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Development of TOSOM Threat Trees

Alan A. Anderson
Signature Research, Inc
(719) 272-7267

www.signatureresearchinc.com

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE 19 MAR 2003	2. REPORT TYPE Presentation	3. DATES COVERED 19-03-2003 to 19-03-2003	
4. TITLE AND SUBTITLE Development of TOSOM Threat Trees		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Alan Anderson		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Signature Research, Inc., P.O. Box 346, 56905 Calumet Avenue, Calumet, MI, 49913		8. PERFORMING ORGANIZATION REPORT NUMBER ; #16164	
		10. SPONSOR/MONITOR'S ACRONYM(S) TARDEC	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army TARDEC, 6501 East Eleven Mile Rd, Warren, Mi, 48397-5000		11. SPONSOR/MONITOR'S REPORT NUMBER(S) #16164	
		12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited	
13. SUPPLEMENTARY NOTES			
14. ABSTRACT TOSOM = Threat oriented Survivability Optimization Model			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	Public Release
			18. NUMBER OF PAGES 25
			19a. NAME OF RESPONSIBLE PERSON

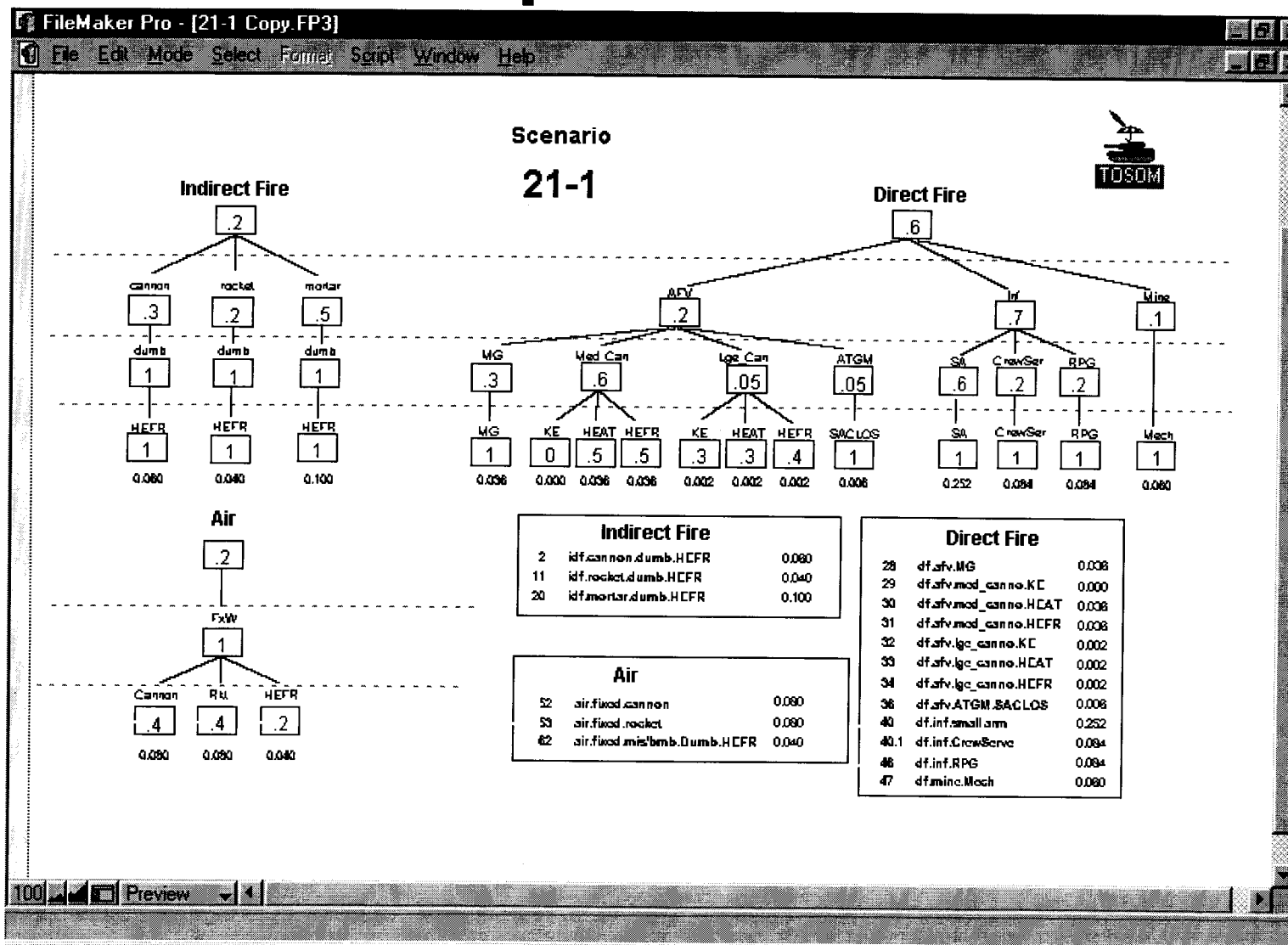
What is TOSOM?

- TOSOM = **T**hreat **O**riented **S**urvivability **O**ptimization **M**odel.
- PC Based Decision Support Tool developed for TARDEC.
- Designed as a front-end “filter” to help the analyst select survivability enhancements.
- Used to support, among others, the Crusader, RST-V, AAV and LAV programs.

What are Threat Trees?

- Representations of possible threat environments for specific vehicle systems.
- Assumes an encounter will take place - weights the likelihood of specific encounters under predicted conditions.
- Output is the weighted expected likelihood of system loss.

Example Threat Tree



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Then What?

- Compare the available or projected countermeasures (with their associated predicted effectiveness against the various identified threats) and the vehicle “budgets” (\$’s, space claim, weight, etc.)
- Generate a list of possible countermeasure suites with associated predicted effectiveness and costs.

Back to the Focus of this Paper - development of the Threat Trees!

- THE MAJOR ISSUE - DATA! What do I need and how do I get it?
- Encounter Data
- Consequence Data
 - Probability of Trigger Pull
 - Probability of Hit (P_h)
 - Probability of Kill (P_k)

TOSOM Threat Data Review

Population DATA

Threat
Encounter
Distribution
-type
-frequency

Scenario
and
Assessment
Driven

Performance DATA

Probability of
Acquisition

Probability of
Hit

Probability of
Kill

Sensor
and
Weapon
Driven

Data Assumptions

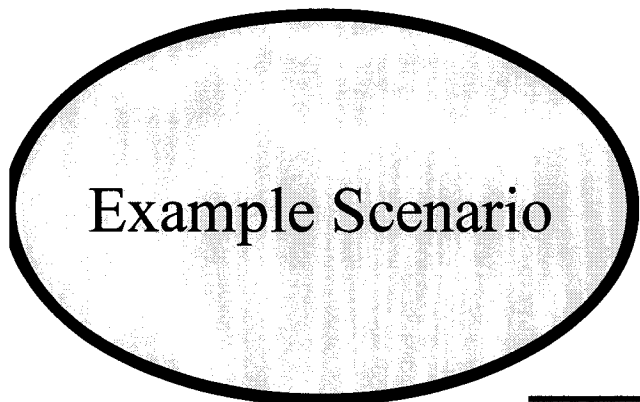
- Data from previous studies, (originally from AMSAA), is acceptable
- Using surrogates for unavailable weapons, (documented), is acceptable
- Indirect fire weapon aiming errors and mission profiles are constant through out vignette(s)
- Use of performance data extracted from existing approved models is acceptable.

Encounters

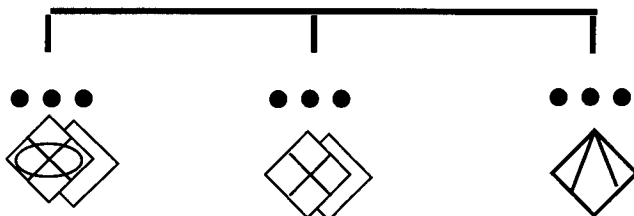
TOSOM works under the assumption that a single encounter occurs. An encounter is defined as a “survivability event” - an event that has the potential of disabling or destroying the vehicle. It is not necessarily a single round or munition. Given an encounter, what was it with?

Scenarios and Vignettes

- Scenarios and Vignettes provide the level of detail needed to support use of models and simulations to conduct...weapon systems analyses.
- Using existing scenarios provides an environment where threat distribution can easily be determined and where the operational context can be derived.



Red TO / Capabilities
Non-Enhanced DPG



- 3 IFV
- 4 82 MM Mort
- 2 RPOA
- 1 MANPAD
- 3 RPG 7
- 24 AK-47
- 1 SVD
- 3 RPK-74

- 2 RPOA
- 1 MANPAD
- 3 RPG7
- 24 AK-47
- 2 SVD
- 3 RPK-74

- 6 Towed 100mm
- 7 MTLBT Prime Mover
- 1 SPT Truck
- 1 Cargo Trailer
- 1 GSR
- 2 Laser Rangefinder
- 6 RPG
- 8 9mm PM
- 44 Ak-47
- 52 personnel

EN Effort


Prepared Defense / Positions

3x Decoys

Obstacles prepared for Emplacement

UNCLASSIFIED

Supporting Assets

● ● ●
 X 2
 3 TANKS

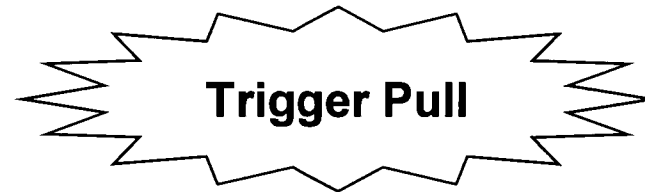


Example of Data Base Table

Index	Category	Wpn Description	Database Wpn Used	Averaged Result
2	idf.cannon.dumb.HEFR	2S1 122mm How w/HEFR WAC-21 155mm How w/HEFR D-20 152mm How w/HEFR M-46 130mm Gun w/HEFR D-30 122mm How w/HEFR	OF-24/122mm vs. LAV 155 HOW/HE vs. LAV MAS-D/152mm vs. LAV ER-428/130mm vs. LAV OF-24/122mm vs. LAV	.116
31	df-afv-mdc-HEFR	B-10 82 mm RCLG w/HEAT BMP-2 30mm HE Frag PT-76 w/76 mm HEAT	BK-881m (82mm HE) vs LAV BMP2 30 mm vs AAV SPG-9 vs. M113 PG-15P (73mm HE) vs LAV	.318

Threat Performance Analysis

- Probability of Acquisition (RSTA)
 - Detect
 - Recognize
 - Identify
- Probability of Hit/Kill
 - Attack Angle Distributions
 - Range Distributions
 - Data Mining



Probability of Trigger Pull (P_{tp})

- This is sort of a rolled up probability of detection /recognition /classification /identification, etc. The probability that a threat will obtain enough information to take a shot at our vehicle.
- For the base (untreated) case, assume $P_{tp} = 1.0$. Treatments/countermeasures may degrade this value.

P_h

- Can be developed using CASTFOREM routines.
- Direct Fire - Some already exist, others generated using vehicle dimensions.
- Indirect Fire - HE & DPICM can be extracted from CASTFOREM.
- Indirect Smart - developed from MLP Data from PM-GSI program.

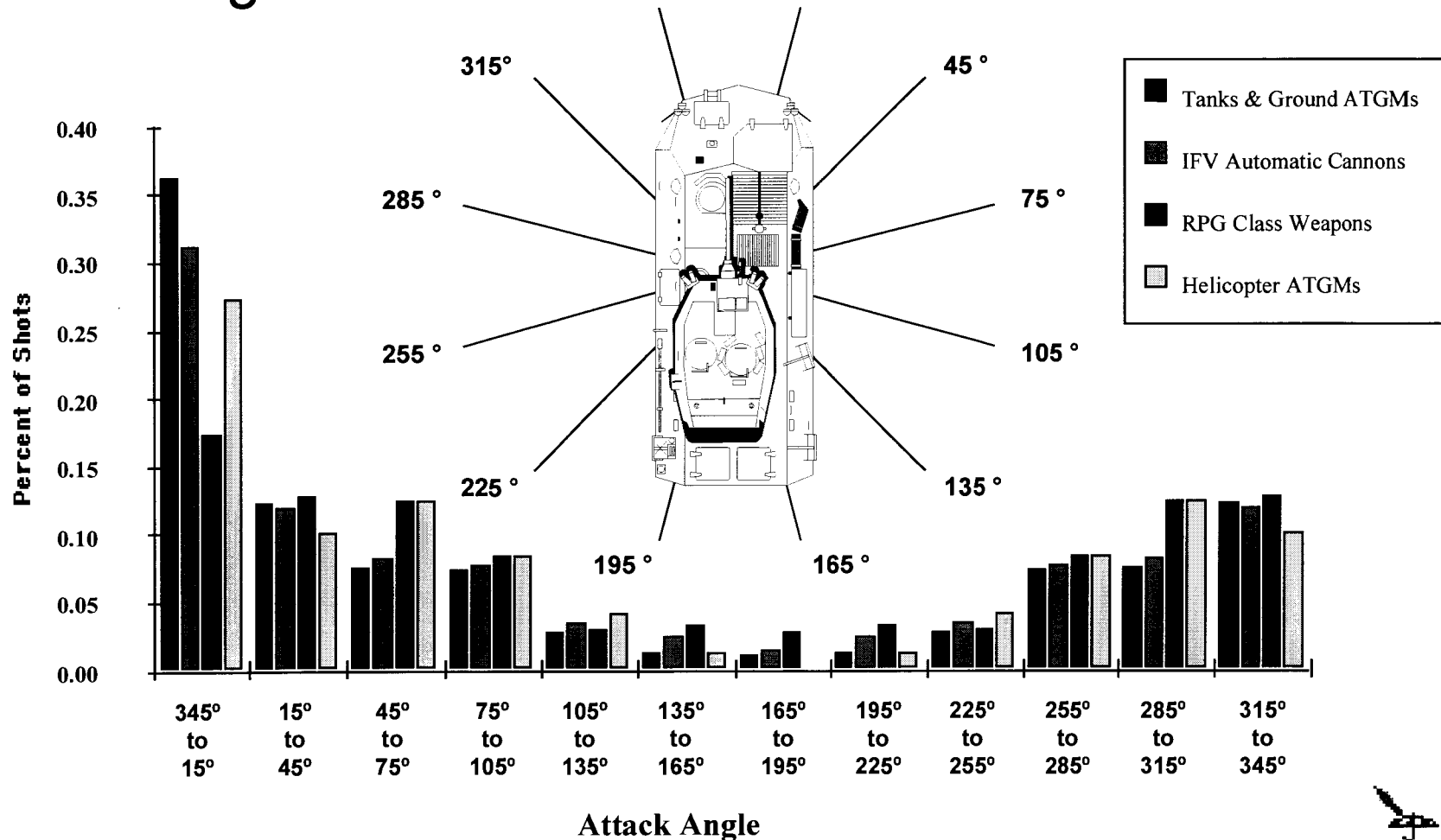
CASTFOREM P_n Tables

Range	Exposure HD = 1 FE = 2	Firer Motion S=1 M=2	Target Motion S=1 M=2	0P	30P	60P	90P	120P	150P	180P
500	1	1	1	0.787	0.816	0.817	0.811	0.817	0.816	0.787
500	1	1	2	0.888	0.895	0.895	0.895	0.895	0.895	0.888
500	1	2	1	0.761	0.795	0.797	0.788	0.797	0.795	0.761
500	1	2	2	0.848	0.862	0.862	0.860	0.862	0.862	0.848
500	2	1	1	0.942	0.964	0.965	0.96	0.965	0.964	0.942
500	2	1	2	0.989	0.994	0.994	0.994	0.994	0.994	0.989
500	2	2	1	0.921	0.949	0.95	0.944	0.95	0.949	0.921
500	2	2	2	0.973	0.983	0.983	0.981	0.983	0.983	0.973
625	1	1	1	0.739	0.783	0.785	0.773	0.785	0.783	0.739
625	1	1	2	0.815	0.841	0.842	0.837	0.842	0.841	0.815
625	1	2	1	0.707	0.758	0.761	0.746	0.761	0.758	0.707
625	1	2	2	0.77	0.806	0.807	0.798	0.807	0.806	0.77
625	2	1	1	0.905	0.941	0.943	0.933	0.943	0.941	0.905
625	2	1	2	0.958	0.977	0.977	0.974	0.977	0.977	0.958
625	2	2	1	0.874	0.918	0.921	0.908	0.921	0.918	0.874
625	2	2	2	0.926	0.954	0.955	0.948	0.955	0.954	0.926
750	1	1	1	0.694	0.751	0.755	0.736	0.755	0.751	0.694
750	1	1	2	0.742	0.792	0.795	0.78	0.795	0.792	0.742

Engagement Range Distributions

- Driven by (among other factors) Threat Sensor and Weapon performance.
- Models tend to engage at maximum range
- Estimates may be necessary.

DUSA(OR) Approved Horizontal Attack Angle Distributions for Armored Vehicles



P_k

- Some Individual Unit Action (IUA) data sets available.
- Extensive data available from ELAN libraries.
- CASTFOREM data
- AMSAA data

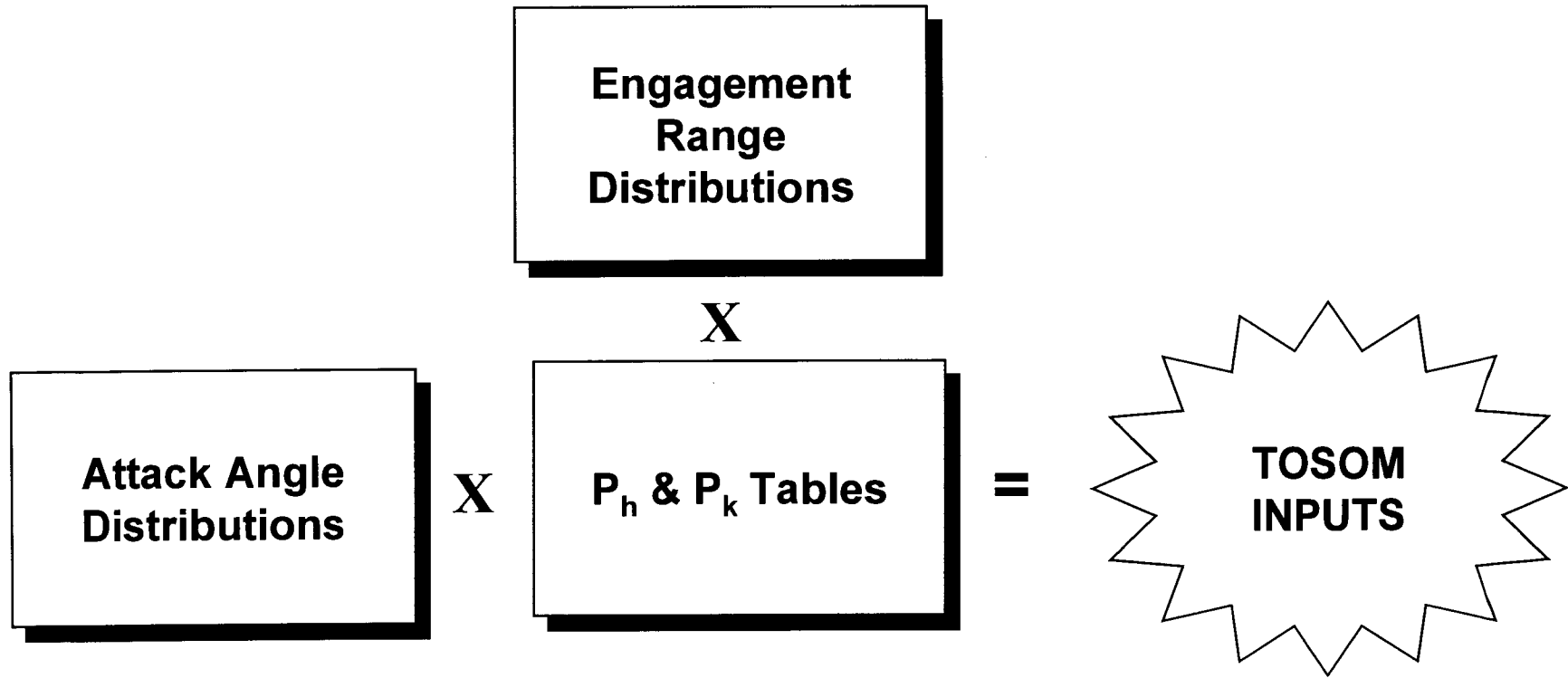
IUA Data

Range	HD=1 FE=2	Disp (ft)	Kill Type	0 P	30 P	60 P	90 P	120 P	150 P	180 P	Cardiod Avg.
250	1	1	1	0.976	0.976	0.976	0.980	0.980	0.980	0.976	0.976
250	1	1	2	0.984	0.988	0.988	0.984	0.984	0.984	0.980	0.984
250	1	1	3	0.984	0.988	0.988	0.984	0.984	0.984	0.980	0.984
250	1	1	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	2	1	0.972	0.972	0.972	0.972	0.976	0.976	0.972	0.972
250	1	2	2	0.980	0.984	0.984	0.980	0.980	0.984	0.980	0.980
250	1	2	3	0.980	0.984	0.984	0.980	0.980	0.984	0.980	0.980
250	1	2	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	3	1	0.972	0.969	0.972	0.972	0.976	0.972	0.972	0.972
250	1	3	2	0.980	0.980	0.984	0.980	0.984	0.980	0.980	0.980
250	1	3	3	0.980	0.980	0.984	0.980	0.984	0.980	0.980	0.980
250	1	3	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	4	1	0.972	0.969	0.969	0.972	0.972	0.972	0.972	0.972
250	1	4	2	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
250	1	4	3	0.980	0.980	0.980	0.980	0.980	0.980	0.980	0.980
250	1	4	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	5	1	0.972	0.969	0.969	0.969	0.972	0.972	0.972	0.969
250	1	5	2	0.980	0.980	0.980	0.976	0.980	0.980	0.980	0.976
250	1	5	3	0.980	0.980	0.980	0.976	0.980	0.980	0.980	0.976
250	1	5	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	6	1	0.972	0.969	0.969	0.969	0.972	0.972	0.972	0.969
250	1	6	2	0.980	0.976	0.980	0.976	0.980	0.980	0.980	0.976
250	1	6	3	0.980	0.976	0.980	0.976	0.980	0.980	0.980	0.976
250	1	6	4	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
250	1	7	1	0.972	0.969	0.969	0.969	0.972	0.972	0.972	0.969

Kill Type
1 = M kill
2 = F kill
3 = M or F kill
4 = K kill



Rolling Up the Data




Consequence Data Inputs

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File Edit Mode Select Format Script Window Help

**Scenario
21-1**



		P _{enc}	P _{soq}	P _{hit}	P _{kill}	P _{lethal}
2	idf.cannon.dumb.HCFR	0.060	1.000	1.000	0.062	0.004
11	idf.rocket.dumb.HCFR	0.040	1.000	1.000	0.022	0.001
20	idf.mortar.dumb.HCFR	0.100	1.000	1.000	0.133	0.013
28	df.afv.MG	0.036	1.000	1.000	0.651	0.023
29	df.afv.mod_canno.KC	0.000	1.000	1.000	0.418	0.000
30	df.afv.mod_canno.HCAT	0.036	1.000	1.000	0.281	0.010
31	df.afv.mod_canno.HCFR	0.036	1.000	1.000	0.296	0.011
32	df.afv.lge_canno.KC	0.002	1.000	1.000	0.399	0.001
33	df.afv.lge_canno.HCAT	0.002	1.000	1.000	0.230	0.000
34	df.afv.lge_canno.HCFR	0.002	1.000	1.000	0.230	0.001
36	df.afv.ATGM.BACLOS	0.008	1.000	1.000	0.580	0.003
40	df.inf.small arm	0.252	1.000	1.000	0.136	0.034
40.1	df.inf.CrowServe	0.094	1.000	1.000	0.512	0.043
46	df.inf.RPG	0.094	1.000	1.000	0.459	0.039
47	df.mine.Mech	0.060	1.000	1.000	0.200	0.012
52	air.fixed.cannon	0.090	1.000	1.000	0.145	0.012
53	air.fixed.rocket	0.090	1.000	1.000	0.138	0.011
62	air.fixed.mis/bmb.Dumb.HCFR	0.040	1.000	1.000	0.053	0.002

Total Lethality= 0.220

100 Preview



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Parting Observations

- Current Scenarios do not incorporate many of the (advanced) postulated future threats.
- Surrogate data is widely used
- Many systems currently under study do not primarily rely on Armor for protection.

For More Information:

- TOSOM Website
- or contact:
 - TARDEC
 - Mr. Jack Reed (586)753-2562
 - Dr. Bill Jackson (586)574-6467

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FAX TO: (586) 978-3131

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14th Annual TARDEC Ground Vehicle Survivability Symposium
Naval Postgraduate School, Monterey, CA
April 7-10, 2003

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Title of Presentation: Development of FOSOM Threat Trees ID# 5006

Presenter(s): Alan Anderson

Organization Name: Signature Research, Inc

Classification of Presentation: Unclassified

Presentation based on Independent Research & Development (IR&D): NO YES (If yes, complete next line).

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