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Does Removing the Human from the Battlespace Increase Military Effectiveness?

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Background

- A major benefit claimed for unmanned vehicles is that they remove the human from some of the more dull, dirty, and dangerous parts of the battlespace.
- Decreasing the risks to humans is clearly a benefit
- But are there additional benefits or disbenefits, other than cost, in moving to unmanned vehicles?
- In particular, how effective are they at doing these D-3 Missions?

Do we understand human / unmanned system interactions?

Some Definitions

Definition

- Autonomy
  - An unmanned system's (UMS) own ability of sensing, perceiving, analyzing, communicating, planning, decision-making, and acting, to achieve its goals as assigned by its human operator(s) through designed human-robot interaction (HRI).
  - Autonomy is characterized into levels by factors including mission complexity, environmental difficulty, and level of HRI to accomplish the missions.

Mode of Operation

- Remote control.
  - A mode of operation of a UMS wherein the human operator, without benefit of video or other sensory feedback, directly controls the actuators of the UMS on a continuous basis, from off the vehicle and via a tethered or radio linked control device using visual line-of-sight cues. In this mode, the UMS takes no initiative and relies on continuous or nearly continuous input from the user.
- Teleoperation.
  - A mode of operation of a UMS wherein the human operator, using video feedback and/or other sensory feedback, either directly controls the actuators or assigns incremental goals, waypoints in mobility situations, on a continuous basis, from off the vehicle and via a tethered or radio linked control device. In this mode, the UMS may take limited initiative in reaching the assigned incremental goals.
- Semi-autonomous.
  - A mode of operation of a UMS wherein the human operator and/or the UMS plan(s) and conduct(s) a mission and requires various levels of HRI.
- Fully autonomous.
  - A mode of operation of an UMS wherein the UMS is expected to accomplish its mission, within a defined scope, without human intervention. Note that a team of UMSs may be fully autonomous while the individual team members may not be due to the needs to coordinate during the execution of team missions.

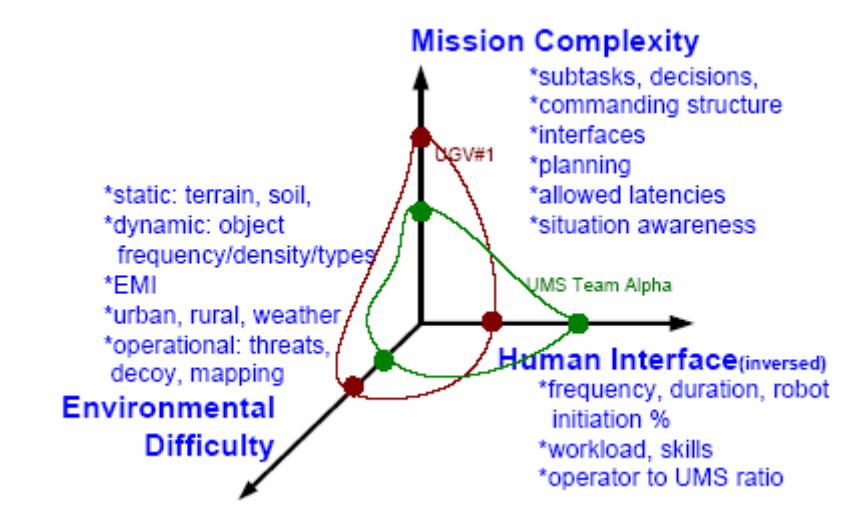
Levels of Autonomy

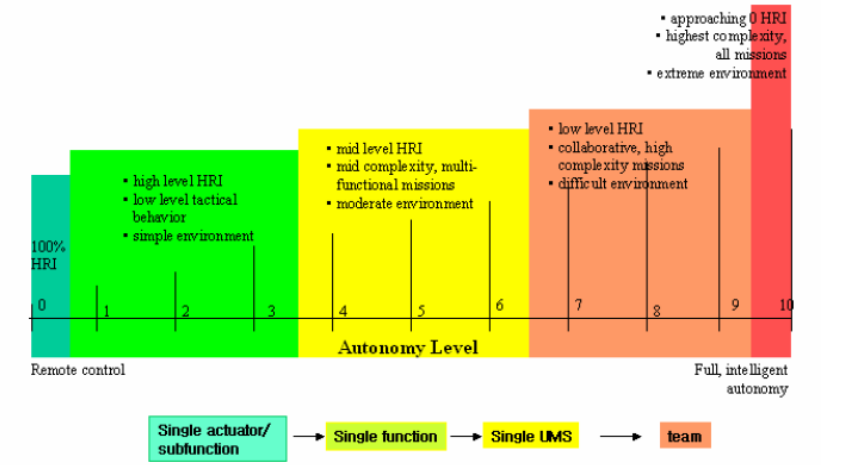
ALFUS Detailed Model

- Mission Complexity
  - Task Decomposition
  - Type of Task
  - Complexity of Task
- Environmental Difficulty
- Human interface
  - Operator Interaction Time
  - Mission Planning Ratio
  - Operator Workload

ALFUS Summary Model

- Level 0 is Remote Control
- Level 10 is when all three axes reach their full value





Language

Do we have the language to engage with the systems engineers and understand what they are offering so that we can represent it in our models and effectiveness assessments?

Roles for which we need to consider effectiveness

Unmanned Combat Aircraft

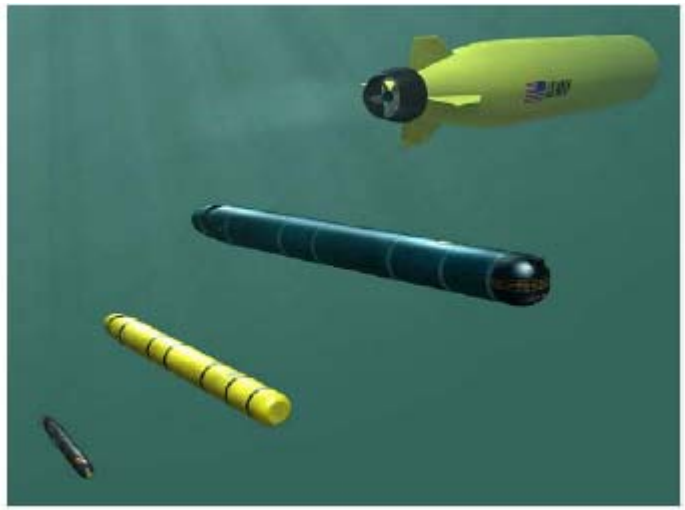
- Proposed Missions
  - High threat environment
  - SEAD/DEAD
  - Deep Penetration
- Close Air Support?
- Survivability
  - Communications links?
  - Size and shape
  - Less susceptible? More vulnerable?
- Benefit
  - Reduction in mission aborts due to high threat?

Reduction in threat to the human?

- Falkland Islands
  - 136 combat sorties - 3 aircraft lost to enemy action, 2.2%
- Desert Storm
  - 53,075 strike sorties – 38 aircraft lost to direct enemy action, 0.072%
- Deliberate Force
  - 2,470 sorties penetrated BH airspace - 1 aircraft lost to enemy action, 0.04%
- Allied Force
  - 10,484 strike sorties – 2 aircraft lost to enemy action, 0.019%
- Iraqi Freedom
  - 20,733 fighter/bomber sorties – 1 aircraft lost to enemy action, 0.004%

Mine Counter Measures

- MCMVs are slow and take a long time to deploy into theatre
- UK & US have a similar solution
- Portable
  - RN has 12 REMUS-100 UUVs for use by FDU 02 & FDU 03 for use in VSW
  - US NSCT 1 with REMUS
- Organic
  - US DDG51 & LCS with AN/WLD-1(V)1 Remote Minehunting System
  - RN MCM Recce UUV
- Deployable
  - MCMVs



Missions and Programmes

Missions have been identified and unmanned programmes developed. Some, such as MCM, result in major changes to how we plan to achieve capabilities

How good are we at modelling and representing these?

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Lessons from Automation

Lessons from Automation

- Reduced Situation Awareness
  - Can reduce the operator's awareness of certain system and environmental dynamics
- Trust, complacency, & over reliance
  - Reliance even when faulty
  - Automation Bias
  - Omission – fail to notice a problem
  - Commission – follow an inappropriate directive
- Skill degradation
  - Both in physical and decision making skills
- Unbalanced mental workload
  - Introduce highs and lows of mental workload
- Performance degradation
  - In many cases the optimum performance was a mix of human and automation

Lessons from Automation – Theory and Practice

Postulated Benefit

- Better results, same system (substitution)
- Frees up resources
  - Offloads work
  - Focus user attention on the right answer
- Less knowledge
- Autonomous machine
- Same feedback
- Generic flexibility
- Reduce Human Error

Real Complexity

- Transforms practice, the roles of people change
- Creates new kinds of cognitive work, often at the wrong time. More threads to track; harder to remain aware of and integrate activity and changes around user
- New knowledge/skills demand
- Team play with people is critical
- New levels & types of feedback
- Explosion of features, etc create new demands, types of error
- New problems human-machine coordination breakdown

The Impact on Effectiveness

Autonomy places these issues at the centre of determining effectiveness

Can we capture and represent them?

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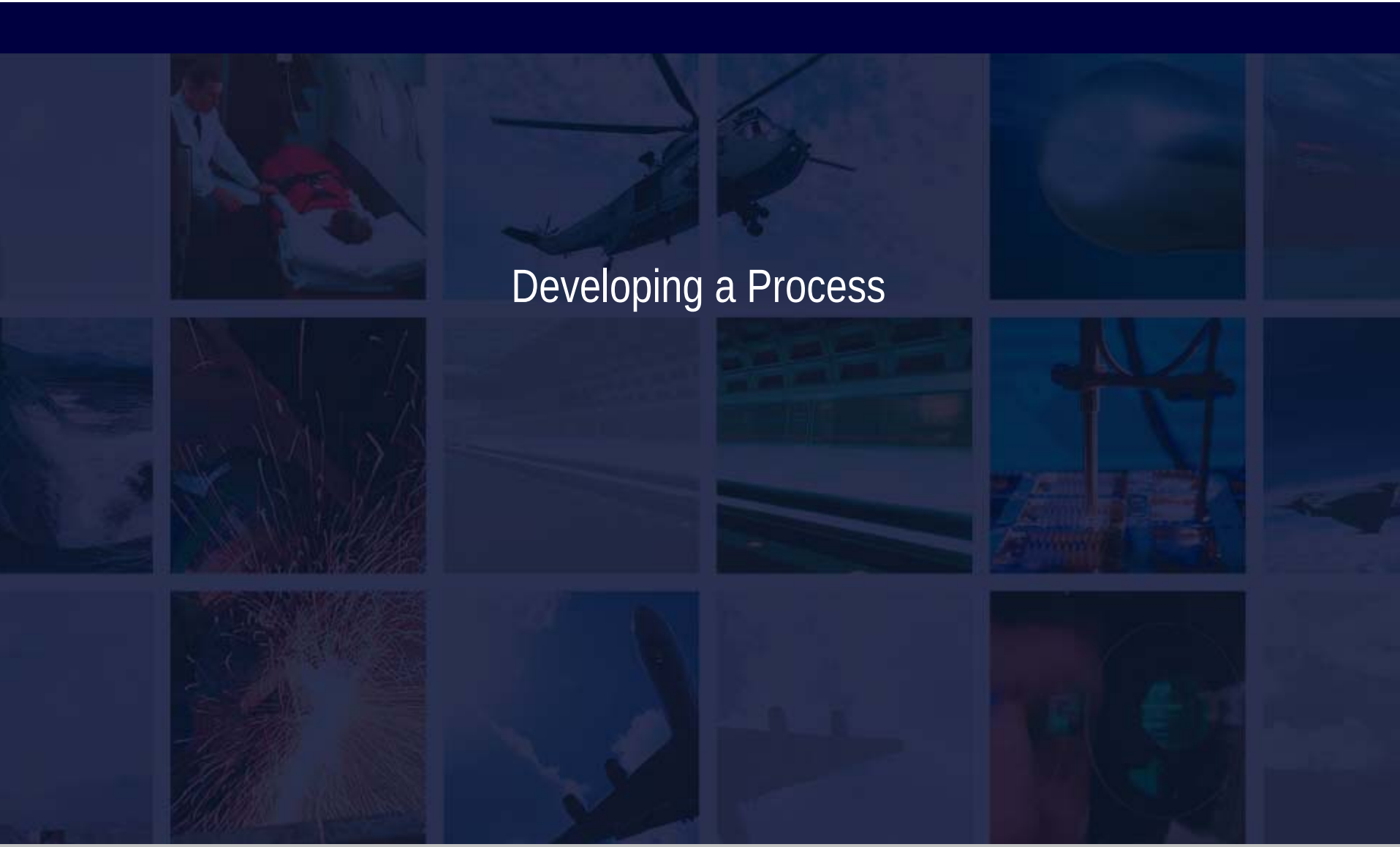
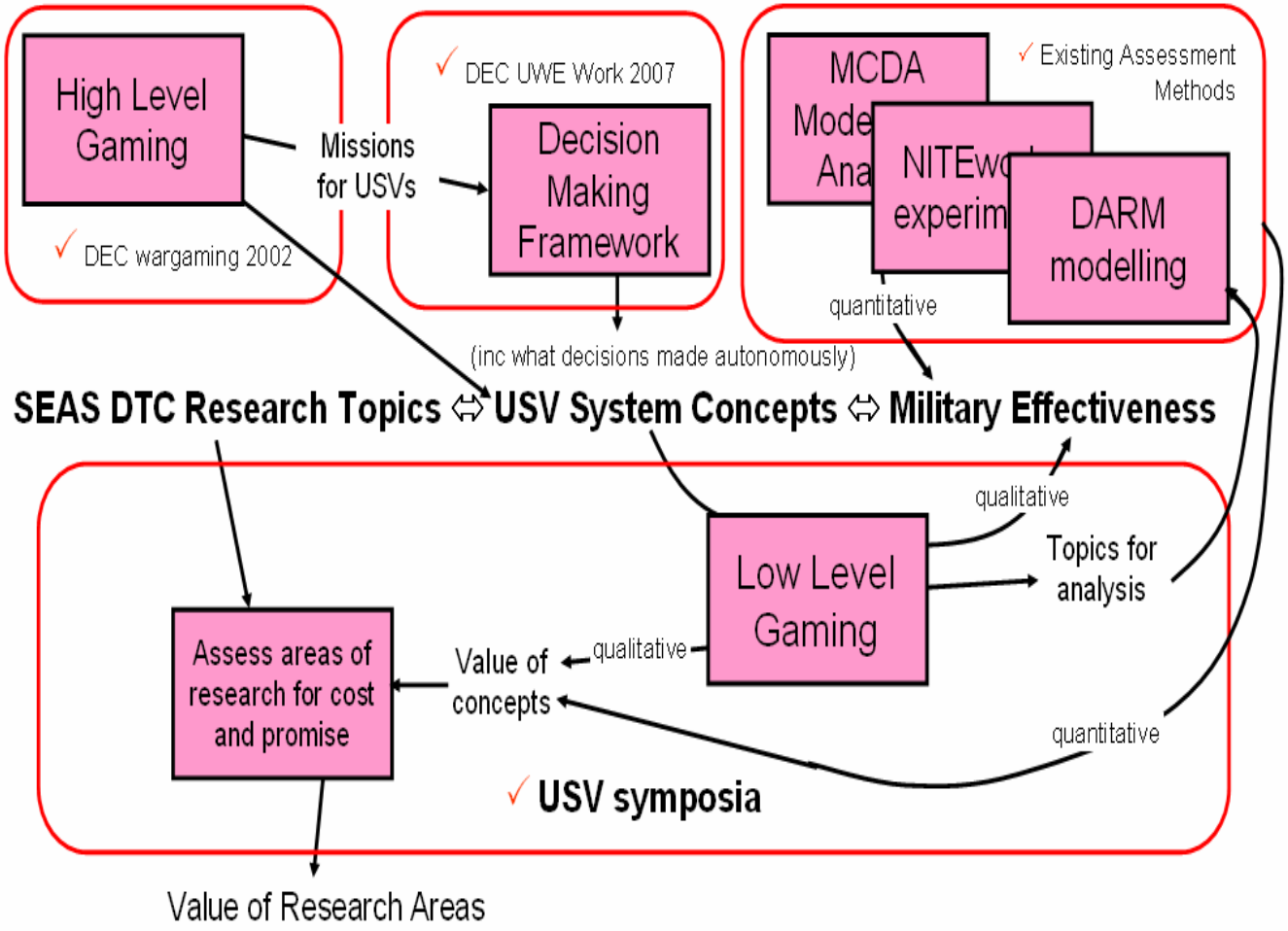


Developing a Process

Outline Process



Identification of Missions – High Level Gaming

- Wide Spread of Missions
  - Mine reconnaissance, hunting and disposal in deep, shallow and very shallow water
  - Environmental data gathering in support of oceanographic databases
  - Rapid environmental assessment
- Gaming Technique
  - Structured elicitation of military/expert judgement.
  - Based around manual wargame.
  - Each turn each team of players proposes and argues an action
  - Game outcome does not matter!
- Outputs
  - UUV roles, vignettes, CONEMP

Level of Autonomy and Concept of Use - DMF

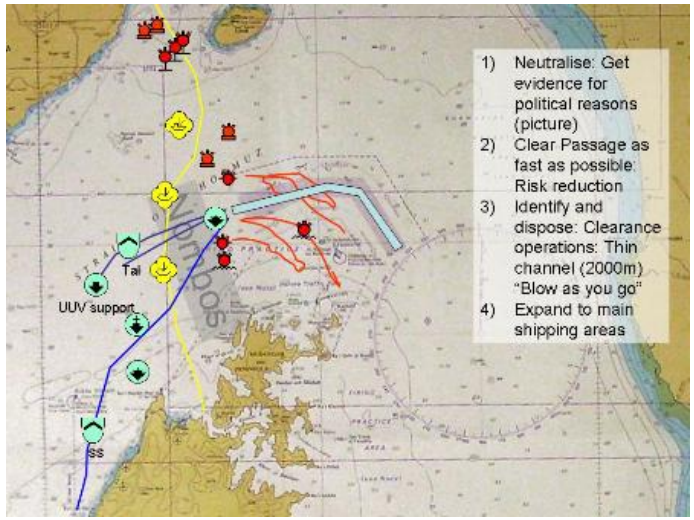
- Earlier presentation by Michele Hughes

- Identify the decisions that could be made during a mission
- Assign attributes to the decisions
- Apply hypotheses to examine balance between human and system decision making
- Conduct sensitivity analysis
- Identify major factors – environment, communications that impact the decision making

- Use results to further develop the Concept of Use

Analysing the Mission – Force Elements & Lines of Development

- Mission and Task Level
- Scenario based gaming and analysis
- Examine & Develop the Concept of Use
- Structure around HLOC & DCF
    - Command, Inform, Prepare, Project Operate, Protect, Sustain
- Identify benefits and challenges
- Develop the concept into a Force Element
- Consider the Lines of Development
    - Training, Equipment, Personnel, Infrastructure, Organisation, Information, Logistics
- Simple Performance Modelling



Experimentation and MCDA

Network Integration Test and Experimentation Works - NITEworks

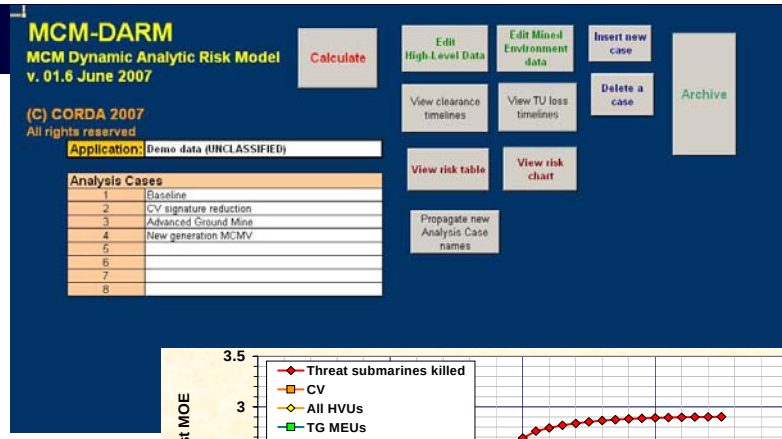
- 2005 MCM Theme
  - In order to enable the UK Maritime Force in a coalition operation to achieve timely theatre access, what specific military value is provided to the MCM capability in the 2008 to 2010 timeframe by UUVs, an Underwater Networking Capability and C4I improvements.
  - Successfully compared a number of UUV options
  - MOEs of Flexibility, Clearance, and Pace
- 2007 FASST Theme
  - Looking at Influence Sweeping

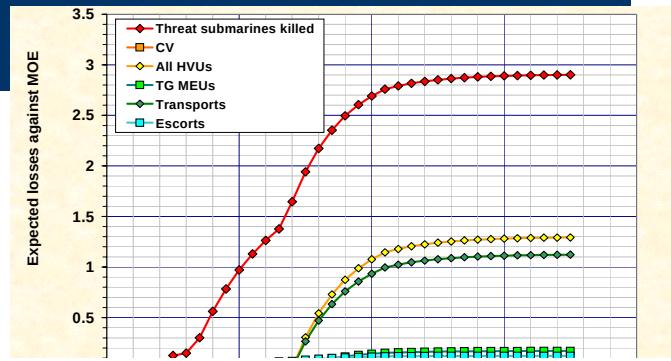
Multi-Criteria Decision Analysis

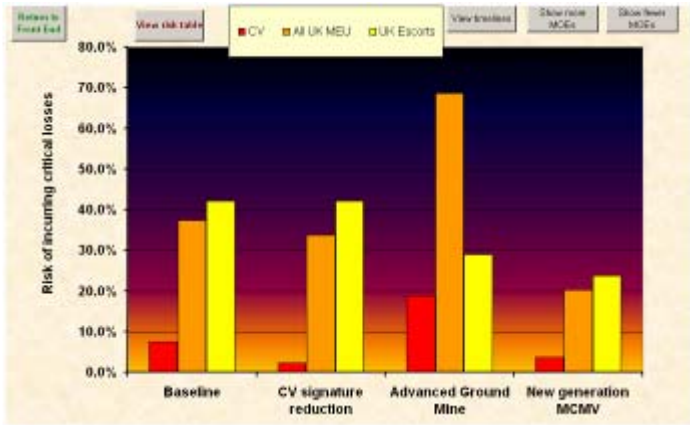
- Alternative focussed MCDA to compare concept options
- Value focussed MCDA to match against requirements

Estimating Effectiveness – MCM DARM

- MCM Dynamic Analytic Risk Model
- Scenario Level Model
  - Single Warfare Area
- Assessment of Capability
  - Combines Force Elements to achieve required effects
  - Effects required in MCM are ships surviving
  - Focus is on the risk that the ships do not survive
- Uses
  - Evaluate capability shortfalls and opportunity
  - Impact of savings and enhancement options
  - Generate benchmarks for Capability Audit
  - Capability requirements for key programmes







Final Comment

We may be taking the human out of the battlespace but UMS development is another major contributor to putting the human at the heart of the OA process

Questions ?