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The representation of stabilisation operations at the tactical level

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This is a review of work we completed last year for Dstl under the DHCSTC contract last year. – Colin did the hard work and I have the honour of presenting it.

During Op Herrick the Land and Logistics Domain of Dstl considered the development of an analytical capability for stabilisation operations as one of its top priorities.

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- "The development of a toolset to help analysts understand the impact of military activities on the important characteristics of stabilisation operations at the tactical level"

- Some of the challenges of representing stab ops
- How we went about meeting the challenges –
  - The approach and tools we adopted
- The proof of the pudding –
  - some example outputs presented at an evaluation event at the end of the project
- Some findings

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The research requirement was simply stated as:

"The development of a toolset to help analysts understand the impact of military activities on the important characteristics of stabilisation operations at the tactical level"

As we shall see, to meet this requirement we needed to bring together an international rainbow team and construct a multi-method hybrid analysis approach.

This paper presents our investigation and demonstration of this hybrid approach.

I shall cover

- Some of the challenges of representing stab ops
- How we went about meeting the challenges –
  - The approach and tools we adopted
- The proof of the pudding –
  - some example outputs presented at an evaluation event at the end of the project
- Some findings

What was the start point for the work?

Dstl needed a way of understanding how short term kinetic "flash and bang" military operations affect longer term "influence and relationships" stabilisation operations, which rely on multiple agencies to deliver over a long timescale. These Stab Ops have characteristics that distinguish them from other types of Op – as shown here.

Dstl had previously tried to use PSOM, and looked at the US TRAC IW (irregular Warfare) approach. Neither satisfied the requirement - PSOM is too high-level (country-wide generally) for Tactical Ops; TRAC IW is too manpower-intensive.

Dstl also tried the discrete event simulation route – STOAT – but there were three significant challenges:

- How to derive a generic set of rules that can be encapsulated in a software tool
- How to represent the different timescales over which kinetic and non kinetic effects of military action are realised
- How to generate a cost-efficient analysis approach.

So Dstl concluded that designing a single generalizable, tractable rules-based software model to represent all aspects of stabilisation operations in all contexts was not feasible. This is due to the large number of variables that are driven by situational dependences

Dstl decided that a new approach was needed which would

- Exploit existing tools to minimise costs
- Revisit the formulation of a set of rules for stab ops
- Use a "reasonable" amount of effort to generate and populate the tools So this work was initiated to identify what that rule set should look like; We quickly determined that it depends – the rule sets are highly context dependent.

Ends – what were we aiming to do?

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- Represent the impact of tactical combat operations in a stabilisation context, particularly the unexpected consequences and downstream impacts
- Allow repeatable, "what-if", analysis to generate a range of quantitative and qualitative outputs to inform decision making
- Produce a transparent and visible 'model' at the tactical level
- Impact of short term military kinetic action on long term stab ops
- Challenge:
  - Accommodate different timescale in a single approach
  - Accommodate influence and kinetic action in a single approach

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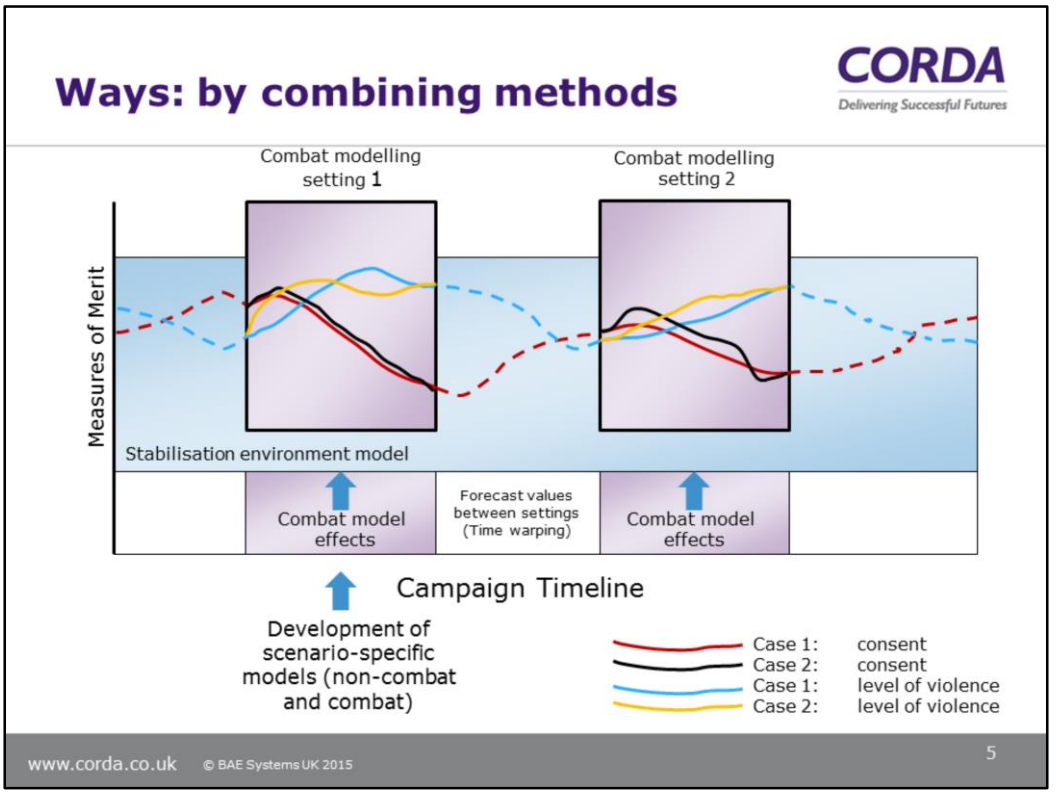
The Aim of the work was to design and assess the utility of an appropriate modelling approach for understanding the impact of combat activities on the stabilisation environment. This was to exploit existing tools – one to represent combat and one to represent the stabilisation environment.

Current combat models operate within their own kinetic bubble, with usually little consideration of how military actions may affect the stabilisation environment. Therefore, there is a need to develop an analytic capability that will assess the overall impact of military actions on elements of the stabilisation state space.

The requirement from Dstl could be paraphrased as
"how do we exploit existing tools to allow analysts to answer military planning questions in the context of a stab op?" – whist satisfying the challenges shown here.

Our initial work highlighted that the rules are highly context dependent, a single rule set is infeasible



This analytical approach should be able to address factors appropriate to a stabilisation operation such as the Geography; Economy; Politics; Criminality; Own forces (light and heavy); Other forces and Key parties, such as insurgents, local government troops, local officials, like state governors

The approach needs to determine values such as

- impact on relevant factions;
- their relationships with each other;
- impact on the current state of governance;
- economic state; and
- levels of security.

This slide shows Dstl's vision for a hybrid approach, with connected combat and non combat tools. The combat would cover largely hard factors over a short period (hours); the non-combat would assess the soft factors over a longer time scale – months. Certain measures would carry across the two.

Some of the measures available from the output of the stabilisation tool could be used to feed the start conditions for the combat tool, which in turn would generate outputs to "reseed" the stabilisation tools, and so on.
Note that the timeline on this slide is not to scale – the "time warping" refers to the much shorter durations of the combat compared to the stabilisation.

Means: the approach used

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- A hybrid modelling approach
- Multi method – semi quantitative
- Combination of tools – SIMBAT and MARVEL
- Scenario to demonstrate – fictitious African setting
- Process – Using subject matter experts from across academia, industry, OGDs and NGOs to build a stabilisation theory of change at the tactical level

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We designed an approach combining a stochastic combat simulation, the SIMple BATtlegroup model SIMBAT (developed by Dstl), with a deterministic system dynamics model of a stabilisation environment, as built in MARVEL, the **M**ethod to **A**nalyse **R**elations and **V**ariables using **E**nriched **L**oops. This is a tool developed by TNO in the Netherlands (Netherlands Organisation for Applied Scientific Research.

These two tools were linked with a bespoke interface. The combination was used to represent a fictitious stabilisation situation in which multiple actors had a role to play, with the British Army being committed to a role as part of a coalition. The evolving situation required multiple kinetic interventions by a British force. The research considered the impact of different force mixes on the evolution of the situation – which I will describe later.

The Team

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- Dstl, BAE Systems CORDA, BAE Systems ATC, TNO, Cranfield University, Birmingham University, and NGO practitioners

Paul Pearce, Mark Taylor	Dstl
Colin Mason, Amanda Sibanda	CORDA
Andrew Leggatt, Hannah Blackford	ATC
Lorraine Dodd	Cranfield
Aletta Eikelboom, Tom Logtens	TNO
Stephanie Blair, Prof Andrew Rathmell; David Couzens	NGO/OGD
Chris Baber	Birmingham

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The team comprised a vast array of talent as shown –

Analysts – from Dstl, CORDA, the ATC and academia
Modellers, from Dstl , CORDA and TNO
Practitioners – from OGD and NGOs
Military – from Dstl and Army HQ

Introducing the tools - SIMBAT

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- SIMBAT is a stochastic tactical level operational analysis model
  - It models units (in terms of their 'sides', locations, status, etc.) and physical entities (e.g. buildings, etc.) and rules of engagement
  - Based on historical data and UK military doctrinal principles.
  - The model outputs data such as: rounds used, number killed and injured
  - Physical actors, objects and decision agents moving in physical space

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What existing tools did we use?

Why did we use SIMBAT?
SIMBAT – models actors executing combat activities, moving around a representative terrain, and interacting with other actors – in this instance land forces manoeuvring in rural and urban areas

SIMBAT was selected for this research by Dstl due to its low data requirement in comparison to other combat modelling tools available e.g. WISE and SIMBRIG. SIMBAT also has a history of usage within the maritime and land sectors due to the flexible nature of its functions. For example, it is not difficult to record new unit orders or to alter the Direct Fire Weapon Types.

The outputs from SIMBAT are also easy to interpret, and the time for post processing can be rather rapid. For this application, the model was set up to simulate a combat action that occurs over a period of six hours. The combination of SIMBAT and MARVEL allows the results of this short combat action on the longer term stability of a specific region to be modelled.

Introducing the tools - MARVEL

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- MARVEL is a system dynamics tool, used to model complex systems; highly applicable to stabilisation environments.
  - It models the direction, strength and speed of influence from one variable to another
  - Based on expert assessment (or can use historical data)
  - MARVEL outputs graphs showing relative changes in the system variables over time
  - Abstract variables influencing each other

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MARVEL: originates from the System Dynamics approach of modelling complex systems behaviour

MARVEL enables quick exploration of a problem structure in a Group Model Building setting.
It allows the dynamic responses to events to be simulated through the underlying causal structure

Building MARVEL models: Method used in this project

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Step 1: Problem analysis - Unravelling of problems and visualisation in qualitative MARVEL model with:

- Variables representing influence of important actors, factors and/or interventions
- Causal relation between these variables

Step 2: Quantifying the model

- Further defining causal relations between the variables
- SME's opinion on relative strength and speed of the relations

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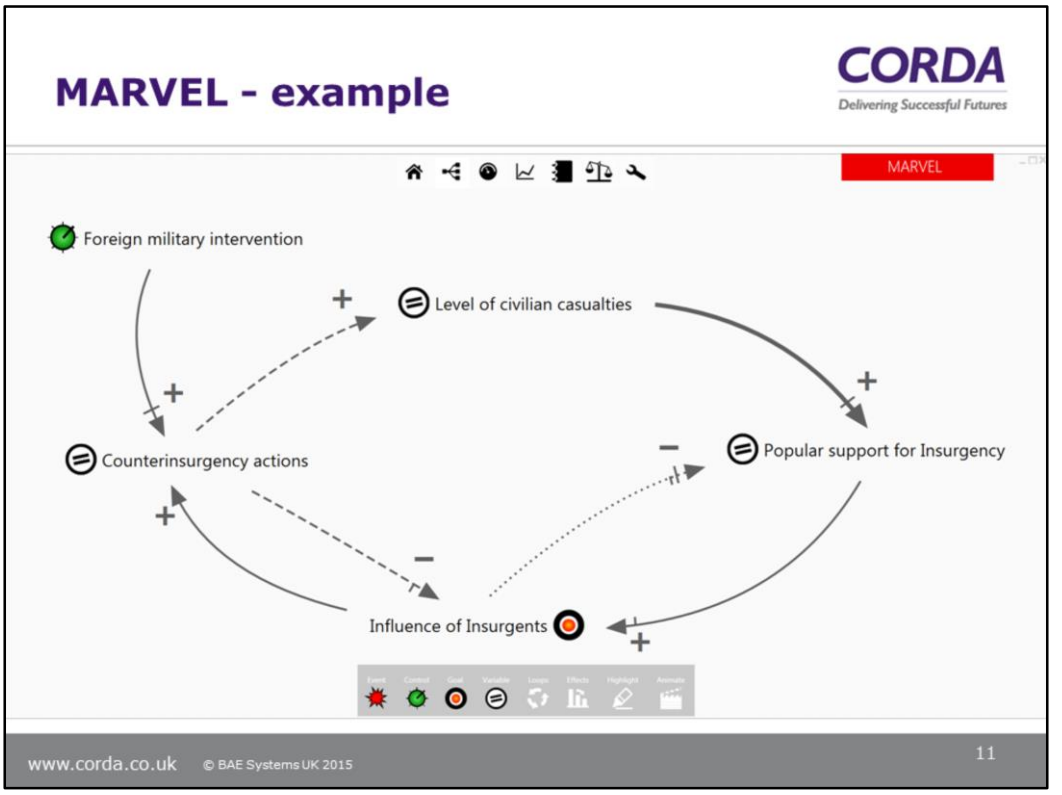
How did we use MARVEL to structure the problem?

The process for building a MARVEL model exploits facilitated expert judgement to construct and validate the representation of the real world. A set of experts with real experience debate and agree the actors, factors, variables and dependences which underpin the situation.

MARVEL integrates a selection of techniques in a novel way. It uses Group Model Building to capture the causal relations between factors identified by the experts forming the Group, and allows this collaborative problem structuring to feed directly into a simulation, using this three step process.

Step one is the facilitated creative process to identify all the elements, using the ubiquitous post it notes
Step 2 puts some quantification on the identified relations



HOW did the experts build relations using MARVEL?

A lot of the power of MARVEL is in examining how the loops and feedbacks changed as a result of changing the variables. This is something considered very important in developing the shared mental model and the buy in from the practitioners. Here we see examples of the loops that might be generated in this step.

The key in this step is identifying the polarity, strength and speed of the relations

Thickness of the arrow shows its strength
Ticks show its “speed” – the delay with which the effect materialises
Sign shows its polarity (up – up; up – down)

Example shows how the causal loops are built up, here we show a reinforcing loop and a balancing loop

The strengths are determined on relative scale (strong, medium , weak), and the speed on a pre -determined 5 point scale (less than a week, more than six months)

Building Marvel models: Method used in this project

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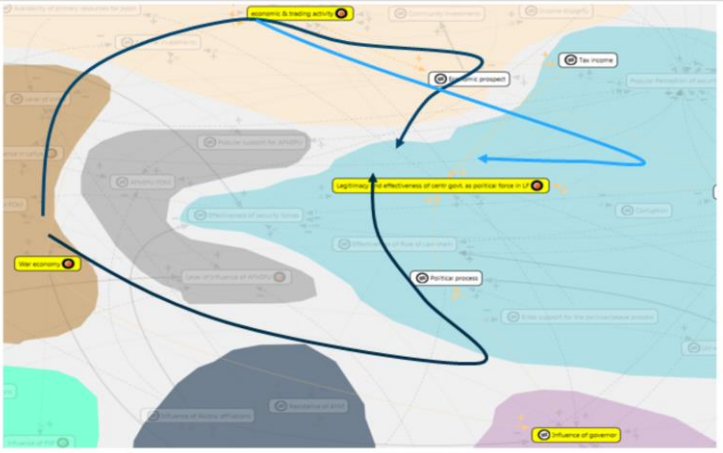


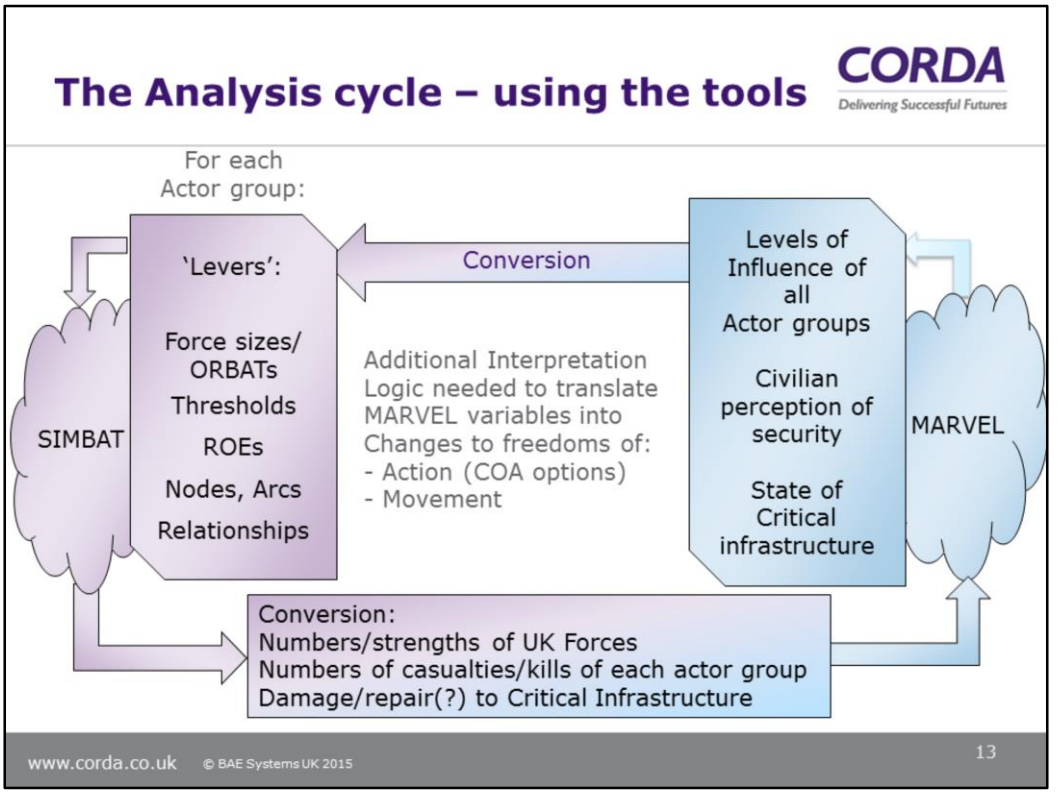
Step 3: Analysis of the model

- Fine-tuning through discussion on unexpected model outcomes resulting is a quantitative MARVEL model

Step 3 pulls it all together and fine tunes the outcomes
Shown here is part of the output representing the scenario – the fine tuning highlights some of the key relations, as illustrated

References for MARVEL

- Collaborative problem structuring using MARVEL; Veldhuis et al; European Journal of Decision Process; May 2015
- MARVEL – Principles of a method for semi-qualitative system behaviour and policy analysis; Van Zijderveld



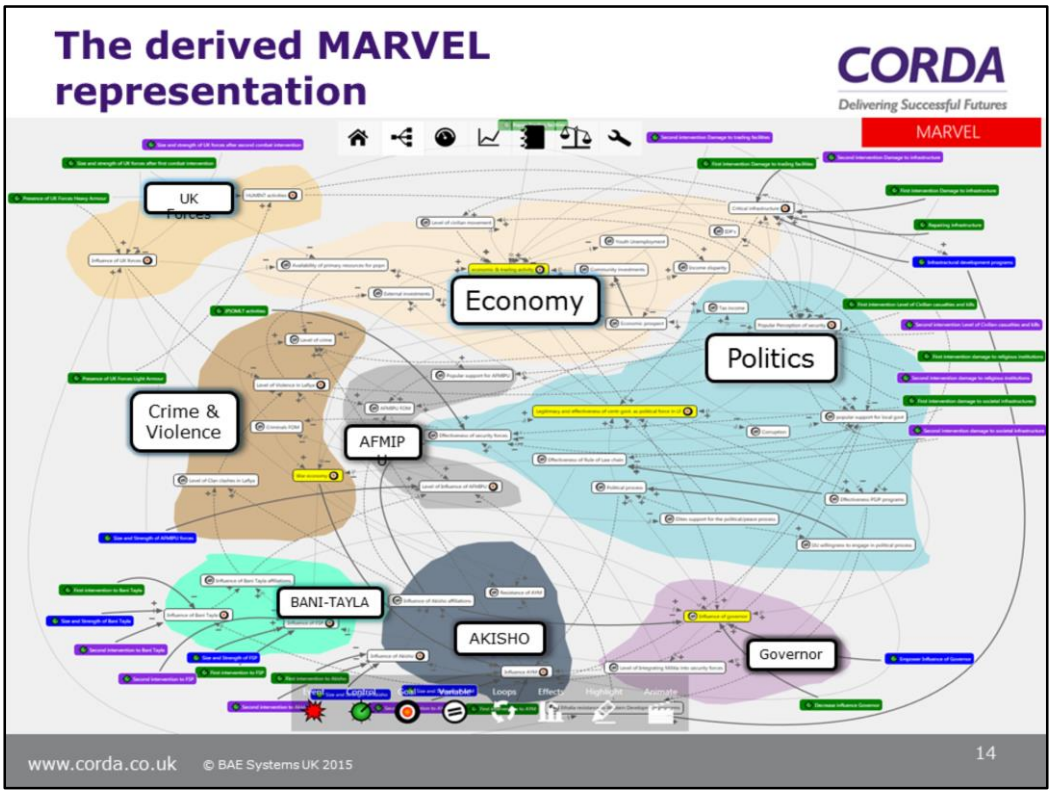
How did we combine the tools ?
So in summary, this is how we pulled together the multi –method approach

This diagram show the complete cycle for running the tools in series, and the method for converting outputs from one to inputs for the other.
Initial ideas for automating this process and simulating the military decision making in a rapid planning algorithm were soon abandoned – both for technical and philosophical reasons
These reasons and the challenges of the interface are sufficient for a presentation in their own right, In the end, we used subjective judgement to define how the commander makes the decisions based on the casualties and damage from the combat in the context of the prevailing Rules of Engagement.

The problem our experts were structuring was a fictitious failing African state, where insurgents were creating a breakaway region.

A number of insurgent parties are in conflict with each other and with the weak government, which has lost control. There is no security for the local populace, border controls are non–existent, there is economic stagnation, and inter-clan violence.
A number of attempts were made by the international community to stabilise the area through the deployment of various peace keeping forces. These interventions largely failed until the African Union (AU) established a mission, with UN authorisation and UK support.

The scenario for the SIMBAT model was created using data supplied by Dstl. The start conditions were adjusted to reflect the conditions from MARVEL.



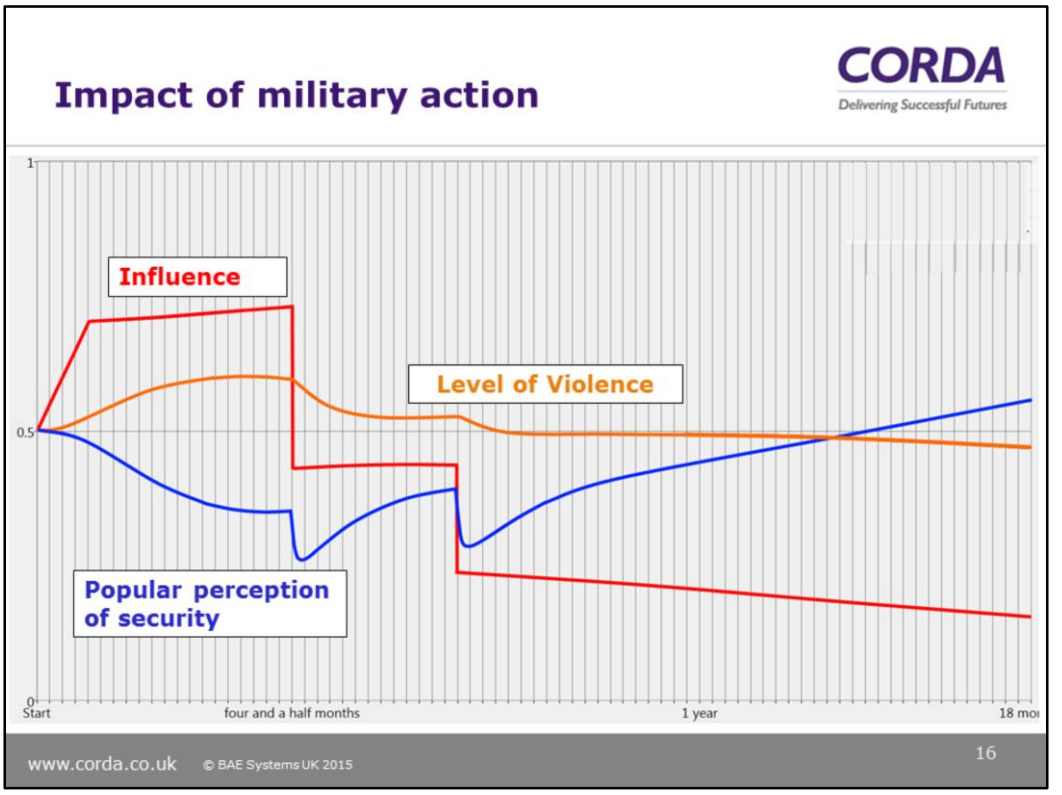
What was the output of the workshops?

This is the final MARVEL model overview of this situation.

The control variables are grouped around the outside of the chart – different colours represent different sets of controls.
For example the green ones are the control variables for the changes from the first combat spike from SIMBAT.
There are about 80 variables in the model as built, and the initial runs of the model highlighted a few as being core to several of the loops - These key variables identified by running the model are shown in yellow – the effectiveness of the central government, the war economy, the trading activity, and the influence of the local governor.

The different model variables are grouped in different sections, each represented by a "cloud" of a different colour.

The main sections are politics, the economy, and Crime & Violence. Other sections are variables attributed to the different actors in the system: UK forces, Insurgents, and African Union forces.



What happens if we deploy a light force?

This chart shows an example of an output, showing the impact of deploying the light force on the stabilisation environment.

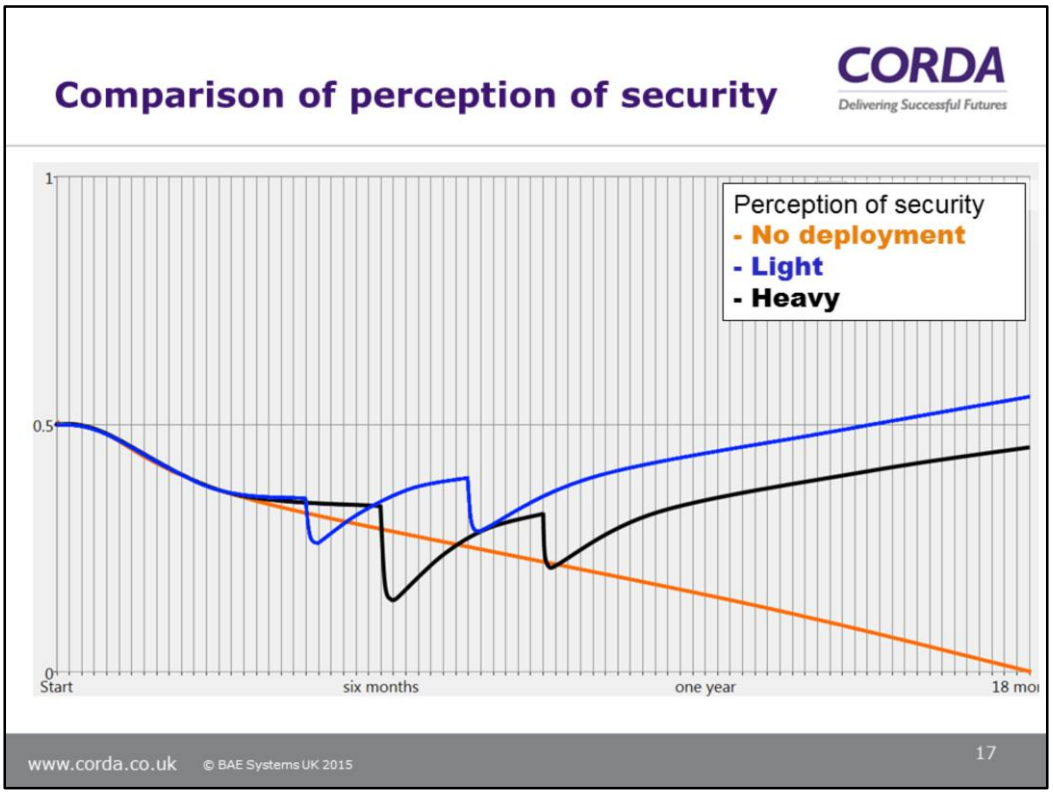
The values are expressed on a continuous range from 0 -1. It is the "Mode of behaviour" or trend that provides the insight, rather than the absolute value

The initial light force deployment (a Lead Commando Group) occurs at 4.5 months and the actual fighting lasts for a number of hours. The discontinuities are effectively where the SIMBAT runs are occurring. Note that these interventions were pre-set – they were not dependent on the state of variables in the tool

We see the popular perception of security (the blue line) declines rapidly at the time of the military intervention, but recovers after a few days. We see a similar effect with the second combat spike, and this leads to a continuing increase for the following year, eventually exceeding the start state.

After the second combat spike, the influence of the insurgents (shown as AYM on the red line on the chart) is very much decreased and keeps decreasing as other factors like economic activity and legitimacy of the government (not shown) increase.
The level of violence (orange line) also decreases to a value which is slightly below

the starting value. The combat action does not eliminate the insurgents, so they return to violent acts, but are more constrained.

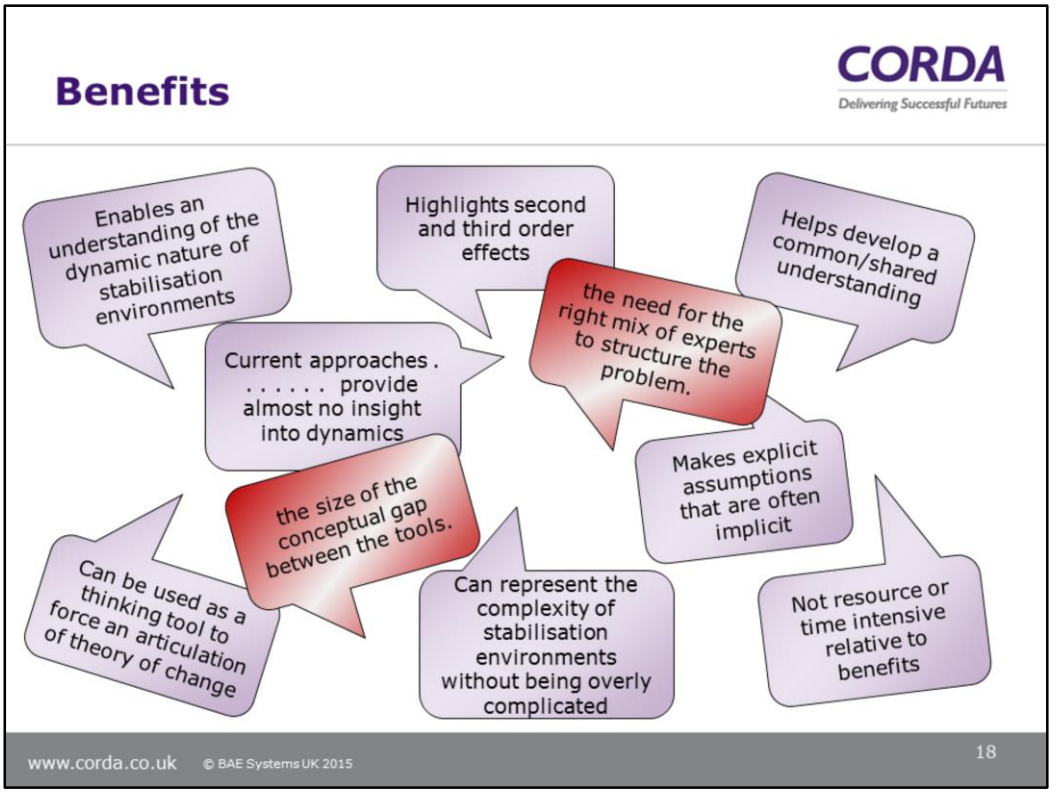


Comparison of force mixes

This charts compares the do nothing with the light and heavy forces, for the perception of security.
If you do nothing, the perception of security declines steadily, along with and economic activity and legitimacy of the government (not shown).

Deploying the light force has a more favourable impact than deploying the heavy force, mainly because it happens earlier, and it causes less damage to infrastructure and fewer civil casualties (not shown explicitly on the chart).

The heavy force engagements (Lead Armoured Task Group) occur at 6 months and 9 months, as it tasks longer to ready this force than the Lead Commando Group.



At the end of the research we conducted an evaluation event , with ten participants from Dstl and Army HQ, as a "validation". Some of their opinions are captured here (only the favourable ones!).
The general feeling was that the approach was a significant step forward. Participants felt that the approach produced output that was credible, with good insights into the effect of combat upon a stabilisation environment. The representation of this environment was felt to be an important advance, providing a potentially valuable contribution to the Dstl analysis toolkit.

Other benefits:

- Models and underlying structures are easy to build (and adapt) and easy to understand
- Detailed input data not necessary
- MARVEL's use of SMEs to build the model mitigates the lack of detail in some planning scenarios.
- The shared understanding of the situation would be very valuable in a real stabilisation planning setting;
- The opportunity to accommodate multiple perspectives of the problem – not just a military one;

Participants did note certain limitations too.:

- the size of the conceptual gap between the tools. This gap was considered difficult to bridge in an easily repeatable and scalable way.
- the need for the right mix of experts to structure the problem.

- The bespoke interface used was based more explicitly on SME judgement then on rules and algorithms as originally planned

Findings

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- The concept of combining a representation of combat with a representation of the stabilisation environment has been proven
- The approach provides the ability to undertake 'what if' analysis at a relatively low resource cost
- This research allows the fast and slow dynamics of the stabilisation situation to be represented
- Defining the model of the stabilisation situation is as useful as running the tools in generating insights
- Potentially useful for planners in theatre as well as the analysts
- Interfaces remain difficult – technically (s/w) and philosophically

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What do we know now that we did not before?

- We have developed a modelling approach that exploits existing tools
- We have developed an approach to generating rules for specific situations
- Our approach uses a "reasonable" amount of effort to generate and populate the tools So this work was initiated to identify what that rule set should look like

This hybrid modelling approach developed by the research works, but has some limitations.

The concept of combining a representation of combat with a representation of the stabilisation environment has been proven, although the interface between the tools selected for this research package was difficult. The approach provides the ability to explore the complexity of the environment during plan development and the ability to undertake 'what if' analysis at a relatively low resource cost.

This research provides Dstl with an analytical framework that exploits existing investment in combat models and tools, whilst allowing the fast and slow dynamics of the stabilisation situation to be represented.

The approach is transparent, with few elements, to permit easy access for scrutiny, ensuring that tailoring to scenarios does not involve significant software coding.

However, The interface between the tools used in this exercise remains problematical, especially translating between “hard” and “soft” values used in the tools.

Exploitation – where next?

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- MOD priorities are in a state of flux, and there remains a requirement to address analysis of Stabilisation Ops, Defence Engagement, and Influence Activities & Outreach
- MARVEL and the multi-method approach have application in other areas – perhaps as part of the planning process
- Analysis approach could be tested in a more stressing environment – on a real exercise, or to replicate historical events
- Further research into the interfaces between the tools
- Conflict prevention – how to prevent deterioration without combat

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How could it be used? How could it be improved?

This approach, combining tools and Group model building workshops, could be tested in a more stressing/real setting, possibly as part of a Multi-National Experiment (MNE) or reproducing a historical situation. This would allow both the development of the components of the toolset; and further testing and validation of the toolset.

In addition, the MARVEL part of the approach might be extended to other forms of influence activity and outreach , including persistent engagement

As well as being a research tool, consideration should be given to exploring the potential for exploiting the MARVEL model building process by tactical stabilisation practitioners (i.e. those involved 'on the ground' delivering stabilisation), and Influence Activities and Outreach (IA&O).

In the longer term, MARVEL could be exploited more generally. It might be used to support other MoD and Government units like DFID's Stabilisation Unit

Further research into the linkage between the models would be worthwhile,

And extending it to look at the trigger points for combat, and how deterioration could be prevented

If you have been, thank you for listening.

Questions?