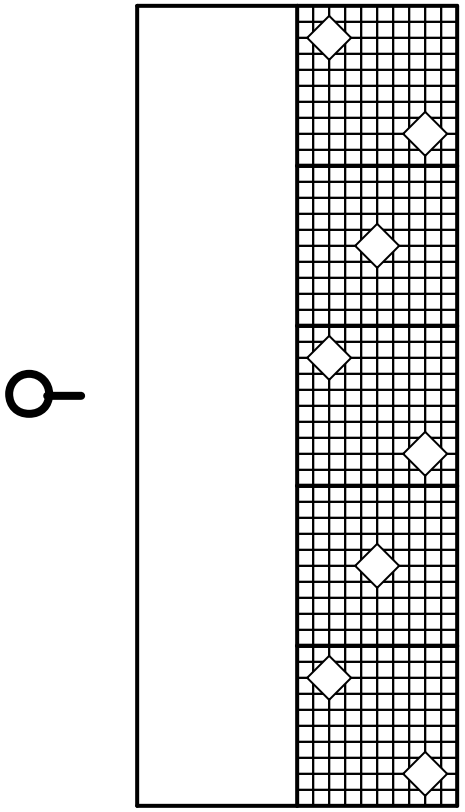
AAAV 30mm HE Lethality Testing

Test procedures and casualty models

Outline

- Target
- Test Objectives
- Test Set-up
- Models Used
  - JMEM
  - ComputerMan
  - ORCA
- Data Collection
- Model Results
- Data Evaluation and Results
- Summary

AAAV ORD Infantry Target



- Eight man infantry squad on line
- Infantry deployed in 10 x 50 meter area, with preceding 10 x 50 meters as part of target area
- Range 1500 meters

Test Objective

Determine the most effective high explosive round

or combination of rounds

against the AAAV ORD Infantry target

Test Ammunition

Tested eight different types of HE rounds or combination of rounds

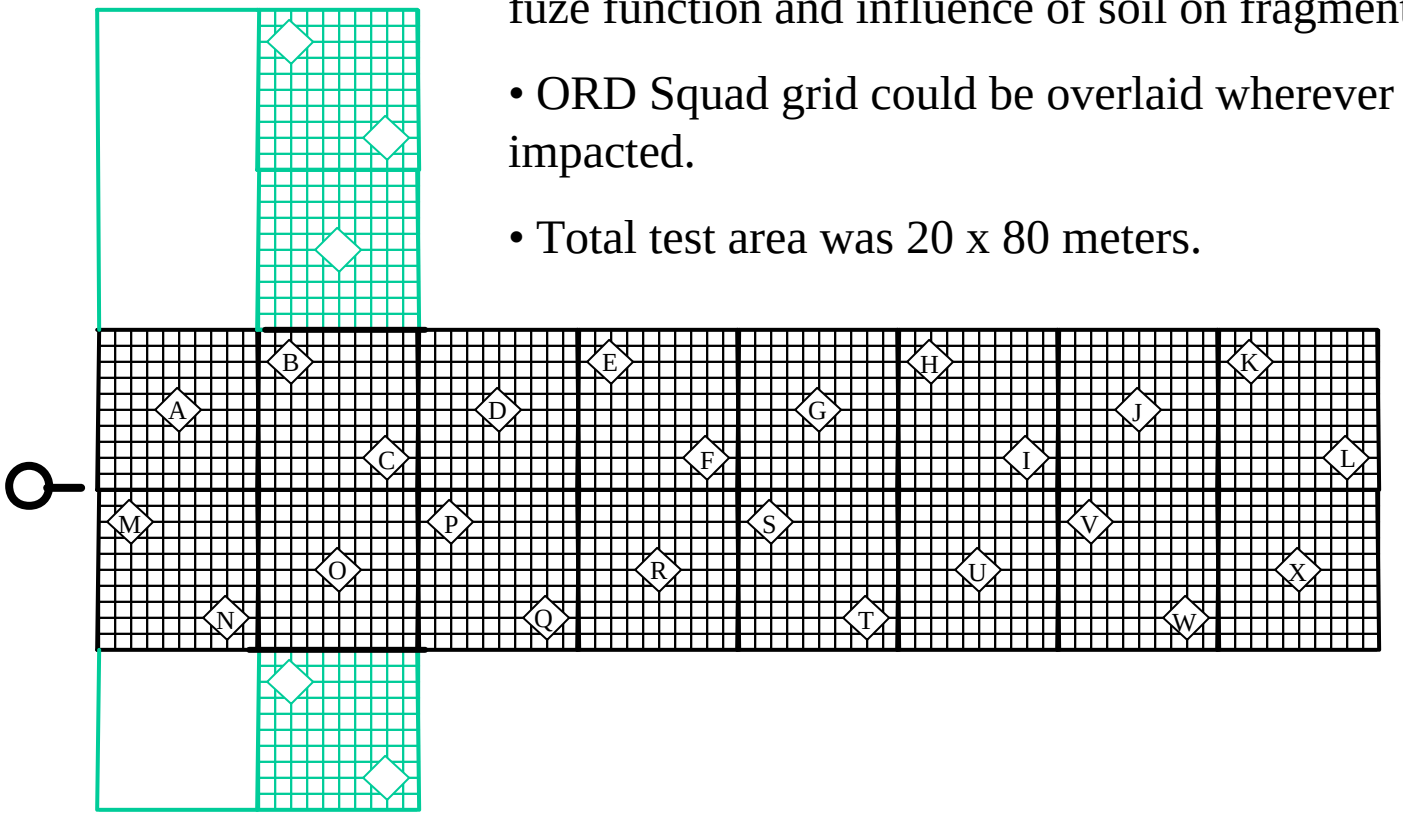
Test Set-up

• 20 meter wide section of squad stacked in depth to increase probability of round impact within test area.

• Left column on hard clay road, right column in soft sand. Goal was equal number of rounds in each column, evaluate fuze function and influence of soil on fragment dispersion.

• ORD Squad grid could be overlaid wherever round impacted.

• Total test area was 20 x 80 meters.



Test Mannequins

- Ballistic mannequins constructed of 7-ply marine grade plywood.
- Each mannequin equipped with Kevlar PASGT vest and helmet.

Three Models – Three Flavors

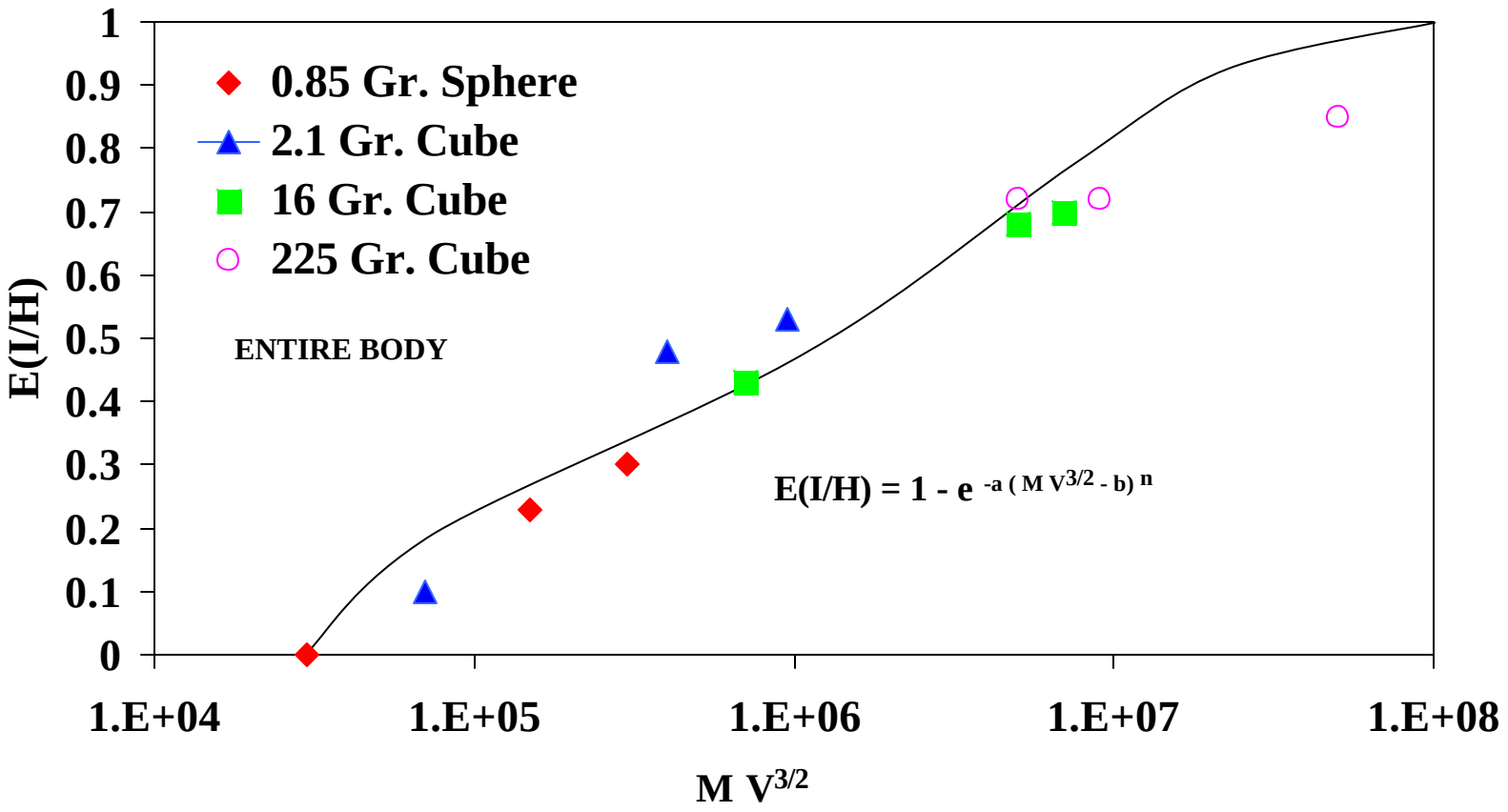


- **Dummy General**
  - Produces JMEM Result
  - Expected Level of Incapacitation given a hit or series of hits
  - Averaged result for a gross anatomical part
  - Preprocessor for ComputerMan and ORCA
- **ComputerMan**
  - Produces a Probability of a Level of Incapacitation for a given tactical scenario at a certain post-injury time
  - Relies on post-injury Limb State/Limb Incapacitation
- **ORCA**
  - Compares insult severity to ability to accomplish certain defined tasks
  - Weighed Task Average provides a ratio of tasks that can be completed versus the total number of tasks to be completed

Dummy General (DumGen)

- Calculates fragment mass and striking velocity
- JMEM Result for both Assault 5 minute & Supply 12 hour tactical role
- Each strike produces an averaged result over an entire body section
- Output is an accumulated result for all strikes on target

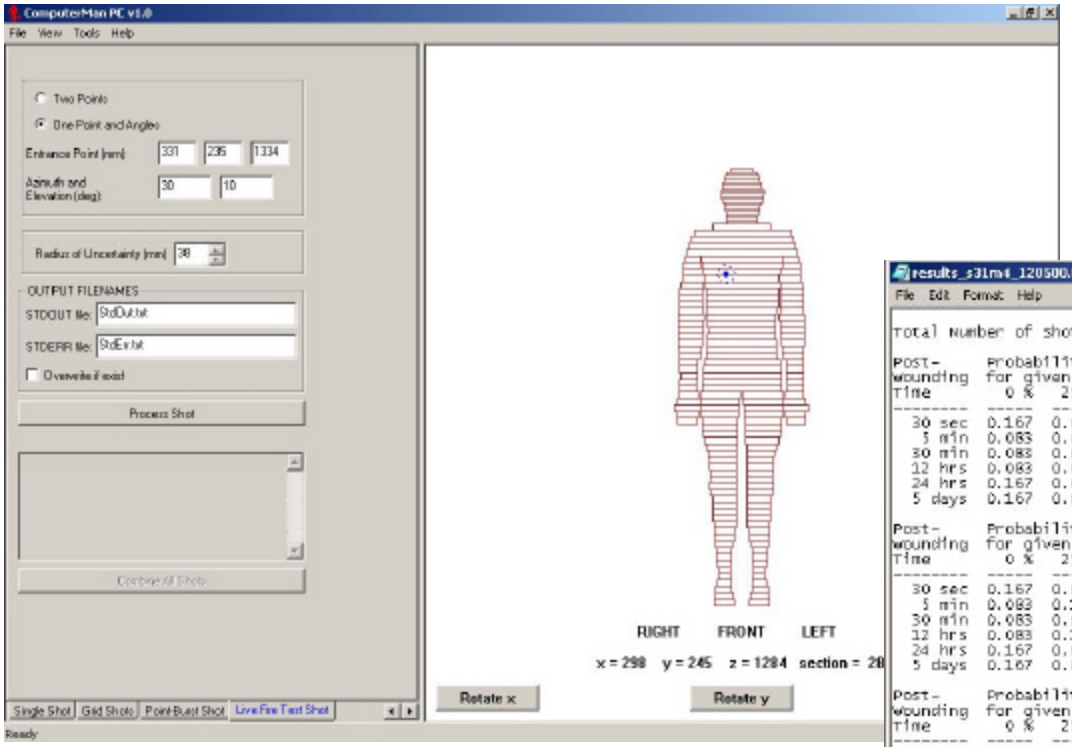
The Incapacitating Effects of Fragment Impacts (Kokinakis & Sperrazza, c. 1965)

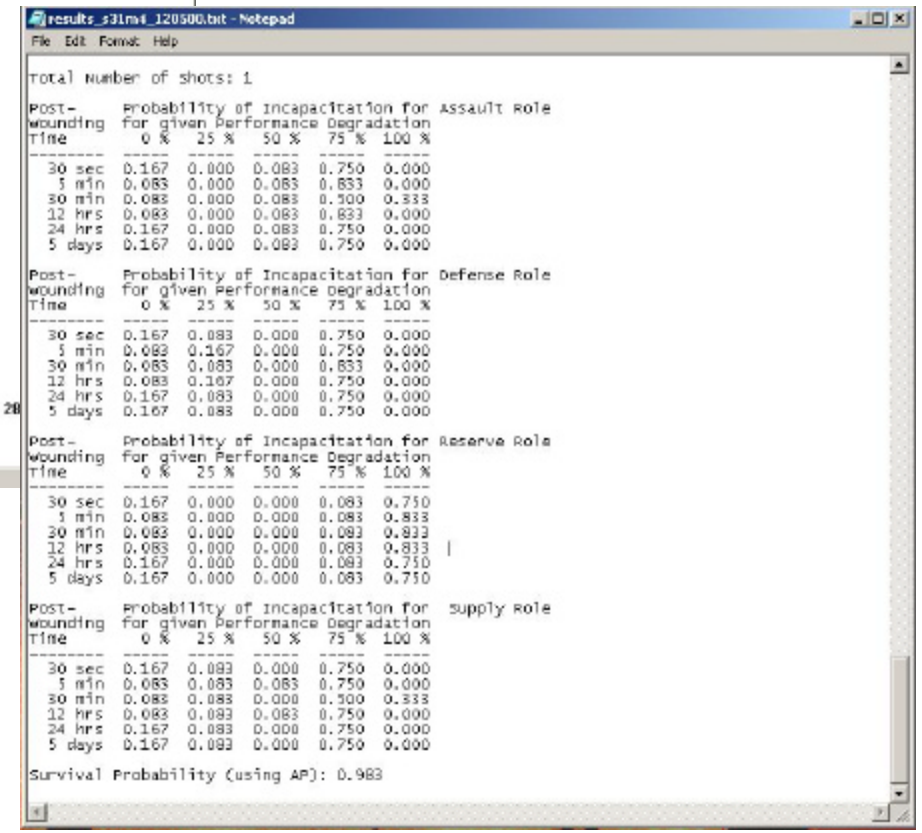


ComputerMan Model

- Discrete shot-line resolution compared to JMEM averaged result
- Detailed anatomical geometry
- Penetration insult only
- Probability of a level of incapacitation for a given tactical scenario
- Requires fragment mass, striking velocity & location
- Requires azimuth and elevation angles for each fragment strike
- Some interpretation required to translate strike location from mannequin to model

ComputerMan Screenshots

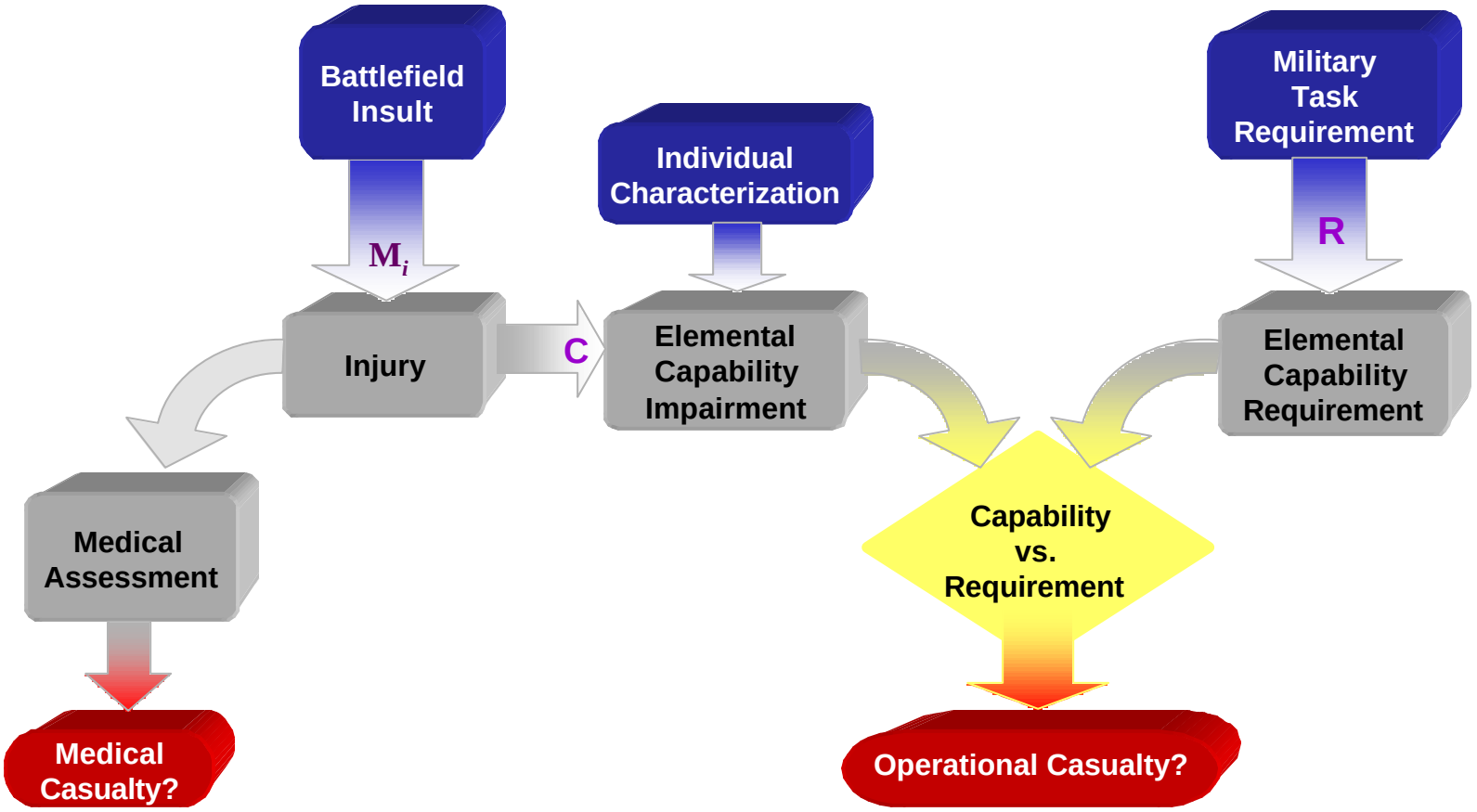




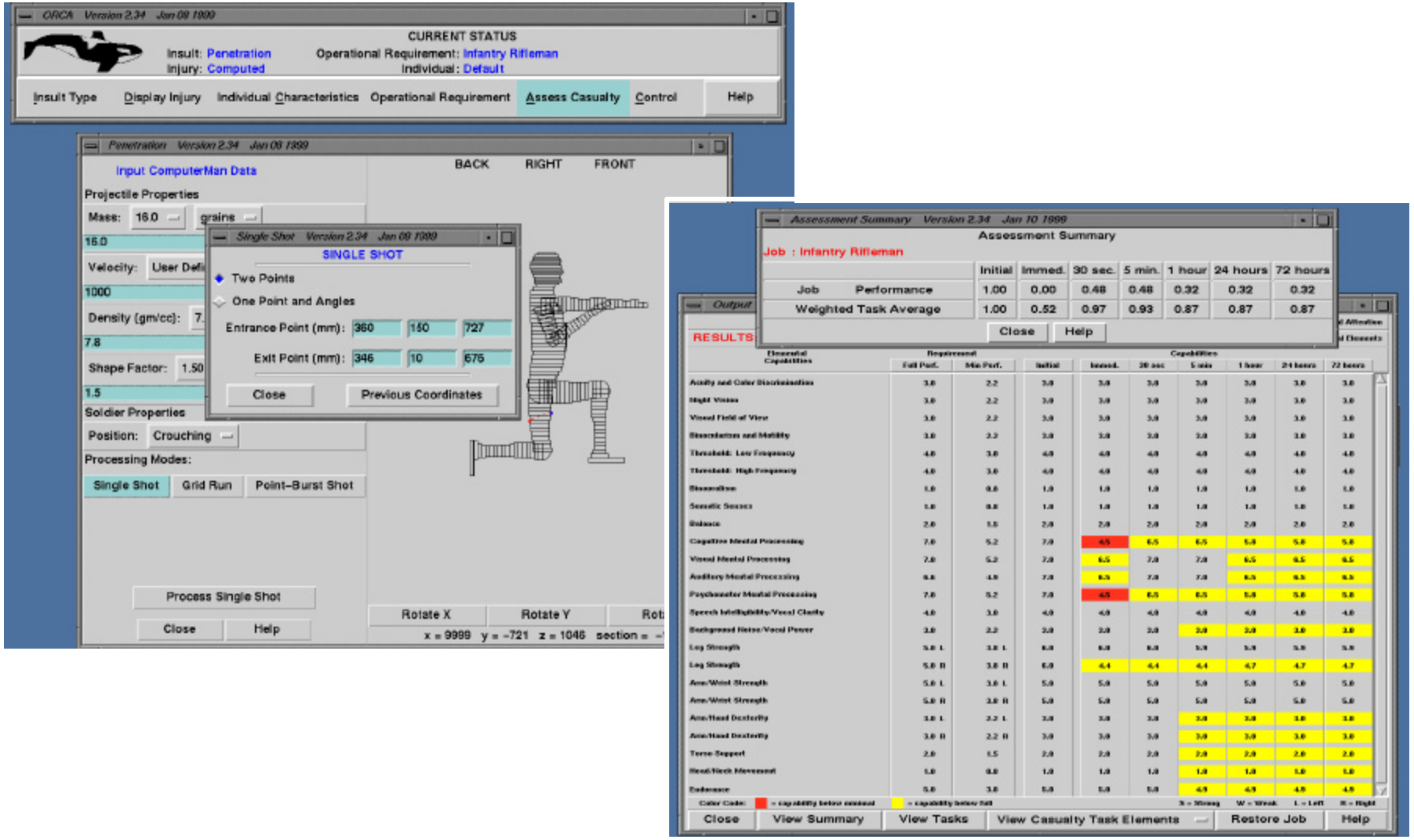
Operational Requirement-based Casualty Assessment Model (ORCA)

- Numerous injuries (insults) addressed
- Strong reliance on adaptation of existing models
- Requires same inputs as ComputerMan
- Uses same anatomical geometry and shot-line convention as ComputerMan
- ORCA requires job definition of target (Infantry Rifleman)

ORCA Casualty Assessment Methodology



ORCA Screenshots



Data Required for Models

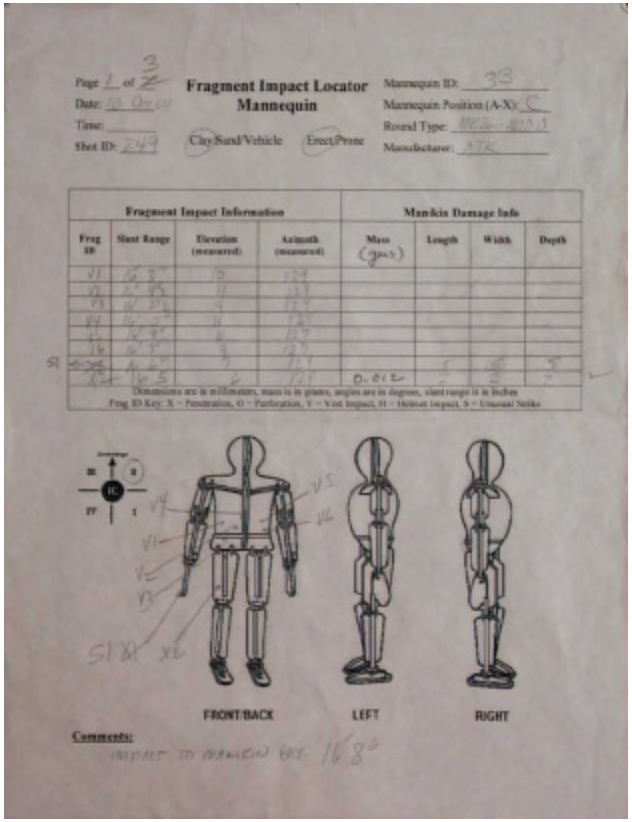
- Fragment impact (strike) location on mannequin
- Shot-line Information
- Fragment mass

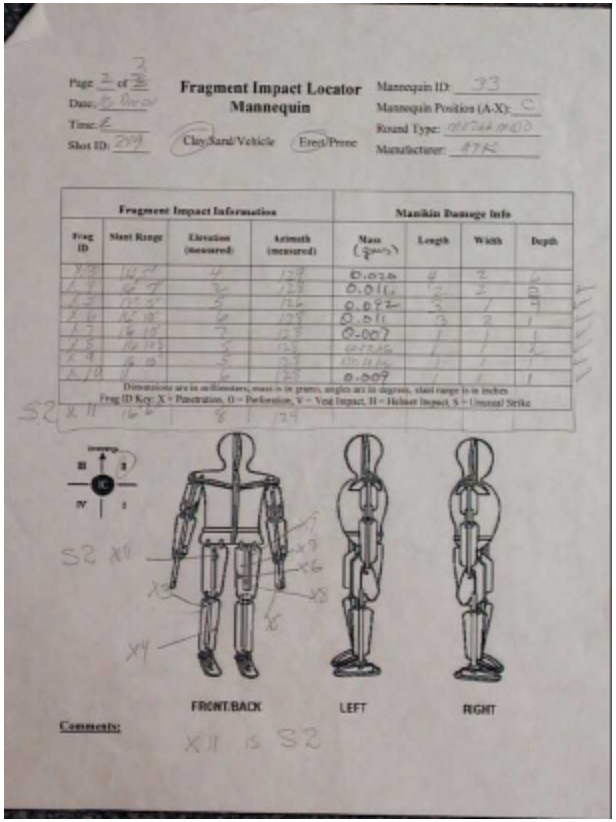
Data Collection

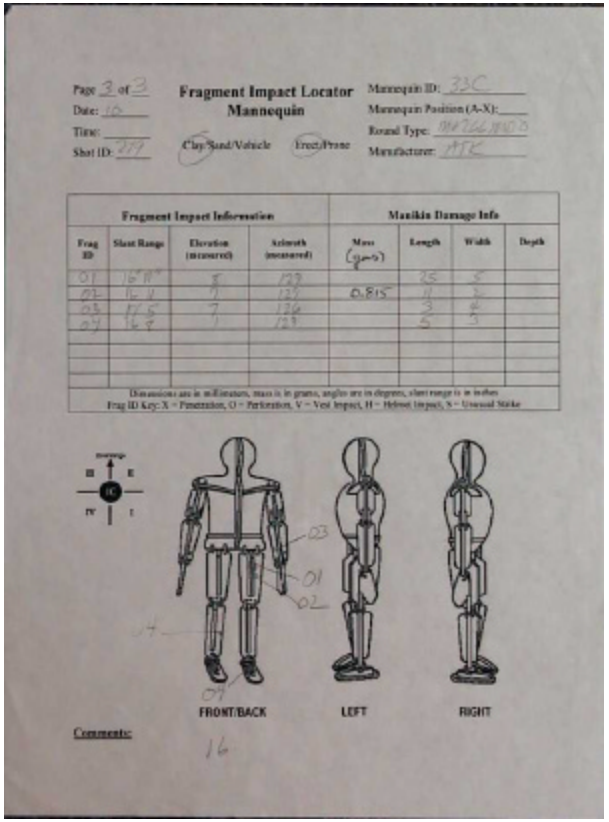
- Fragment Impact Locator sheet
- Strike Logging
- Fragment Data Collection
- Shot-line Information
- Photographic Record
- Hierarchical bagging system

Data Collection (cont.)

Representative Model Results – Field Data







Shot 249, Position C, Mannequin 33

Conversion from Field Data to Model Input

- Determine gross anatomical part affected (DumGen)
- Calculate striking velocity (DumGen)
- Calculate fragment mass if required (DumGen)
- Determine entrance point of fragment (ComputerMan and ORCA)
- Convert measured Azimuth and Elevation angles to model angle convention (ComputerMan and ORCA)

Model Outputs and Filter Process

- Selected specific model outputs to incorporate in analysis
- Focus on 5 minute timeframe, Assault tactical role (ORCA: Infantry Rifleman job)
- JMEM result is in proper “format”
- ComputerMan results for 5 minute Assault role broken down into two probability values
- ORCA 5 minute Weighed Task Average inverted to a measure of “incapacity”

Representative Model Results
Shot 249, Position C, Mannequin 33

DUMGEN Preprocessor JMEM Results	
Assault 5 min E(I/H)	Supply 12 hour E(I/H)
0.95	0.92

ORCA RESULTS	Initial	Immediate	30 sec	5 min	1 hour	24 hours	72 hours
Job Performance	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighed Task Average	1.00	0.04	0.08	0.06	0.03	0.03	0.03

Representative Model Results
Shot 249, Position C, Mannequin 33 (cont.)

ComputerMan Results

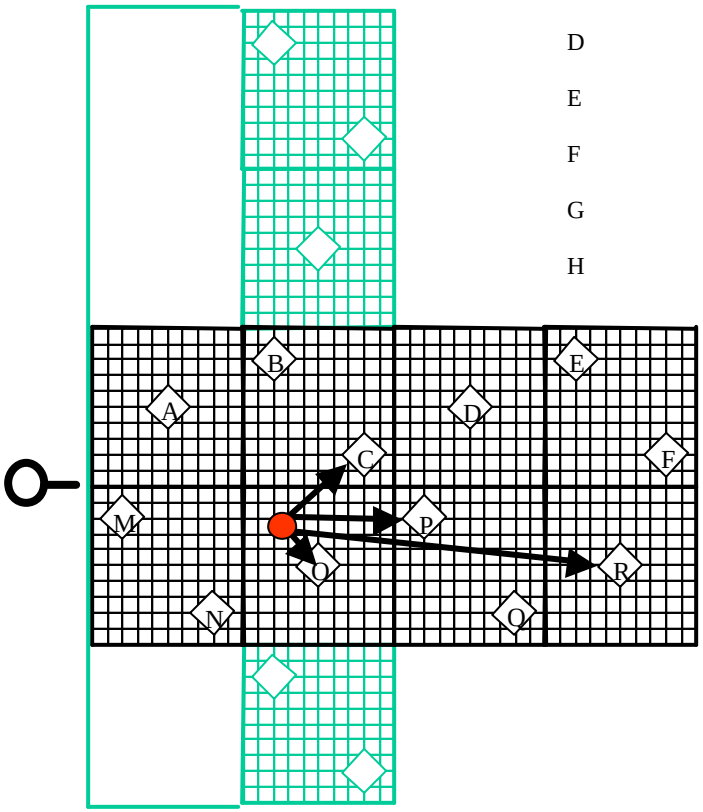
Post-Wounding Time	Probability of Incapacitation for Assault Role for given Performance Degradation				
Time	0%	25%	50%	75%	100%
--------	-----	-----	-----	-----	-----
30 sec	0.191	0.000	0.628	0.167	0.014
5 min	**0.111**	**0.000**	**0.303**	**0.272**	**0.314**
30 min	0.084	0.000	0.227	0.204	0.485
12 hrs	0.032	0.000	0.200	0.305	0.463
24 hrs	0.064	0.000	0.400	0.337	0.199
5 days	0.064	0.000	0.400	0.337	0.199

Representative Model Results
Shot 249, Position C, Mannequin 33 - Filtered

JMEM Assault 5 min E(I/H)	ComputerMan Assault 5 min p(25%+)	ComputerMan Assault 5 min p(75%+)	ORCA 5 minute 1-WTA
0.95	0.889	0.586	0.94

Data Evaluation Examples

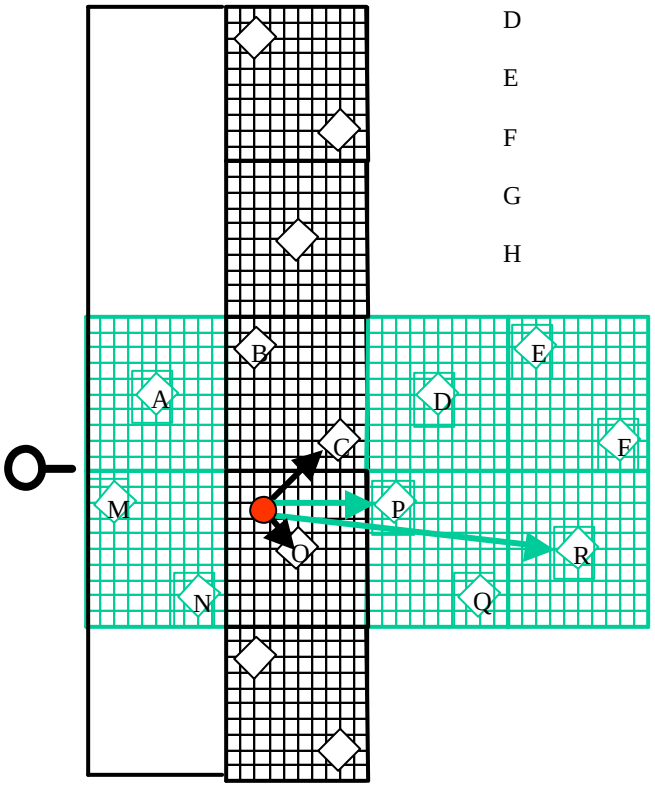
Round	ave per	JMEM	Cman.25+	Cman.75+	ORCA 1-WTA
A	2.3	0.495	0.454	0.353	0.508
B	1.66	0.547	0.442	0.339	0.434
C	2.6	0.485	0.439	0.365	0.365
D	1.9	0.353	0.320	0.201	0.256
E	1.75	0.456	0.434	0.277	0.343
F	1.5	0.492	0.433	0.400	0.183
G	1.92	0.463	0.435	0.301	0.349
H	1.71	0.461	0.434	0.295	0.320



All mannequins hit, regardless of whether they would have been in the squad or not

Data Evaluation Examples

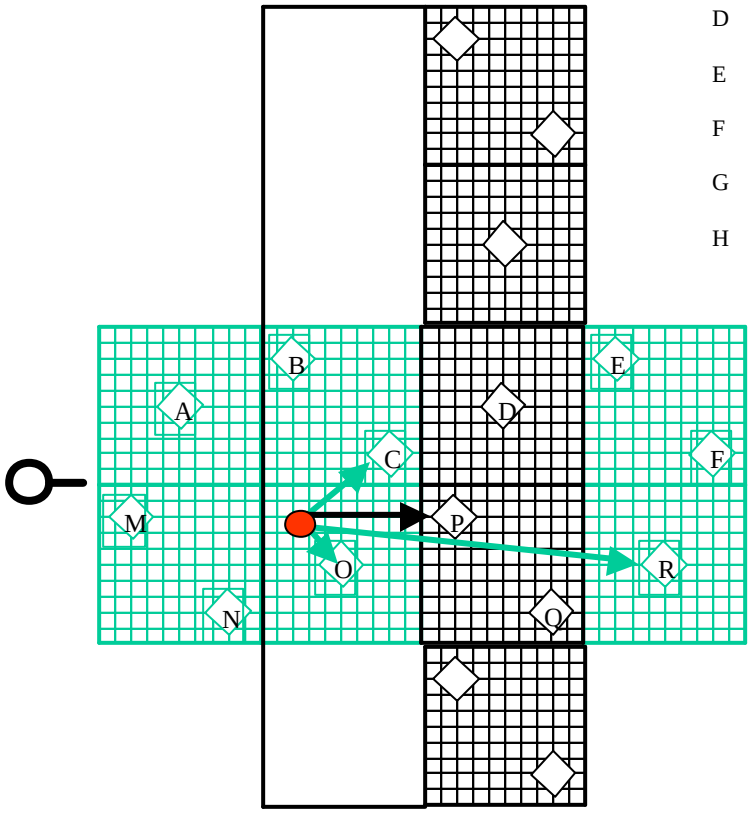
Round	ave per	JMEM	Cman.25+	Cman.75+	ORCA 1-WTA
A	0.666	0.339	0.403	0.349	0.482
B	0.333	0.27	0.292	0.292	0.32
C	0.20	0.172	0.106	0.056	0.006
D	0.857	0.346	0.353	0.234	0.249
E	1	0.573	0.549	0.384	0.378
F	0.25	0.223	0.188	0.188	0.083
G	0.84	0.493	0.46	0.318	0.304
H	0.875	0.515	0.489	0.351	0.329



Only mannequins hit that would have been in squad area

Data Evaluation Examples

Round	ave per	JMEM	Cman.25+	Cman.75+	ORCA 1-WTA
A	1.16	0.65	0.611	0.273	0.404
B	1.16	0.65	0.611	0.273	0.404
C	1.2	0.750	0.716	0.650	0.552
D	0.857	0.234	0.174	0.101	0.155
E	0.70	0.211	0.167	0.080	0.193
F	1	0.370	0.438	0.396	0.170
G	0.8	0.319	0.277	0.194	0.265
H	0.75	0.238	0.212	0.133	0.189



Only mannequins hit that would have been in squad area had the round impact in the 20 meters preceding the squad

Ranking and Scoring Example

Round	ave per		JMEM		Cman.25+		Cman.75+		ORCA 1-WTA		Score/ Rank
A	2.3	2	0.495	2	0.454	1	0.353	3	0.508	1	1.8/ 1
B	1.66	7	0.547	1	0.442	2	0.339	4	0.434	2	3.2/ 3
C	2.6	1	0.485	4	0.439	3	0.365	2	0.365	3	2.6/ 2
D	1.9	4	0.353	8	0.320	7	0.201	8	0.256	7	6.8/ 7
E	1.75	5	0.456	7	0.434	5	0.277	7	0.343	5	5.8/ 6
F	1.5	8	0.492	3	0.433	6	0.400	1	0.183	8	5.2/ 5
G	1.92	3	0.463	5	0.435	4	0.301	5	0.349	4	4.2/ 4
H	1.71	6	0.461	6	0.434	5	0.295	6	0.320	6	5.8/ 6

Data Evaluation Results

All evaluation categories

	SECT 1	SECT 2	SECT 3	SECT 4	SECT 5	SECT 6	SECT 7	SECT 8	SECT 9	SECT10	SECT11	SECT12	SECT13	SECT14	SECT15	1 T0 15	8 TO 10
ROUND	ALL	A MANN	A LETH	B MANN	B LETH	A+B MA	A+B LE	A ADJ	B ADJ	A+B AD	P 90	P 70	D 90	D70	D AVE	AVE B-P	AVE I-K
A RANK	1	3	3	2	2	2	1	3	1	1	3	2	2	2	2	2	1.66
A SCORE	1.8	3.6	3.6	2.4	2.2	2.6	1.6	3.2	1.2	1.4	2.25	2.5	3	2	2	2.36	1.93
B RANK	3	1	6	2	2	3	2	5	1	2	2	1	3	4	4	2.73	2.66
B SCORE	3.2	2.2	5.4	2.4	2.2	3	3.2	5.2	1.2	2.4	2	1.75	3.6	4.2	4	3.06	2.93
C RANK	2	6	8	1	1	1	3	8	6	8	1	3	1	1	1	3.4	7.33
C SCORE	2.6	5.8	8	1	1	1.8	3.4	8	5.4	8	1.75	4.25	1	1	1	3.6	7.13
D RANK	7	7	5	6	6	8	7	4	4	5	7	7	4	5	5	5.8	4.33
D SCORE	6.8	7	4.8	5.4	5.8	7	6.6	3.8	4.2	4.4	7.25	7.25	4.2	4.4	5	5.59	4.13
E RANK	6	5	1	7	7	7	5	1	5	3	5	6	7	6	8	5.26	3
E SCORE	5.8	5	1.2	5.6	6.4	6.2	4.6	1.2	5.2	3.4	5.5	5.25	6.4	6.4	8	5.08	3.26
F RANK	5	2	7	4	3	5	7	7	2	6	6	3	5	6	3	4.73	5
F SCORE	5.2	3.2	7	3.8	3.4	5	6.6	7	3	5.8	7	4.25	5.6	6.4	3	5.09	5.26
G RANK	4	4	4	3	4	4	4	6	6	7	4	5	2	3	6	3.73	6.33
G SCORE	4.2	4.8	3.8	3.2	4	4.4	4.2	5.4	5.4	6.6	4	5	3	3.6	6	4.5	5.8
H RANK	6	3	2	5	5	6	6	2	3	4	5	4	6	6	7	4.66	3
H SCORE	5.8	3.6	2.2	4.8	5.2	6	5.8	2.2	3.6	4	5.5	4.75	5.8	6.4	7	4.85	3.26

Data Evaluation Results

All evaluation categories by model

	B-O AVE	1 TO 14				I-K AVE	8 TO 10				
	JMEM	CM.25+	CM.75+	ORCA 1-WTA		JMEM	CM.25+	CM.75+	ORCA 1-WTA		
ROUND											ROUND
A	**2**	**1**	**1**	**1**		**1**	**1**	**1**	**1**		A
	2.643	2.5	2.786	1.357		2	2.333	2	1		
B	**1**	**2**	**2**	**2**		**2**	**2**	**2**	**2**		B
	2.5	2.786	3.214	2.571		3	2.666	2.666	2.333		
C	**3**	**3**	**4**	**4**		**7**	**8**	**8**	**7**		C
	3.5	3.786	3.429	4.143		7.666	6.666	6.333	7.333		
D	**8**	**7**	**8**	**7**		**4**	**5**	**6**	**4**		D
	6.071	6.214	6.571	6.071		3.666	4.333	5.666	5		
E	**6**	**6**	**7**	**3**		**2**	**4**	**5**	**2**		E
	4.857	5.857	5.929	4.071		3	3.666	4.333	2.333		
F	**7**	**4**	**3**	**8**		**5**	**6**	**4**	**6**		F
	5.429	4.5	3.286	7.143		5.333	5	3.666	7		
G	**4**	**5**	**5**	**5**		**6**	**7**	**7**	**5**		G
	4.286	4.714	4.571	4.143		5.666	6	6	5.333		
H	**5**	**4**	**6**	**6**		**3**	**3**	**3**	**3**		H
	4.786	4.5	4.786	5.143		3.333	3	3.333	3.333		

Summary

- Three models – three flavors of results
- Some conversion/translation required
- Focus on specific outputs
- Test objective met

Questions?