
A multi-dimensional Operations Research Approach to investigate future technology innovation, integration and vulnerabilities

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Report Documentation Page

*Form Approved
OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 01 OCT 2003	2. REPORT TYPE N/A	3. DATES COVERED -	
4. TITLE AND SUBTITLE A multi-dimensional Operations Research Approach to investigate future technology innovation, integration and vulnerabilities		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Land Operations Division, DSTO Australia		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited			
13. SUPPLEMENTARY NOTES See also ADM001929. Proceedings, Held in Sydney, Australia on July 8-10, 2003., The original document contains color images.			
14. ABSTRACT			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	UU
			18. NUMBER OF PAGES 18
			19a. NAME OF RESPONSIBLE PERSON

Overview

- Aim of the Study is to support Future Land Warfare Branch of Army HQ in studies of the effects and implications of future technologies
- Our inputs and tools are:
 - Army as a System (AAAS) descriptors of warfare
 - 7 core skills/capabilities
 - Agent Based Distillations (ABD)
 - to explore behaviours
 - Field Anomaly Relaxation (FAR) to identify inconsistencies
 - Historical analysis to identify success factors

Army as a System Descriptors

- A conceptual approach to describing Land Force activity
 - Engagement
 - Information collection
 - Communication
 - Protection
 - Movement
 - Sustainment
 - Decision-making

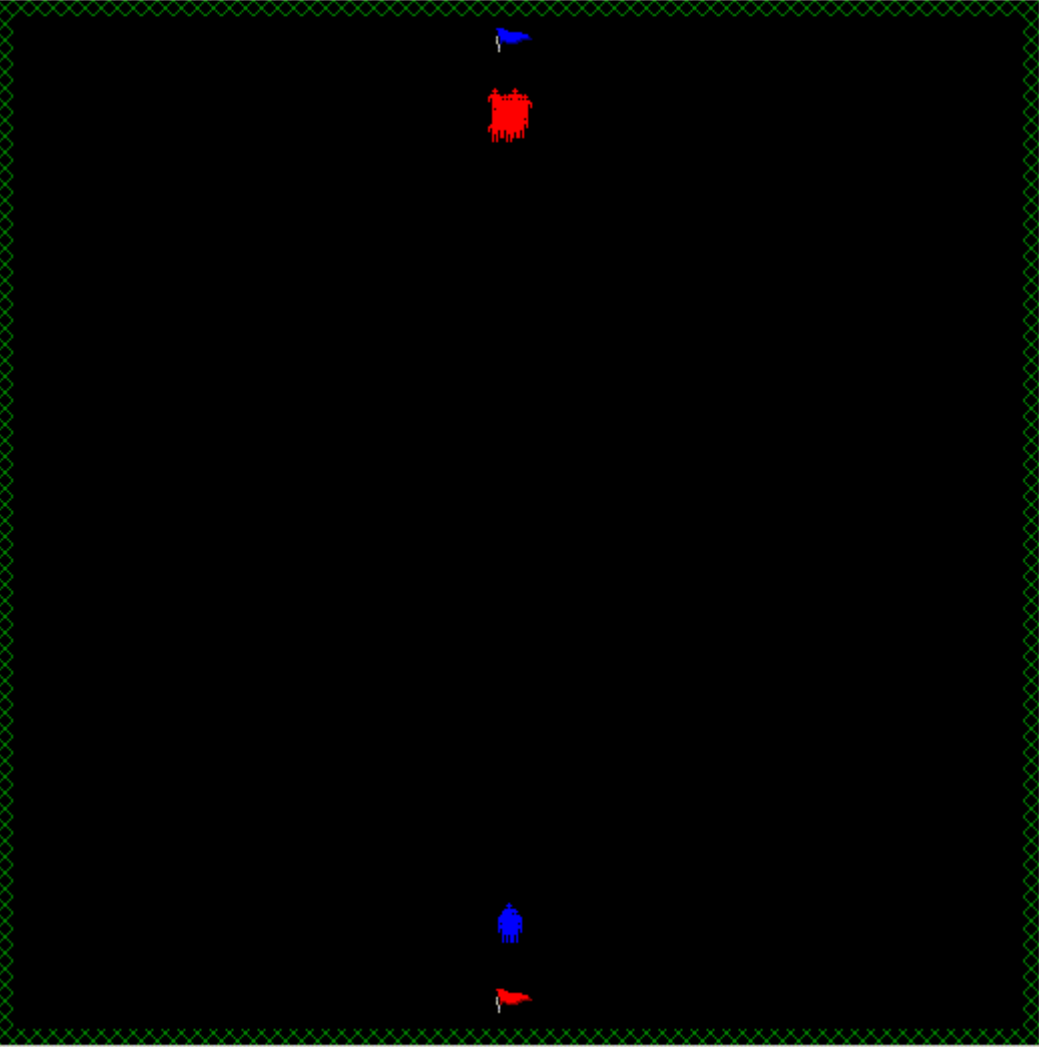
Agent-Based Distillations

- Low-resolution constructive simulations
- Use agent techniques to model behaviour rather than physics
- Use personality vectors and probabilistic rules to control behaviour
- Aims to show emergent behaviour for conceptual insight rather than realism for prediction
- We have used MANA, developed by Stephen, Anderson and Lauren from New Zealand's Defence Technology Agency



MANA - SK30

File Setup Display View Extra Data Help



Pause **Run**

MultiRun **Reset**

Step Delay[ms]
25

Max. Steps
500

Seed
-870369133

Lock

Width: 200 Height: 200
Sound Flags LOS BG Int Fire
Dead Anim Path Netcentric
STOPPED
RecAgtS RecStaps RecDets
RecLocs RecMDets RecNet

Terrain= BilliardTable, Elevation= 0.0m 199, 9 0.0, 0.0 Step: 0 Run: 1

The Field Anomaly Relaxation (FAR) Approach

- Uses Rhyne's FAR methodology as a means of manipulating data (not for futures projection)
- Use the AAAS descriptors as sectors
- Classify levels - Eg engagement (E) E_1 (poor) - E_4 (good)
- The skills are not independent
 - can you have E_4 and P_4 ? ie perfect weapons against perfect protection - an **anomaly**
 - assists - a high value in a field enhances value in another
- Resources or other constraints, additional to FAR calculations, will lead to other reasons why you can't have a perfect $E_4 I_4 S_4 C_4 P_4 M_4 D_4$

The FAR approach (2)

- How many combinations?
 - If 3 levels then 3^7 possibilities
 - = 2187
 - If 4 levels - 4^7 possibilities
 - = 16384
- FAR allows us to eliminate many of these possibilities
- Goal is to use FAR to develop plausible combinations of core skills
 - These could be potential concepts ie put words around a combination eg $E_4I_3S_2C_3P_2M_4D_2$ = first in light strike force

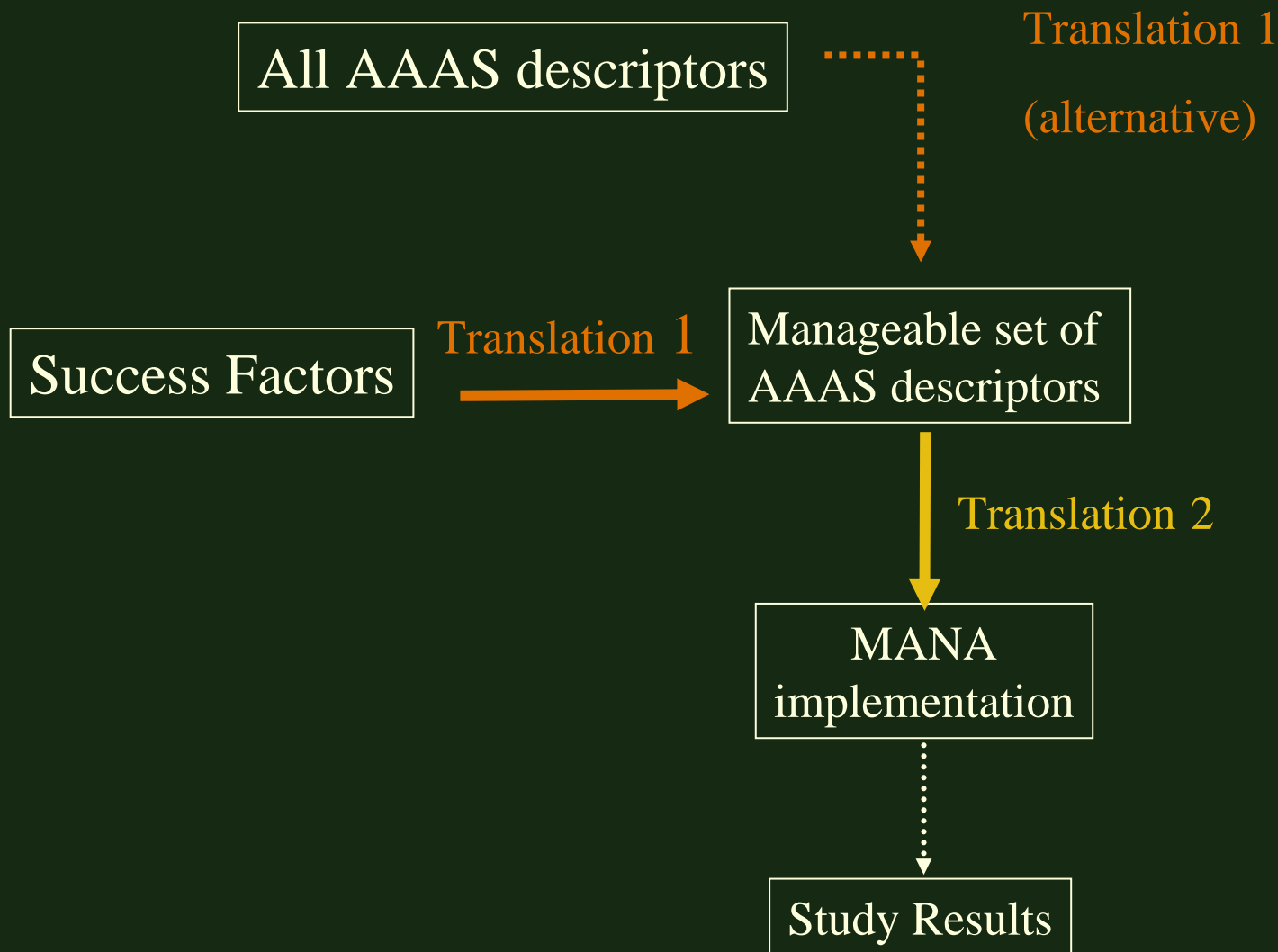
The Historical Analysis Approach - Success Factors

Based on quantitative analysis, you must have these to achieve success, or to avoid failure:

1. Surprise
2. Shock
3. Aggressive Reconnaissance
4. Air Superiority
5. Intelligence
6. Logistics
7. Command, Control and Communication (C³)
8. Mobility
9. Special Forces
10. Attack Reserves
11. Commanders Intention
12. Defence Frontage
13. Defence Effectiveness
14. Attack Boldness

Adapted from Speight, Rowland and Keys, MOR, 1997

Approach taken in our studies



Translation 1 - Success factors to AAAS descriptors

Expert opinion gives us the translation in terms of the effect on the “**differential**” between blue and red

	E	I	C	P	M	S	D
Surprise							
Shock							

Where darker is larger contribution

Engagement Information collection Communication Protection
Movement Sustainment Decision-making

Rationales for success factor translations - surprise

- When surprised, it takes some time to re-orientate.
 - Blue force is prepared and everything is in place with clear purpose
 - When shot at, the sensor range and movement speed of red force are degraded.

Rationales for success factor translations - shock

- Shock is evident when the adversary is able to react to an attack but does not.
 - Blue has overwhelming directed firepower and clear purpose
 - When the enemy section is shot at, their sensor range and firing range are degraded, and the degraded values remain in place for a certain duration (varied through the experiment).

Translation 1 - Success factors to AAAS descriptors 2

So if we start from a “neutral” state of $E_2I_2S_2C_2P_2M_2D_2$, then we can propose indicative new states

	New blue state	New red state
surprise	$E_{2.5}I_{2.5}S_2C_3P_2M_{2.5}D_3$	$E_{2.5}I_{1.5}S_2C_1P_2M_{1.5}D_1$
	Large gain for C and D lesser for I and M	Large loss for C and D lesser for I and M
shock	$E_3I_{2.5}S_2C_2P_2M_{2.5}D_3$	$E_{1.5}I_{1.5}S_2C_2P_2M_{1.5}D_1$
	Large gain for E and D lesser for I and M	Large loss for E and D lesser for I and M

Engagement Information collection Communication Protection
Movement Sustainment Decision-making

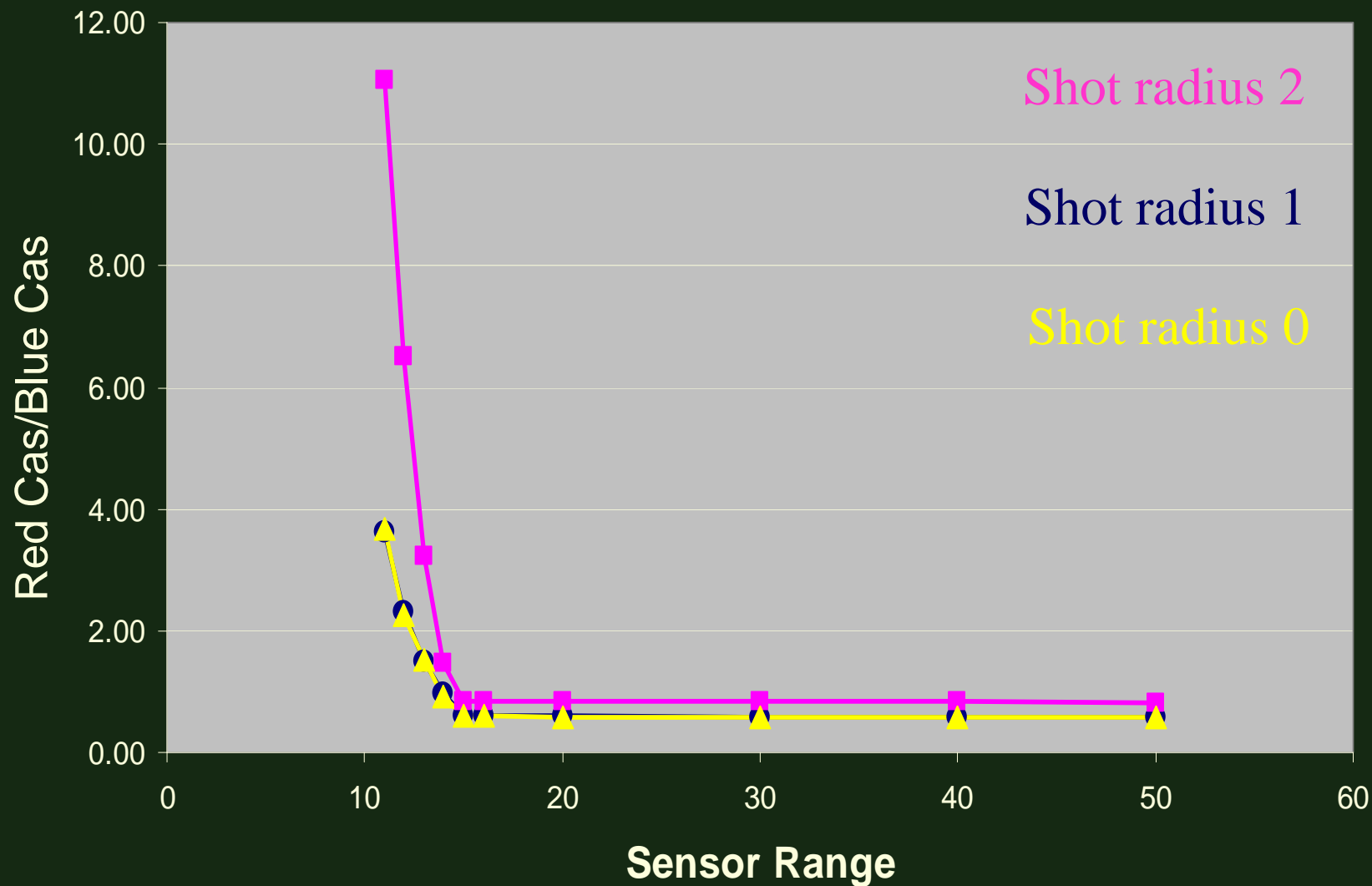
Translation 2 - AAAS descriptor to MANA factor

		Movement speed	Sensor range	Firing Range	Duration of state
Surprise	Initial value	200	50	15	
	“Shot at” State	0, 5, 10, 50, 100, 500	11-16, 20, 30, 40, 50	15	2
Shock	Initial value	100	20	15	
	“Shot at” State	100	0, 2, 4, ..., 20	0, 2, 4, ..., 16	1-5

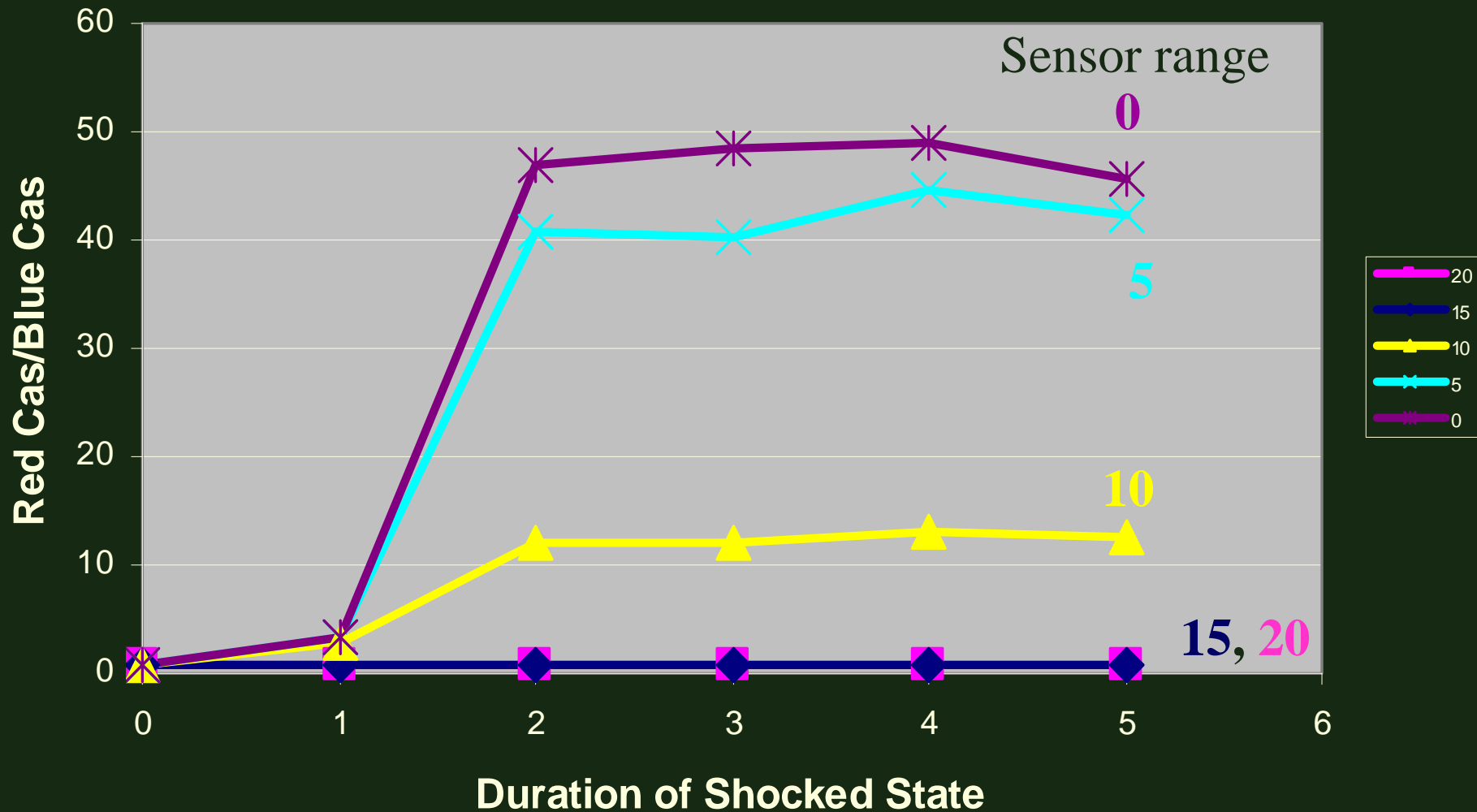
Studies - scenarios tested in MANA

- Elementary scenarios based on the Army Tactical Tasks
- Small squads (up to 30)
- Simple behaviour
 - action on contact
 - ambush
 - raid
 - etc

Preliminary results for Surprise



Preliminary results for Shock



Further Work

- Continue with other success factors
- Parametric studies with individual AAAS descriptors
- Ditto with combinations (play off to find “best”)
- Tactics
- Develop new concepts based on tactics and combinations of AAAS descriptors
 - Eg $E_3 I_3 C_1 P_1 M_3 S_1 D_2$ (highly mobile lethal strike but not sustainable)