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# Assessing Realism in Simulation Environments

**US Army Operational Test Command  
And  
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# DOT&E is Concerned with the Realism of Tests

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Title 10 United States Code, Section 139:

“Operational test and evaluation means --

- the field test, under **realistic** combat conditions... and
- the evaluation of the results of such test.”

2012 DOTE Annual Report, p. 315:

“...These force-on-force battles must contain enough **realism** to cause Soldiers and their units to make tactical decisions and react to the real-time conditions on the battlefield. Real Time Casualty Assessment (RTCA) is needed to ensure that the simulated engagements have **realistic** outcomes based on the lethality and survivability characteristics of both the systems under test and the opposing threat systems...”



# What do you mean by “Realism”?

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## What We Mean by “Realism”

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**Realism**: The absence of **risk** of the **simulated environment** incorrectly portraying the real-world environment **factors** that are most influential in the performance of selected **tasks**...

[and for a test] using the **system(s)** under consideration.



# Even a Small Example of Realism is Far From Simple

**Vegetation:** Type, Density  
**Buildings and Structures:** Dimensions  
**Natural Environment:** Rain, Fog, Snowfall, Dust  
**Troops - Sensor:** Spectral Band  
**Atmospheric:** Luminance  
**Troops Individual:** Field of View

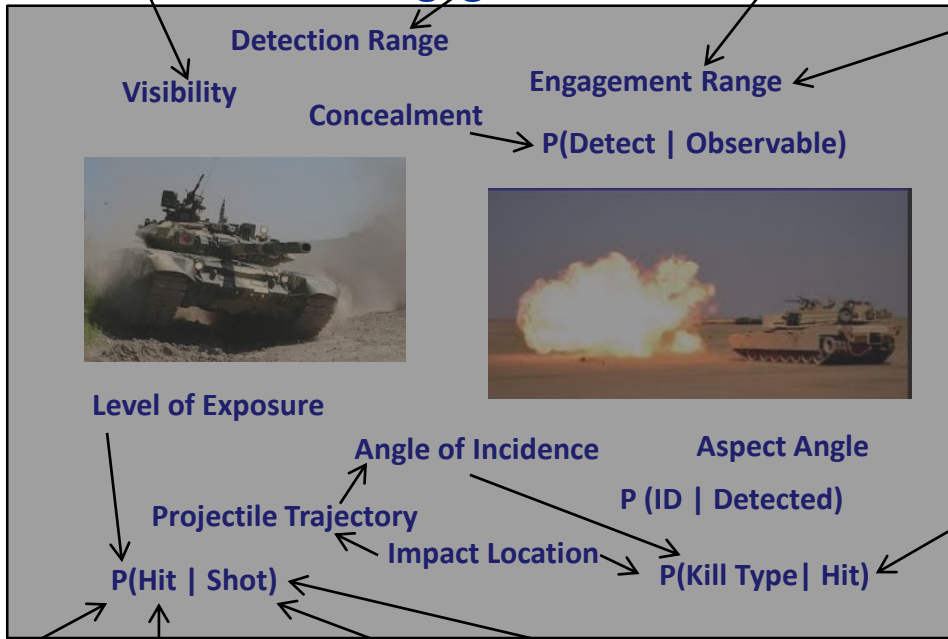
**Terrain:** Features  
**Vegetation:** Condition, Density, Type  
**Buildings and Structures:** Composition, Dimensions, Distance Between  
**Natural Environment:** Rain, Fog, Snowfall, Dust  
**Threat - Vehicle or Wpns Sys:** Visual Signature, Infrared Signature, Concealment  
**Troops - Sensor:** Magnification, Field of View, Materiel State, Spectral Band

## SIMULATED INPUT

## Live Simulated Engagement: M1A2 vs. T-90

**Troops - Weapon:** Effective Range

- Mission/Task
- Survivability Characteristics
- TTPs
- Mobility Characteristics
- Projectile Impact Indicators
- Obscurants
- Component Locations
- Target Signatures/Dimensions
- Individual/Crew Proficiencies
- Sensor Characteristics
- Weapon Lethality
- Immersive Firing Indicators
- Countermeasures
- Prior Damage
- Terrain Allocation



## OUTPUT Engagement Outcome

**Threat - Vehicle or Weapons System:** Current Damage, Kill State, Orientation, Antenna Location, Fuel Storage Location, Powertrain Location, Radio Location, Weapon Location, Weapon Sensor Location, Ballistic Protection, Countermeasures  
**Troops - Rounds Fired**  
**Troops - Fire Control and Target Acquisition:** Gun/Target Line  
**Troops - Weapon:** Effective Range  
**Troops - Weapon:** Maximum Rate of Fire  
**Troops - Projectile or Missile:** Type, Caliber, Explosive Amount, Explosive Type, Fuse Type, Mass, Propellant Type

Not all Object – Attributes or dependencies are shown

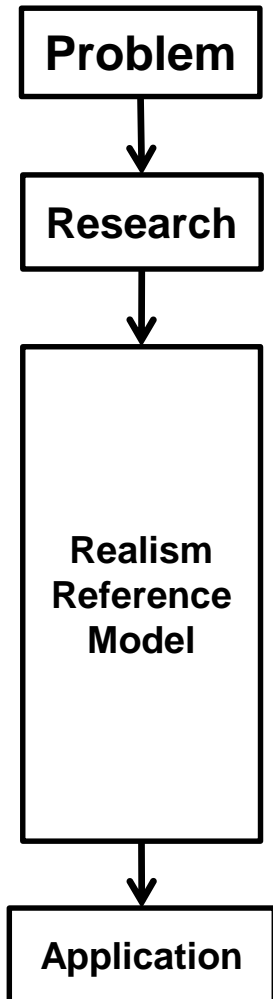
**Threat - Vehicle or Weapons System:** Dimensions, Exposure, Countermeasures, Obscurants, Velocity  
**Threat - Element / Individual:** Cohesion, Experience, Proficiency, Fatigue  
**Troops - Vehicle or Weapons System:** Velocity

**Weather / Atmospheric**  
**Natural Light**  
**Terrain Surface**  
**Terrain Features**  
**Vegetation**

## LESS CONTROLLED INPUTS



# How we arrived at a solution: Through Joint and Army Doctrine



“Realism” in testing is often spoken of but never defined well enough to quantify

Very little information exists on “realism” in testing, some references but no definition or methods to quantify

- **Environmental Model** – structure to define the environment in which a capability is used.
  - Primarily based the Army Mission Variables **METT – TC (Mission, Enemy, Troops, Terrain, Time, and Civil)**
  - Plus the **Immersive Environment (METT-TC + I)**
- **Capability Taxonomy**
  - Mutually exclusive and collectively exhaustive
  - Each capability contains a set of **Realism Factors** that influence its effectiveness (both positively and negatively)
    - **Magnitude** of impact based on scientific / engineering models or SME assessment
    - **Likelihood** of inadequate simulation in an operational test based on SME assessment

User interface to assist user in tailoring the capability taxonomy



## Having this Capability Allows You to:

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- 1) Communicate realism across the testing community
- 2) Assess a test or test design plan's level of realism
- 3) Justifying test planning / design decisions
- 4) Optimize the portfolio of test simulation capabilities
- 5) Support test design of experiments



# How We Quantify Realism Risk

- The risk of Realism Factors jeopardizing the integrity of a test are assessed using the Army's Composite Risk Management model (FM 5-19):
  - What is the likelihood of failing to properly simulate a certain phenomenon?
  - If that happens, how bad is it?

Probability of Inadequately Simulating

		Very likely	Likely	Occasional	Seldom	Unlikely	
Impact Severity	Catastrophic	E	E	H	H	M	E - Extremely High
	Critical	E	H	H	M	L	H - High
	Marginal	H	M	M	L	L	M - Moderate
	Negligible	M	L	L	L	L	L - Low





# Realism Can Be Described Using 29 General Factors For Tests of Combat Systems

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## Mission—BLUFOR and OPFOR

- Mission and Tasks
- Rules of Engagement
- Uncertainty or “Fog of War”
- Area Provided

## Enemy and Troops

- Tactics, Techniques, and Procedures
- Proficiency
- Comms and Networks Characteristics
- Mobility Characteristics
- Engagement Simulation
- Unit Type, Strength, and Task Organization
- Survivability Characteristics
- Lethality Characteristics
- Cyber and EW Lethality
- Supporting Arms and Services
- Usability Factors
- Interoperability Characteristics

## Terrain (Environment)

- Terrain
- Weather and Light
- Obscurants
- Network Environment

## Time

- Time Available
- Timing
- OPTEMPO

## Civil

- Civil Characteristics

## Immersive Environment

- Aural
- Behavioral
- Physical
- Visual
- Test Restrictions and Intrusiveness



# Example Parameters: Tactical Vehicle Operational Test

## Mission

- Troops - Conduct an Attack
- Enemy - Defensive

## Troops and Enemy

- Live Engagement Simulations:
  - Direct Fire: MILES (laser based)
  - Indirect Fire: Fire markers and possibly HITS
  - CAS: NA.
  - Mines/IEDs: TASC-provided simulator; OC casualty assessment
- BLUFOR networks and communications: Organic
- OPFOR networks and communications: Organic
- Cyber and EW capability: NA – issue deferred to future test.

## Terrain (Environment)

- Specific Training Area of CONUS Fort

## Time

- Plan and Prep time consistent across trials

## Civil: NA

## Immersive Environment

- Visual modification (VISMOD) OPFOR vehicles
- OPFOR uniforms
- Blank cartridges
- Artillery and IED simulators— provide flash and smoke



# Manual Task Walkthrough Method is Painstaking

## Realism Factor

Example: Conduct an Attack  
(Mission, Enemy): 12 of 464  
rows shown

## Task Step

### TASK: CONDUCT AN ATTACK

10. The unit executes the attack. It takes the following actions:
- a. Moves to the line of departure (LD) using a technique and formation based on the factors of METT- TC (may be executed by other unit leaders while the unit leader is forward conducting a leader's reconnaissance).
  - b. Navigates from checkpoint to checkpoint or phase line by using basic land navigation skills supplemented by precision navigation.
  - c. Moves from the LD through the assault position to support positions, assault positions, or breach or bypass sites. Pauses in the assault position if absolutely necessary, to ensure synchronization of all friendly forces.  
Takes the following actions:
  - d. Conducts the assault mounted. (A mounted assault is only conducted against light resistance or when there are no heavy antiarmor weapons on the objective.) Takes the following actions:
- (1) Does not stop after moving forward of the assault position.
  - (2) Controls supporting fires to support risk management initiatives.
  - (3) Isolates the objective, which includes:

Mission										Enemy										
Mission - Task (OPFOR)	Rules of Engagement (OPFOR)	Uncertainty / "Fog of War" (OPFOR)	Area Provided (OPFOR)	Mission - Task (BLUFOR)	Rules of Engagement (BLUFOR)	Uncertainty / "Fog of War" (BLUFOR)	Area Provided (BLUFOR)	OPFOR TTPs	OPFOR proficiency, including MILES	Comms/Network Characteristics	Mobility Characteristics	Engagement Simulation	Unit Type, Strength, and Task Org	Survivability Characteristics	Kinetic Weapon Lethality	Cyber and EW Weapon Lethality	Supporting Arms and Services	Sensor Performance	Usability Factors	Interoperability Characteristics
	L			L		M	L	M				M			M		M		L	
				L		L	H									M	M			
		H		L		M	L	H	M			E	M	E	E	H	H	H		

## Associated Risk Factor has on task step



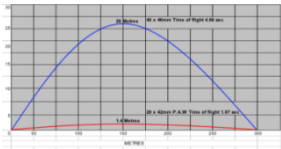
# Identified Risks Apply to Both Test Team and Technology Development

## Mission

- Mission - Task
- Rules of Engagement
- Uncertainty / "Fog of War"
- Area Provided

## Enemy and Troops

- TTPs
- Proficiency, including MILES
- Comms/Network Characteristics
- Mobility Characteristics
- Engagement Simulation
- Unit Type, Strength, and Task Org
- Kinetic Survivability
- Cyber and EW Survivability
- Weapon Lethality
- Supporting Arms and Services
- Sensor Performance
- Usage (IAW OMS/MP)
- Usability Factors
- Interoperability Characteristics



## Terrain (Environment)

- Terrain
- Weather and Light
- Obscurants
- Network Environment



## Time

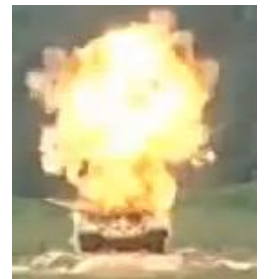
- Time Available

## Civil

- Civil Characteristics

## Immersive Environment

- Immersive Effects - Aural
- Immersive Effects - Behavioral
- Immersive Effects - Physical
- Immersive Effects - Visual
- Test Restrictions and Intrusiveness





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**That took 40 manhours...**

***Now, let's do it in 5 minutes***



# The Application Provides Similar Results In Far Less Time

Factor	Ranking	
	Manual	App
Proficiency	1	4
Weapon Lethality	2	3
Engagement Simulation	3	1
Survivability Characteristics	4	5
Immersive Effects	5	2
Obscurants / Atmosphere	6	9
Comms / Network Characteristics	7	16
Terrain	8	8
Supporting Arms and Services	9	7
Weather and Light	10	6
Network Environment	11	20
Interoperability Characteristics	12	-
Rules of Engagement	13	18
TTPs	14	12
Battlefield Uncertainty / "Fog of War"	15	17
Sensor Performance	16	13
Unit Type, Strength, and Task Org	16	11
Mission - Task	18	24
Mobility Characteristics	19	14
Usability Factors	20	21
Area Provided	21	15
Time Available	21	23
Civil Characteristics	23	19
Test Restrictions and Intrusiveness	24	10
Usage (IOW OMS/MP)	24	22



# Where We Are Headed

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- **Expanding the realism framework**
  - **Cyber / Electromagnetic Operations**
  - **Intelligence**
  - **Mission Command**
  - **Communications**

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