Using PSMs in the public sector: the experience at Dstl

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Presentation to Operational Research Society Problem Structuring Methods SIG Seminar

LSE 11 October 2006

Dstl/CP21858

Overview

- Quick introduction to Dstl
- Trends on use of Soft OA in Dstl
- Sample of methods used at Dstl
- Dstl's Soft OA CoP
- Questions.

Dstl Overview

- Dstl's Mission
  - Creating the winning edge for UK Forces and Government through the best use of science and technology
- Dstl's Vision
  - To be the indispensable source of science and technology at the heart of defence
- Part of MoD
- Approx 3,000 employees
- Project based organisation.

Dstl Departments

- Policy & Capability Studies
- Naval Systems
- Land Battlespace Systems
- Air and Weapon Systems
- Joint Systems
- Information Management
- Energetics
- Electronics
- Sensors & Countermeasures
- Biomedical Sciences
- Physical Sciences
- Environmental Sciences
- Detection

Systems Science Technology

Aim of Talk

- Provide an overview of the use of Soft OA in Dstl
- Background context
  - Increasing complexity of world
- Different types of problems
  - Puzzles
    - What needs to be done and how to do it is clear
  - Problems
    - What needs to be done is clear, but not how to do it
  - Messes
    - What needs to be done and how to do are both unclear.

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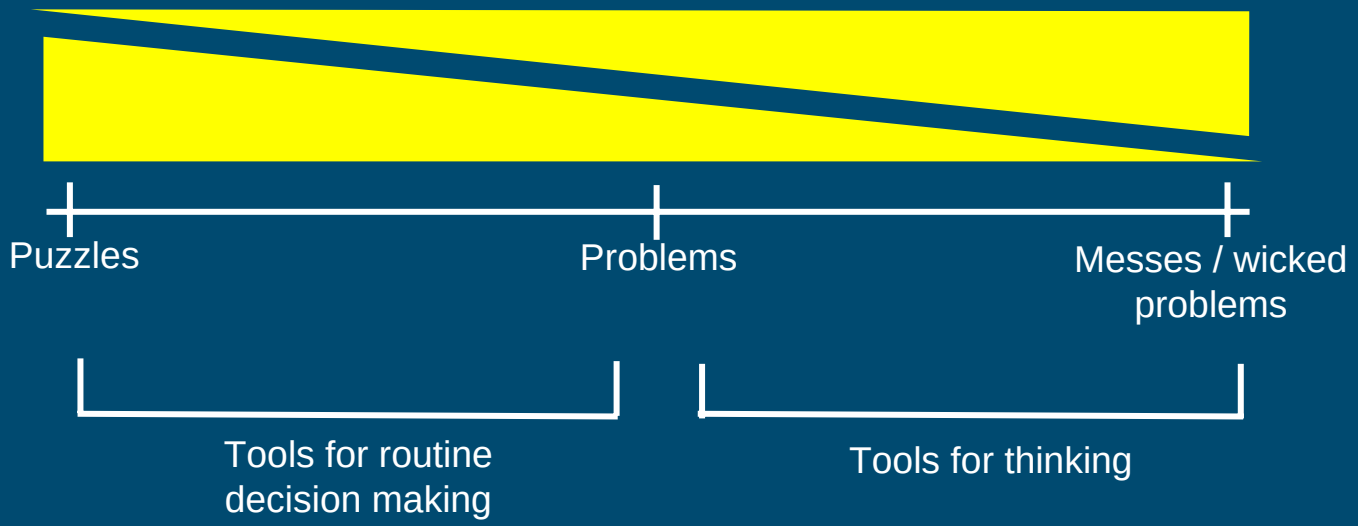
Why use Soft OA?

From Pidd (2004) Systems Modelling: Theory and Practise



- Provides tools for thinking
- Helps address messes and wicked problems.

Use of soft methods in Dstl

Method	% of respondents with experience
Cognitive Analysis	12
Decision Analysis/Decision Trees	46
Drama Theory	2
Game Theory	10
Metagame Analysis	0
Robustness Analysis	0
Scenario Planning	34
SSM	29
Storytelling/ Narrative Approach	12
SCA	7
SODA	7
System Dynamics	29
Total Systems Methodology	5
Viable Systems Model	0
Others	83
ACTIFELD	
Benefits Mapping	
CLD	
Experimental Gaming	
Influence Analysis	
MCDA	
Strategic Assessment Method	
Strategic Gaming	

- Output from MSc OR Student project
- Based on a small sample (41 respondents).

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Trends of use at Dstl

- Complementarity
  - Complementary use of hard and soft methods
  - Combining hard and soft methods
- Multi-methodology
  - Combining together more than one methodology (in whole or part) within a particular intervention.

Project Start-up

- Understanding the problem
  - SSM (elements of)
  - Brainstorming
  - Influence diagrams
  - Dialogue mapping
  - NATO CoBP for C2 studies
  - SWOT / PESTLE
  - What / how / why / where / when / who
  - ……
- Eliciting the customer's requirements
  - Neuro-Linguistic Programming
  - Cognitive mapping
- Who do we need to consult?
  - Stakeholder analysis

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Sample of methods used during a project

Strategic Assessment Method

Dstl/CP21858

Strategic Assessment Method (SAM)

- Aims to understand the strategic context for a given situation
  - Context is complex
  - Designed to look into the medium term
- Identifies
  - Key risks and opportunities
  - Key indicators of approaching crises
  - Strategic options
- Supports the development of policy, plans and strategy.

History: SAM's R&D Programme

- Inception: 1997
- Programme of methodological R&D, funded by MOD
- Eight experimental trials 1997-2003:
  - Angola
  - SE Asia
  - Cyprus
  - Southern Caucasus
  - Operational support to PJHQ
  - Nile Basin
  - UK Critical National Infrastructure Protection
  - Defence Diplomacy & Conflict Prevention
- Case study: 2004
  - Indo-Pak Conflict Prevention Fund.

Key questions SAM seeks to help answer

- Risks and Opportunities
  - What are the key risks and opportunities?
  - How can we reduce our exposure?
- Crises
  - What are the key trends and events that might lead towards a crisis?
  - Which ones can we influence? By what means?
  - What would the crisis look like? How would it affect us?
- Stability
  - Is the situation relatively stable - politically, economically, socially, technologically?
  - What or who is causing any instability?
  - How fast might the situation change? How much warning might we have?
- Surprise
  - How can we reduce the likelihood of strategic surprise?
  - What key indicators can forewarn me of otherwise unexpected events?
  - What do we not know?

Overview of Process

Part	Phase	Name
1	0	Preliminary preparations
	1	Expert judgement capture
2	2a	Analysis, visualisation and modelling
3	2b	Desk-level assessment of strategic options
	3	Principals' assessment

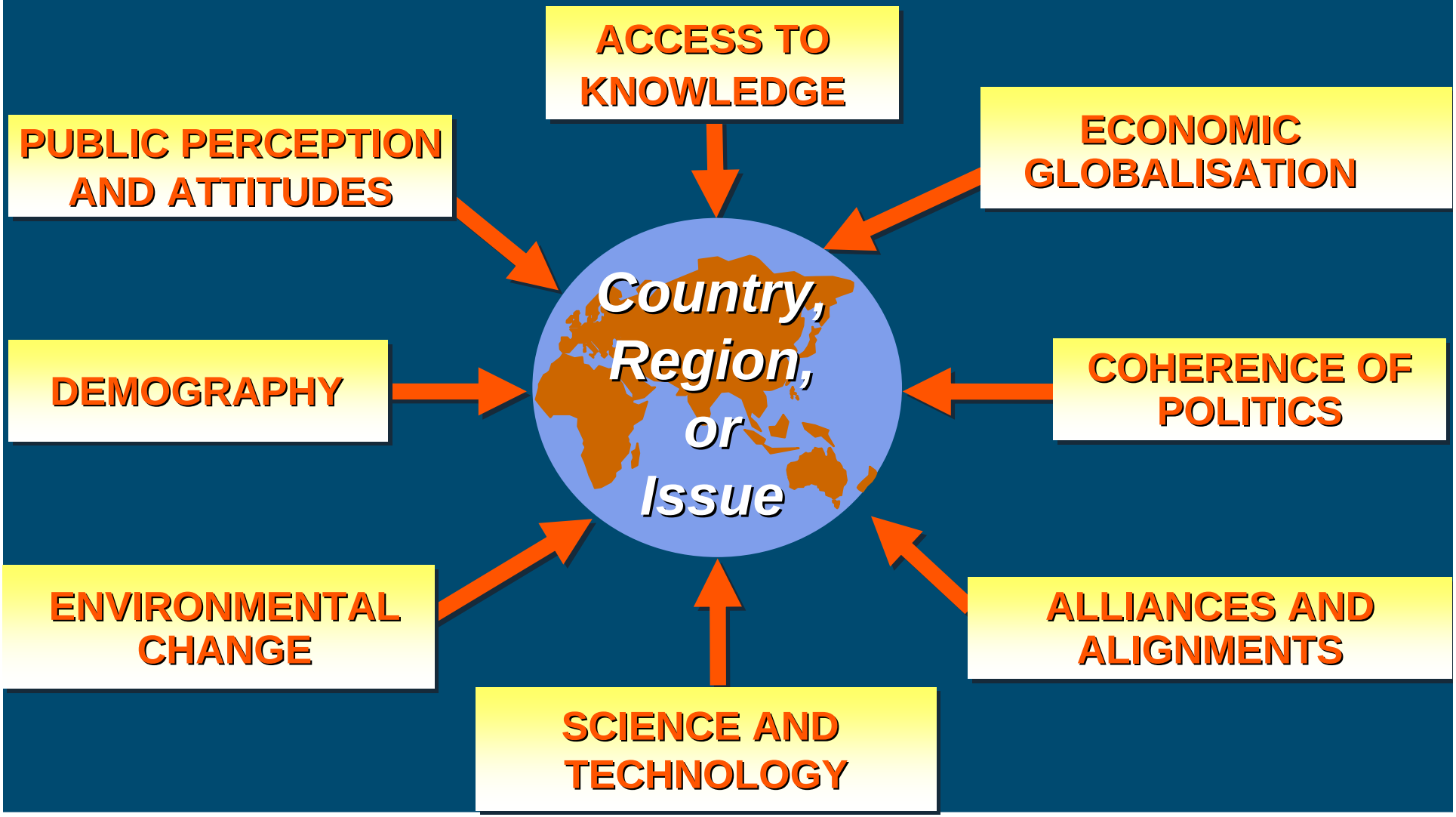
Basic Assessment

Full Assessment

Phase 1: Expert Judgement Capture

- What data do we want?
  - Horizon Scanning
- How do we capture the data?
- Who are the experts?
- Where are the experts from?
- Why do we use so many people?

Horizon Scanning



Phase 1: Expert Judgement Capture

- What data do we want?
- How do we capture the data?
  - Interviews
  - Workshops
  - Written material
- Who are the experts?
- Where are the experts from?
- Why do we use so many people?

Phase 1: Expert Judgement Capture

- What data do we want?
- How do we capture the data?
- Who are the experts?
  - Subject matter experts in geographical area
  - Those with in country / region experience
- Where are the experts from?
- Why do we use so many people?

Phase 1: Expert Judgement Capture

- What data do we want?
- How do we capture the data?
- Who are the experts?
- Where are the experts from?
  - Academia, industry, media, various areas of public sector
- Why do we use so many people?

Phase 1: Expert Judgement Capture

- What data do we want?
- How do we capture the data?
- Who are the experts?
- Where are the experts from?
- Why do we use so many people?
  - Holistic view of issue
  - Minimise bias

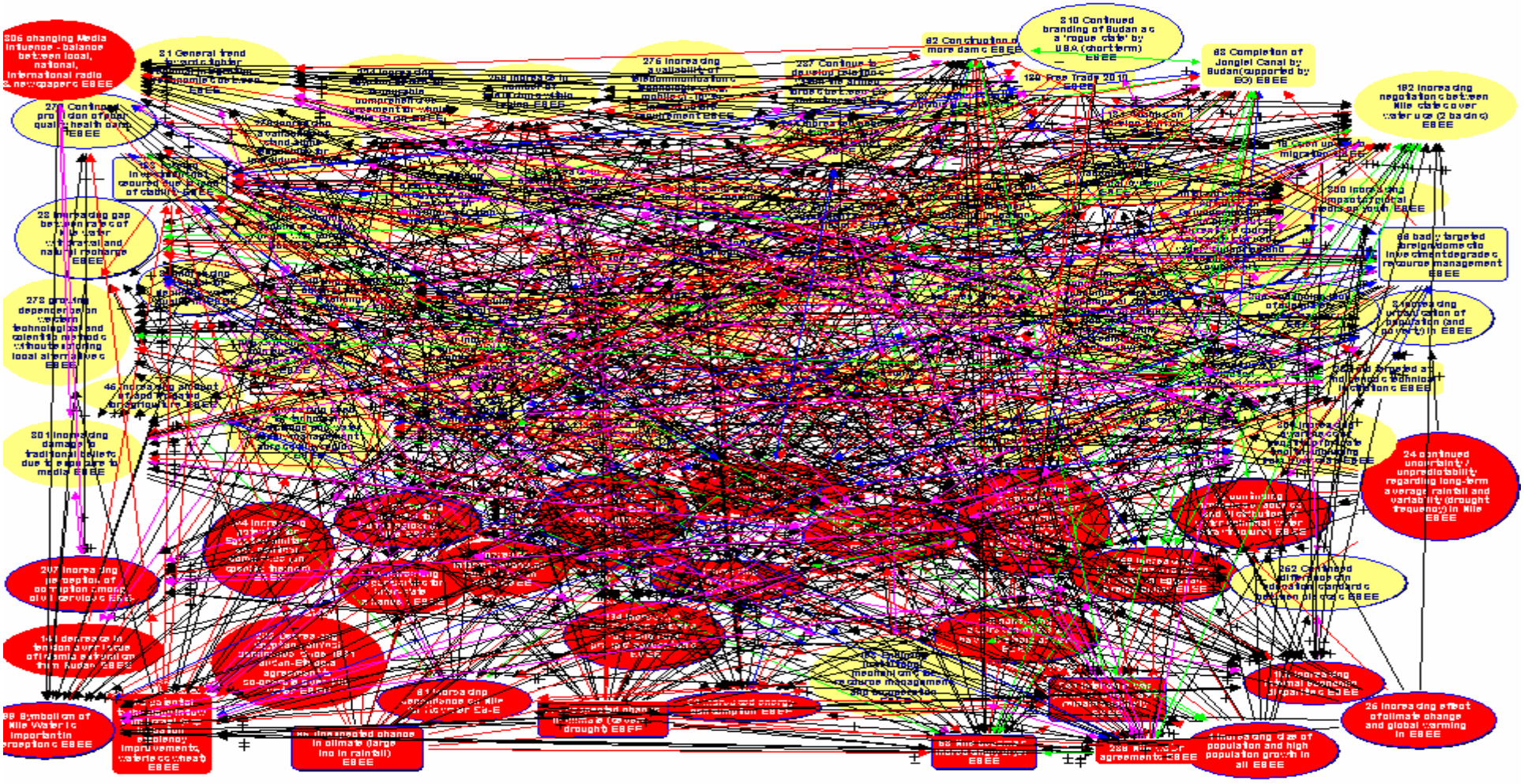
Phase 2a: Analysis and Visualisation

- Aims to create extra understanding beyond the raw captured judgements
  - Key risks and opportunities
  - Potential key indicators
  - Gaps in knowledge

- Analytical techniques include:
  - Thematic analysis - ‘seeing through lenses’
  - Cause and effect analysis
  - Risk and opportunity mapping - visualisation.

Visualisation of the Concepts

NB Numbers are only serial numbers



[dstl]

12 October 2006

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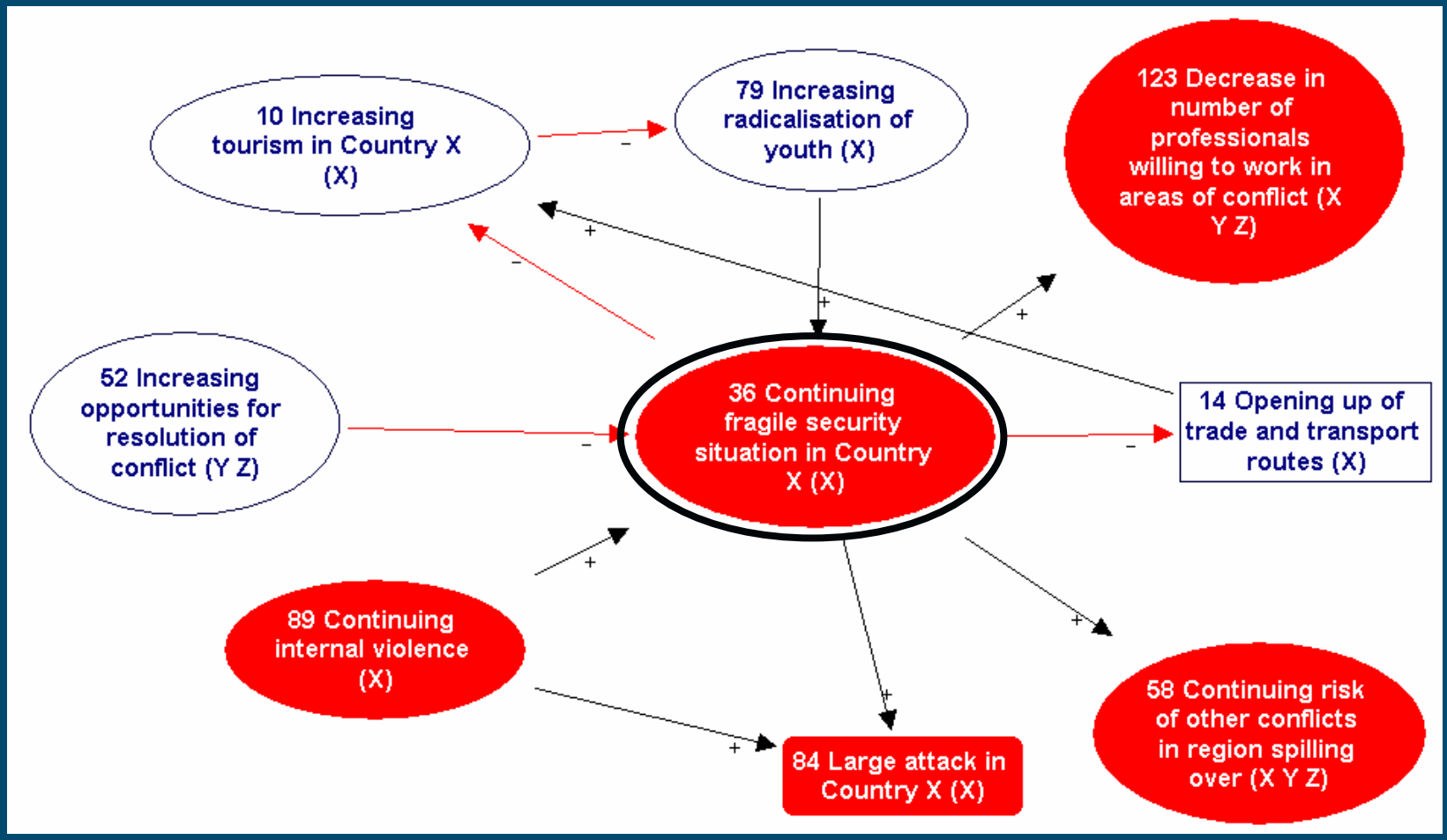
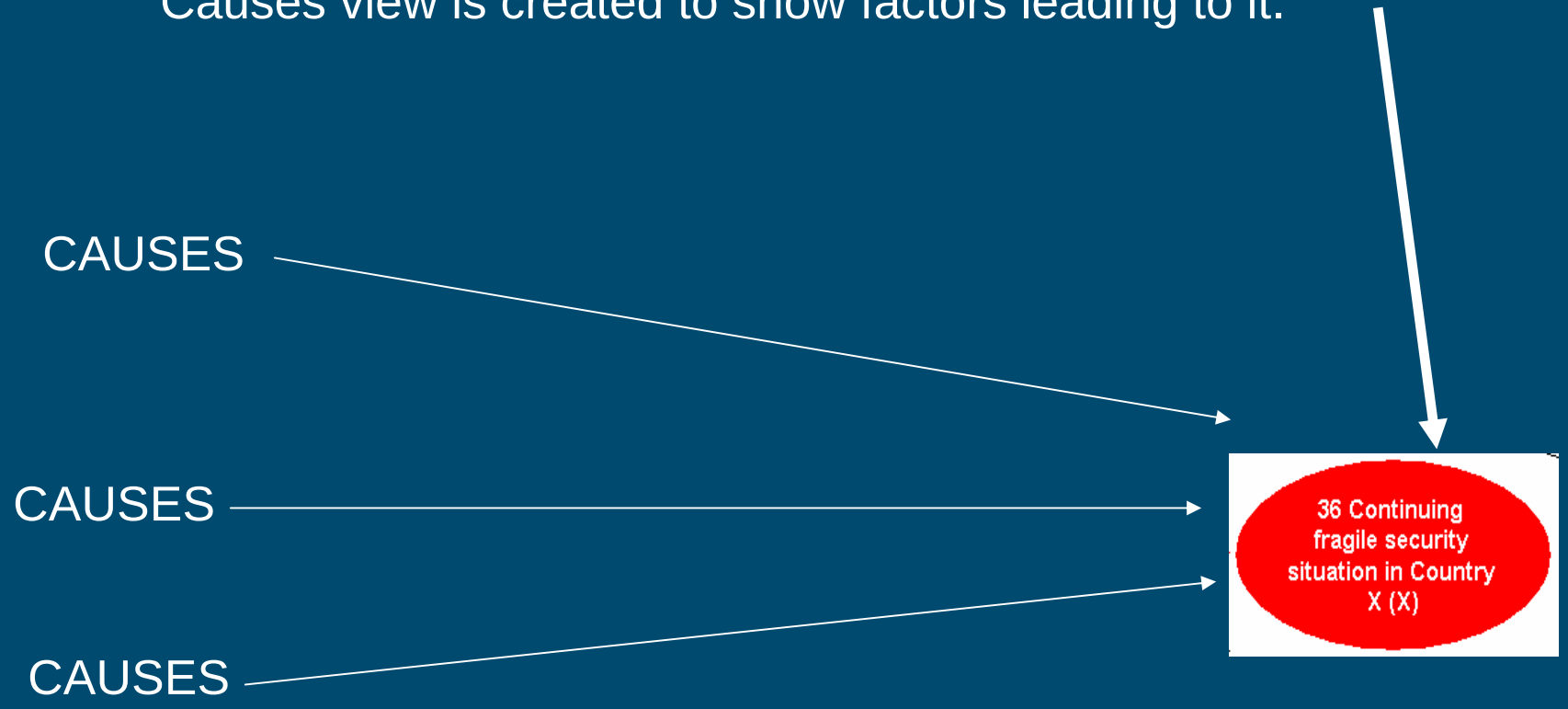
Dstl is part of the Ministry of Defence

All issues surrounding node 36

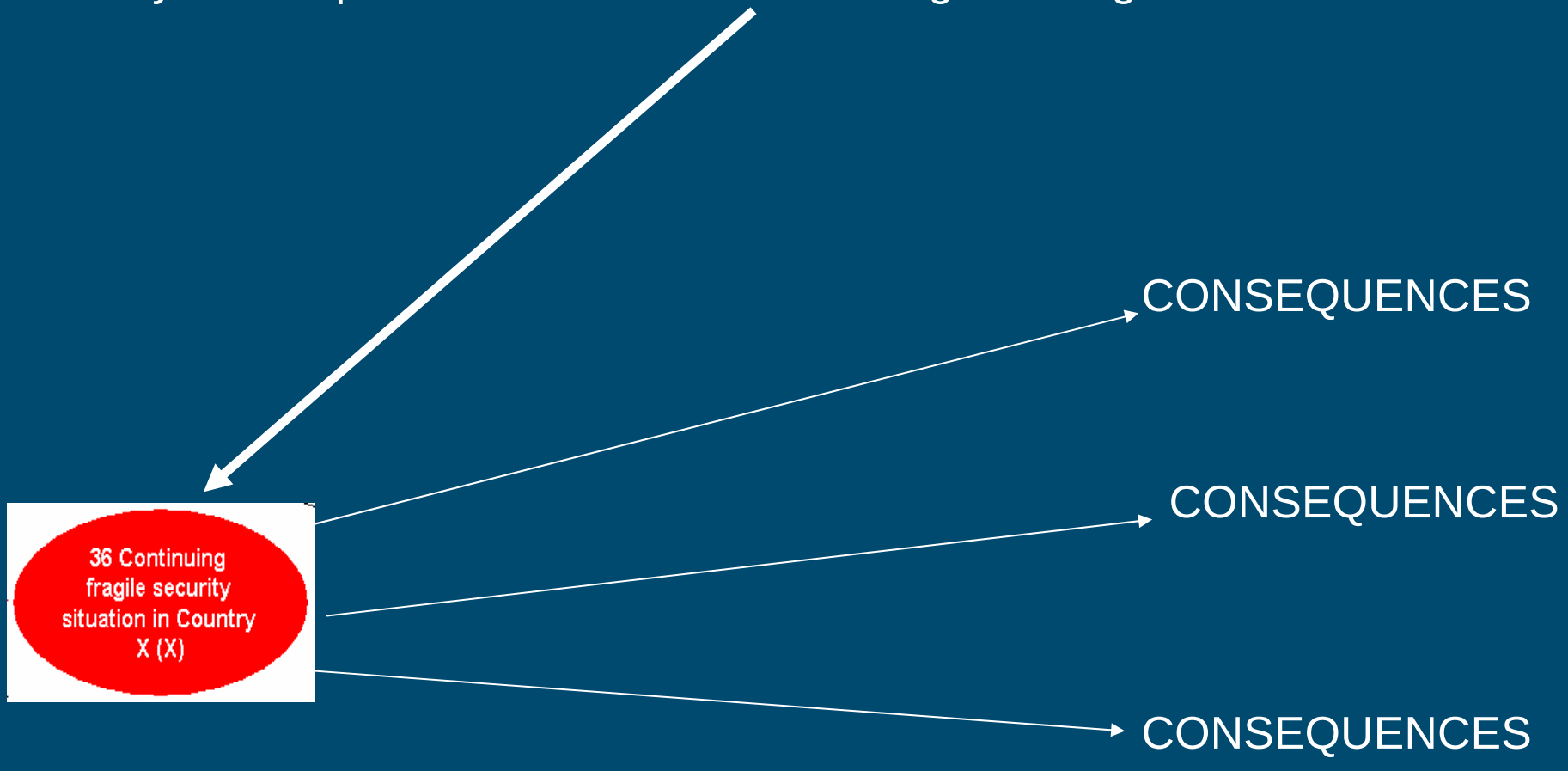


Identify central factor on diagram -
Causes view is created to show factors leading to it.



DIAGRAMS - read Left to Right

Identify Consequences from the factor - things leading from it



DIAGRAMS - read Left to Right

Phase 2b: Options Generation Workshops

- Aim: generate and prioritise strategic options
- Identify primary risks and opportunities
- Use these to inform option generation
- Assess options (H - M - L)
  - Effectiveness (including track record if applicable)
  - Feasibility (would the country of interest permit it?)
  - Political attractiveness (to HMG)
  - New idea?

Reviews of SAM

- Psychological review of phase 1
  - "An improvement in the group decision-making process when compared with unstructured methods"
- Defence Scientific Advisory Council (DSAC) OA Working Group
  - "SAM represent a solid and praiseworthy attempt to bring credibility to qualitative decision support in MoD"

Inclusive

Identifies strategic options

Reduces complexity

SAM ADDED VALUE

Holistic

‘Joined-up’

Increases understanding

Structured process

Scenarios

Scenario Planning

- Scenarios provide focus and detail against which issues can be explored and assessed

- Why use scenarios?
  - Predicting the future [!?]
  - Springboard for creative thinking
  - Build consensus and buy-in for policy
  - Test the robustness of a policy, plan or strategy

- Different methods for constructing scenarios.

Scenario Planning 2

- Different ways to use scenarios
  - Modelling
  - Gaming
  - Discussion
- The scenario method doesn't stop with the creation of a scenario or a number of scenarios, it begins there
- Scenario use at Dstl
  - Future equipment and force structure requirements
  - Testing and refining government policy.

Gaming

Gaming - using the Scenarios

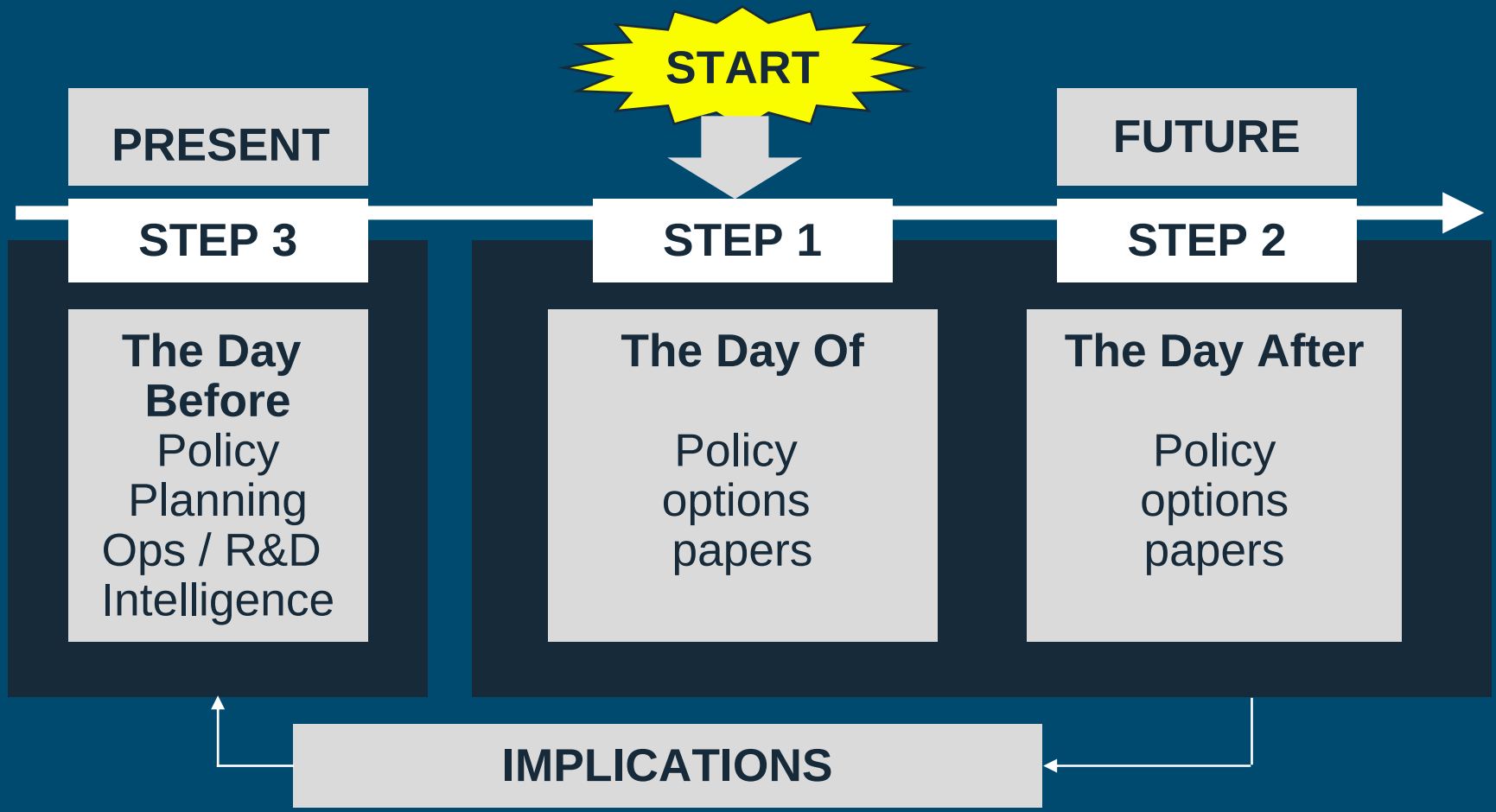
- What are games?
  - Scenario based exercises involving real-time, human interaction and decision making
- Designed to explore operational concepts, capture issues, explore decision making processes or to enable planning
- Different types,focusing on different types of information
  - War Games
  - Politico-Military Games
  - Strategic Games, e.g. ‘The Day After’ Method.

‘The Day After…’ Method

- What?
  - Scenario-based exercises using a simulated crisis with real issues.
  - Participants are senior advisers to national leader (i.e. not role play).
  - Decision points force discussion and recommendations in context of:
    - limited time;
    - significant uncertainty.
  - Carefully designed, scripted, tested and executed.

- Why?
  - Key benefits / products include:
    - Shared understanding of the ‘big picture’.
    - Better informed policy / strategy.
    - Pragmatic guidance for contingency planning.
    - Networking (intra- and inter- Government).

Strategic Gaming Exercises - Method



Experimental Gaming Overview

- Customer questions
  - Gain an improved understanding of the mechanisms through which coercive effects can be achieved
  - Examine the means by which HMG can change an adversary's intent to use force
- Why gaming?
  - Adversaries have choices
  - Interested in affecting Red's perceptions of gain and loss, and Red's cost/benefit calculus
  - We don't fully know how to model humans and their decision making, yet.

Potential Areas of Insight (easier to harder to address)

1) How will a given regime behave when under pressure to change their intent?

2) How susceptible to intent change is a given regime?

3) What level of pressure is required to change the intent of the target regime?

4) What ways of attempting to change Red's intent are more effective than others?

5) Are we able to change the intent of the adversary before they undermine our will?

6) When will we win?

Experimental Gaming

- Structured role playing of different Red leaders
  - Skilled role players / actors “wrapped” inside a profile
  - Profile extensively reviewed by experts
  - Provided players with detailed character profiles:
    - Personality info
    - Personal history
    - Cultural info
    - Historical info
    - Political info
    - ORBAT
  - Game conditions controlled.

Experimental Gaming

- Structured role playing of different Red leaders
  - Skilled role players / actors “wrapped” inside a personality and leadership profile
- Two independent variables that are varied between the games

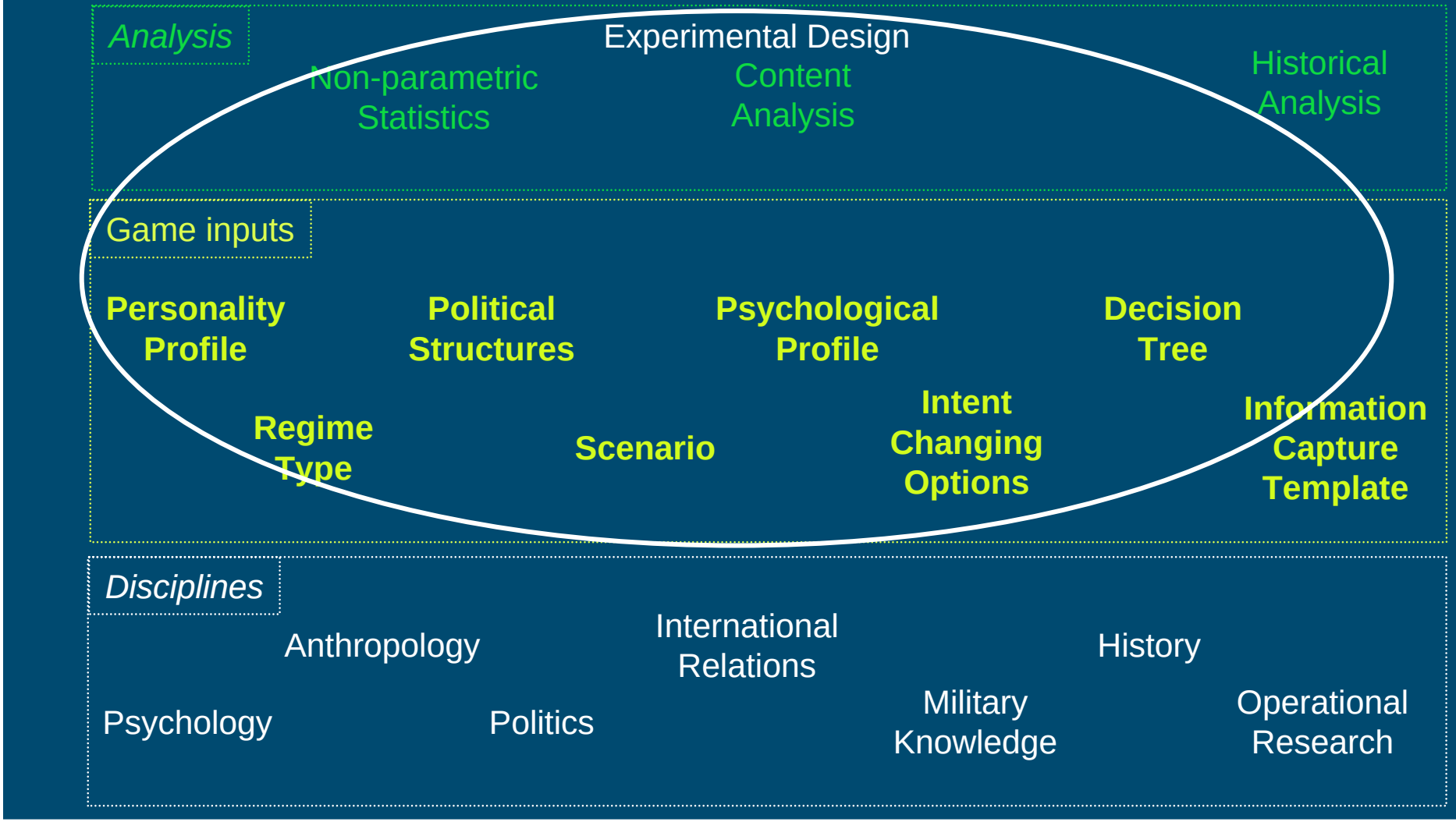
  (1) Regime Type

  (2) Blue strategies
- Scenario scripted using a decision tree with a discrete set of options available to the player
- Information captured at each game turn and at game end.

Using the Results

- Method has been extensively reviewed by experts
  - Assessed as groundbreaking and fit for purpose
- Findings have
  - An extremely high degree of consistency with reality
  - The potential to inform strategic planning and balance of investment in military capabilities
- Follow-on work is seeking to pull through the results into a model that can be run stochastically alongside existing high-level Operational Analysis campaign models.

Multi-disciplinary and Methodology



Social Network Analysis

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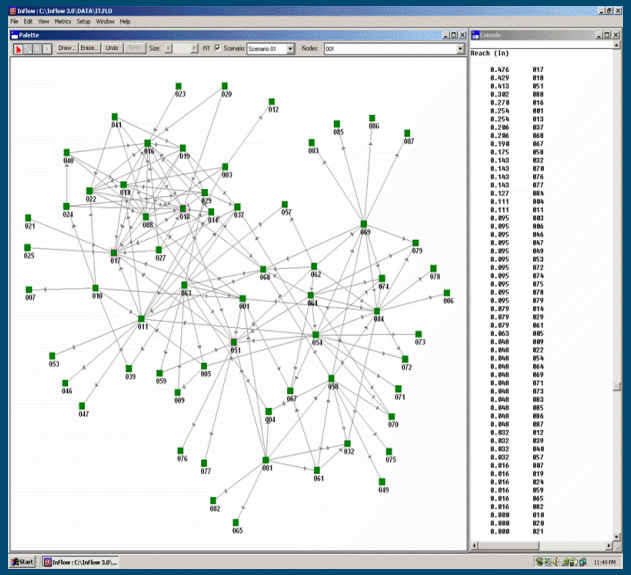
Social Network Analysis (SNA)

- SNA is the analysis of the pattern of interaction between individuals in social networks, in two stages:

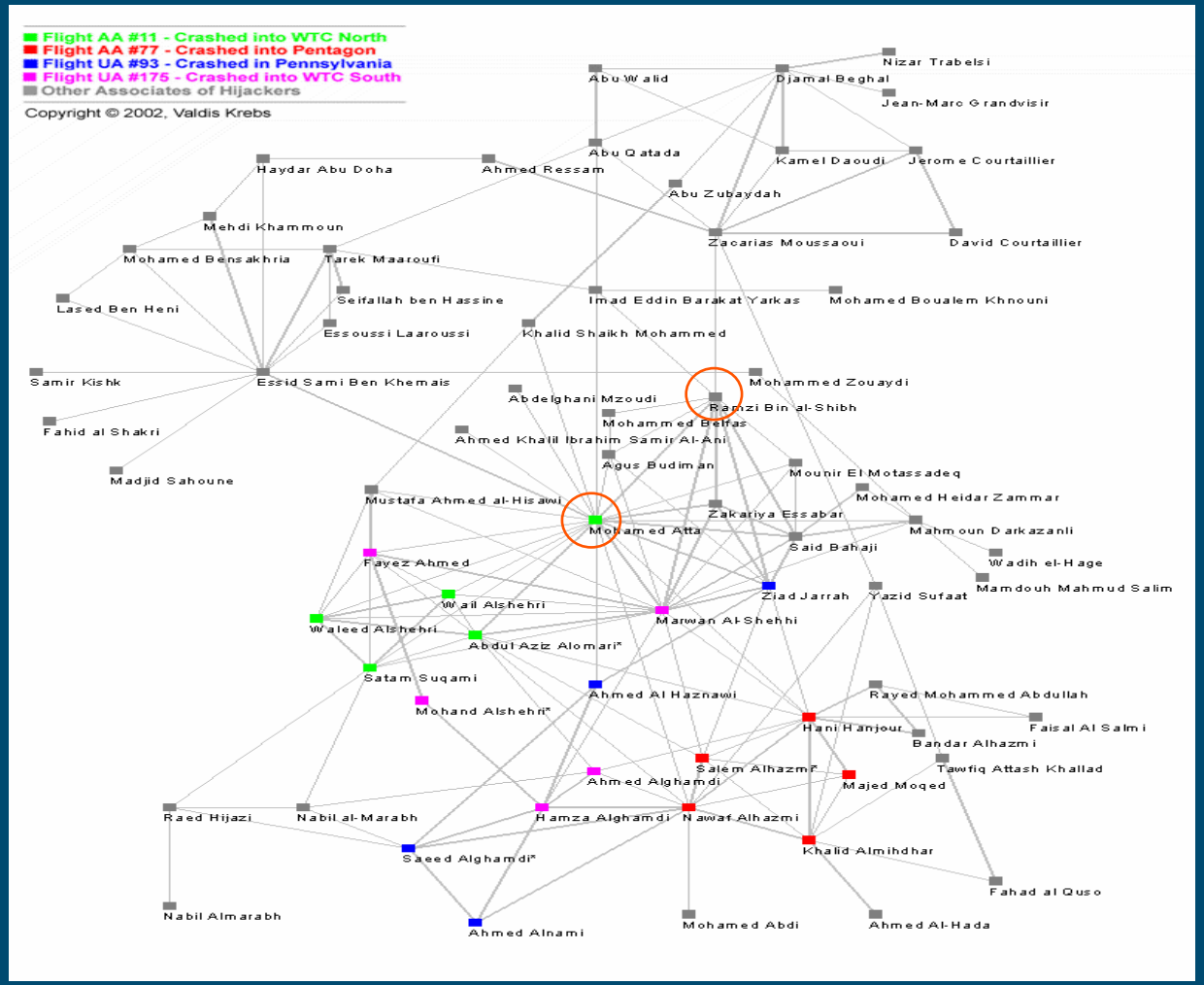


- Network Construction (Qualitative)
  - Relational Data
  - Network Visualisation
- Network Analysis - Graph Theory (Quantitative)
  - Measure of properties of nodes in relation to other nodes in network:
  - Centrality, Equivalence, density, weak ties.

SNA cont.

- SNA can be applied to aid targeting and strategic policy
- Current practice by Intelligence Analysts
  - Production of a visual briefing aid, usually based on analyst's own opinions
- Which SNA measures are useful?
  - Centrality (Closeness & Betweeness), Weak Ties, Structural Equivalence/ Redundancy
  - Identification of key generic roles in networks
    - Organisers, extenders/contact brokers, seams, low redundancy (Williams 2000)
- Limitations - incomplete data, fuzzy boundaries, dynamic networks.

SNA Example - 9/11 Highjackers



Source: V. Krebs, www.orgnet.com

Network Disruption - Concepts

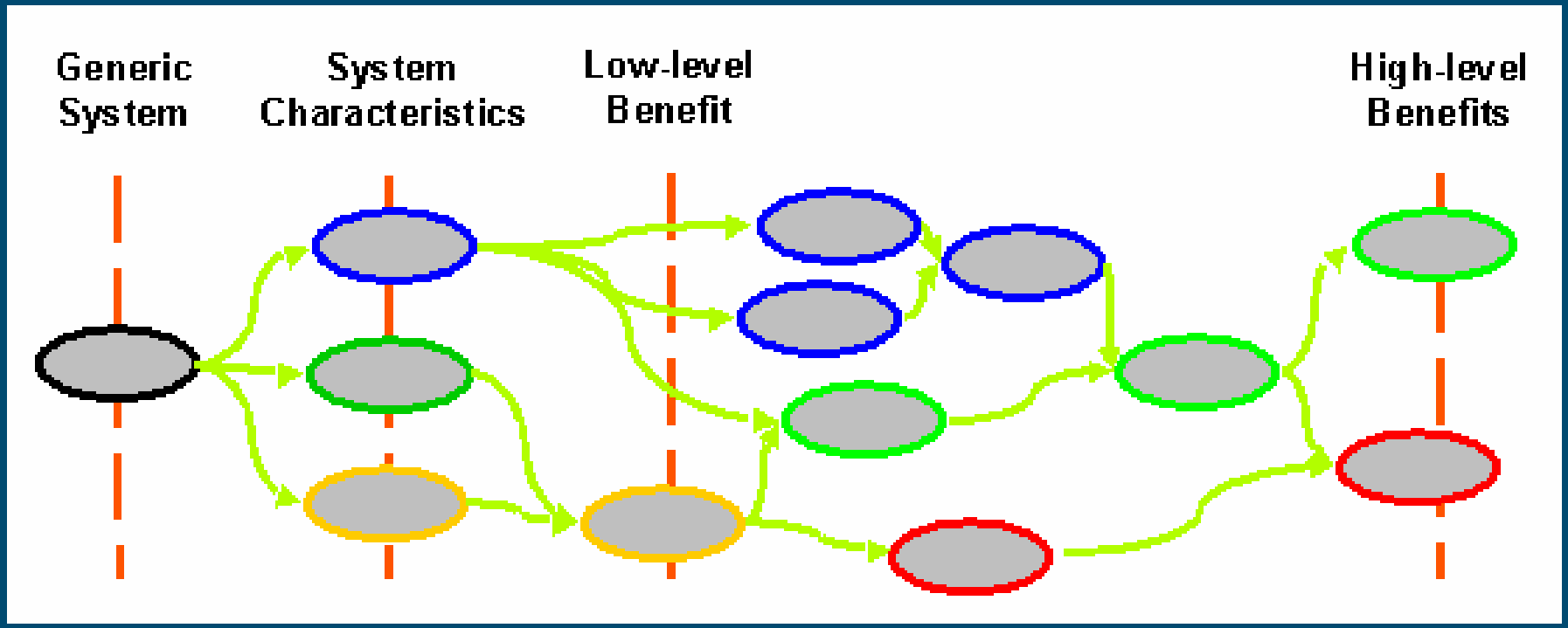
- Once network is understood we can develop concepts for disrupting it by targeting:
  - Nodes with high centrality (closeness & degree) & high cognitive load
  - Network seams / cross-overs and extenders and weak ties (betweeness)
  - Nodes with low redundancy
- Measurements of network disruption
- Disruption does not always require a physical attack - SNA could be used to inform Info Ops etc. ...

Benefits Analysis

Benefits Analysis

- Systematic method for formulating complex, multi-factor investment appraisal problems
- Analysing benefits, particularly non-financial benefits
  - Management of equipment capability
- Method has evolved over past decade
  - Derivation from a number of other methods, including MCDA, QFD and Casual Mapping.

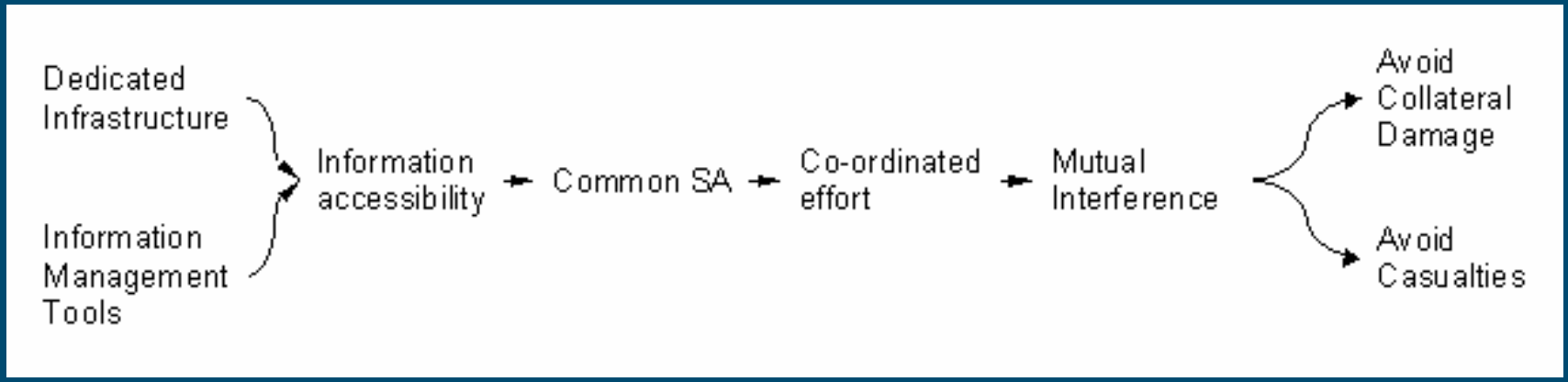
Generic Benefits Map



Problem Modelling Phases

- Elicitation and mapping
  - Usually conducted during a workshop
  - Product is a causal map showing the lines of argument between investment variables and the value criteria
- Qualitative analysis
  - Appreciation of the qualitative relationships in the causal map
  - Identification of themes and strands within the map.

Example Benefits Strand



- Investment variables considered
  - Provision of information management tools and dedicated information infrastructure
- Line of argument
  - Increased investment in information will lead to better information accessibility and situational awareness.

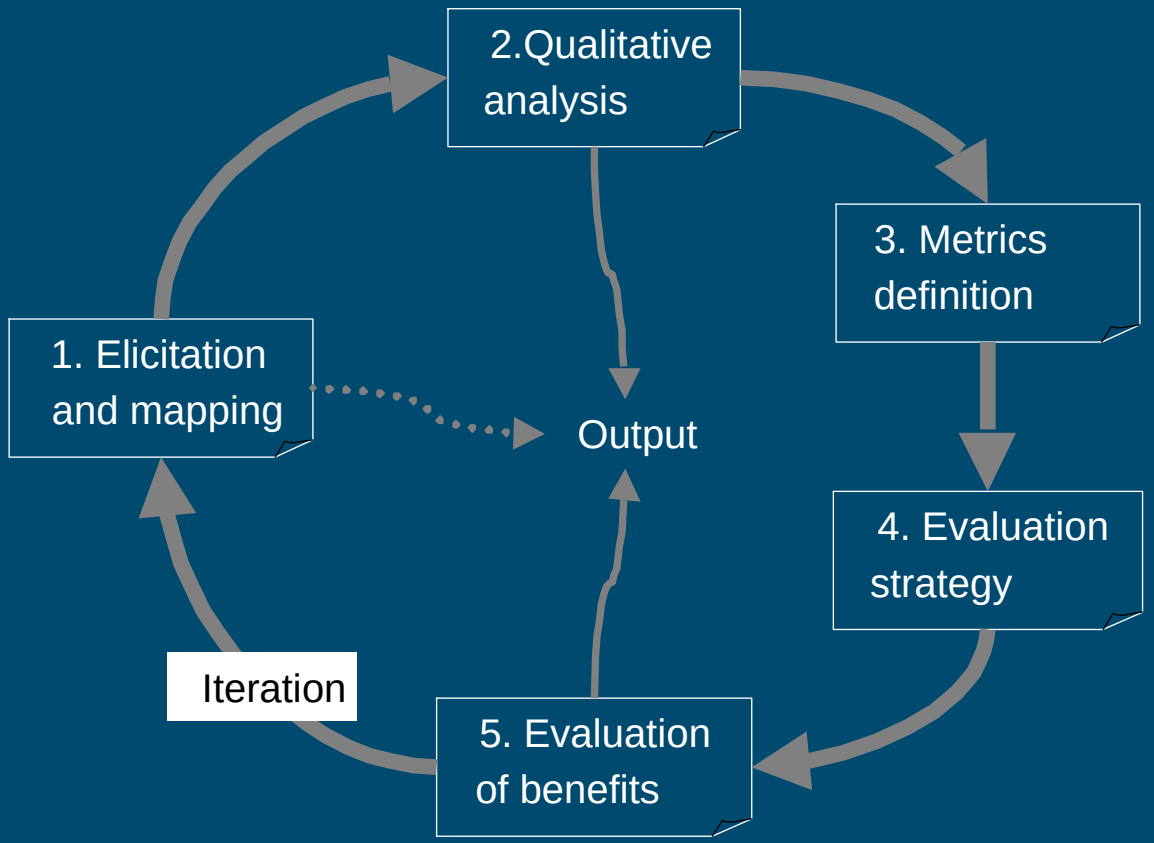
Problem Modelling Phases

- Metrics definition
  - First step towards quantification of the benefits
  - Causal map used to identify metrics and surrogate metrics
  - Metrics measure something meaningful (measures of effect)
    - Avoid casualties: absolute number of losses
- Modelling the problem may be sufficient, if not...

Benefits Evaluation Phases

- Evaluation strategy
  - Three different types
    - Matrix-based scoring
    - Network-based functions
    - Strand-based multi-method evaluation
- Evaluation of benefits
  - Dependant of evaluation strategy
  - Must be rigorous
    - Provide a reliable and realistic product.

Benefits Analysis Method



Benefits Analysis Overview

- Benefits
  - Provides an explicit and clear problem model
  - Can facilitate the efficient use of expensive or efficient scarce resources
  - Flexible
    - Different evaluation strategies
    - Different uses
  - Rigorous
- Limitations
  - Unsuitable for wicked problems
  - Limited utility in a direct decision support context
  - Unable to deal with cyclic behaviours

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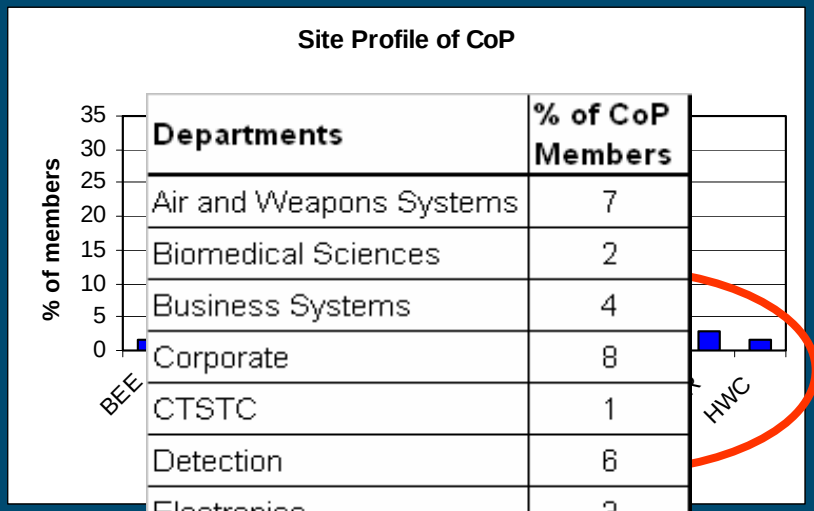
Why Form a Soft OA CoP?

- Dstl is a project based organisation
  - Continually required to elicit customer requirements, design and deliver a piece of work that matches these
- Trend towards increasingly complex problems
- Soft OA techniques are increasingly being used across the lab
- CoP aim
  - Strengthen Dstl and MoD's soft OA capability.

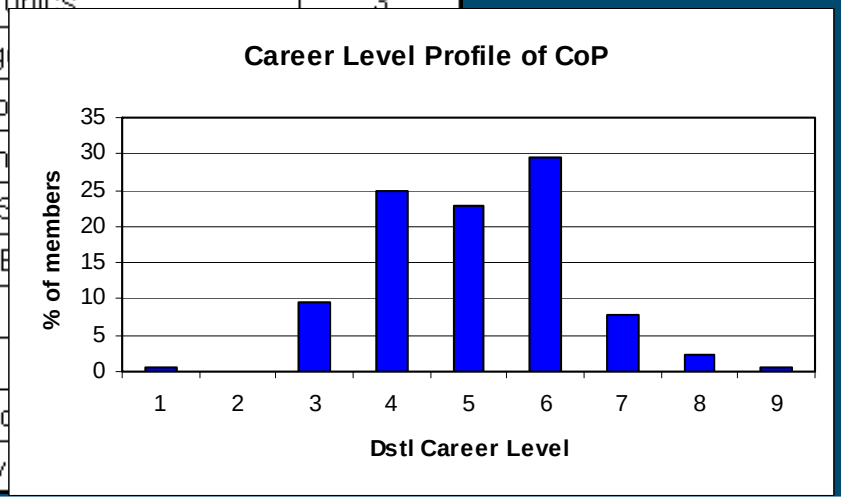
Dstl's Soft OA CoP

- Formed in Feb 06
- Currently contains 180 members
- Lifespan of years
  - End when no longer a demand for learning about soft OA!
- Members are geographically dispersed
- High degree of legitimacy within organisation
  - Formally funded network.

Drilling into the who…



Departments	% of CoP Members
Air and Weapons Systems	7
Biomedical Sciences	2
Business Systems	4
Corporate	8
CTSTC	1
Detection	6
Electronics	3
Energ	
Enviro	
Inform	
Joint S	
Land E	
MoD	
Naval	
Physic	
Policy	



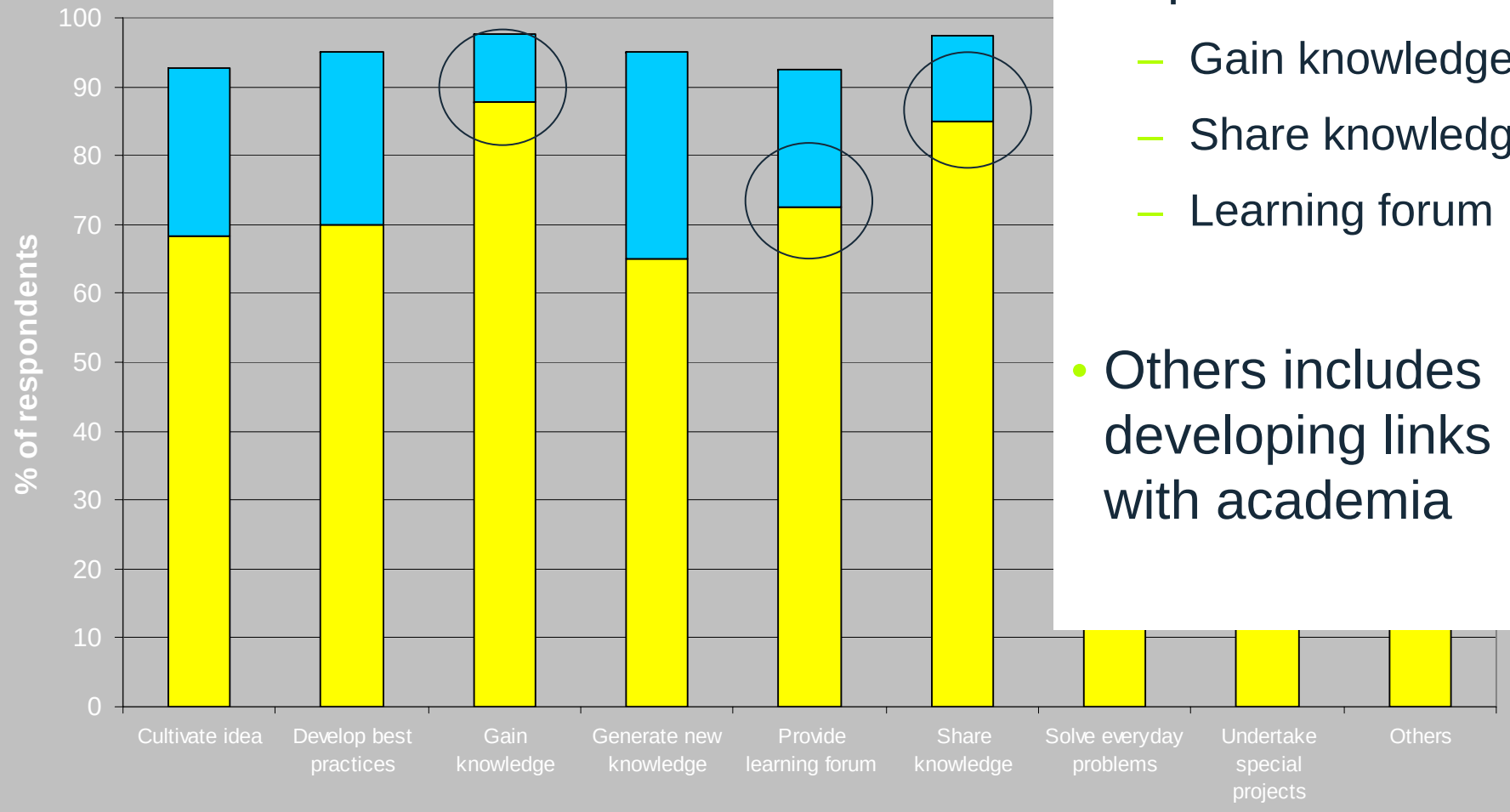
CoP members span many sites across the country

CoP members are not just in Dstl, also MoD & warfare centres ……

CoP members work on very different problems

CoP members are at varying stages in their career

What do CoP members want?



- Top three areas:
  - Gain knowledge
  - Share knowledge
  - Learning forum
- Others includes developing links with academia

CoP Activities (1)

- Establish and sustain a CoP!
  - Identify interested parties
  - Understand what people want and identify the ‘core’ group
  - Knowledge management strategy (MSc OR project)
- Create a repository of knowledge
  - Intranet site, books
- Keep abreast of developments in soft OA field
  - Horizon scanning, academic links
- Develop skills
  - Training courses (internal and external), presentations, interaction between members, experiential learning.

CoP Activities (2)

- Past activities
  - SSM day
    - Short introduction
    - Briefs on uses within Dstl
  - 2 day introduction to PSM course
  - ACTIFELD brief
- MCDA is next on the agenda
  - Academic brief
  - Training courses, including internal course on Benefits Mapping
  - Internal briefs on uses of MCDA within Dstl
- In the future…..

How can you help?

- Do you have anything to offer the CoP?
  - KM thoughts
  - Titles of good books or papers
  - Interested in giving a talk to the CoP?
  - Exciting events, thoughts on them!
  - ANO …….

Closing….

Other Issues

- Learning from different disciplines
  - New methods
  - Different perspectives to problems
- Verification and validation
  - Work is fit for purpose
  - Ensure that the design fulfils its stated purpose
  - Different approaches to validation
    - Not just realist (against real world events).

Closing

- Wide use of soft OA in Dstl
  - Growing use
- Trend of use is towards
  - Home created multi-methods
  - Complementary use with hard OA
    - Help structure problem at onset
- Important to address V&V issues.

Questions?

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