ranging from operational analysis modelling, seminar wargames, military judgement panels, multi-criteria decision analysis through to man-in-the-loop live and virtual experimentation. While there has been considerable improvement, particularly in relation to the Integrated Analysis and Experimentation approach[8], which draws evidence from multiple techniques either to consolidate for a particular question or to shed light on multiple different problems, it is the contention of this White Paper that current methods fall short when employed in support of complex systems analysis.

The Niteworks partnership's experience drawn from many projects is that existing approaches to complex problems and interventions for improvement within the complex system can be insufficiently open-minded, flexible and agile. These observations are consistent with experience in other countries and other domains. For example, the analytical community has, in the past, resorted to shaping the problem to fit the techniques, rather than developing techniques better able to address the problem[9]. This has provided a less robust baseline against which interventions can be evaluated.

The use of inappropriate tools and the absence of a robust baseline may have been a key contributor to some analysis activity being discounted in the past at the point when it should be informing decisions. When a political decision runs counter to advice generated from rigorous and detailed analysis the analysis can appear irrelevant or narrow without due regard to these contextual political and social factors. Consequently the financial cost of these analytical activities does not generate the benefits expected. A more holistic approach that acknowledges the wider geo-political and social context as well as the capability and effectiveness factors as part of the complex system is likely to have more traction with the decision-making community and better value for money, especially if these key stakeholders participate in the journey alongside the analyst.

6 HQ ARRC Understanding Techniques Aide Memoire, Final Draft April 2014.

7 Army HQ Land Handbook Jul 14.

8 Integrated Analysis and Experimentation – A paper by DCBMJ6/DAES. DG Info 11/8/3 Nov 2004.

9 R. Heyer (2004) Understanding Soft Operations Research: The methods, their application and its future in the Defence Setting, Command and Control Division Information Sciences Laboratory, Australian Department of Defence.

The problem situations we are interested in generally involve a desire to 'improve' (according to one measure or another) the behaviour or other properties of a complex system. This is generally achieved by a managed change, which transforms the system from its current 'state' to the desired 'state' by means of one or more interventions.

Therefore noting the challenge set by JDP 2-00, the question that this white paper seeks to address is:

*How can analytical methods and tools for Force Development support the **understanding** of the impact of interventions on complex systems?*

Drawing from best practice guides[10] and the Niteworks partnership's experience across many projects, a multi-method approach is proposed that adopts an holistic, exploratory and pragmatic appraisal of interventions to a complex system. The proposed approach – called Holistic Complex System Intervention Evaluation (HCSIE) – is applicable to any type or level of complex system within Defence, from the individual soldier to the Defence Enterprise. The approach brings together aspects of complex systems science[11] and Soft Systems Methodology[12] with simulation and modelling and is likely to require collaboration from a multi-disciplinary team including subject matter experts in human sciences, social behaviour, military operations as well as military warfare specialists, legal, policy and other government departments.

Key benefits of the approach are that it provides:

- More holistic appreciation of the complex system and exploration of the potential impact of interventions on the complex system. This is intended to lead to informed analysis and evidence generating activities in support of MOD decision making.
- An opportunity for the research programme to be better co-ordinated in response to complex systems analysis and intervention evaluation.
- Optimisation of technique application in support of the evaluation of complex systems.

**Related work**

A key task currently being conducted for Army HQ by Dstl and CORDA[13] is the development of an Evidence Framework for Army HQ and its contribution to research planning. The evidence and sensemaking framework, drawing from the work of Cynthia Kurtz and David Snowden[14] in relation to complex systems, will help refine the analysis estimate approach within Army HQ. Niteworks has participated in discussions on the evidence framework approach, particularly in relation to complex systems and reciprocal advice on the shaping of the HCSIE approach has been incorporated in this White Paper.

10 TTCP Guide for Experimentation 2006; Code of Best Practice for Warfighting Experimentation 2012; the Magenta Book – HM Treasury Guidance for Evaluation; Guidance on evaluating the impact of interventions on business. BIS 2011.

11 For example see P Cilliers (1998) Complexity and Postmodernism. London, Routledge.

12 For example see B. Wilson (1984) Systems: Concepts, Methodologies and Applications. John Wiley, Chichester

13 Task 41 – Peer Review of Land Force Development Operational Analysis Evidence Framework Dstl Ref: FTS4/RED/TA0001.

14 Kurtz, C. F.; Snowden, D. J. (2003). "The new dynamics of strategy: Sense-making in a complex and complicated world". IBM Systems Journal, Volume 42, Number 3.

**Key Recommendations**

Niteworks recommends that the HCSIE approach is adopted as a routine part of the analysis process to complement existing methods for evidence based analysis, specifically in relation to interventions analysis and management.

The key steps required to achieve the adoption and further development of this are, in outline:

- Endorsement and advocacy of the approach by D Scrutiny and capability staffs as an appropriate means of deriving evidence for decision making;
- Application of the approach to a candidate project, thus enabling refinement and prototyping of the methodology;
- Development of high level guidance for inclusion in the Analysis and Experimentation handbooks being developed in the Joint and Land single Service Commands (sSCs);
- Consultation with Industry, Academia and MOD to develop guidance on how to implement the proposed methodology;
- Review of the MOD Science and Technology Research Programme to understand how HSCIE and the evidence framework can support future decision making.

## The Characteristics of Complex Systems

The question of what exactly constitutes a complex system is the subject of much scientific and philosophical debate[15,16]. For our purposes, a system can be characterised as complex if it has the following properties:

- Large **numbers** of and high degrees of **variability** in the elements, particularly if those elements include people;
- Large **numbers** of and high degrees of **variability** in relationships between elements, such that the system cannot easily be reduced to a number of distinct subsystems;
- **Emergent properties/behaviours**[17] that are novel or unpredicted; ie where "the whole is greater than the sum of its parts[18]";
- Elements within the complex system change themselves and their relationships in response to their environment – known as **adaptation**;
- There is considerable **uncertainty** in relation to outcomes, such that cause and effect relationships within the system are only possible to establish in retrospect;
- Non-additive effects or **non-linearities** exist, such that the combined effect of two or more factors does not equal the sum of the two individual effects;
- There is **sensitivity to initial conditions**, where the same system can exhibit significantly different behaviours from near identical starting conditions.

### Simple, Complicated and Complex systems

As a way of describing the differences between problems that are simple, complicated or complex, the following table (Table 1), from Glouberman and Zimmerman[19] provides an example of each: simple - following a recipe; complicated - sending a rocket to the moon, and complex - raising a child. The three examples articulate some of the characteristics of each type of problem.

15 For example see Herbert 2006: Student Understanding of Complex Earth Systems. In C. Manduca and D. Mogk (Eds.), Earth and Mind: How Geologists Think and Learn about the Earth : Geological Society of America Special Paper 413, p.95-104.

16 Magee, C. L., O.L. de Weck. (2004). "Complex System Classification." Proceedings of the 14th Annual International Council on Systems Engineering International Symposium, 20-24 June 2004, Toulouse, France.

17 The defining feature of a system is that a group of elements, when interacting with each other and their environment, can generate emergent behaviours and properties. For example, the minimum stopping distance of a car on a wet road is an emergent property of the car and its elements (including the type of tyres and their air pressure, the type of brakes and their condition, the mass of the car, etc), and the car's environment (properties of the road surface, surface contaminants, depth of water, etc).

18 Attributed to Aristotle.

19 Glouberman, S., and Zimmerman, B. (2002) Complicated and Complex Systems: What Would Successful Reform of Medicare Look Like? Ottawa: Commission on the Future of Health Care in Canada.

**Table 1: Characteristics of simple, complicated and complex problems (Reprinted with permission from Glouberman and Zimmerman 2002)**

| Simple – Following a recipe | Complicated – Sending a rocket to the moon | Complex – Raising a child |
|---|---|---|
| The recipe is essential. | Formulae are critical and necessary. | Formulae have a limited application. |
| Recipes are tested to assure easy replication. | Sending one rocket increases assurance that the next will be OK. | Raising one child provides experience but no assurance of success with the next. |
| No particular expertise is required. But cooking expertise increases success rate. | High levels of expertise in a variety of fields are necessary for success. | Expertise can contribute but is neither necessary nor sufficient to assure success. |
| Recipes produce standardized products. | Rockets are similar in critical ways. | Every child is unique and must be understood as an individual. |
| The best recipes give good results every time. | There is a high degree of certainty of outcome. | Uncertainty of outcome remains. |
| Optimistic approach to problem possible. | Optimistic approach to problem possible. | Optimistic approach to problem possible. |

It can be seen that activities encountered on a daily basis have aspects of all three. However, while the example cited of a complex system is useful to illustrate some of the characteristics of raising a child, it is not particularly helpful in providing an understanding of the complex military environment. What is it about the military environment that is complex, what is merely complicated and what could be described as simple or routine? The next section examines complex systems within the defence context.

**Complex systems within UK Defence**

The Contemporary Operating Environment based on the Future Character of Conflict can be described as a complex system. The Future Operating Environment will contain actors interacting with local populations, with uncertain outcomes, and emergent behaviours arising in a wide range of contexts including individual, group, command and political. Several key dimensions are relevant:

- Cognitive Dimension, which includes the factors that shape decision making;
- Operational Dimension, which includes the effects delivered by appropriate decision making;
- Physical Dimension, which includes the physical environment and the constraints imposed as a context for decision and action.

Figure 1, developed in Niteworks as part of the Decision Support in Complex Environment project, highlights some of the factors associated with these dimensions.

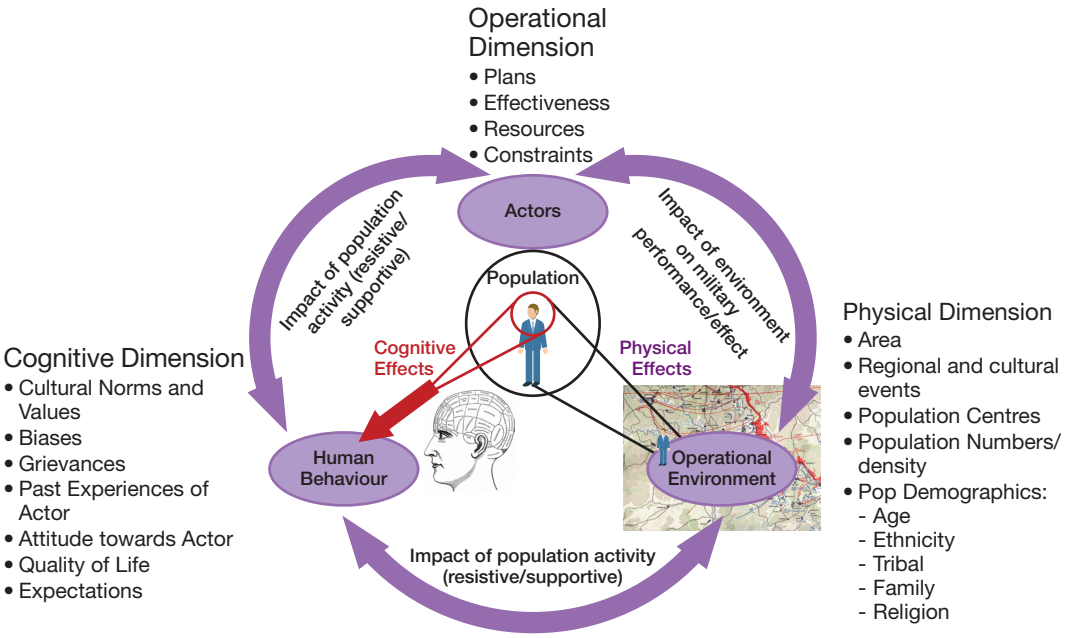


**Figure 1: Aspects of the Contemporary Operating Environment that contribute to complexity**

Military activity does not happen in a vacuum. There are external influences or constraints on any military activity. The political, military, economic and social relationships within and between countries characterise some of the constraints within the complex system. Figure 1 highlights some of these factors, particularly quality of life, attitude towards the actor and allegiance, whether resistive or supportive.

As an illustration of potential future operating environment complexity drivers, some examples, drawn from a variety of Niteworks assessments of complex system interventions in training and experimentation, are provided below.

**Equipment:** The introduction of situational awareness downlinks from a UAV to platoon and section commanders was expected to enhance their situational awareness and facilitate shared awareness with the company commander. However the company commander did not see the technology as beneficial as it enabled the platoon and section commanders to participate in a discussion about what was being shown. The company commander viewed this as a disadvantage as the additional information generated multiple opinions on what was being seen. The linear expectation of technology insertion leading to enhanced SA was not supported. The consequence was a **non-linear outcome** that resulted in reduced information sharing.

**Doctrine:** The presence of a civilian population within the environment makes engagement and/or removal of the opposing force more difficult. The lack of situational awareness and knowledge of the local culture, habits and behaviours can lead to **uncertainty** in how to respond to the population. This, coupled with **uncertainty** due to a lack of situational awareness of own forces within a congested and contested area, adds to the **variability** of behaviours.

**Training:** Participants are likely to have different and possibly unknown levels of training as well as varying tactics, techniques and procedures for sharing and reporting information. This can lead to substantial complexity through variability of approaches and **uncertainty** of outcomes.

**Organisation/Information/Leadership:** One commander may manage and control the information available to him and his subordinates and only issue orders based on his assessment. Other commanders might delegate more, resulting in more decisions being made by other actors. The scope for different decision making strategies adds to complexity through **variability** and **uncertainty** of outcomes. Organisations brought together in a particular scenario may only have worked together in limited circumstances (eg in a battlefield context) and may need to align their activities through real-time **adaptation** and generate **novel or unpredicted** outcomes.

**Personnel:** Individual soldiers and vehicles should be under orders at all times, but there are occasions where such elements may be operating autonomously. This introduces complexity through **variability**, **uncertainty** and **novel or unpredicted** outcomes.

These examples illustrate two key points about the way complexity can be manifested within a system:

- In a positive sense, through the ability of the system to support innovation, self-organisation or other beneficial adaptation (for example through commander's way of working and concepts and doctrine developments);
- In a negative sense, through wide variability of behaviours of participants and uncertainty due to the changing environment underpinned by, for example, a lack of appropriate training.

It is clear that training and experimentation events have the potential to provide considerable insights into complex systems issues. Indeed, it is hard to see how such insights could be derived other than through investigations involving highly representative systems[20]. However this assertion presumes the ability to adequately replicate reality in an evidence-based environment. The paper goes on to discuss this challenge.

20 While models and simulations can provide insights, the testing of interventions in highly representative systems is necessary to understand the impact of emergent behaviour and variability of human activities.

## Existing Approaches to Evidence Generation for Complex Systems Interventions

The challenge when undertaking decision-making relating to complex system interventions comes primarily in the generation of reliable evidence to underpin the decisions. The non-linear and adaptive nature of complex systems, coupled with emergent behaviour, reduces the confidence of finding a direct cause and effect relationship between factors, and therefore whether a particular intervention demonstrated a benefit.

Instead, it is more likely that only by looking back at a particular situation is it possible to identify factors that contributed to the outcome[21]. In addition, due to the variability of individuals and relationships within the complex system, the outcome might vary on a case-by-case basis with different factors contributing to the outcome in each case.

**Current approaches to evidence generation**

Delving deeper into the way analysis has been conducted to support decision making, there is evidence that the analyst is prone to use the same tools in a similar way to previous decades [as cited previously – see footnotes 5 and 9]. This means that tools developed to analyse equipment and the harder, more quantitative, aspects of performance and effectiveness have been favoured over an alternative approach that would look holistically at the capability.

This is not surprising as the root of the analytical approach has been hard science in a reductionist, hypothesis-based context. The system is broken down into individual and controllable parts to investigate the effect of particular factors. Ackoff[22] calls this machine age thinking. His alternative, systems age thinking, describes a system within an open boundary, that is partially observable but only through holism and synthesis can it be understood.

Hypotheses are defined for a given cause and effect relationship and the expectation is that, if appropriately designed, the experiment or other analytical activity will detect a predictable difference that can be attributed to the intervention.

To amplify further, the techniques developed in support of the analysis have been equipment focused. However, the provision of a platoon to the front line is not just about the equipment. It is about the integration of all of the Lines of Development, including Training, Personnel, Doctrine, Organisation etc that come together to deliver a capability. An holistic systems perspective needs to be adopted that understands the interactions that will or could take place between soldiers in the platoon, with other platoons, with the environment, and with the threat that they are likely to face.

21 For example see: Snowden and Boone 2007: A Leaders Guide to Decision Making by Snowden and Boone. Harvard Business Review.

22 Ackoff (1981) Creating the corporate future: Plan or be planned for. John Wiley and Sons: New York.

Several approaches have been adopted to analyse the contemporary operating environment as a basis for establishing baselines and for evaluating interventions. The Integrated Analysis and Experimentation Campaign approach (see footnote 8) attempted to address the benefits of a multimethod rather than single method approach. However there is a real challenge getting people to accept that it is appropriate for each method to use different metrics and, to some extent, assumptions. Even in these integrated plans the emphasis has been on the quantitative data. For these plans to work, more emphasis needs to be applied on the holistic evaluation of the complex system.

The following diagram (Figure 2) provides an interpretation of the current analytical principles, as derived from extant guidance from TTCP GUIDEx[23] and the Logic of Warfighting Experimentation[24]. The example is focused on warfighting experimentation and comparison experiments but the principles apply more broadly.

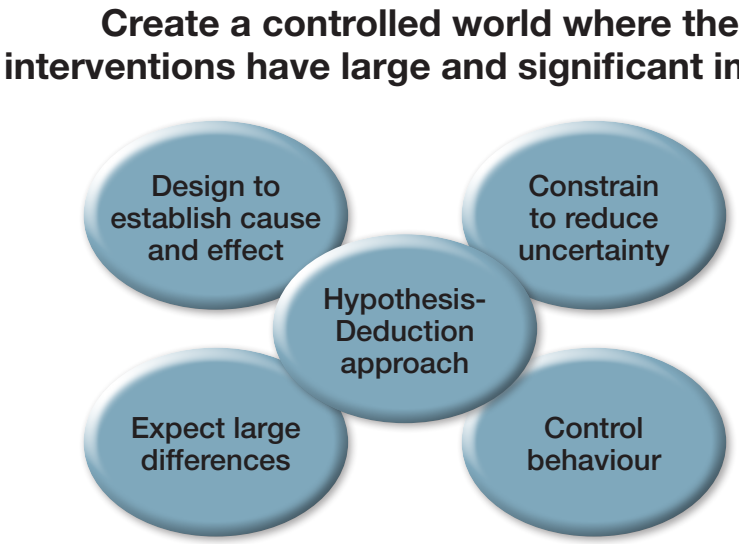


**Figure 2: Current approach to (complex) system intervention evaluation**

The key principles of such approaches are:

- Design for Cause and Effect[25]: the experiment must be constructed such that if a cause and effect relationship exists it can be demonstrated;
- Constrain to reduce uncertainty: Confounding variables – elements that could interfere with the study – need to be removed or managed and the task focus needs to be carefully managed;
- Expect the intervention to have a large effect: Identify interventions where their introduction will yield large differences thus demonstrating the benefit of the intervention;
- Control behaviour: Manage participation to ensure repeatability;
- Hypothesis-Deduction based approach: Evidence is used to support or reject the hypotheses.

23 The Technical Co-operation Program (TTCP) Guide for Experimentation. GUIDEx 2006.

24 R. Kass The Logic of Warfighting Experimentation CCRP 2006.

25 This is based on the Manipulation Experiments designed to examine cause and effect, however correlational studies, known as Empirical Studies in the MOD lexicon, are also conducted. The emphasis in the literature has been strongly on cause and effect.

In the case of comparison experiments, ie "is intervention A better than intervention B" designed to examine cause and effect[26], for example, realism has the potential to be compromised by the experiment controls and limited freedom of action needed to guarantee repeatability. In addition these constraints reduce opportunities to innovate.

From our discussion of complex systems and the characteristics of variability, adaptability, emergence and unpredictability, it should be clear that the comparison experiment will not work well for evaluating complex systems. That is not to say that techniques such as the comparison experiment or other analytical techniques are inappropriate for evaluating complicated or ordered systems (see Table 2).

**Table 2: An assessment of the advantages and disadvantages of comparison experiments**

| Advantages | Disadvantages |
|---|---|
| Good for complicated systems or where cause and effect have the potential to be determined. | Limited applicability to complex systems. |
| Good exposure and engagement with participants and customers. | One big event – one narrow focus opportunity. |
| Many people can participate in the experiment gaining first hand exposure to relevant issues. Good for informing understanding of situational awareness and decision making. | Requires multiple participant groups to ensure one is used as a control in comparison to another or if using the same group, learning is a real challenge. |
| Many assumptions are agreed in order to define the experiment activity. | Many factors controlled or treated as random when they could impact the outcome considerably. |
| With the right participants, right equipment and appropriate measures data can be collected with the intention to inform decision making. | The ability to understand what has actually occurred during the event can be difficult due to many factors playing a part. |
| Good for understanding the effect of a particular factor if highly controlled. | It is difficult to apply the findings beyond a particular instance. |

At one extreme, the drive towards rigour in terms of repeatability and objectivity leads to artificial and over-constrained evidence generation, but which pertains to a simplified system that is insufficiently representative of the real complex system of interest. Any decisions based on such evidence could have unpredictable consequences when the interventions are applied to the real system. At the other extreme, the drive towards system fidelity results in uncertainty over whether an intervention was responsible for

26 Called Manipulation Experiments in the MOD lexicon.

a change in the complex system – or some other factor was responsible that was not accounted for. This is the classic conundrum of ‘internal’ validity, ie a good experiment design that should provide statistically valid results, versus ‘external’ validity, ie the extent to which the results can be generalised, which plagues all evidence generation. The many interdependencies in a complex system exacerbate the problem.

In an attempt to introduce a cause and determine whether it has an effect, the complex system has typically been overly constrained. In addition the focus on introducing interventions that yield large effects may result in perturbations across the complex system. The next section offers some thoughts on an alternative approach to **explore**, rather than **experiment**, with complex systems.

## A New Way of Generating Evidence for Holistic Complex System Interventions Evaluation - HCSIE

This section proposes a pragmatic approach to evidence generation that is appropriate for complex systems. It requires a shift in thinking to accept that evidence should not be solely generated at the end of an analysis activity[27] but is collected throughout any form of investigation as the complex system becomes better understood. The approach is called Holistic Complex System Interventions Evaluation, or HCSIE.

The ideas that underpin the approach to HCSIE should facilitate exploration in a complex world and support the evaluation of interventions in such contexts (see Figure 3). The approach acknowledges and accepts the properties of complex systems, rather than ignores them. HCSIE should therefore provide a more appropriate approach to evaluating the effect of interventions on complex systems than traditional techniques. The key ideas are examined in the paragraphs that follow.

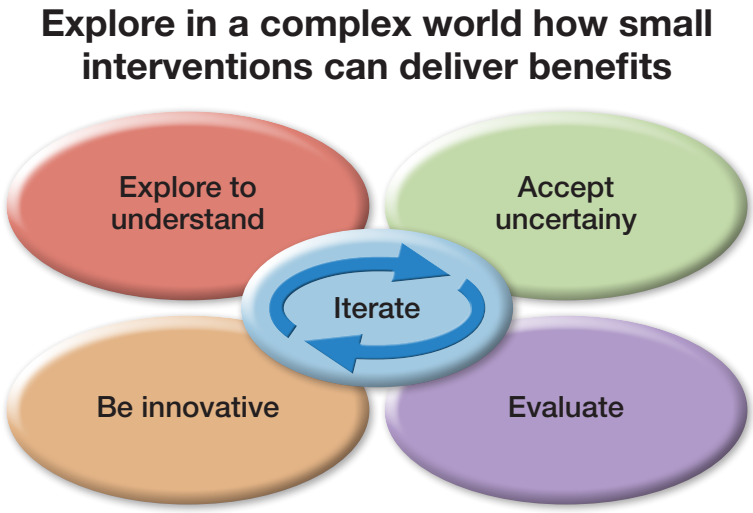


**Figure 3: Holistic Complex System Intervention Evaluation approach**

Complex systems have been characterised in this paper by their variability, unpredictability, adaptability and emergent behaviours. Rather than defining specific relationships between factors and interventions, the HCSIE approach provides a high-level description of the elements that are present within the complex system. While attempts have been made in the past to map out the complex system and the relationships between many different factors, there is a risk that such definition overly constrains what is really a loosely coupled system.

The methodology is described in the subsequent paragraphs however several examples are provided at Annexes A and B to illustrate how the HCSIE approach has been applied within Niteworks and could be applied to address complex problems.

27 The concept behind integrated analysis and experimentation planning is to generate knowledge and evidence progressively; the HCSIE approach begins with understanding the complex system and conducting analysis and experimentation to generate evidence to enhance the initial understanding of the interactions within the complex system.


### Explore to understand

The first idea underpinning the approach is the adoption of an exploratory mindset[28] that permits breadth and curiosity, trend analysis and pattern identification rather than a specific perspective focusing on cause and effect. The aim should be to understand and make sense of the complex system. This is an inherently divergent activity, expanding the problem space, identifying connections and examining interdependencies.

The use of wargaming as a collaborative multi-user technique is recommended throughout the steps that follow to facilitate the collaborative development of sensemaking such that varied perspectives can be shared. While a facilitated military judgement panel or a well-organised meeting can achieve some of the understanding, the use of a wargame that provides consideration of red, blue and other organisations will encourage critical thinking about the context, the capability and the outcome. The HCSIE approach is likely to require ongoing collaboration across a multi-disciplinary team that may include subject matter experts in human sciences, social behaviour, military operations as well as military warfare specialists, legal, policy and other government departments.

### Step 1: Understand the Strategic Context

Complex systems have both local and global aspects that need to be considered. The starting point for sensemaking for Force Development is the strategic context of the environment in which the UK defence forces are likely to deploy. UK Defence policy and the National Security Strategy will influence this as well as wider governmental strategies and international relations.

The strategic context does not apply soley to the local environment, for example, Afghanistan. The broader regional context should be considered, particularly the neighbouring and associated countries, for example, Pakistan, as any activity that the UK participates in has the potential to affect the wider strategic landscape. In addition there is the UK context – the attitudes of the UK population, the political perspective, and the social context (see Figure 4). This is taking a truly holistic view of the problem with the intention of addressing or at least considering the interactions and sensitivities that may exist.

28 A recent NATO study identifies that analysis should involve exploration and self-critical analysis whilst making sense of the complex system and developing an awareness of the potential for change within the system. Dr. C. De Coning discusses Complexity Theory and the implications for measuring peace-building operations. Chapter 10 of Innovation in Operations Research: Recent developments in measuring results in conflict environments. Edited by A. Williams, J. Bexfield, F. F. Farina and J. de Nijs. NATO ACT (2013).

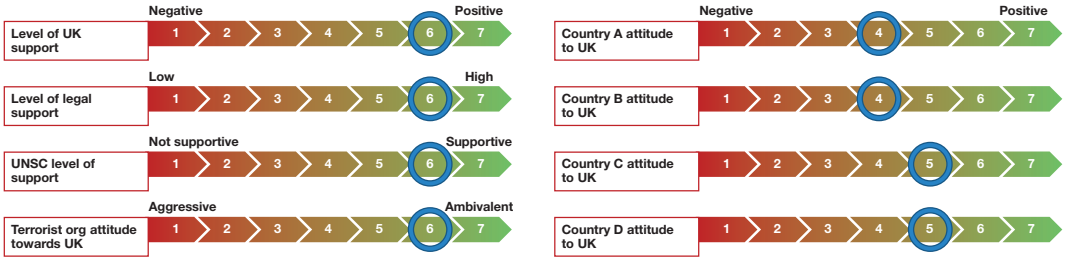


**Figure 4: Understanding the strategic context: UK focus and allegiances**

### Step 2: Establish Strategic Intent (or the overarching goal)

Strategic intent needs to be established to help shape the understanding of the problem space. In one case it could be to maintain stability in the wider region, in another it could be to maintain a legal position but raise the profile of the UK.

### Step 3: Understand the Operational Context

For the HCSIE approach the PMESII-PT (Political, Military, Economic, Social, Information, Infrastructure, Physical Environment and Time Pressure) framework[29] has been used to capture the operational context.

For a given context the settings for PMESII-PT variables may or may not apply however each variable should be assessed to provide an understanding of the context. Ratings of Red/Amber/Yellow/Green/Grey (RAYGG) based on a qualitative assessment of their impact to the problem under consideration should be applied. The RAYGG assessment captures whether a factor was likely to have a positive or negative impact; Red highlighting significant risk; Amber a major risk; Yellow a minor risk, and; Green representing a negligible risk. Grey indicates not relevant.

The assessment would be captured in two ways:

- For each variable a sheet describing the colour coding and justification remarks (for example see Table 3);
- A dashboard showing the coloured assessments (for example see Figure 5).

29 PMESII-PT is used by US Department of Defence for military planning within a counter-insurgency context (see NATO AJP-2(A)) and promoted in the development of the Decisive Action Training Environment (DATE) for collective training both in the US and UK.

**Table 3: Justification table for PMESII-PT categories (Political, Military, Economic and Social are shown)**

| PMESII-PT Category | Variable | Assessment | Justification | Assessment | Justification |
|---|---|---|---|---|---|
| Political | Attitude to UK | | Favourable towards current govt; good trade relations | | 1 green, 4 amber - overall amber |
| | Centres of pol power | | Pol power is dispersed and unruly | | |
| | Governrnent type | | Government shows signs of dictatorship | | |
| | Govt effectiveness | | Govt action has not improved situation | | |
| | Influential pol groups | | Muitiple pol groups affect multiple tribes | | |
| Military | Govt military forces | | Significant capability | | All amber - overall amber |
| | Non state paramilitary | | A wide range of guerilla forces | | |
| | Unarmed combatants | | Potential for combatant increase high | | |
| | Non-mil armed combatants | | Farmers are picking up weapons | | |
| Economic | Diversity | | There are several different mechanisms for growth but confused picture | | Mixed picture so overall yellow |
| | Employment Status | | 60% unemployed | | |
| | Economic activity | | Economy in poor situation | | |
| | Illegal economic activity | | None registered | | |
| | Banking and finance | | Banking is in OK shape | | |
| Social | Demographic mix | | Large proportion of 18-25 year olds - youth bulge indicative of instability | | Highly concerning - overall red |
| | Social volatility | | Highly volatile - years of deprivation | | |
| | Education level | | Education focussed on reinforcing state ideals on supporting theocratic | | |
| | Ethnic diversity | | Highly varied and tensions between groups | | |
| | Religious diversity | | Highly varied and tensions between groups | | |

In terms of the HCSIE approach, an assessment would be made of the relevant variables and factors that would provide an indication of how the political, social, economic etc context is described for the scenario or situation of interest (see Figure 5).

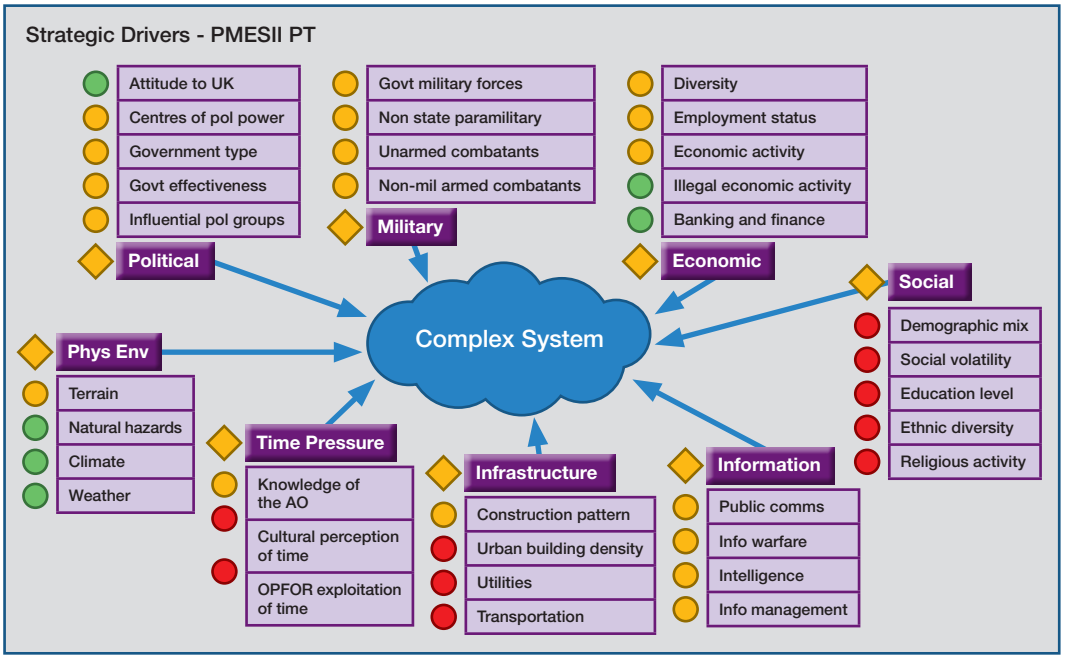


**Figure 5: PMESII PT factors to help define the strategic context (to be tailored for a given scenario)**

**Step 4: Define operational objectives to satisfy strategic intent**

Operational objectives must be defined to satisfy the strategic intent in a particular context. The operational objective could be **'to establish stability in region A by removing the threat in the area'**.

**Step 5: Understand how the military capability can satisfy the operational objective**

The Defence Capability Framework describes seven components of capability: Command, Inform, Operate, Sustain, Prepare, Project and Protect. Each component of capability should be considered to ensure all aspects of the capability are addressed holistically. If the fighting force is highly capable of delivering effect but cannot be sustained, the duration and effectiveness of the mission may be heavily curtailed. Alternatively, if the force is equipped and sustained but the troops are not adequately protected, the force may be vulnerable or delivery of effect may be sub-optimal. To address each of the components of capability, the Military Tasks List (Land) activities associated with each component of capability should be considered as in Table 4 and Figure 6.

**Table 4: Justification of baseline assessment - example showing Command, Inform, Operate and Protect categories**

| DCF Category | Task | Task Assessment | Justification | Assessment | Justification |
|---|---|---|---|---|---|
| Command | Understand | | Some level of understanding from ISR assets | | Those assessments that apply are Orange |
| | Plan | | Limited ability to plan - as unclear future | | |
| | Integrate | | | | |
| | Control | | | | |
| Inform | Direct | | Limited direct - mostly ISR | | While process and disseminate are good, the direct and collect status drives the front end of the inform capability therefore Orange |
| | Collect | | Limited direct - mostly ISR | | |
| | Process | | Good process tools | | |
| | Disseminate | | Ability to share information good | | |
| Operate | Offensive Ops | | Cannot commit offensive ops | | Those assessments that apply are Red |
| | Defensive Ops | | | | |
| | MASD/Stabilisation | | Inaction is likely to make stabilisation more difficult | | |
| Protect | Force Protection | | | | None apply |
| | OPSEC | | | | |
| | Counter Intelligence | | | | |
| | Preotective Security | | | | |

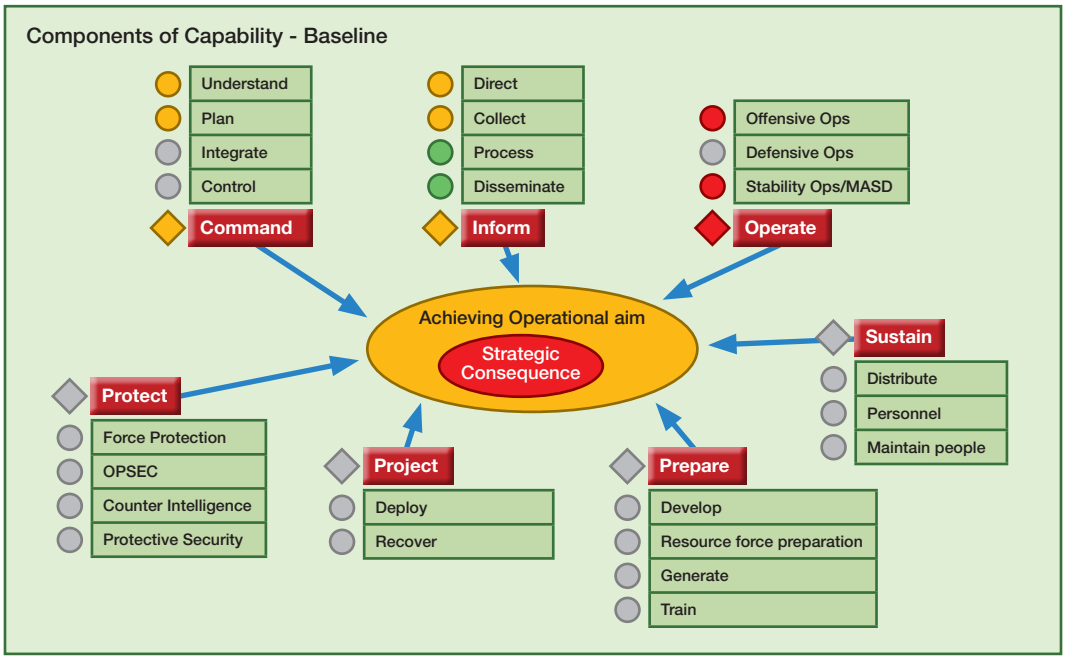


**Figure 6: Defence Capability Framework components of capability**

**Step 6: Understand the strategic consequences of military capability.**

Shared understanding of the strategic context and the components of capability should be established through the previous steps however the sensemaking activity would not be complete without an appreciation of the consequences that are likely to arise as a result of military intervention.

**Understanding the baseline capability - summary**

The HCSIE approach provides a rudimentary understanding of the baseline capability in relation to the operating environment, and the broader operational and strategic context. Using RAYGG scoring the six steps provide an assessment of the strategic context, operational context, military capability against operational objectives and strategic consequences of action.

The depth of understanding at each step will largely depend on the level of engagement and collaboration that occurs between stakeholders in arriving at a shared understanding and the evidence and assumptions that underpin their judgement. Ideally there would be an underpinning set of look up tables for the baseline components of capability such that it would be possible to establish the extent to which the Lead Armoured Task Force, for example, could satisfy the Commander's intent. As a convergent thinking activity this will then provide opportunity to identify any gaps in realising the Commander's intent and the risks and opportunities presented by the strategic contexts and outcome indicators. Such gaps may be addressed through the introduction of interventions, for example the areas where the assessment has highlighted Amber or Red ratings.

**Accept uncertainty**


The second idea underpinning the HCSIE approach is to **accept uncertainty**. Uncertainty is a common trait of complex systems and no representation or sense-making effort can be 100% accurate. In early developments of the HCSIE approach, several attempts were made to map the relationships between factors, whether they were components of capability, strategic drivers or even outcomes. Such a mapping proved challenging and over constraining. The approach therefore has been to allow the factors to be loosely coupled as shown in the figures above.

No attempt has been made in the HCSIE approach to establish the relationship between Command and Operate, or Inform and Protect or any other combination; they are implicit rather than explicit relationships. Similarly, the PMESII-PT factors interact, but the complex way in which they interact is not represented. It is sufficient to identify the factors and accept their implicit relationships.

The approach therefore is to conduct multiple investigations to explore multiple alternatives. Example questions could include: What if the opposing force was better equipped? What if the neighbouring countries were more supportive of UK involvement? What if the enemy's tactics changed almost immediately?

There will always be uncertainty in military operations. As an operation matures the degree and nature of uncertainty will change, and hopefully reduce, as evidence is gathered on the progress of an operation. Either through operations or from data collected across training events and wargames, further information to supplement our understanding of the complex problem could be gained that highlights the sensitivity of the system to particular events. The light touch approach in the HCSIE method provides opportunities to modify our understanding of the complex system either through RAYGG changes or adding new factors. The key message in the adoption of the approach is not to wait until all uncertainties are addressed, but equally don't ignore key drivers that may have a major impact on the complex system or any intervention.

The next section moves from the understanding of the baseline to the identification of interventions, focussing particularly on innovation.

**Be innovative**


The third idea is **be innovative** in the identification of potential interventions. The realist community (Bhaskar (1978)[30], Pawson (2013)[31]) emphasise that consideration of an intervention should focus on what works, for whom, in what circumstance. Just because an intervention has proved successful in one particular situation does not mean it is likely to be successful in another context. The interactions between elements within the complex system and the resultant emergent behaviour are likely to be different, so innovation is key.

This is once again a divergent thinking activity. It provides opportunities to think beyond current constraints to address gaps highlighted during analysis of the baseline capability. A pan-DLOD approach to the identification of interventions should be adopted, such as changes to ways of working, change of personnel, improved training and better information. Once interventions have been identified they should be expressed in relatively simple actions or as small building blocks so that the potential impact of the intervention can be understood.

Taking an example, the UK involvement in the Middle East against terrorist organisations is a particularly 'wicked' problem. There are potential interventions one could consider, including: political engagement; targeted airstrikes; targeted drone strikes; SF on the ground, and; troops on the ground. Most of these are not innovative but they cover multiple DLODs and are complex. Are there innovative alternatives, for example the use of social media, increased or alternative use of NGOs, or specific engagement with country X? Each of the interventions has the potential to address some of the current challenges. What is required is to take each intervention and explore how it would change compared to the baseline. Noting the realist's point, what worked in Iraq or Afghanistan might not work here. Every tribe, every religious context is subtly different and needs to be studied carefully.

30 Bhaskar R. (1978) A Realist Theory of Science. London: Verso.

31 Pawson. R. (2013) The Science of Evaluation: A Realist Manifesto. Sage Publications.

The mechanisms for implementation of an intervention should not unduly constrain innovative thinking. It largely depends on the timescale and maturity of the intervention. Interventions to solve problems in the next six months may need to have high maturity. Interventions for opportunities 5 years away can be much less constrained.

Using a tactical example, namely making soldiers invisible to thwart enemy detection might seem like a valid intervention but there is, as yet, no technological solution that might achieve such an intervention. However, providing clothing that reduces infra-red (IR) signature, using technology that is already in service with other nations might demonstrate a realistic intervention. Alternatively, identifying a benefit through reduced enemy detection might spur our industrial partners' research and development activities to explore how it could be done.

With a set of innovative interventions the big question is what do we choose to develop further and what do we discount? The next section tackles that question by looking at the evaluation of the intervention.

**Evaluate**


The fourth idea is to **evaluate** the complex system with the proposed interventions applied. Multiple investigations could be conducted where each of the interventions is introduced and evaluated for their potential contribution to addressing the shortfalls identified from analysis of the baseline. This convergent activity will take the innovative ideas proposed as potential interventions, and highlight those interventions that are likely to have the desired effect and those that are not. This could highlight a priority and therefore a sequence for the application of the interventions.  The key premise is to evaluate the total system and to capture that evaluation as an update to each of the dashboards (see Figure 7 for an example of the dashboard evaluation for a Middle East North Africa (MENA) country). For each task within a capability component an assessment is made relating to the impact of the intervention. The impact of the intervention is considered for each task, and assessed for each component of capability. The baseline assessment is shown alongside to highlight the change from the baseline.

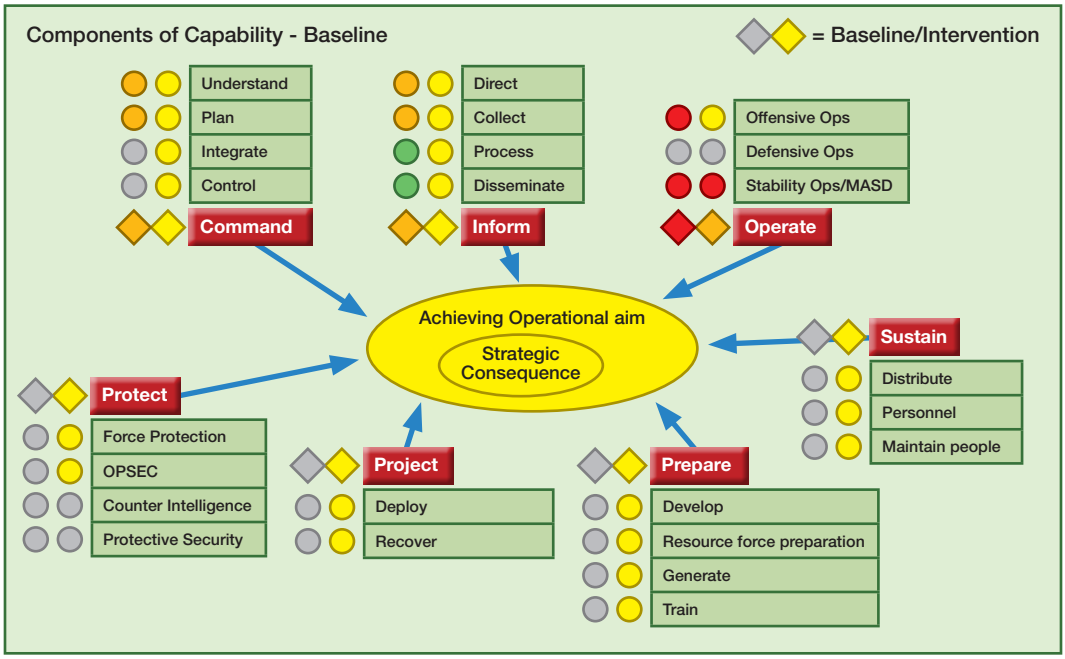


**Figure 7: Intervention example – an airstrike over MENA country**

The complexity of the contemporary and future operating environment is such that both state and non-state actors could be working to disrupt or attack UK interests abroad or more close to home. The tolerance of the military capability to changing conditions should be considered as part of this 'understand and explore' activity. This tolerance, or the ability to adapt to changing situations, is described by NATO as Agility. The NATO System Analysis and Studies (SAS)[32] Panel describes the following enablers that contribute to agility:

- Flexibility - Ability to achieve success in different ways;
- Innovativeness - To generate or develop a new tactic or way of accomplishing something;
- Versatility - Being able to successfully take on a new task or mission;
- Adaptability - Being able to change organisation, processes and/or structure to become better suited for the challenge;
- Responsiveness - Ability of a force to act (or react) effectively in a timely manner;
- Resilience - Being able to repair, replace, patch or otherwise reconstitute lost capability or performance.

These characteristics are effectively ways in which the capability can address alternative tactics from the opposing force or from emergence in the contemporary operating environment.

32 NATO System Analysis and Studies Panel SAS-085 focuses on Command and Control Agility but identifies the enablers underpinning any form of agility.

### Enriching the evaluation

Application of the HCSIE method and particularly the evaluation of an intervention is a qualitative activity that will typically use colour labels and change indicators derived from an MJP or workshop as well as supporting lookup tables. The approach is intended to provide a gross error check to understand where the intervention is likely to impact the complex system. Experimentation and wargaming could be used to explore particular aspects of the complex system, for example enhancing the specific scoring of the Command dimension to strengthen the confidence of the assessment. Figure 8 shows an arrangement of the contributory methods to the HCSIE approach.

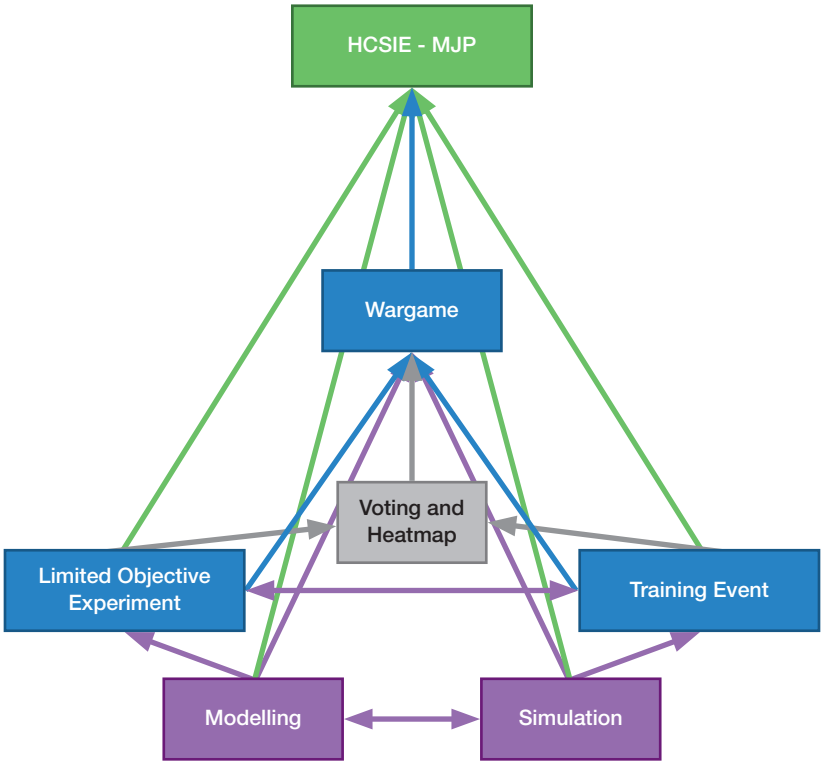


**Figure 8: Contributory Methods to the HCSIE approach**

The idea is that an MJP could be used to generate the ratings for the HCSIE method. However, the outcome of the MJP is likely to be more robust if a wargame is used to underpin it by examining different perspectives within a scenario-based context. Alternatively, voting on particular parameters of a capability, for example, wheeled vehicles in muddy terrain, will produce a heat map of parameters against capability components. This data could underpin the MJP or support the Wargame. The voting activity covers a wide range of factors that could be pertinent to the complex system and by generating the heat map of parameters versus capability components it is possible to see how a particular capability covers the problem space.

It is important that all of this supporting data is managed in relation to the HCSIE method in order to preserve the notion and construct of the complex system. The use of limited objective experiments (focused on cause-effect relationships), training events, models (eg cost modelling or survivability modelling) and/or simulations of the scenario terrain would be used to enhance the understanding of specific aspects of the complex system. They would not however be used to evaluate the totality of the complex system. The holistic evaluation would be achieved through the activities of the HCSIE method – of developing understanding, accepting uncertainty, innovating and evaluating.

**Iterate with small steps**


The fifth and final idea is to take the potential interventions, and identify the next likely candidate intervention **iterating with small steps**. The process starts with a new baseline, ie original baseline plus intervention, and requires exploration of the appropriateness of the intervention to the requirement. This will largely depend on the extent to which the first intervention addressed the gaps or issues or whether any new problems or shortfalls have been identified. The controlled, though not necessarily linear, introduction of intervention steps enables some of the gaps to be filled or issues to be addressed whilst managing the interaction between interventions and the complex system. Iteration may stop when an intervention has addressed the identified gaps in a way that satisfies the requirements of agility whilst acknowledging the constraints of affordability.

**Benefit of the HCSIE approach**

The HCSIE approach provides an easy to use method for exploring and evaluating complex systems. It requires little training on method and draws together a range of analytical techniques whilst remaining firmly in the complex problem space. The ideas behind the approach encourage the user to think creatively about potential interventions and the overall approach permits examination of the complex system from a range of different perspectives: strategic; military task and outcome as well alternative perspectives from ‘red’ teams or NGO participants. The dashboard form of presentation is intended to provide the military user with the tools to modify values and ratings rather than rely on any particular software. Table 5 provides a list of the advantages and disadvantages of the HCSIE approach from examination of the comparison experiment or traditional reductionist approach and that proposed by HCSIE.

**Table 5: Advantages and Disadvantages of HCSIE approach**

| Advantages | Disadvantages |
|---|---|
| Good for complex systems particularly where elements are loosely coupled. | Less useful for complicated or simple systems. |
| Good consideration of a wide range of factors that might be affected by an intervention. | The relationship between factors may not be fully understood. |
| Exploration with agreed assumptions as participants are skilled and task familiar. | Small number of factors controlled. They are thought of as what-if issues or in terms of sensitivity. |
| With the right participants, right equipment and appropriate data, information can be collected with the intention to inform decision making. | Making sense of the impact of an intervention requires expert judgement. |
| The investigation method should be applicable to a range of different situations. | The output is qualitative rather than quantitative. |

**Wider applicability**

The HCSIE approach as described focused on the components of capability required to deliver force elements to the operational environment. The approach could equally be applied to the MOD enterprise where the Direct, Develop, Deliver, Generate and Operate components of the Defence Operating Model replace the components of capability. Once the baseline effectiveness of the MOD enterprise, together with the Strategic context has been established the same principles and assessment approach would then apply.

**A change in mindset**

The approach described in this section of the White Paper is a more holistic approach than previous methods to evidence based decision making as it explores the interactions between system elements and the effect of interventions on the complex system. It requires a change in mindset from a reductionist system thinking approach to a more holistic complexity thinking style focusing on trends and contributory factors.

The goal must be to retain the properties of the complex system, whilst providing opportunities for examining the effects of introducing interventions into that system. The output will not be a mission success value and an absolute estimate of casualties for a given intervention, but a dashboard of factors and their estimated change as a result of the intervention. Such an approach should lead to holistic evaluation of complex system interventions.

**Exploitation**

The HCSIE approach is commended to the Scrutiny and Research communities for inclusion as part of an evidence-based approach to decision making. The approach is also commended to support Continuous Capability Evolution providing a sensemaking framework into which the proposed information and communications technology (ICT) intervention is applied. If taken forward, the opportunities for early risk reduction, through better appreciation of the complex system and the contributions of particular interventions, could lead to accelerated acquisition.

## Conclusions

The complexity of the Contemporary and Future Operating Environment cannot be overstated and the approach to evaluating complex systems needs to change. Experience within Niteworks and more broadly within Defence indicates that analysis of complex systems requires an alternative approach to that required for complicated or simple systems. The HCSIE approach is intended to fill that approach gap by providing a simple, easy-to-use technique to understand the interaction of factors within the complex system both at Strategic and lower levels, tied to robust outcomes, whilst providing a framework for other techniques to be incorporated. The ongoing consultative, collaborative and multi-disciplinary approach to HCSIE provides an opportunity to ensure an holistic approach to the evaluation of complex systems.

## Recommendations

Niteworks recommends that for complex systems the approach to HCSIE proposed herein is adopted as the underpinning basis for evidence based analysis and experimentation within a pan-DLOD approach to capability development and acquisition.

The key steps required to achieve the adoption and further development of this approach are, in outline:

- Endorsement and advocacy of the approach by D Scrutiny and capability staffs as an appropriate means of deriving evidence for decision making;
- Application of the approach to a candidate project, thus enabling refinement and prototyping of the methodology;
- Development of high level guidance for inclusion in the Analysis and Experimentation handbooks being developed in the Joint and Land service areas;
- Consultation with Industry, Academia and MOD to develop guidance on how to implement the proposed methodology;
- Review of the MOD Science and Technology Research Programme to understand how HSCIE and the evidence framework can support future decision making.

# ANNEX A

## Example 1 -Terrorist Engagement

This hypothetical example looks at the engagement of a terrorist organisation overseas in an attempt to reduce their influence and impact. The application of force in a country overseas, in this case using the example of a country in the MENA region, requires considerable thought and examination of a range of options. These options include tactical options that will have a tactical and/or strategic effect and strategic options expected to have strategic effect but which might only result in tactical impact. Niteworks believes that the HCSIE approach can be used to examine complex problems such as this example.

### 1.1 Explore to understand and accept uncertainty

**Step 1: Understand the Strategic context for terrorist organisation in MENA**

The assessment in Figure 9 shows the support of neighbouring countries for the terrorist organisation. It can be seen that Country A and Country B have a very supportive attitude towards the terrorist organisation. Country C and Country D are less supportive. The implications are the neighbouring countries are unlikely to support action by the UK, nor lend support for any local staging post.


**Figure 9: Baseline strategic context – attitude of neighbours to terrorist organisation**

**Step 1: Strategic context - UK Perspective**

Looking at the UK perspective (Figure 10), the will of the people and the government of the UK, as well as legal considerations in the UK have been assessed. The will of the UK is positive as the UK is maintaining limited involvement. The level of legal support is high because the current approach of non-involvement is considered legal. Similarly the United Nations Security Council (UNSC) is supportive or at worst ambivalent and the terrorist organisation is less aggressive to the UK as there is no direct intervention on the terrorist organisation in the MENA country.

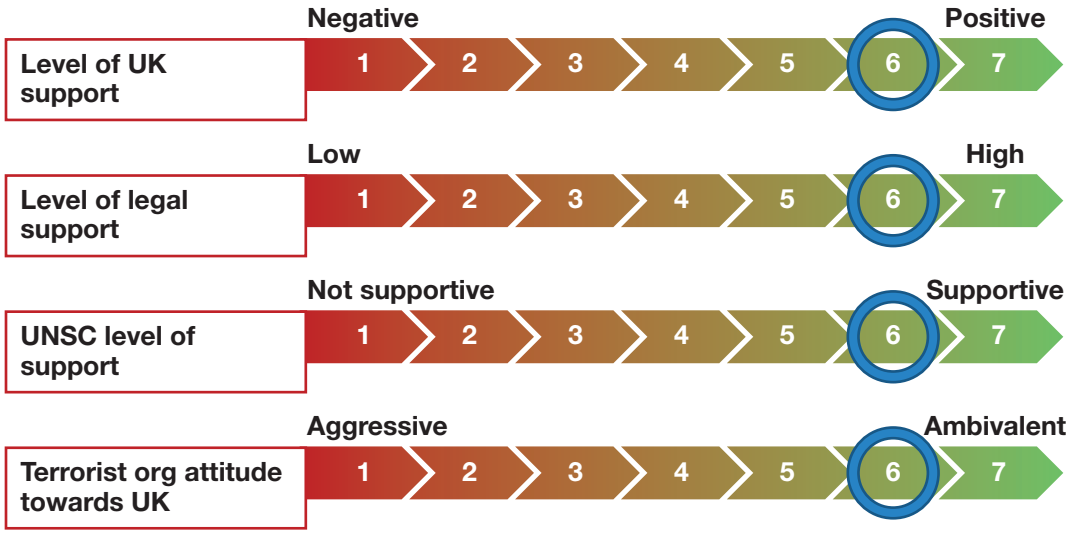


**Figure 10: Baseline strategic context – attitude of UK, legal, UN and Terrorist**

**Step 2: Establish Strategic Objective (or the overarching goal)**

The strategic intent in this scenario is:

**Demonstrate active collaboration alongside other nations by reducing the capability of the terrorist organisation.**

### Step 3: Understand the Operational Context

The operational context assessment is shown in Table 6 and Figure 11.

**Table 6: Justification table for PMESII-PT (Political, Military, Economic and Social are shown)**

| PMESII-PT Category | Variable | Assessment | Justification | Assessment | Justification |
|---|---|---|---|---|---|
| Political | Attitude to UK | | | | All Red |
| | Centres of pol power | | | | |
| | Governrnent type | | Government show signs of dictatorship | | |
| | Govt effectiveness | | Govt action has not improved situation | | |
| | Influential pol groups | | Muitiple pol groups affect multiple tribes | | |
| Military | Govt military forces | | Significant capability | | All Red |
| | Non state paramilitary | | Terrorist organisations | | |
| | Unarmed combatants | | | | |
| | Non-mil armed combatants | | | | |
| Economic | Diversity | | | | All Red |
| | Employment Status | | | | |
| | Economic activity | | Economy in poor situation | | |
| | Illegal economic activity | | None registered | | |
| | Banking and finance | | Banking is in OK shape | | |
| Social | Demographic mix | | | | Highly concerning - overall red |
| | Social volatility | | Highly volatile - years of deprivation | | |
| | Education level | | | | |
| | Ethnic diversity | | Highly varied and tensions between | | |
| | Religious diversity | | Highly varied and tensions between | | |

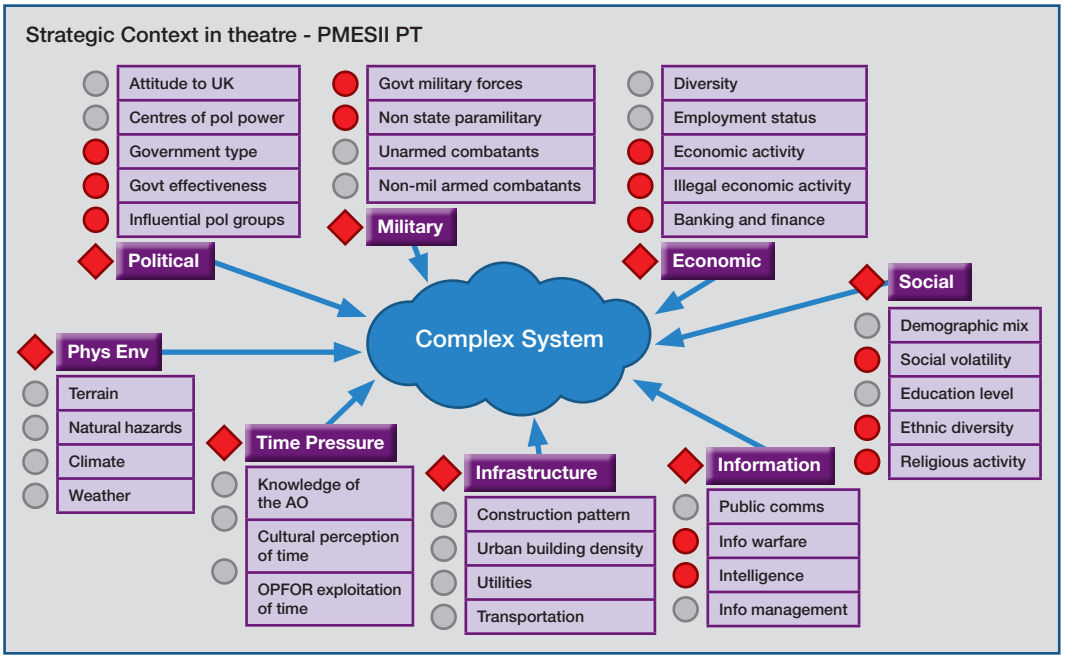


**Figure 11: Baseline operational context for Terrorist example**

Most of the factors are red – highlighting significant risk. The assessment highlights that the government and influential political groups have a negative and unacceptable impact on the complex system. In a similar way the government military forces and non-state paramilitary have a negative impact. There is considerable ethnic and religious diversity in the region that has led to social volatility and instability in the region. The instability in the country is of major concern as is the support from neighbouring countries. This will affect the planning of any tactical action in terms of establishing deployed locations and potential use of Air Points of Departure (APOD). The use of a map exercise (MAPEX) or war game may help to understand the options available.

**Step 4: Define operational objectives to satisfy strategic intent**

Given the operational context and the hostile environment that is present within the MENA country the operational objective is to remove and/or reduce the effect of the terrorist organisation.

**Step 5: Understand how the military capability can satisfy the operational objective**

The current baseline in terms of military capability is that no airstrikes or ground troops are involved against militia in a specific MENA country. Table 7 and Figure 12 shows the assessment of the baseline capability. In terms of achieving the operational objective of removing or reducing the effect of the terrorist organisation the baseline capability has been assessed as amber. This is due to an ability to supply command and inform

functions – inform primarily from intelligence and ISTAR but no ability to operate offensively due to no UN mandate or UK legal basis and, as a consequence, no ability to provide stability in the area.

**Table 7: Justification table for the tasks associated with each component of capability**

| Caucasus PMESII-PT Category | Task | Task Assessment | Justification | Assessment | Justification |
|---|---|---|---|---|---|
| Command | Understand | | | | Those assessments that apply are Orange |
| | Plan | | | | |
| | Integrate | | Government shows signs of dictatorship | | |
| | Control | | Government action has not improved situation | | |
| Inform | Direct | | Significant capability | | While process and disseminate are good, the direct and collect status drives the front end of the inform capability therefore Orange |
| | Collect | | Terrorist organisations | | |
| | Process | | | | |
| | Disseminate | | | | |
| Operate | Offensive Ops | | | | Those assessments that apply are Red |
| | Defensive Ops | | | | |
| | MASD/Stabilisation | | Economy in poor situation | | |

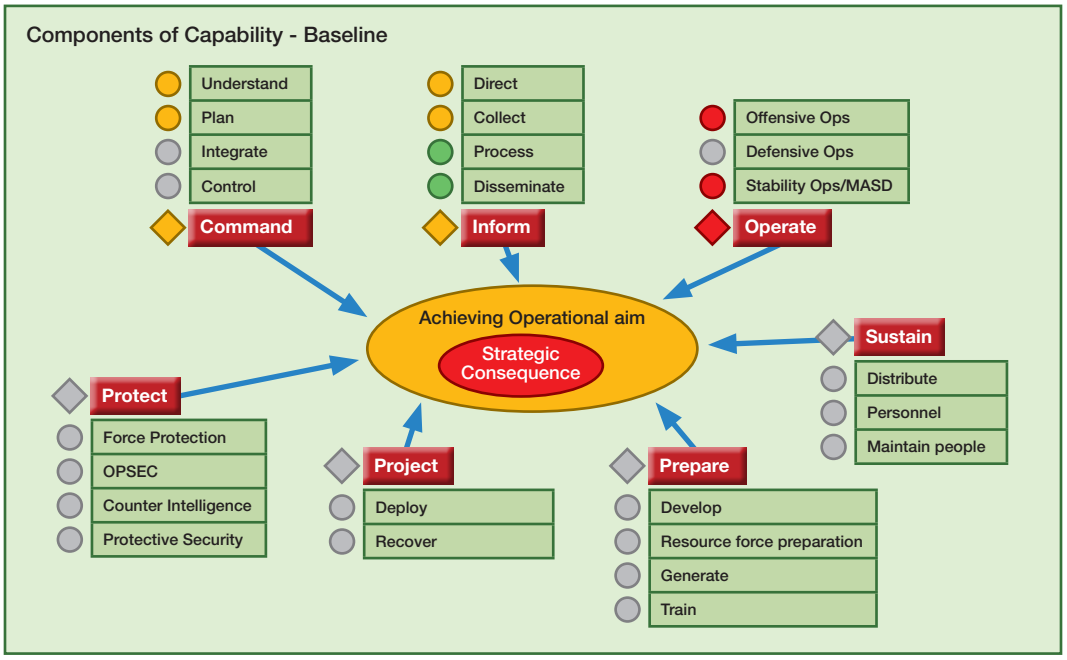


**Figure 12: Current baseline example - no airstrikes on terrorist militia in MENA country**

**Step 6: Understand the strategic consequences of military capability.**

The strategic consequences of no offensive operations are also captured in Figure 12. Against the strategic objective of 'demonstrating active collaboration alongside other nations in prosecuting decisively the terrorist organisation' the assessment is red as no such demonstration or prosecution is possible. In addition the implications for other country's attitudes towards the UK has remained unchanged (Figure 13).


**Figure 13: Neighbouring countries attitudes to the UK - baseline**

None of the other strategic assessments are likely to change as no major military intervention has taken place in the baseline.

**Summary of the baseline**

The UK's inactivity in relation to the terrorist organisation has meant that the UK is failing to achieve its strategic and operational objectives but has not antagonised countries that are supportive of the terrorist organisation. Interventions therefore need to be identified that better address the strategic and operational objectives.

**1.2 Intervention Option A – Airstrike over MENA country**

If an airstrike intervention is considered, the strategic and operational context and objectives remain the same so only steps 5 and 6 apply.

**Step 5: Understand how the military capability can satisfy the operational objective**

The assessment of military capability in an airstrike intervention highlights increased Command, Inform, Operate, Protect and Sustain activities over the baseline. Primarily

focused on Offensive operations supported by ISTAR this would need significant Command and Control. Protection is likely to be higher than the baseline as aircraft would need to be stationed such that they can deliver effect; which may put them more in harm's way. The neighbouring nations are sympathetic to the terrorist organisation so it is unlikely that any of these nations could be used to base assets.

The Operate component is assessed as amber due to the ability to perform offensive ops but in so doing might add instability or make the follow on task of stabilisation more difficult.

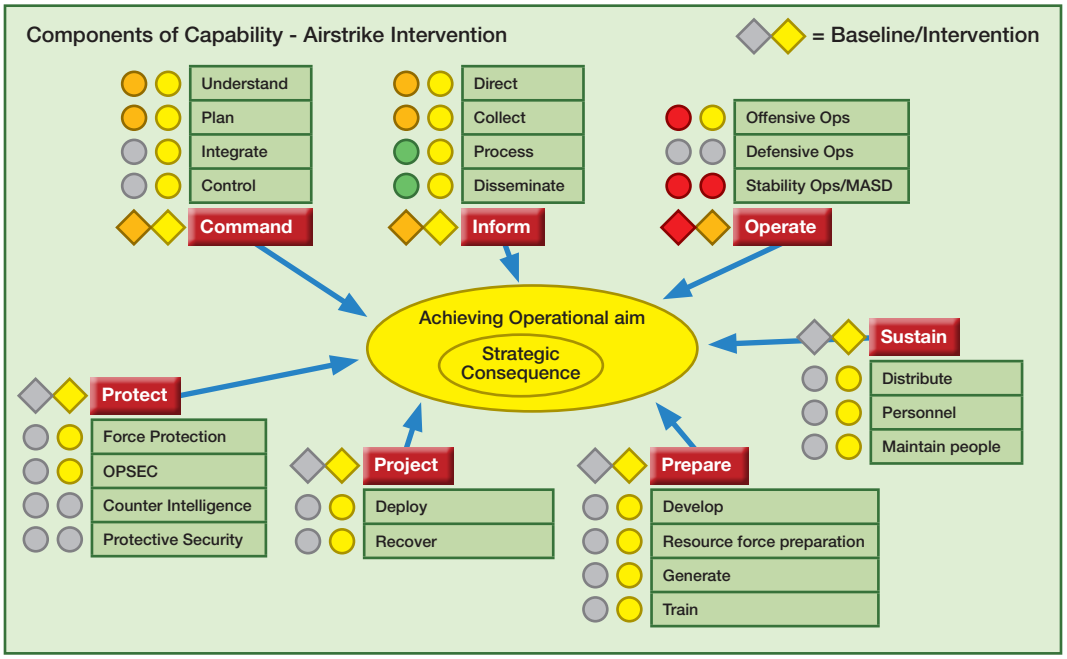


**Figure 14: Components of capability – example airstrike intervention**

**Step 6: Understand the strategic consequences of military capability.**

The strategic consequences of airstrikes is captured in Figure 14. Against the strategic objective of 'demonstrating active collaboration in prosecuting the terrorist organisation' the assessment is yellow as the UK is participating with other coalition members in airstrikes to neutralise the threat.

The effect of such an action on the attitude to the UK of countries neighbouring the terrorist organisation are quite stark. Unsurprisingly each country's attitude is more negative to the UK.

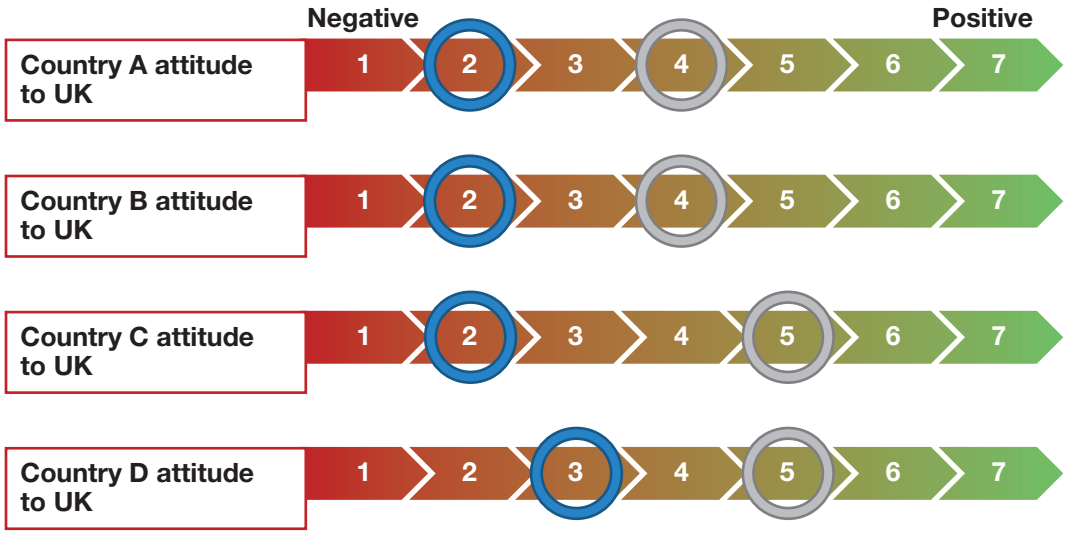


**Figure 15: Intervention option A – Airstrike over MENA country (baseline circles in grey)**

If the UK situation is considered: UK population support is reduced; there are greater legal considerations and so legal support is reduced; the UN support is reduced unless there is a UN mandate and the terrorist organisation aggression has been raised as the UK is directly attacking terrorist organisation installations.

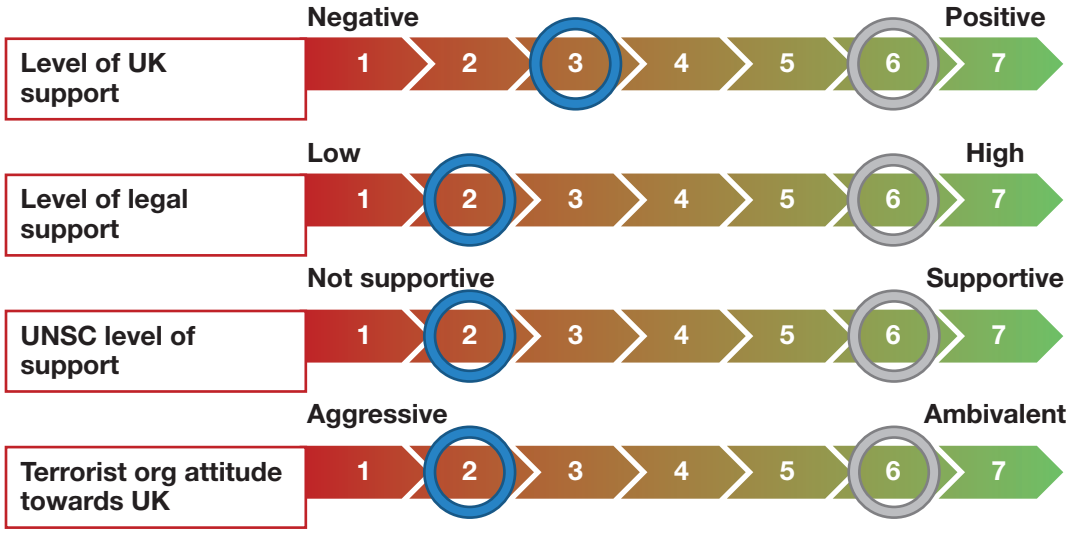


**Figure 16: Intervention option A - Airstrike over MENA country (baseline circles in grey)**

### 1.3 Intervention Option B – Drone strike over MENA country

If a drone strike intervention is considered, the effect of such an action on neighbouring countries' attitudes to the UK, who are supportive of the terrorist organisation, is different to that for airstrike.

**Step 5: Understand how the military capability can satisfy the operational objective**

The assessment of military capability in a drone strike intervention highlights that Command, Protect, Project, Prepare and Sustain components are green. The Inform component is yellow as the Inform requires support from ISTAR collectors and processors and the Operate component is assessed as yellow due to the ability to perform limited offensive operations and not destroy major parts of the country that would make the follow-on task of stabilisation more difficult. Focused on very specific offensive operations with intelligence fed to the mission planner, there would need to be some deconfliction, however the co-ordination with other assets is much reduced compared to airstrikes. Depending on where the drone is flown from, the level of Protection could still be an issue but the asset is smaller and intervention is very focussed.

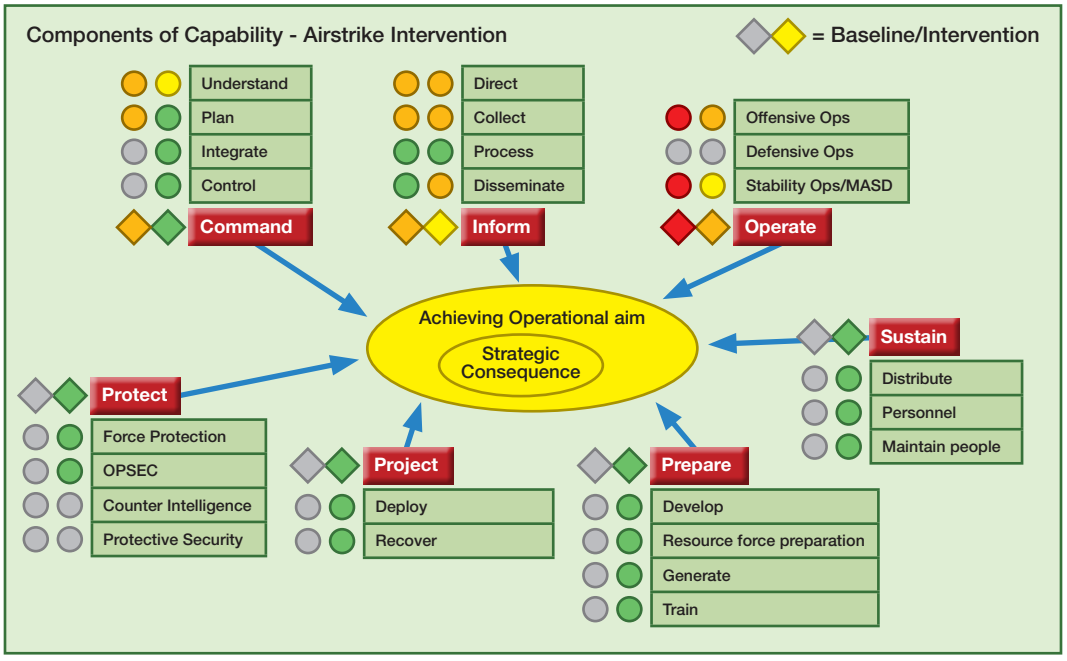


**Figure 17: Components of capability – example drone strike intervention**

**Step 6: Understand the strategic consequences of military capability.**

The assessment of the strategic consequences of drone strikes is captured in the inner elipse in Figure 17. Against the strategic objective of 'demonstrating active collaboration in prosecuting the terrorist organisation' the assessment is amber as the UK is participating alone to deliver drone strikes to neutralise the threat. The effect of such an action on countries neighbouring the terrorist organisation becomes more negative than the baseline (Figure 18).

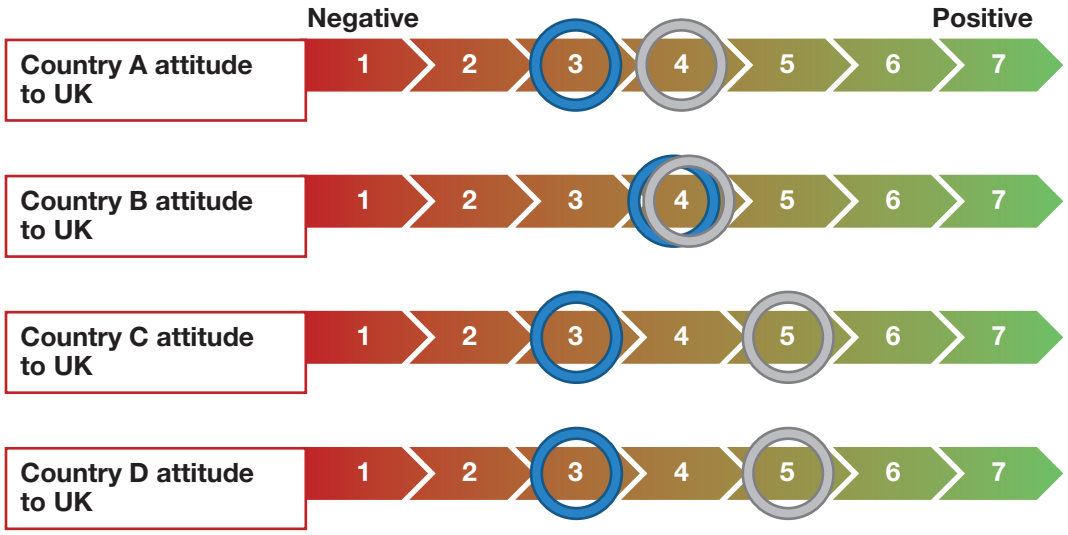


**Figure 18: Intervention option B – Drone strike over MENA country**

If the UK situation is considered; UK population support is reduced; there are legal considerations – more than the baseline though not as significant as for airstrikes, and so legal support is reduced; the UN support is reduced without a UN mandate and the terrorist organisation aggression has been raised as the UK is directly attacking terrorist organisation installations.

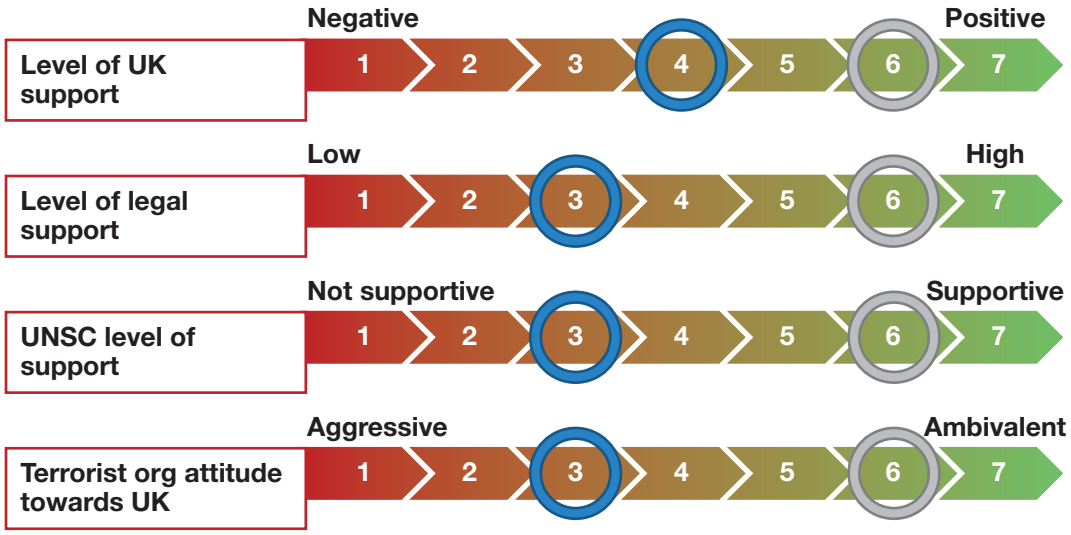


**Figure 19: Intervention option B – Drone strike over MENA country**

### 1.4 Intervention Option C: Armoured Ground Forces in MENA country engaging terrorist organisation

The Armoured ground force intervention is examined in this example drawing from Niteworks participation in Light Forces and Lead Armoured Task Force projects. If a ground forces intervention is considered, the military capability required and the effect of such an action on neighbouring countries' attitudes to the UK is considerably different to that for airstrike or drone strike.

#### Step 5: Understand the military capability to satisfy the operational objective

The assessment of military capability in the armoured ground force intervention highlights significant Command, Inform, Operate, and Sustain activities when compared to the baseline. This effort would be both offensive and defensive, and geographically dispersed to counter the organisation. All areas are highlighted as amber or red as it would require significant effort in all respects. Risk of casualties would be high as forces are inserted into an already occupied space.

Supporting analysis of encounters with similar terrorist organisations would provide a richer assessment of the likely impact of the intervention.

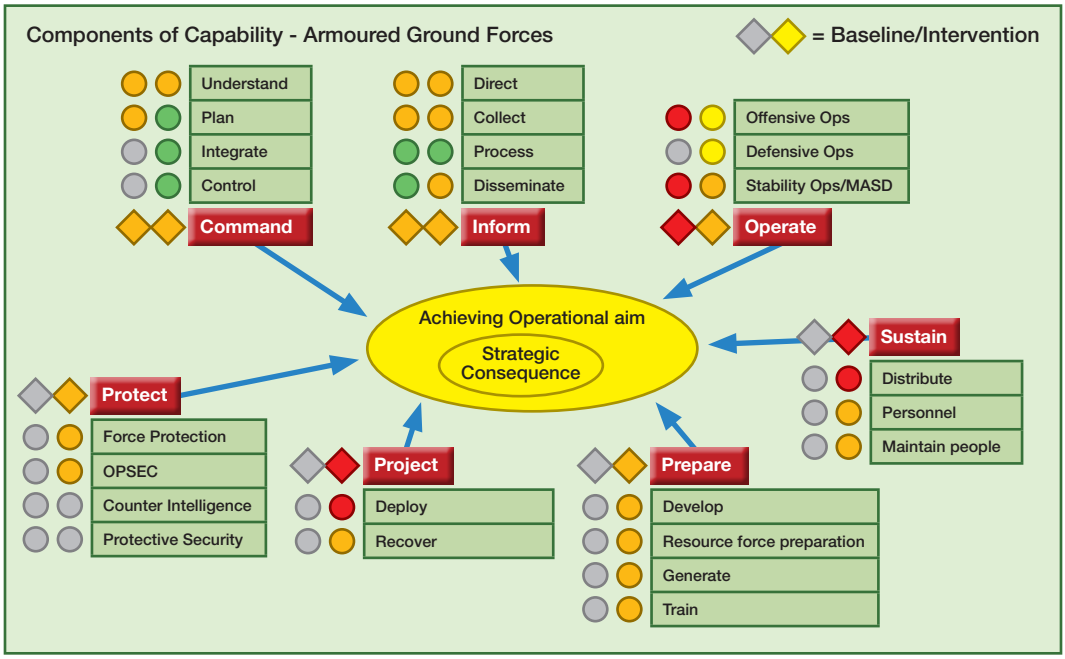


**Figure 20: Armoured Ground Forces on MENA country soil engaging terrorist organisation**

**Step 6: Understand the strategic consequences of military capability.**

It is expected that each country that is supportive of the terrorist organisation would have very negative attitudes towards the UK (see Figure 21) if the UK engaged the terrorist organisation with ground forces.

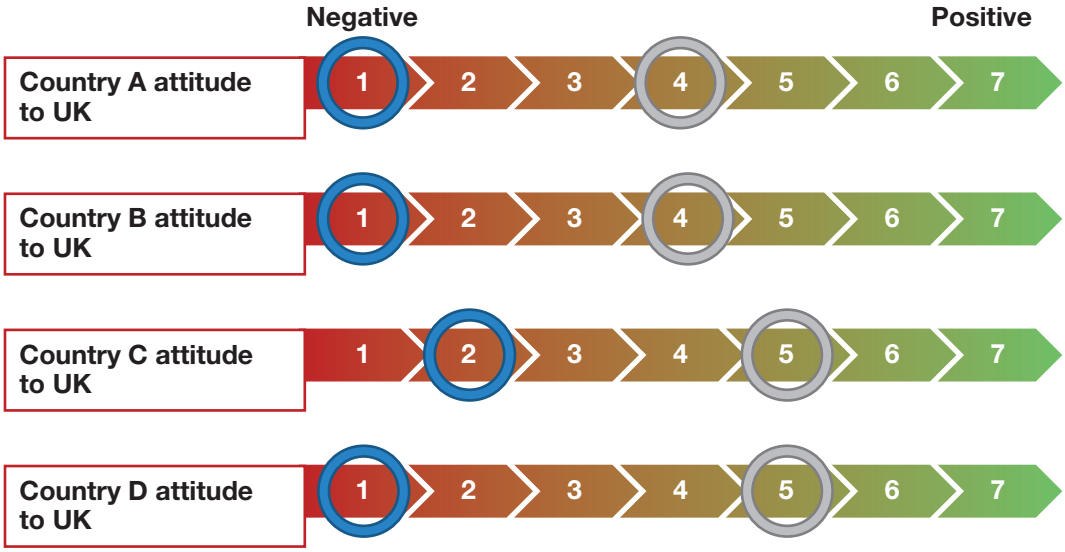


**Figure 21: Ground Forces on MENA country soil engaging terrorist organisation**

UK support for an intervention is not high, given the previous land asset engagement commitments to Iraq and Afghanistan. In addition the legal considerations for such action are high and without a specific mandate from the UN the UNSC is not supportive. Finally the terrorist organisation's view and response is to be much more aggressive to UK interests.


**Figure 22: Armoured Ground Forces on MENA country soil engaging terrorist organisation**

### 1.5 Intervention Option D: Light Ground Forces in MENA country engaging terrorist organisation

For this example a Light Ground force intervention is examined. The Light Force has minimal armour on any vehicles, offering limited protection, and relies mostly on dismounted engagement activity. It has the benefit, while not being armoured, of being flexible and light in delivery to the troops and manoeuvre in the battlefield.

#### Step 5: Understand the military capability to satisfy the operational objective

The assessment of military capability in the ground force intervention (Figure 23) highlights similar Command and Inform concerns to Armoured Forces but the Operate, Protect and Sustain activities are significant for the Light Forces. The degree of protection required for the vehicles, using other assets such as Indirect Fire and Overwatch, makes the offensive and defensive ops more challenging both when compared to the other ground forces intervention and the baseline. However the lighter vehicles provide less of a footprint and can be airlifted into theatre. All areas are highlighted as amber or red as it would require significant effort in all respects. Risk of casualties would be very high as forces are inserted into an already occupied space.

Supporting analysis of encounters with similar terrorist organisations would provide a richer assessment of the likely impact of the intervention.

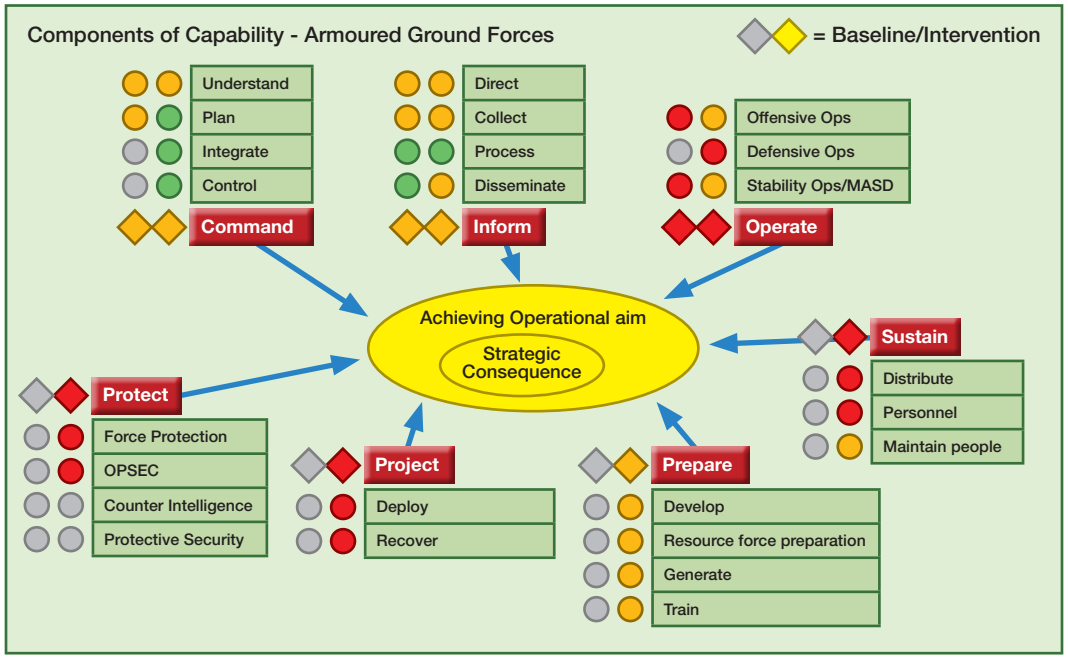


**Figure 23: Light Ground Forces on MENA country soil engaging terrorist organisation**

**Step 6: Understand the strategic consequences of military capability.**

It is expected that each country that is supportive of the terrorist organisation would have very negative attitudes towards the UK (see Figure 24) if the UK engaged the terrorist organisation with ground forces.

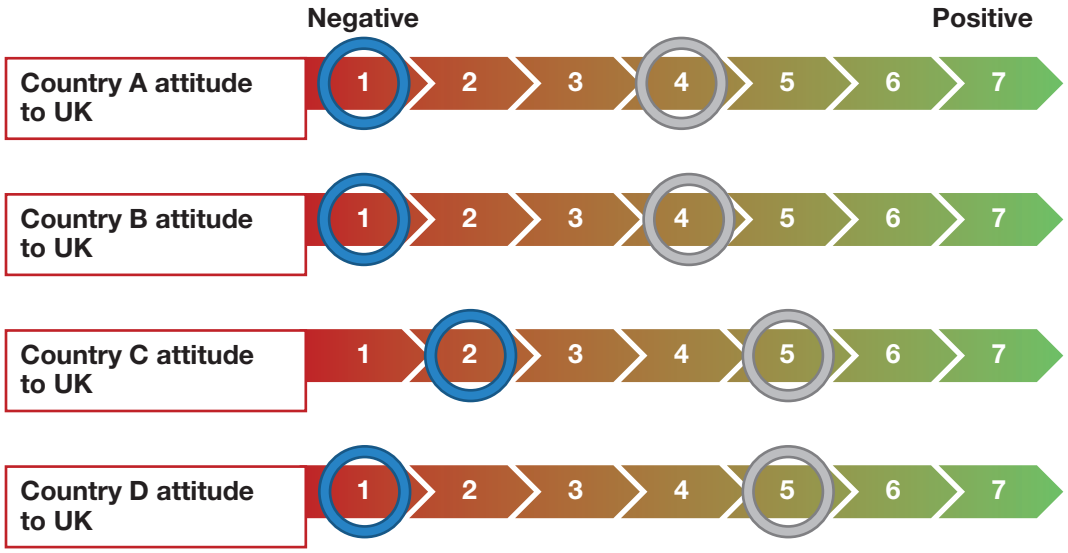


**Figure 24: Light Ground Forces on MENA country soil engaging terrorist organisation**

UK support for an intervention is not high, given the previous land forces engagement commitments to Iraq and Afghanistan. In addition the legal requirements for such action are high and without a specific mandate from the UN the UNSC is not supportive. Finally the terrorist organisation's view and response is to be much more aggressive to UK interests.

### 1.6 Terrorist organisation engagement example - summary

Several interventions have been considered ranging from a drone strike to heavy armoured ground forces. It would be possible to adopt an incremental approach such as drone strikes, then air strikes and then ground forces each building on the previous intervention. However all of the military interventions have undesirable consequences and fail to achieve the strategic or operational aims.

An alternative more innovative intervention would be to take steps to improve the local economy, generating jobs and hence a focus away from participating in terrorist activities. The HCSIE approach in this example has been used to illustrate how complex actions on a complex system are likely to play out in a particular scenario context. The next example looks at how the approach could be used to look more at the sensor and collect side of the defence enterprise rather than the delivery of effect.

# Example 2 - Command and Control of ISR on Contingent Operations

The Niteworks Command and Control of Intelligence Surveillance and Reconnaissance (ISR) (C2 of ISR) project has been looking at the command and control and networking aspects of the ISR assets following a refocusing of the Armoured Infantry Brigade and Divisional responsibilities. This example, while not explicitly replaying the thinking or findings of the project has used an exercise scenario as a handrail and attempted to think about the issues that would be pertinent to interventions in this particular problem space.

Prior to the return to contingency the brigade HQ had control of the intelligence collect assets. The move back to contingency has given rise to a policy whereby the Divisional HQ has control of the intelligence assets and the Brigade Commander can make requests for the assets. The Division is there to act as the Director and Resource Manager supporting the Brigades and holding resources on their behalf. The Brigades are there to deliver decisive effect. The example provided below, drawing from a Divisional level exercise, represents an illustration of potential interventions and their impact. The following sections describe the allocation and management of ISR assets. The allocation of ISR assets to the Divisional Commander will be considered the baseline for the purposes of the example. The C2 of ISR outcome metrics of tempo, information superiority and agility are discussed following analysis of each intervention.

**2.1 Explore to understand and accept uncertainty**

**Step 1: Understand the Strategic context**

The strategic context for this example is drawn from a recent exercise using the DATE Atropia scenario set in the Caucasus region. Neighbouring nations Ariana and Minaria have invaded Atropia and have pushed Atropian forces East towards the country's capital city. NATO forces have been tasked to regain the country pushing the Arianian and Minarian forces back West, with the objective of regaining major cities and re-establishing stability in the region. Neighbouring nations Gorgas and Donovia are attempting to make reforms and are largely supportive of Atropia and the rule of law. Figure 25 shows that the Minarian and Arianian attitudes are very negative but the Gorgas and Donovia populations are fairly positive about the nation of Atropia and its sovereign rights.

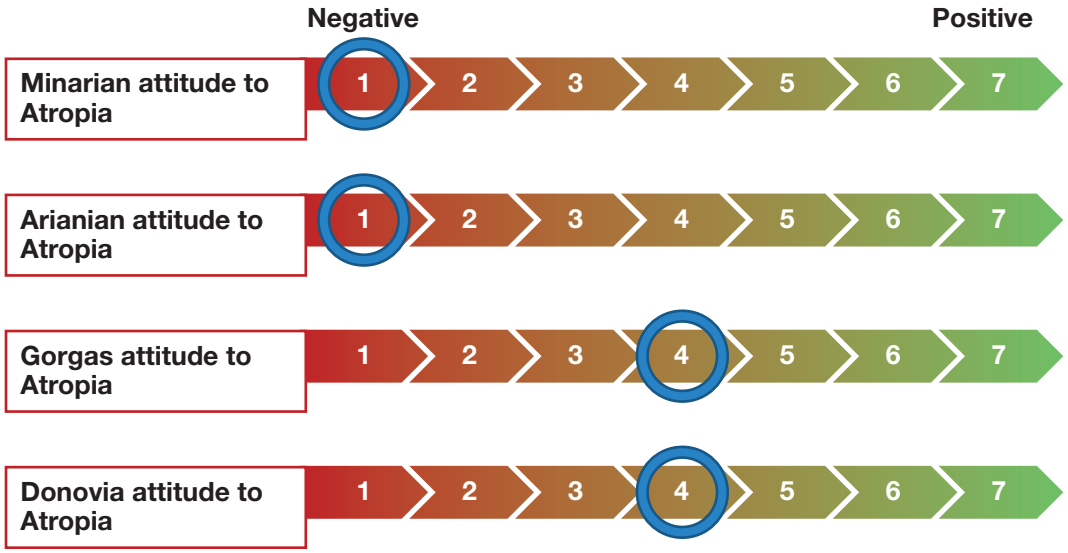


**Figure 25: C2 of ISR Baseline strategic context – attitude of countries to NATO**

**Step 1: Strategic context - UK Perspective**

Looking at the UK perspective, the will of the people and the government of the UK, as well as legal considerations in the UK have been assessed however other factors deemed relevant to the particular problem could be used. The will of the UK is positive as the UK recognises the need to commit and engage the aggressive forces. The level of legal support is high because the current approach is considered legal with a mandate as part of NATO to commit forces. Similarly the UN is supportive of the NATO mission as there is considerable instability in the Caucasus region that could expand to the surrounding regions. A further indicator in this example is the attitude/quality of life of the Atropian people. Currently that indicator is supportive of NATO involvement. Whether that continues to be the case as the mission progresses will be considered later.

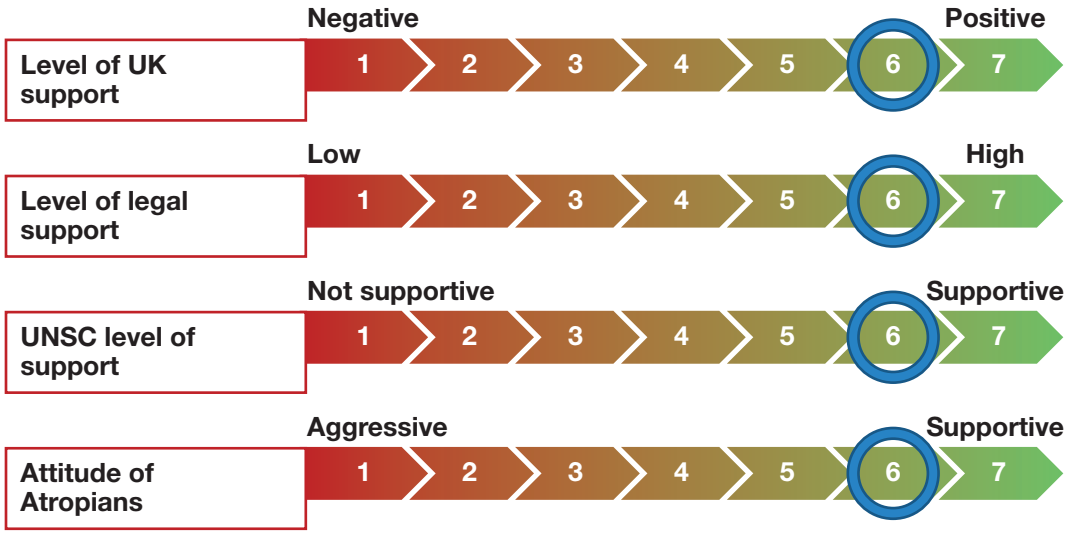


**Figure 26: C2 of ISR Baseline strategic context – attitude of UK, legal, UN and Atropian**

**Step 2: Establish Strategic Objective (or the overarching goal)**

The strategic intent in this scenario is:

> **Secure and consolidate the NATO achievements and successes to date in deterring, defeating and expelling Minarian and Arianan forces from Atropia**

**Step 3: Understand the Operational Context**

The operational context assessment is shown in Table 8 and Figure 27 and focuses on the region of the Caucasus rather one specific country. It is the region in general that is relevant to ensure that the context is sufficiently well understood before considering intervention options.

Most of the factors are red – highlighting significant risk. The assessment highlights that the Minarian and Arianan forces have significant presence and political might given the presence of a minority population who are willing to take up arms. There is considerable ethnic and religious diversity in the region that has led to social volatility and instability in the region. There is widespread criminal activity in Atropia and the criminal organisations advocate the overthrow of the existing Atropian government.

**Table 8: C2 of ISR Justification table for PMESII-PT categories**

| Caucasus PMESII-PT Category | Task | Assessment | Justification | Assessment | Justification |
|---|---|---|---|---|---|
| Command | Attitude to UK | | | | All red |
| | Centres of pol power | | | | |
| | Governrnent type | | Government show signs of dictatorship | | |
| | Govt effectiveness | | Govt action has not improved situation | | |
| | Influential pol groups | | Muitiple pol groups affect multiple tribes | | |
| Inform | Govt military forces | | Significant capability | | All red |
| | Non state paramilitary | | Terrorist organisations | | |
| | Unarmed combatants | | | | |
| | Non-mil armed combatants | | | | |
| Operate | Diversity | | | | All red |
| | Employment Status | | | | |
| | Economic activity | | Economy in poor situation | | |
| | Illegal economic activity | | None registered | | |
| | Banking and finance | | Banking is in OK shape | | |
| Protect | Demographic mix | | | | Highly concerning - overall red |
| | Social volatility | | Highly volatile - years of deprivation | | |
| | Education level | | | | |
| | Ethnic diversity | | Highly varied and tensions between | | |
| | Religious diversity | | Highly varied and tensions between | | |

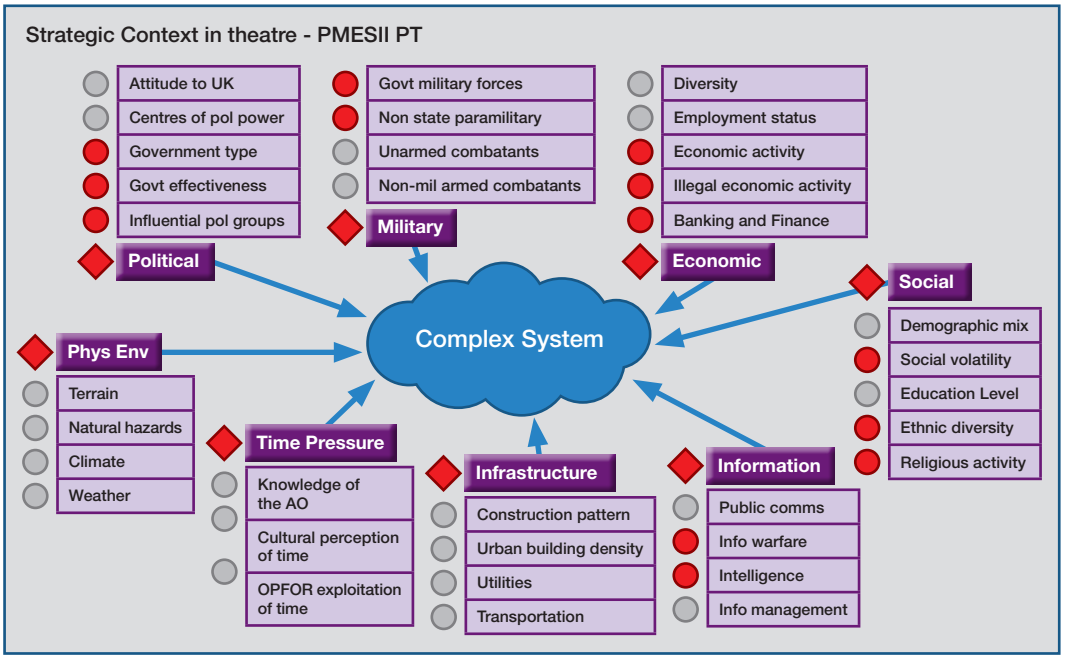


**Figure 27: C2 of ISR - Baseline operational context**

**Step 4: Define operational objectives to satisfy strategic intent**

Given the operational context and the hostile environment that is present within the Atropia region the operational objective is to drive back the forces of Minaria and Ariana.

**Step 5: Understand how the military capability can satisfy the operational objective**

Figure 28 shows the assessment of the baseline exercise construct. In terms of achieving the operational objective of driving back the forces of Minaria the baseline capability has been assessed as yellow. This is due to an ability to achieve good command and control of assets, co-ordination with other agencies and the task of ISR assets to inform current ops and future ops. The command and control of ISR at Divisional level may require more co-ordination depending how far forward the ISR assets are deployed. In addition knowledge of the tactical aspects of influence and understanding (I&U) and information activities and capacity building (IA&CB) is limited.

By contrast, the Bde HQ is finding that its ability to plan and execute is constrained by requesting ISR support from Div HQ. In addition the lack of organic ISR is causing Protection problems as the Bde Commander has less understanding of Red's activities. There is greater risk exposure for the Bde Commander as a consequence.

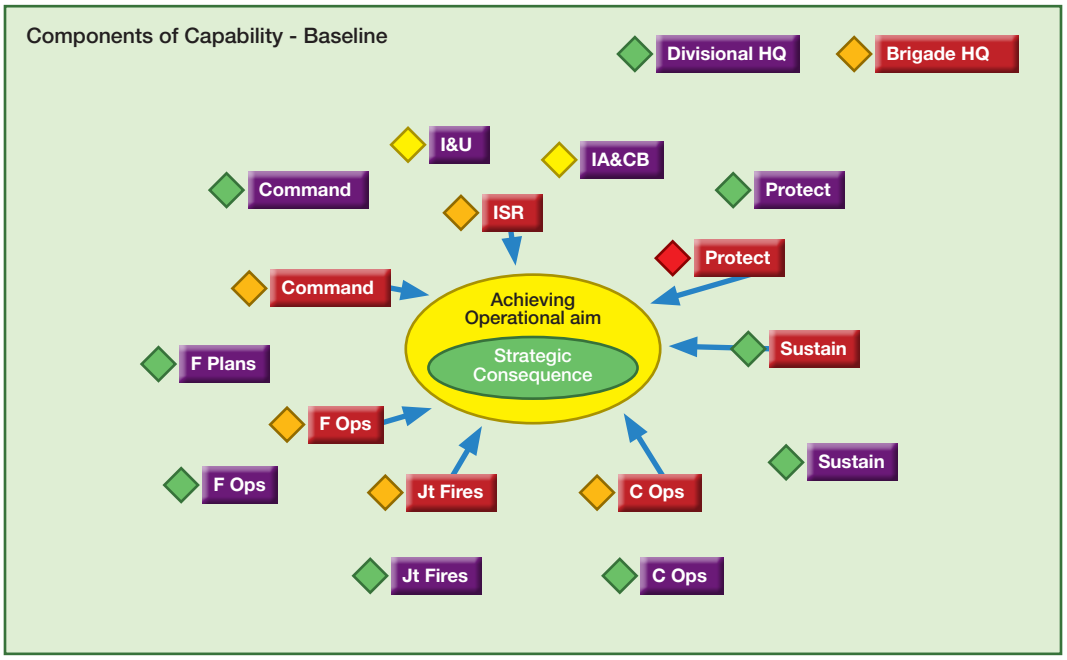


**Figure 28: C2 of ISR - Current baseline**

**Step 6: Understand the strategic consequences of military capability**

The strategic consequences of the ISR arrangement appear good. The ability to co-ordinate ISR capability at the same level as engagement with other organisations both in-country and with other UK government departments is likely to contribute to a good strategic outcome. Against the strategic objective of 'Secure and consolidate the NATO achievements and successes to date in deterring, defeating and expelling Minarian and Arianian forces from Atropia' there is a high requirement for ISR capability. Co-ordination at the Divisional HQ level appears to provide the opportunity to task ISR assets in a co-ordinated manner with other Divisional tasks.

The commitment of UK forces to the NATO mission has strategic consequences in terms of the message being given to the countries in the Caucasus region. The co-ordination of ISR has reduced the likelihood of civilians being targeted, and has supported aspects of prevention, sensing, early warning and interception of Minarian and Arianian attacks.

The indicators therefore remain unchanged.

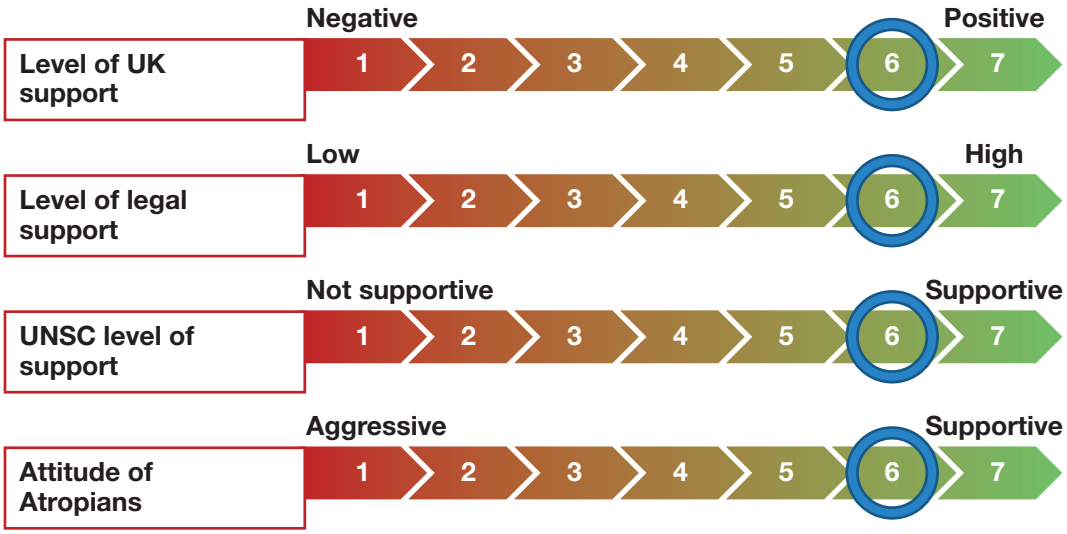


**Figure 29: C2 of ISR - Attitude of UK, legal, UN and Atropian - Baseline**

**Summary of the baseline**

The management of ISR assets at the Divisional HQ level appears to provide an appropriate arrangement for ensuring co-ordination across all facets of the Divisional Commander's responsibilities.

### 2.2 Intervention Option A – Some ISR assets with Bde

The first intervention considers the impact of dividing the co-ordination of ISR assets between Bde and Div HQs.

**Step 5: Understand how the military capability can satisfy the operational objective**

Figure 30 shows the assessment of the intervention where some ISR assets are dedicated for Bde use. In terms of achieving the operational objective of driving back the forces of Minaria the baseline capability has again been assessed as yellow. Command and control of assets is generally good at the Div HQ, with co-ordination with other agencies maintained. The co-ordination of ISR tasking to inform current ops and future ops is more difficult as ISR capability resides in both C2 organisations. The Brigade still senses an element of vulnerability without direct access to ISR and for those ISR assets allocated to the Brigade it may have to provide protection for the platform and supporting teams. The Command function is therefore more difficult as it requires more liaising between the Brigade and Divisional HQ to understand the focus of planning for the next 48-96 hours.

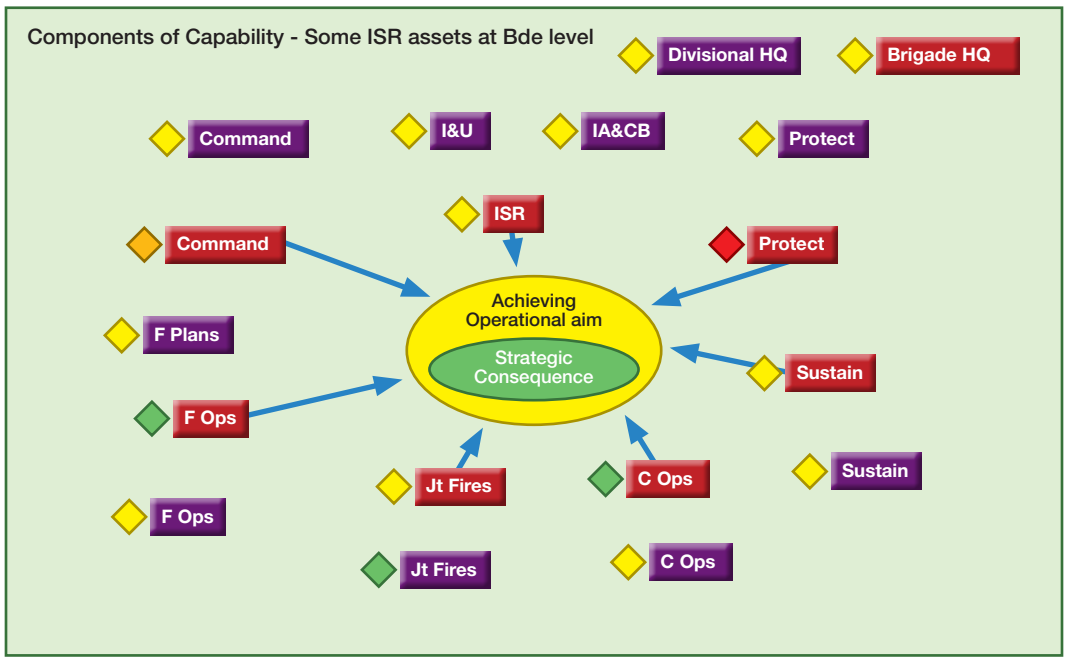


**Figure 30: C2 of ISR - ISR allocated between Divisional and Brigade HQs**

**Step 6: Understand the strategic consequences of military capability.**

The strategic consequences of the ISR arrangement also appear good. The ability to co-ordinate ISR capability at the same level as engagement with other organisations both in country and with other UK government departments remains likely to contribute to a good strategic outcome. Against the strategic objective of 'Secure and consolidate

the NATO achievements and successes to date in deterring, defeating and expelling Minarian and Arianian forces from Atropia' the co-ordination of ISR has impacted on the Minarian and Arianian forces. However not to the same extent as the baseline, resulting in a reduction in the level of support from the Atropians. There is potential for confusion and disconnect between the named areas of interest and collection plans at the Divisional HQ level  vis a vis the Brigade level. The level of confusion would depend on the nature of the communications and networks between the Brigade and the Division for the sharing of information.

The co-ordination of ISR has reduced the likelihood of civilians being targeted. The potential for confusion and the requirement for deconfliction increases as the Brigade activities may overlap with other Brigades or external agencies in the operational area. Such confusion could lead to inappropriate/inaccurate targeting. This has an effect on the attitude of the Atropians but not UN, Legal or UK support.


**Figure 31: C2 of ISR - Attitude of UK, legal, UN and Atropian – Intervention option A**

### 2.3 Intervention Option B: All ISR assets at Brigade

**Step 5: Understand the military capability to satisfy the operational objective**

The second intervention considers the impact of all of the ISR assets being held at Bde as has been done prior to contingency.

**Step 5: Understand how the military capability can satisfy the operational objective**

Figure 32 shows the assessment of the intervention where all of the ISR assets are dedicated for Bde use. In terms of achieving the operational objective of driving back the forces of Minaria the baseline capability has again been assessed as amber. The removal of ISR assets to the Bde level from the Div HQ has impacted the planning and execution

activities of the Current Ops, Future Ops and Command cells. Command and control of assets is generally good at the Bde HQ. The allocation of ISR assets to Bde has shifted the emphasis of Protect and Sustain to the Bde HQ. However protecting own forces has been alleviated as ISR is better able to support the Bde forces. The Brigade feels less vulnerable now having direct access to ISR. The Command at Bde level is therefore good as it requires less liaising between the Brigade and Division to understand the focus of planning for the next 48-96 hours. By contrast, the Div HQ is finding that its ability to plan and execute is constrained by the release of ISR support to the Bde HQ. On balance therefore it is a mixed benefit that disadvantages the Div more than the Bde and therefore the operational objective.

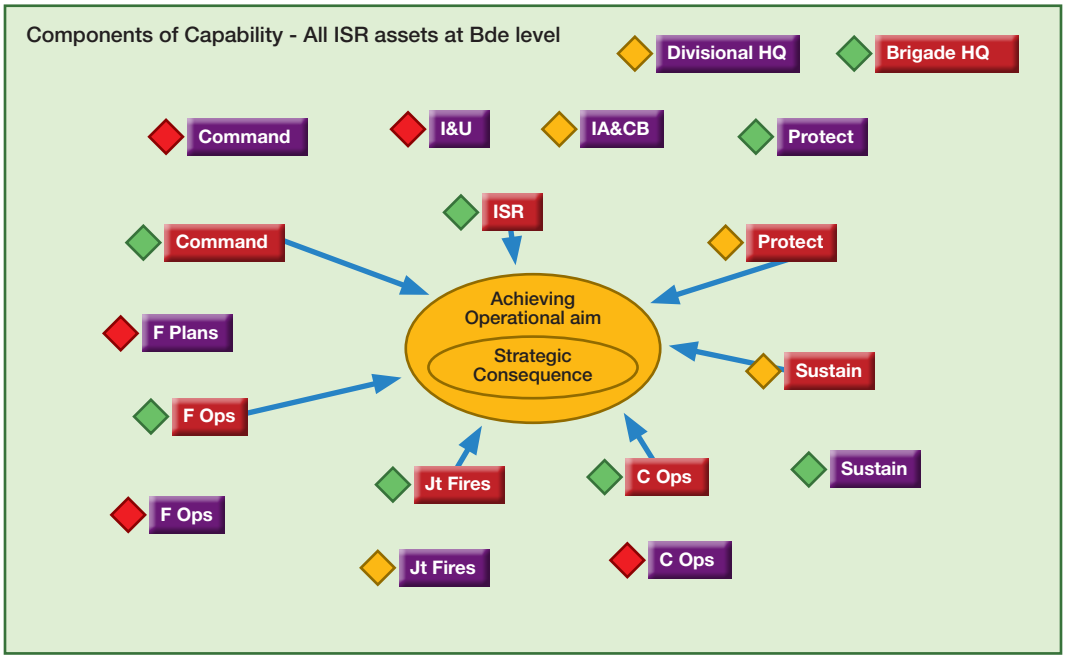


**Figure 32: C2 of ISR - All ISR assets at Bde**

**Step 6: Understand the strategic consequences of military capability.**

The strategic consequences of the ISR arrangement where ISR assets are held at Bde are assessed as amber. The potential for disconnect between the Bde plan and the Divisional Commander's strategic intent, relationship and liaising with the other nation forces and agencies is moderate to high depending on the communications and information systems between the two headquarters. Consequently the risk of misalignment, duplication, loss of opportunity or tempo could be high. Against the strategic objective of 'Secure and consolidate the NATO achievements and successes to date in deterring, defeating and expelling Minarian and Arianian forces from Atropia' the co-ordination of ISR to affect Minarian and Arianian forces impacts more tactically and does not support the strategic objectives sufficiently.

The co-ordination of ISR has reduced the likelihood of civilians being targeted but the potential for confusion increases and the Brigade activities may overlap with other agencies in the operational area. Such confusion could lead to inappropriate/ inaccurate targeting. This has a substantial effect effect on the attitude of the Atropians but not UN, Legal or UK support.

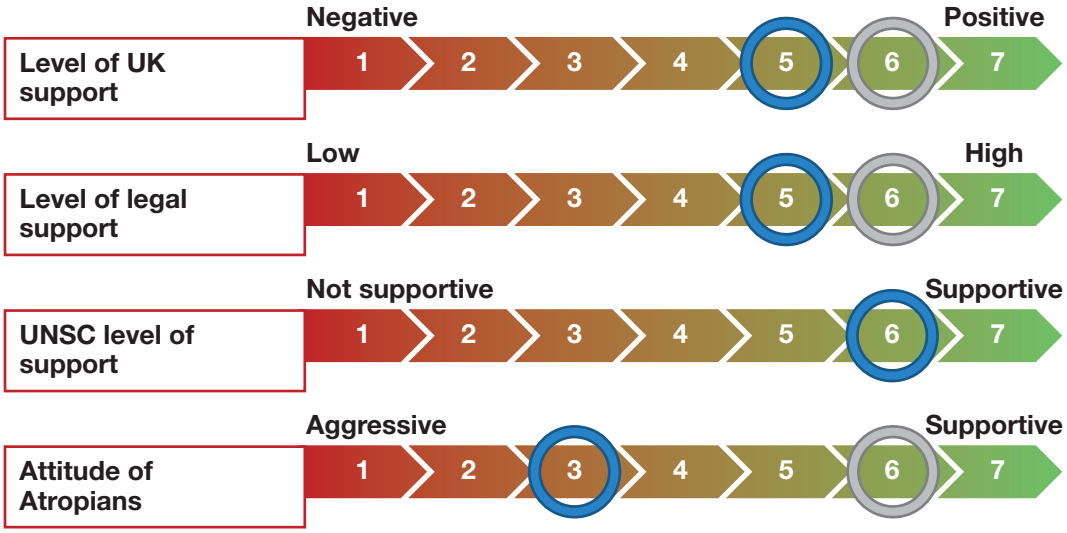


**Figure 33: C2 of ISR - Attitude of UK, legal, UN and Atropian – Intervention option B**

### 2.4 ISR Coherence example - summary

This example focused on a specific problem area – that of ISR coherence. It looks at both the Divisional and Brigade HQ organisational cells and examines the impact of different degrees of allocation of ISR assets. From the assessment the middle ground – partial allocation of assets to Bde – seems to provide the Bde with some comfort and directed protection at the same time as supporting the Divisional HQ objectives and strategic intent. Rather than displaying change indicators with reference to the baseline in the capability diagrams as in the previous example, in this particular example it is worth viewing each option – baseline, intervention A and B and understanding their relative merits.

A summary of the three project metrics of Tempo, Information Superiority and Agility is provided in Table 9. The summary highlights the positive and negative aspects of each option. As for the other forms of analysis, there are benefits from adopting a Div focused ISR approach particularly for the Div. Equally there are benefits for adopting an approach that holds ISR assets at the local level. The summary table complements the other assessments of the intervention and highlights the wide range of factors that need to be considered.

The HCSIE approach has been used to illustrate how actions on a complex system are likely to play out in a particular scenario context drawing from the exercise scenario and DATE information. Aspects of the example are speculative and represent a considerably

simplified analysis of the military and strategic considerations to illustrate the way in which the approach could be applied. For example, the nature of the communications is not focused upon in the comparison of interventions, nor is the access to information and intelligence (although highlighted in Table 9). Similarly for the impact of the Division HQ and Brigade HQ locations: ISR assets are harder to re-assign to another unit if allocated to a Brigade that is dispersed. For a more detailed assessment that is more closely tied to the scenario, a wargame with appropriate participants is recommended.

**Table 9: C2 of ISR Summary of Tempo, Information Superiority and Agility**

| | Tempo | |
|---|---|---|
| | Div | Bde |
| Option A: Assets under Div control | Larger force + HQ to sustain, so Div move likely slower. | No guarantee of quick access to ISR collect assets in accordance with Bde priorities. Totally reliant on Bde/Div comms. |
| | Short command links to sensors shorten timelines. | Bde can fight light without concern over Sustainment/Force Protection or Movement of ISR assets. |
| Option B: Some assets available to Bde or through Div | Ties up Div HQ staff as Bde<>Asset 'relays'. | Provides benefits of assess without support overheads. Supports high-tempo execution of key missions. |
| Option C: Assets under Bde control | Div somewhat lighter but still slow. | More HQ and ground forces to move, sustain, and protect. |
| | Information Superiority | |
| | Div | Bde |
| Option A: Assets under Div control | Richest picture at Div level<br>Short command links to sensors. All info sources pass through Div, so Div has best opportunity feed ISR brain, analyse output and to conduct effective co-ordination. | Greatest risk of Bde I2 priorities being lost/ subordinated to Div priorities. |
| | Smoothing' effect of pooled assets against demand fom Div + Bdes - offers potential for most efficient use of assets. | But overall efficiences in I2 collect and analyse will offset the above. |
| Option B: Some assets available to Bde or through Div | Assets lost to Div planning, info collection plans impacted. | Supports ISR/Fires integration on key missions. |
| Option C: Assets under Bde control | Unless all data/I2 shared with Div (not practical over Bowman), risks incoherent Bde/Div understanding. | Best opportunity for Bde ISR/Fires integration. |
| | Agility | |
| | Div | Bde |
| Option A: Assets under Div control | Best ability to reallocate assets in response to changing overall priorities (no need to move support/control systems). Best opportunity to coordinate ISR collect tactics (cross-cue, massing, layering, etc). | Mimises ability to fight light. |
| Option B: Some assets available to Bde through Div | Reduced overall efficency of asset use. | Offers a combination of direct Bde tactical control and agile asset allocation. |
| | | Resilient C2 arrangement in the face of losses/ changing plans. |
| Option C: Assets under Bde control | | Vulnerable to asset loss/failure. |
| | | Resilient to comms failures between Div and Bde. |

## About the authors

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