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Using your BRAIN to get beyond “It Depends”

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INCOSE International Symposium 2020

Agenda

Origins

- BRAIN

Application

- Case Study #1: Robotic Unmanned Systems Technology Research
- Indicators of an Unconstrained Problem Space
- Using BRAIN to Explore and Assess Concepts

Expansion

- Getting Past “It Depends”
- Case Study #2: Persistent Wide Area Messaging Capability Definition
- The Combined Approach

Conclusions & Reflections

Origins

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BRAIN – Inspiration from an Unexpected Source

A tool for parents to use to do risk assessment on proposed medical interventions during childbirth:

Benefits

Risks

Alternatives

Issues

(Do) **N**othing

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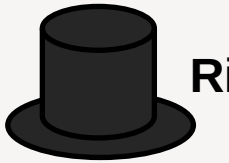
If the Hat Fits …

The BRAIN categories map reasonably well onto De Bono's Six Thinking Hats (which also comes from a healthcare background)

Benefits

Symbolizes brightness and optimism. Under this hat you explore the positives and probe for value and benefit



Risks

Judgment - why something may not work. Spot the difficulties and dangers; where things might go wrong

Alternatives

Focuses on creativity; the possibilities, alternatives, and new ideas

Issues

Signifies feelings, hunches and intuition

(Do) **N**othing

Calls for information known or needed.

BRAIN method

Used to manage the thinking process

Definitions taken from www.debonogroup.com/six_thinking_hats.php

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Application

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Case Study #1 “We don’t want to constrain your thinking”

Contracted to deliver a pair of research studies into future (2035+) unmanned concepts to be employed in the Land environment

At the kick-off meeting, the client declared that there were no bounding scenarios, and that we should take a broad interpretation of any pre-existing concepts – we were free to explore our own paths

The aim was to deliver recommendations for a science & technology research programme into unmanned autonomous robotic systems for the British Army

Where, or indeed how, to start?

Indicators of an Unconstrained Problem Space

Indicators that you're dealing with an unconstrained problem space include:

- Vaguely defined mission/objectives
- More questions than answers
- Desire for novel and innovative capabilities
- Assessing future concepts beyond the "near future"
- Dependent on an unclear/undefined/uncertain wider enterprise

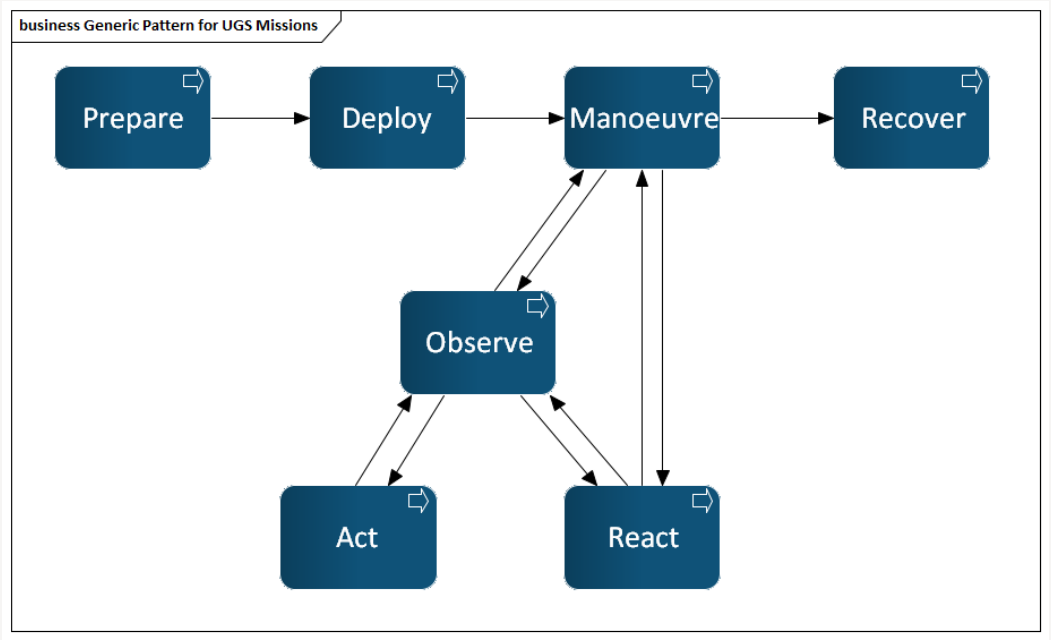
Sometimes you just need to apply your own constraints… and your brain.

Concept Definition – use common building blocks

Concepts were defined using a common approach, consisting of one or more **autonomous elements**, with some form of **human element** for preparation, deployment & recovery and to provide command and control purposes using some form of C4I suite whilst they are in mission

Autonomous elements consist of a **platform** and a **payload**, and can perform a number of use cases in each operational phase

The **platform** consists of subsystems to provide mobility & power, and structural elements to provide capacity & survivability



Common pattern for in-mission processes

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Framing the Relevant Military Problem Space

UK Land Doctrine provides a set of useful definitions:

Types of operations (of varying intensity from warfighting to non-combatant evacuation or other forms of assistance) and the **operational framework** of activities (shaping, decisive action, sustain, protect)

Military tasks are situated against these to identify a suitable set of candidates to investigate further

Impractical to cover everything

		Warfighting	Intervention	COIN	Stabilisation	NEO
		Decreasing Intensity →				
Shape		1. OP Matrix 2. Screening 3. Recce in force 4. Route Recce 5. Obstacle Recce 6. Wet Gap Recce 7. Beach Survey 8. Riverine Recce 9. Secure POE/POD 10. Close Target Recce 11. CBRN Recce	2. Screening 3. Recce in force 4. Route Recce 5. Obstacle Recce 6. Wet Gap Recce 7. Beach Survey 8. Riverine Recce 9. Secure POE/POD 10. Close Target Recce 11. CBRN Recce 12. ESM SIGINT	4. Route Recce 5. Obstacle Recce 6. Wet Gap Recce 8. Riverine Recce 9. Secure POE/POD 10. Close Target Recce 11. CBRN Recce 12. ESM SIGINT 13. ISTAR Soak	4. Route Recce 5. Obstacle Recce 6. Wet Gap Recce 9. Secure POE/POD 12. ESM SIGINT 13. ISTAR Soak 14. Framework Patrol (+ KLE) 15. Movement Control (checkpoints etc)	4. Route Recce 5. Obstacle Recce 6. Wet Gap Recce 8. Riverine Recce 9. Secure POE/POD 12. ESM SIGINT 13. ISTAR Soak
Decisive Action		16. Attack 17. Delay 18. Urban Attack 19. Obstacle Crossing 20. Wet Gap Crossing 21. Amphibious Assault 22. Air Manoeuvre Asslt 23. Riverine Landing 24. Link-Up 25. BDA (part of F3EA) 26. Electronic Attack	16. Attack 18. Urban Attack 19. Obstacle Crossing 20. Wet Gap Crossing 21. Amphibious Assault 22. Air Manoeuvre Asslt 23. Riverine Landing 24. Link-Up 25. BDA (part of F3EA) 26. Electronic Attack	18. Urban Attack 19. Obstacle Crossing 20. Wet Gap Crossing 22. Air Manoeuvre Assault 23. Riverine Landing 25. BDA (part of F3EA) 26. Electronic Attack 27. Framework Patrol 28. Raid / Strike 29. Ambush	22. Air Manoeuvre Assault 25. BDA (part of F3EA) 26. ECM Attack 27. Framework Patrol 28. Raid / Strike 30. Cordon & Arrest 31. Public Order 32. Border Security 33. Restoration of Infrastructure	26. Electronic Attack 28. Raid / Strike 34. Evacuation of Non-Combatants
		Some tasks recur across the grid in different operational contexts				
Sustain	Enablers	35. Convoy 36. CASEVAC 37. Rebro Station 38. Logisitic Re-supply	35. Convoy 36. CASEVAC 37. Rebro Station 38. Logisitic Re-supply	37. Rebro Station 38. Logisitic Re-supply 39. Combat Logistics Patrol	37. Rebro Station 38. Logisitic Re-supply 39. Combat Logistics Patrol	36. CASEVAC 37. Rebro Station 38. Logisitic Re-supply
Protect	Enablers	40. Rear/Flank Security 41. Route Security 42. Air Defence 43. Counter Sniper 44. Counter UAV	40. Rear/Flank Security 41. Route Security 42. Air Defence 43. Counter Sniper 44. Counter UAV	41. Route Security 43. Counter Sniper 44. Counter UAV 45. FOB/PB Security 46. VA/VP Security	41. Route Security 43. Counter Sniper 44. Counter UAV 45. FOB/PB Security 46. VA/VP Security	41. Route Security 42. Air Defence 43. Counter Sniper 44. Counter UAV

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Example Vignette – Robot ‘Gundogs’ supporting close target reconnaissance

Based on MODAF OV-1a

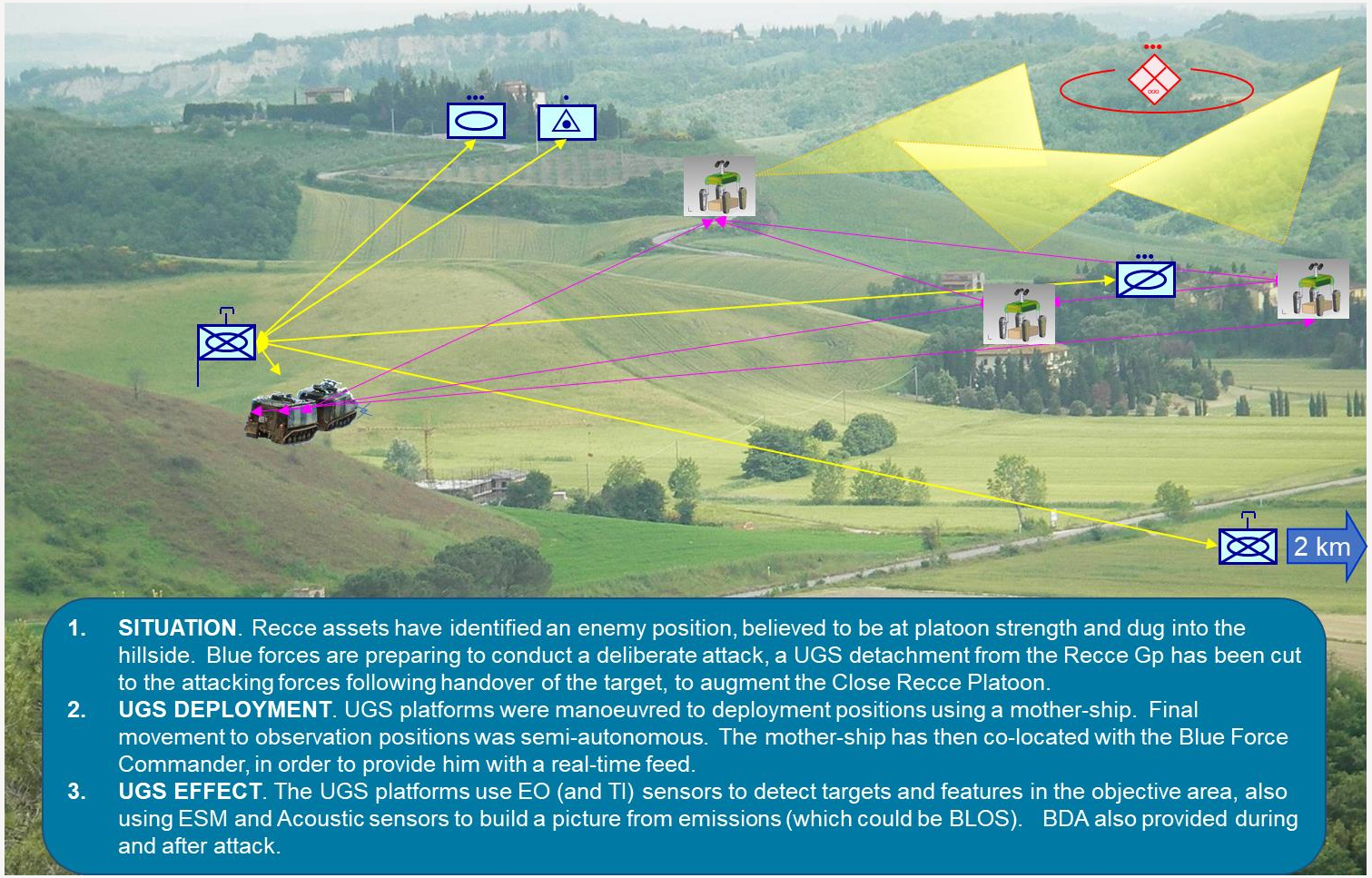
Concepts shown using graphical visualisations

Supporting elements using military symbols

Comms links and effects shown to aid the reader

Real photos used as backgrounds where possible

Description covers Situation, Deployment and Effect for the unmanned ground system (UGS) concept



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Example BRAIN Assessment

Benefits

- Able to reach parts of the battlefield that other traditional platforms cannot reach
- Able to remain “on-station” continuously without a need for comfort breaks etc
- Able to remain in place following hand-over of command
- Provides a richer sensor feed on target activities & dispositions

Risks

- The UGS may expose itself when manoeuvring into position, and hence give away the blue force intentions
- The UGS may get stuck when manoeuvring across broken or complex terrain, and required assistance or recovery from human elements
- Command and control signals from mother-ship to UGSs may be detected, giving away blue force intentions

Alternatives

- Could use ESM and Acoustic sensors to pick up enemy depth positions which cannot be seen from observation points
- Could use UAVs instead to provide sensor feeds
- Could use a second pack of “Gundogs” to provide sufficient communication nodes to enable an ad-hoc mesh network to form between the UGSs and the mother-ship
- Could use adaptive concealment techniques to avoid optical detection

Issues

- Difficult to develop a sense of “self-awareness” and “situational awareness” for autonomous platforms that would enable them to hunt and hide effectively
- Robots are good at getting stuck and getting lost, particularly in terrain that has not been mapped for them in advance. Self-localisation and mapping will be needed
- Energy density and power density characteristics of the batteries will limit the available time for manoeuvre and observation activities

Do Nothing

- The advanced recce force would need to stay in place and conduct a traditional handover to a close recce force, rather than being able to leave UGS assets in place
- Less exposure to risk at the operational level from “smart” platforms doing unintentionally dumb things

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Using BRAIN to Explore and Assess Concepts

Benefits indicate how suitable the concept might be within the confines of that vignette.

› These may change as you step forwards and backwards along the timeline for the overall task, or step across to use the same concept in other related tasks, indicating where the sweet spot may lie.

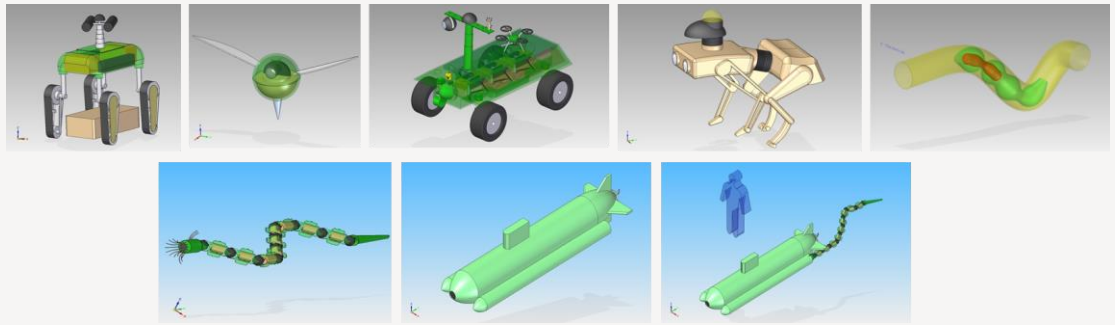
Risks, Alternatives and Issues play two key roles:

› Drivers for innovation – Can this be done differently? Could a different concept achieve similar effects?

› Discovery and assessment of blockers – is it a fundamental blocker or an opportunity for long-term research?

Do Nothing helps establish the baseline case

Iteration is essential to generate and test new ideas and concepts



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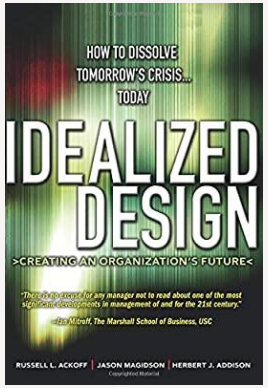
Russell Ackoff – Principles of Idealized Design

1. Keep constantly in mind that the current system (object or process) was destroyed last night

[In other words, don't anchor yourself in present solutions – think of something new]

2. Focus on what you would like to have if you could have whatever you want ideally, not on what you do not want
3. Don't worry about the availability of resources required to implement what you want or whether it is even possible to implement it
4. If you disagree with someone else's design idea, do not criticize it; improve on it
5. Keep the system's larger containing system intact during the initial design



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Expansion

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Getting Past “It Depends”

How often have you shown an end-user a set of architecture views and asked them for validation, only to get the answer “well it depends …”?

Some ways out of this:

Use recognised patterns

- Understand, Decide, Detect, Deliver, Assess (UD3A); Find, Fix, Finish, Exploit, Analyse (F3EA); Plan, Review, Execute, Evaluate (PREE), Plan, Source, Make, Deliver, Return, Enable (Supply-Chain Operation Reference model)

Understand the parameters which the answer might depend upon… and then play with them

- Identify potential configurations for the system-of-interest and the wider enterprise
- Identify potentially relevant operational scenarios (including intensity, phase and location)
- Identify effects and targets
- Identify classes of technical solutions

Follow the loops around the wider systems-of-systems

~80% of processes will probably turn out to be common regardless of the situation

Case Study #2 “Don’t Shoot the Messenger”

A set of user (stakeholder) requirements was needed for a new capability that would deliver a suite of tools that could be used by the Army, Royal Navy or Royal Air Force to deliver persistent wide-area messaging within an area of operations

The project had been bouncing around for a while

- It did not neatly fit into any particular part of the UK MOD acquisition delivery organization
- There were some very diverse and polarised views on what might be needed

Various solutions were already in use, including mobile radio stations, billboard campaigns, and targeted cyber-based influence operations

Needed an approach to bring all of the potential messaging channels into a single analysis, whilst recognising the need for continuous technology evolution

Critically, this was part of a wider system-of-systems and would consist of a wide variety of disjoint elements hosted by other systems, with many interdependencies

Expansion to the previous approach

Defining a capability rather than a set of technology concepts

Scenario/Task/Vignette approach still valid, but more variation in desired effects

Need to consider impact of messages on Audiences, Actors and Adversaries

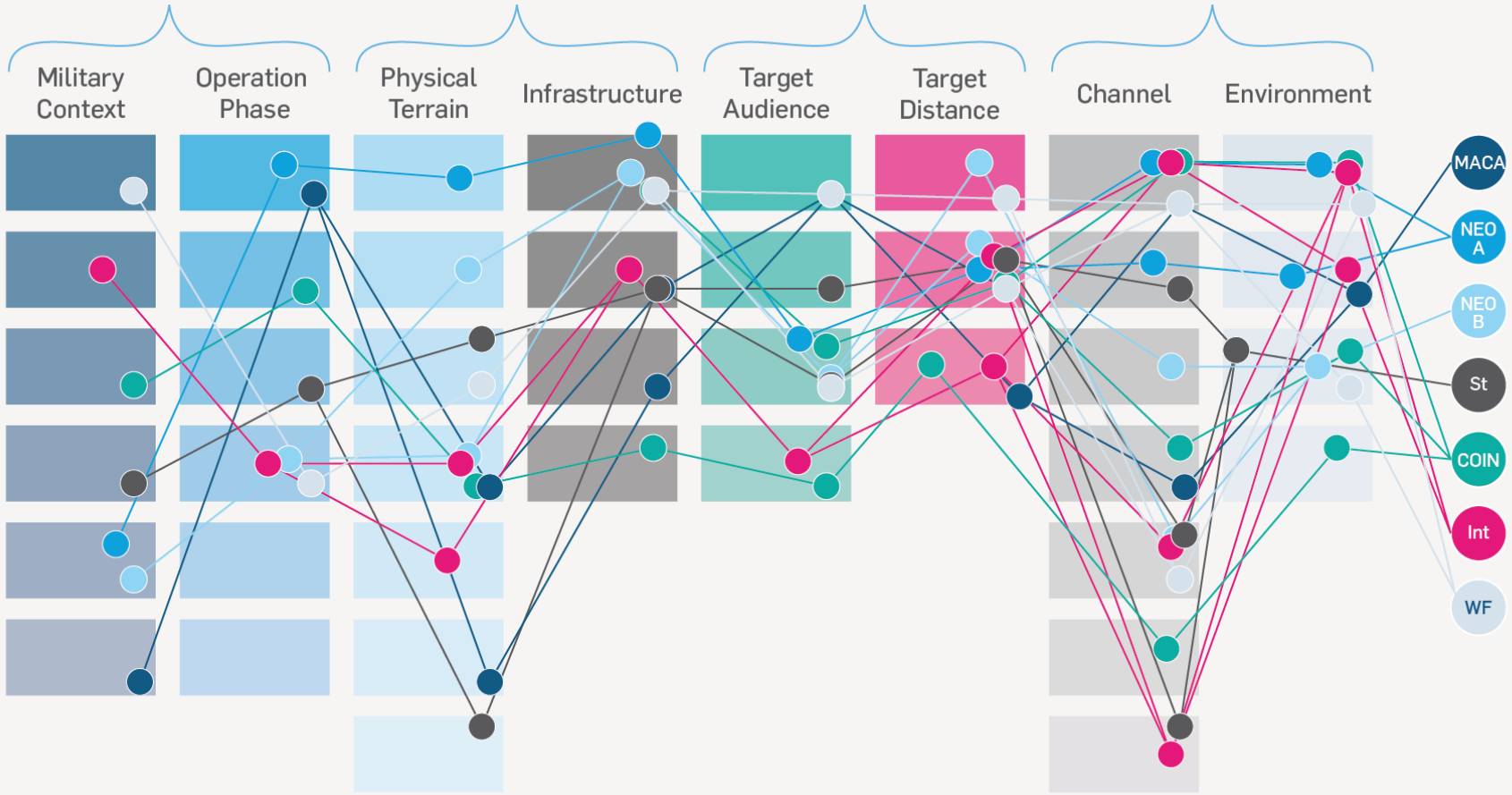
Dependencies on peer systems and host platforms within a system-of-systems

Quite a few more parameters to explore…

Using Parameters to Characterise Vignettes

Combination of parameters relating to the scenario, the mission and the concept

Intent was to cover each valid point in the parameter set at least once with a feasible vignette, whilst exploring the full range of potential system options



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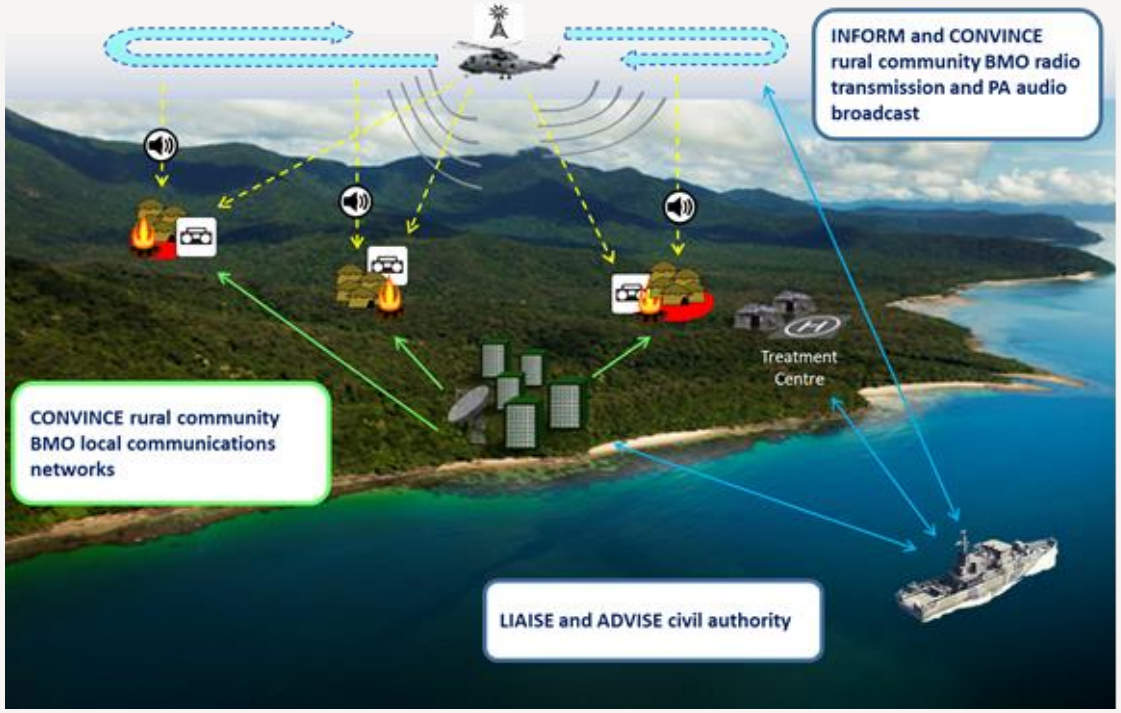
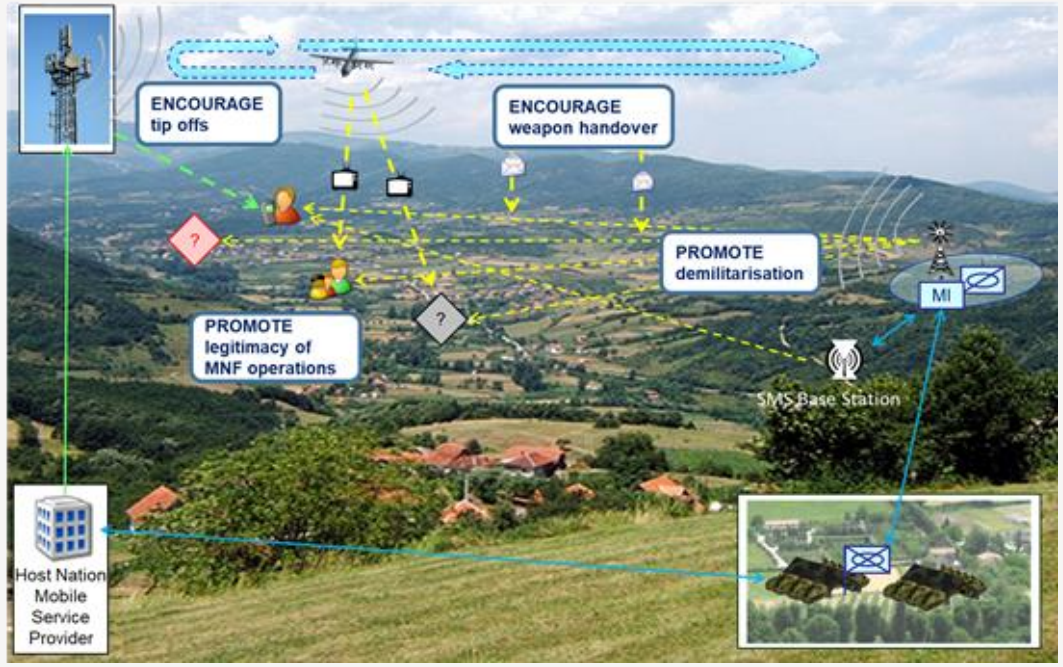
Example Vignettes for the Messaging Capability



Humanitarian Aid & Disaster Relief



Stabilisation

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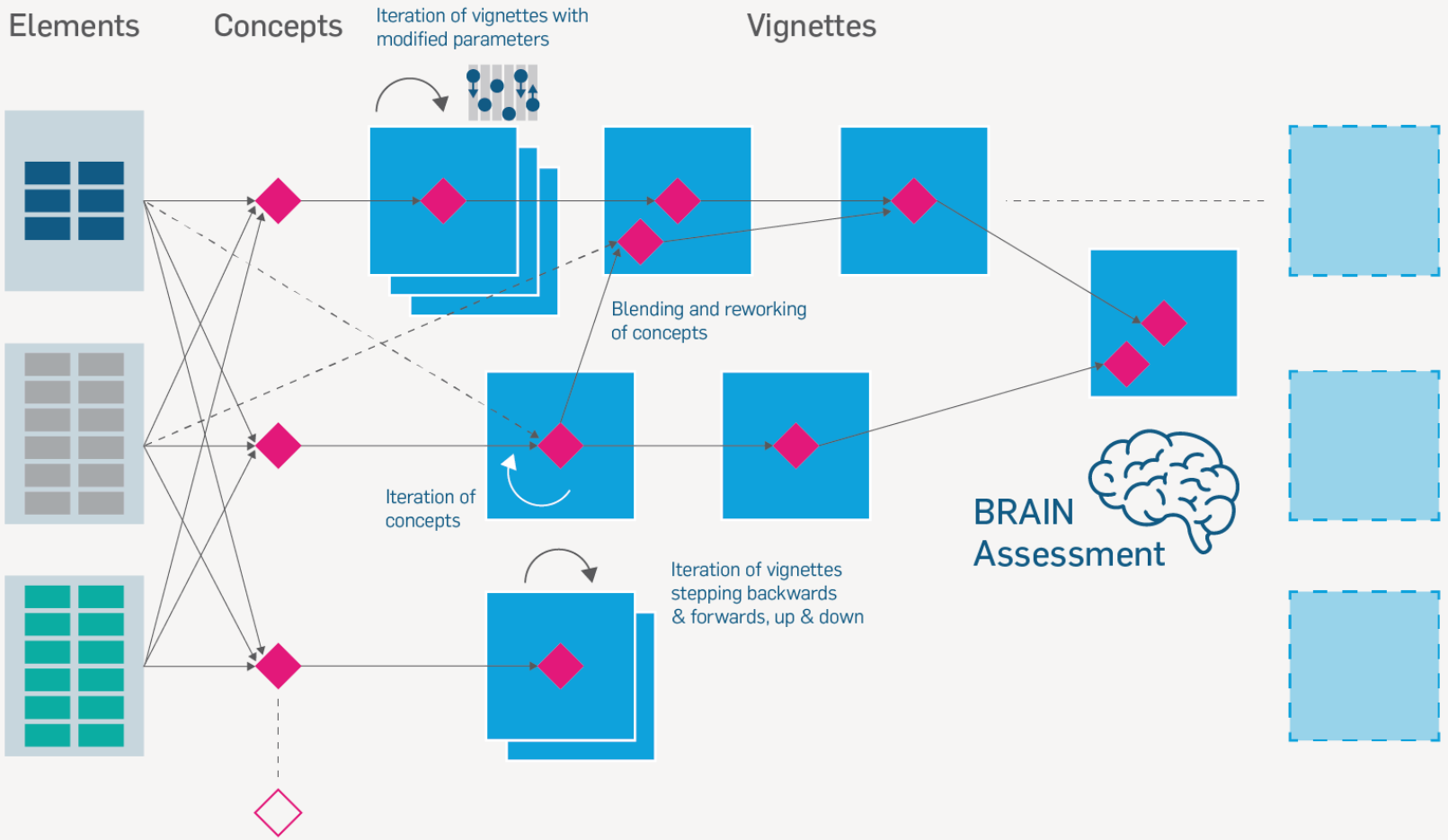
Using BRAIN in a Combined Approach



These concepts can then be used in stakeholder validation exercises (e.g. workshops) to understand how they align to current tasks & missions, and to explore the appetite for innovative or disruptive approaches

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More than a set of Dependencies

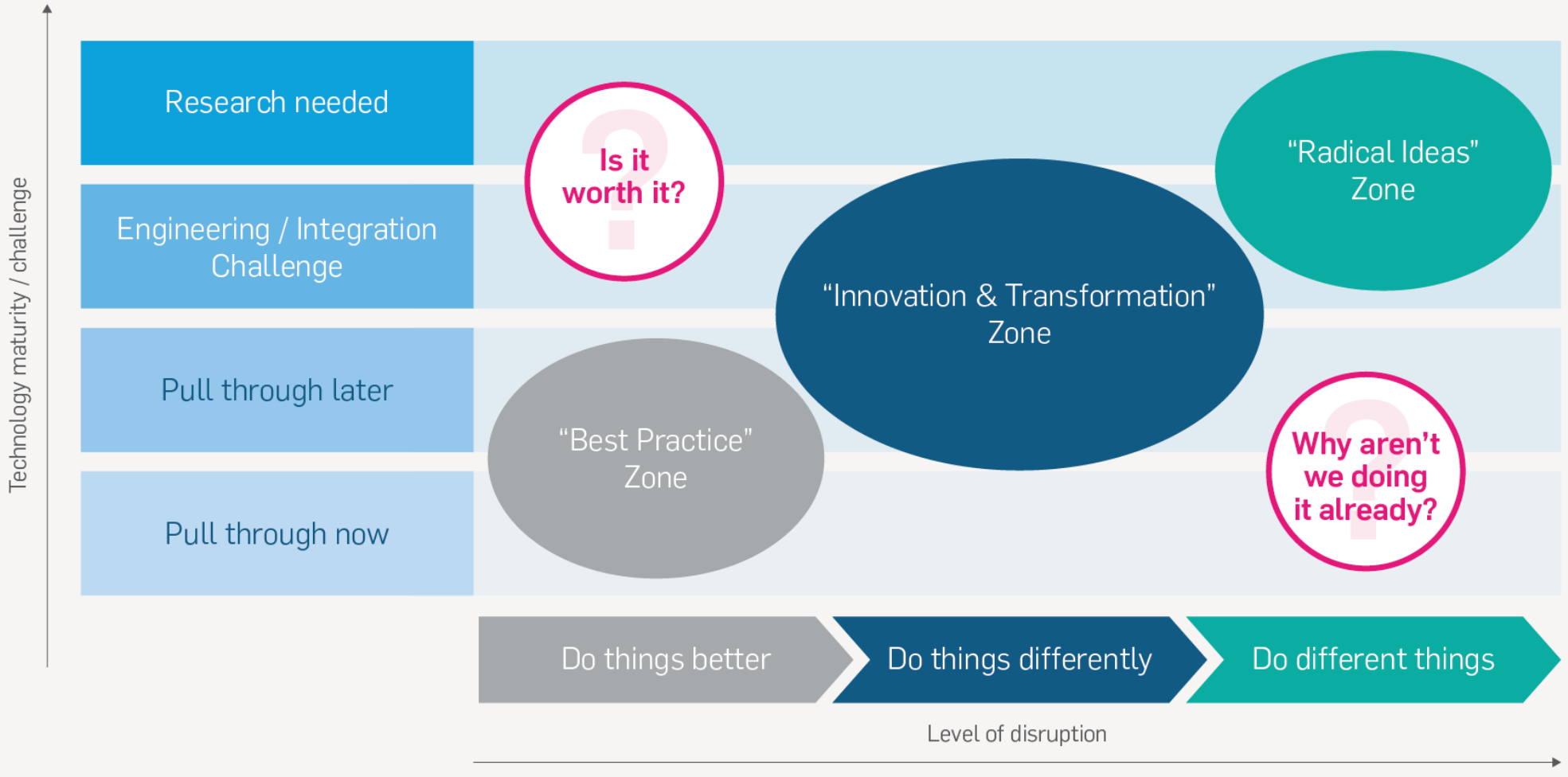
The output of this approach will be a set of concepts, built using a variety of system elements, which will be valid within a set of defined tasks & missions

But it can also deliver much more:

- A set of underpinning enterprise use cases
- A set of dependencies into the wider systems-of-systems
- A set of bounding assumptions, risks and issues
- A set of technology trees which can be used for TRL assessment and roadmapping
- An understanding of where the interesting edge conditions are for the capability (the “it depends” aspects)
- An initial set of qualitative benefits
- A sense of user appetite for innovation and disruption

You can even explore how to do things differently to get to the future…

From Innovative Concepts to Disruptive Capabilities



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Conclusions & Reflections

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Conclusions

Both the scenario framing and BRAIN assessment techniques can be used to good effect by themselves. The scenario framing approach has been observed to offer these benefits:

- Identifies the scenarios that need to be modelled to achieve good coverage of the problem-space and solution-space
- Enables sensitivity analysis with stakeholders using qualitative methods

Similarly, BRAIN assessment has been observed to offer these benefits:

- Very easy for stakeholders to understand
- Drives thinking around alternatives and mitigation of risks and issues

Conclusions

Combining both methods together has some useful emergent properties that can be exploited during early ‘Pre-Concept’ Systems Engineering:

- Quick method to generate concepts and assess their broad suitability in particular contexts
- Can be extended to consider value functions and MoEs, providing quantification of benefits
- Useful way to summarize concepts during early lifecycle studies
- Encourages exploration of Systems-of-Systems configurations during pre-concept phase
- It could be a useful complement to set-based design approaches

Reflections – Aptitude and Attitude

We found that it was essential to have team members with some relevant military experience, but to balance them with technical engineers who could ask the challenging "why?", or indeed "why not?" questions and architects who could bring order and re-usability to the analysis – but without setting everything in stone from step one

In terms of attitude, this would work well with a mixture of "Pioneers" and "Settlers" from Wardley's "Pioneer-Settler-Town Planner" model

- Pioneers come up with new ideas and concepts
- Settlers make changes that actually work in practice
- Town Planners optimise enterprises

"Effective mission engineering teams require members spanning both operational domain experiences and engineering domain skills. The sum total is rare in an individual mission engineer" *[Hutchison et al. 2018 – 'Framework for Mission Engineering Competencies']*

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Questions?

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