2010 Insensitive Munitions & Energetic Materials Technology Symposium

Expedited Transition of Propulsion Modeling and Simulation Capability–- Enabled by a Knowledge Structure

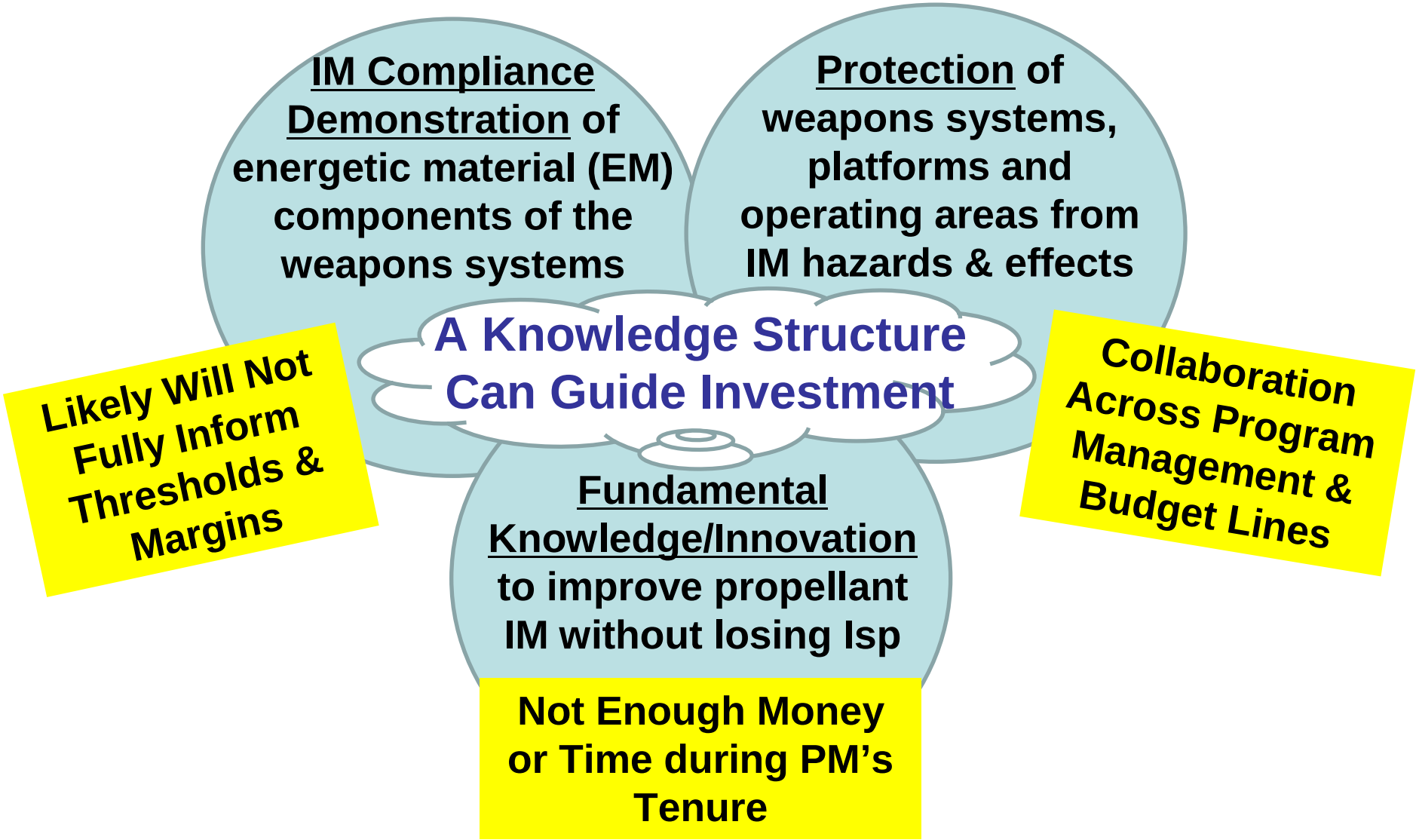
Presenter:

Daniel A. Jones, Strategic Insight Ltd., US

Co-authors:

Thomas H. McCants Jr., Strategic Insight Ltd., US
Thomas E. Swierk, NSWCDD, US

Program Manager's Dilemma: How to Invest in Insensitive Munitions?



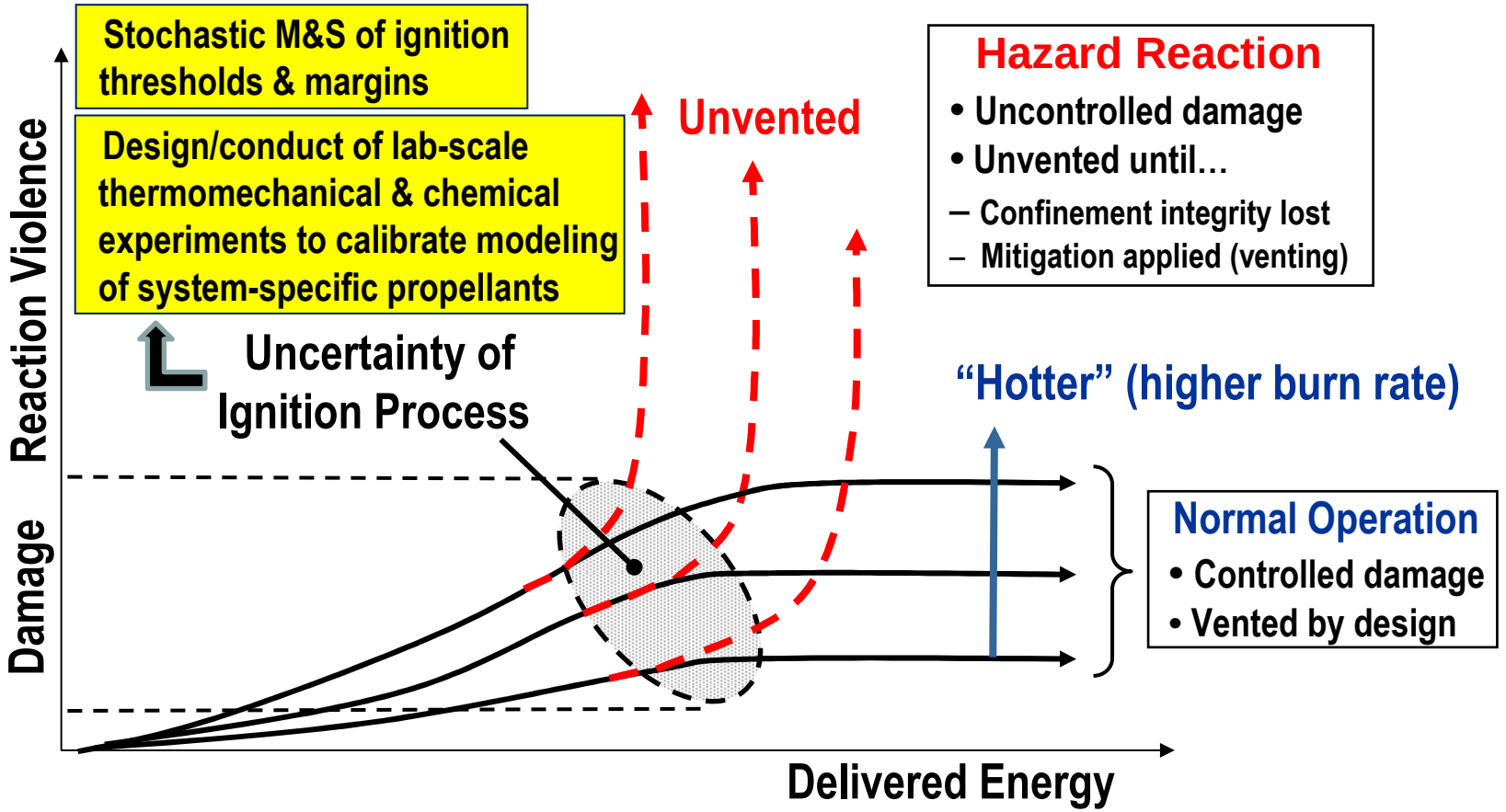
Knowledge Structure Goals

- **Portray the IM safety problem *writ large*-- global risk--from compliance to protection of munitions, weapons systems, platforms & surrounding areas**
- **Demonstrate a system approach using modeling and simulation to better manage safety risk**
  - **Equip Program Manager & Project Team to incorporate state-of-art M&S tools & specialists***
  - **Understand/cope with uncertainty of propulsion reaction thresholds & margins**
  - **Inform strategies that avoid unintended ignition, and/or mitigate effects**

*Strategic Insight, Ltd. acknowledges technical partner Lawrence Livermore National Laboratory, Drs. Bruce Watkins, Keo Springer and Larry McMichael for expert assistance with the knowledge structure, especially modeling and simulation details.

For Normal Operation AND Hazard Reaction, Violence Varies with Propellant Burn Rate

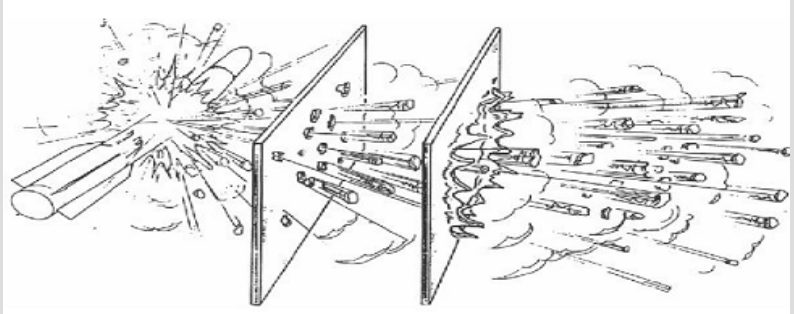
Using experiment-anchored M&S to quantify uncertainty of ignition thresholds and margins and assess benefit of protection measures (avoidance/mitigation)



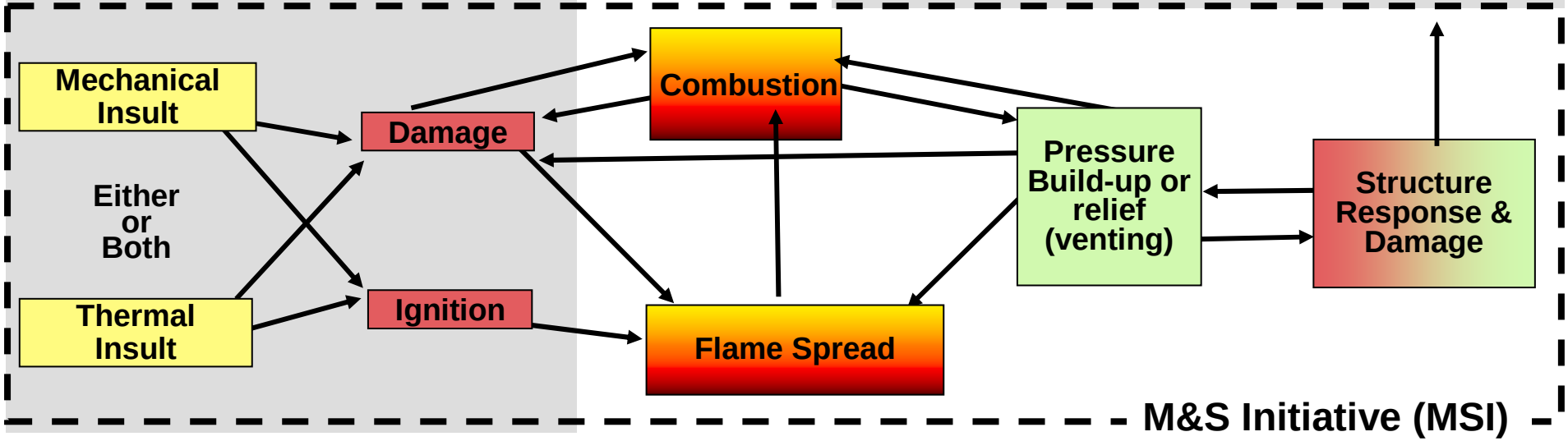
Goal: Achieve Propulsion Performance AND Safety by Layered Protection-- from System Level Down

Knowledge Structure Focus is Avoidance/Mitigation M&S…

Enable design or operational measures to prevent far field effects on other weapons, structures or people



Enable design or operational measures to limit exposure to hazard insults & intervene to prevent unintended ignition & violence of reaction



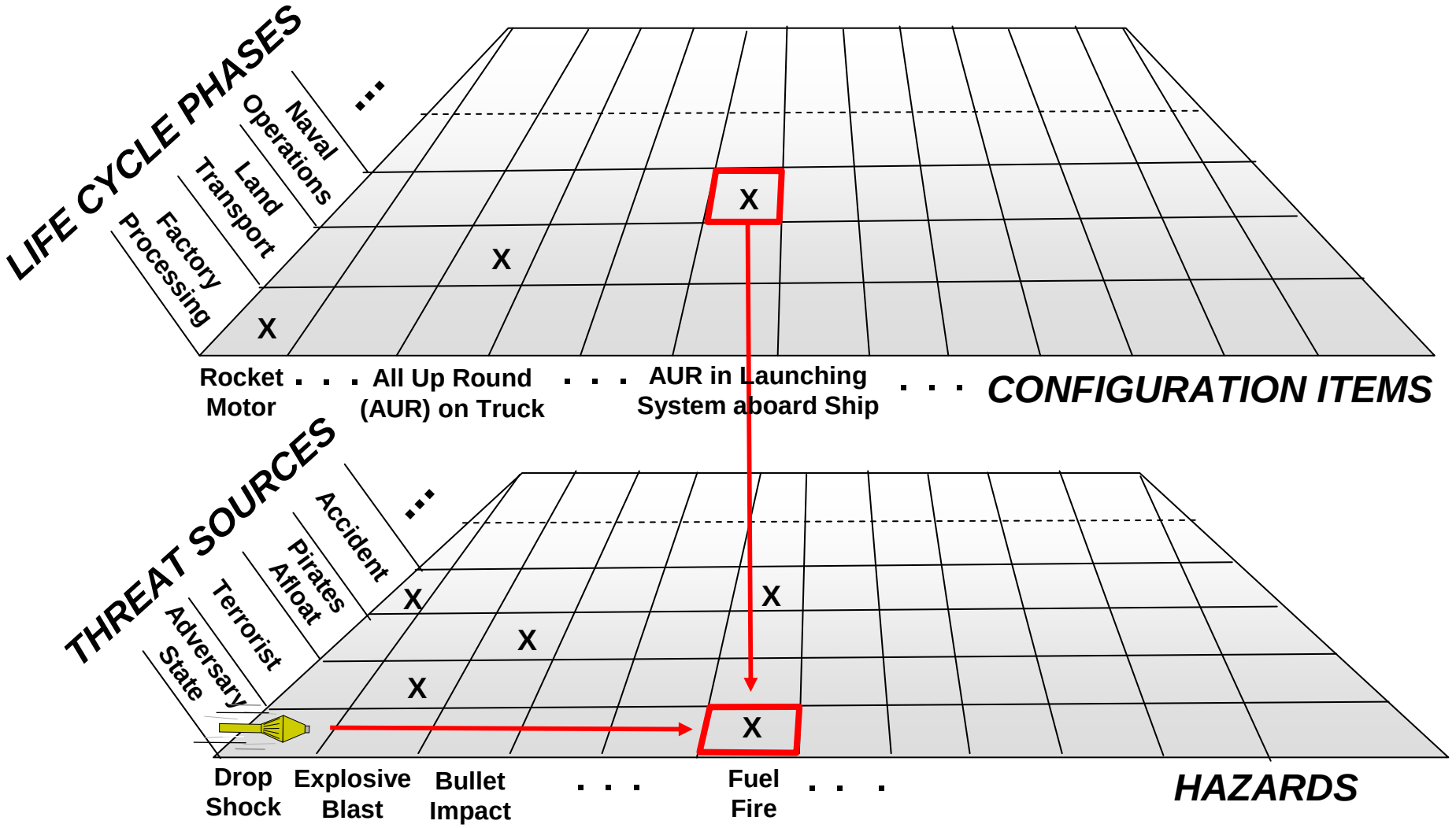
…and Integrating/Leveraging the MSI

Case Example:

Knowledge Structure Methodology for Rocket Propelled Grenade (RPG) Attack on a Naval Ship

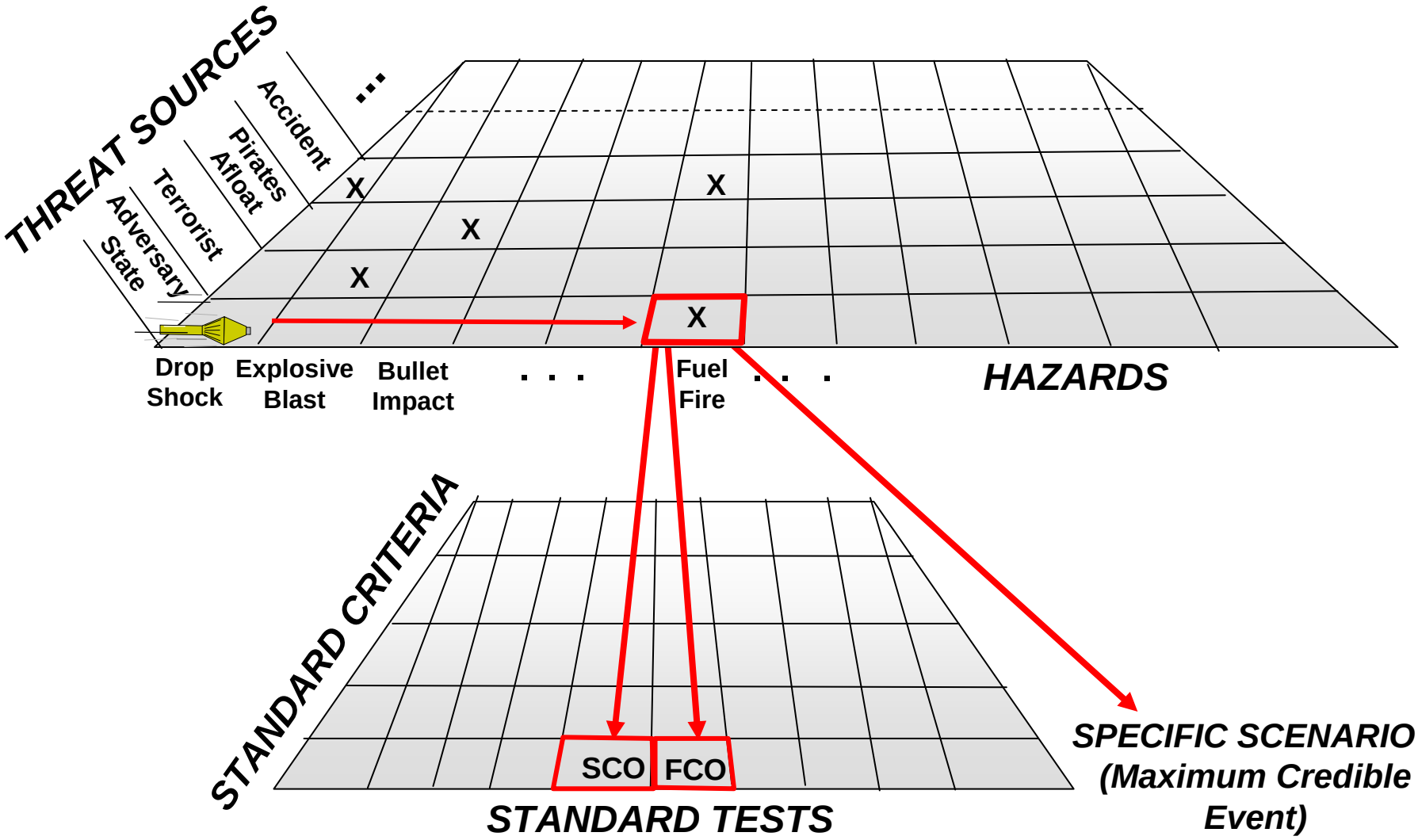
Mapping Configuration Items/Life-cycle Phases to Threat Sources & Hazards

Rocket Propelled Grenade (RPG) Attack During Naval Operations



Mapping Threat Hazards to Standard Tests/Criteria & Specific Scenarios

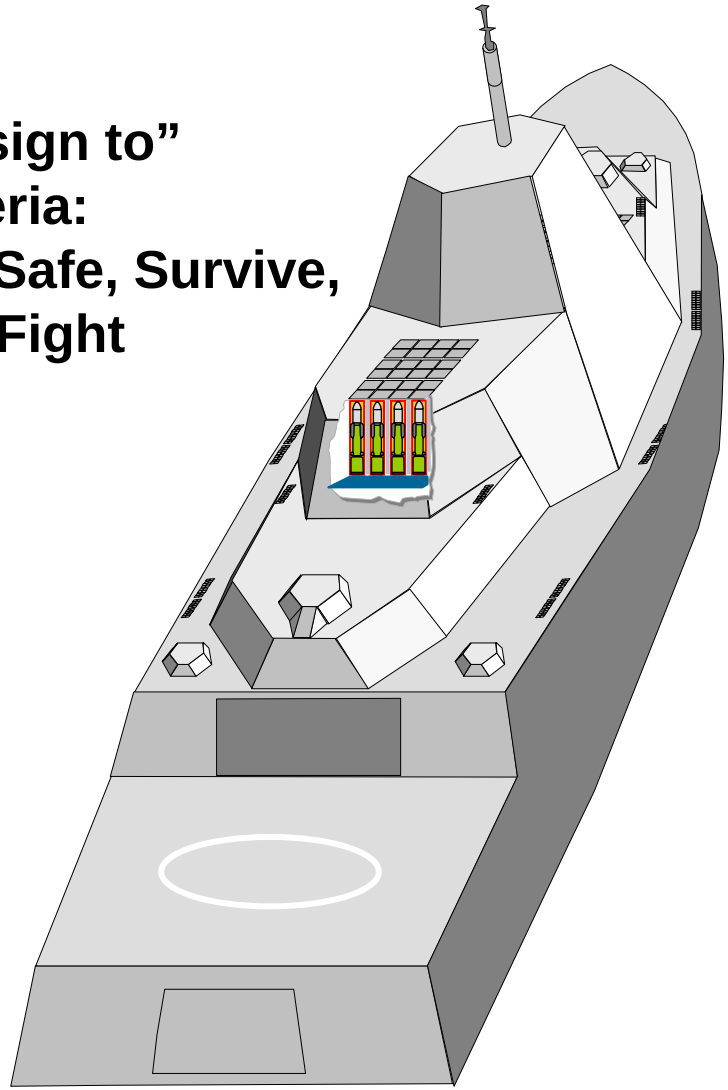
Rocket Propelled Grenade (RPG) Attack During Naval Operations



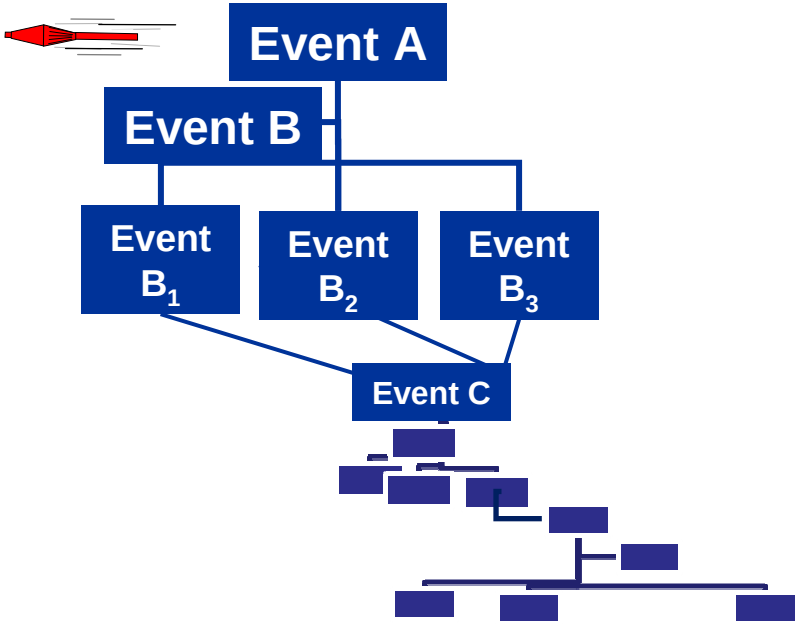
Specific Scenario: RGP Attack During Naval Operations

Creating A Systems Context for Analyzing IM Threats and Hazards

"Design to" Criteria: Fail Safe, Survive, and Fight

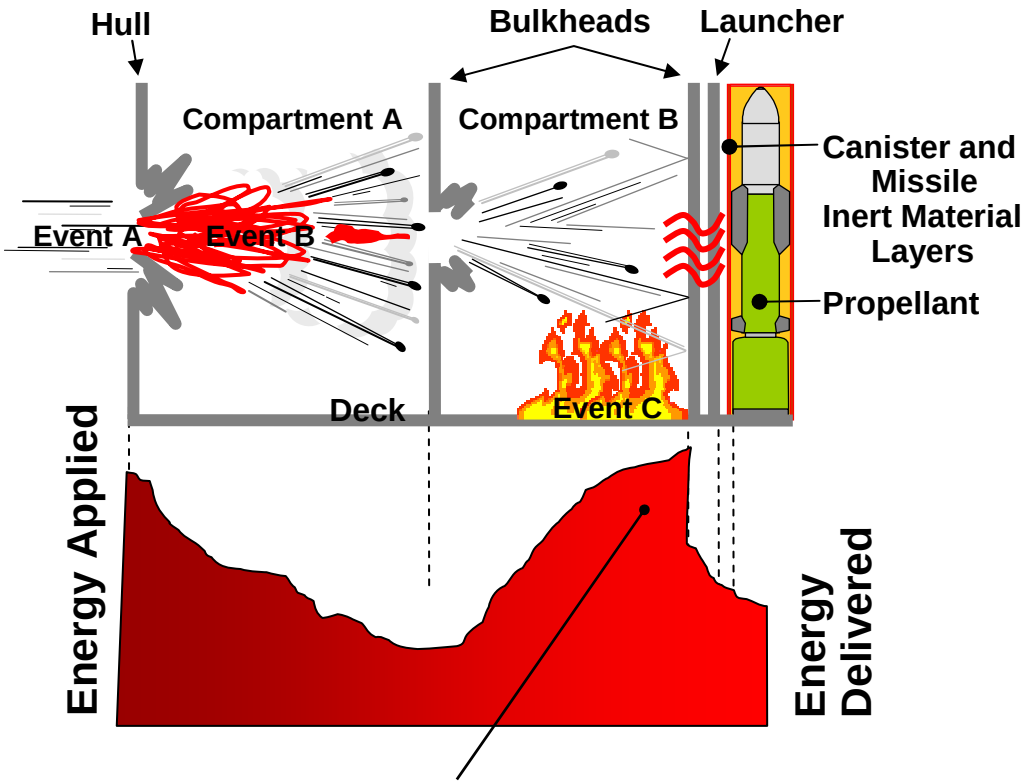


Event	
A	RPG hits ship
B	Shape charge penetration
B_1	Jet
B_2	Heat
B_3	Spall & shrapnel
C	Broken fuel line, fire



Using M&S Tools to Analyze System and Propulsion Response to Hazard Insults…

Specific Scenario Events A, B, C,…
(from previous chart)



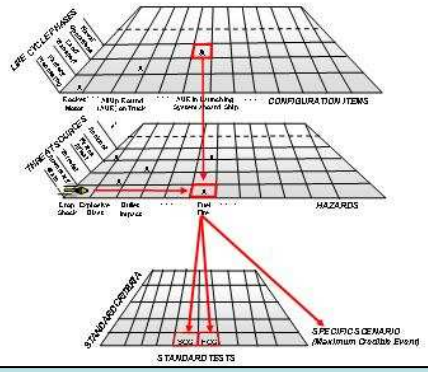
Maximum Credible Event:
Fuel Fire in Adjacent Compartment

System Approach Provides Context for M&S Tools:

- **Encounter between threat and ship**
  - Lethality & Vulnerability
- **Effects translation through layers**
  - Structural Mechanics
  - Rigid & Elastic Body Dynamics
  - Dynamic Properties of Materials
  - Hydrocode Analysis
- **Fire and boundary conditions**
  - Fire & Heat Flux
  - Heat Transfer
- **Propulsion Response**
  - Inert Material response
  - Energetic Material response
  - Ignition & Growth
- **IM Safety Thresholds and Margins**
  - Quantification of Uncertainty

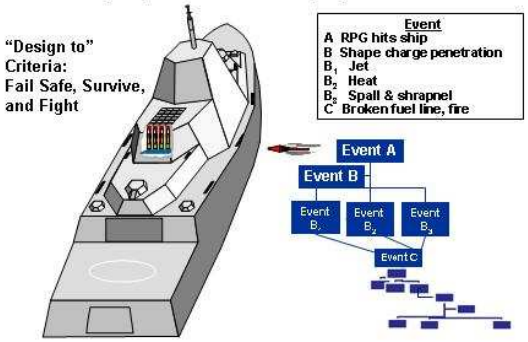
…Enables Quantification of IM Hazard Environment versus Specific Scenario Maximum Credible Events

Knowledge Structure Methodology Encourages System Approach with State-of-Art Modeling and Simulation…



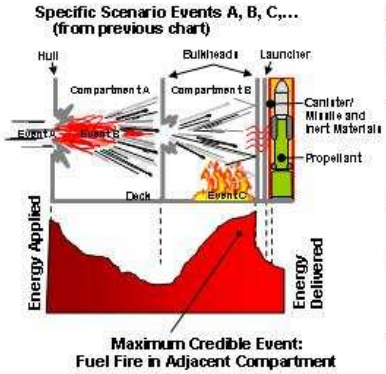
A

Threat Hazard Analysis Mapping to Standard Tests (FCO, SCO,…) and Specific Scenarios



B

Specific Scenarios Establish A System Context for M&S Tool Selection



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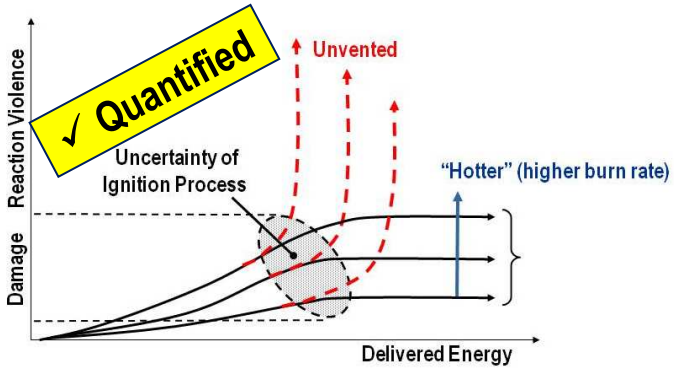
- **IM Safety Thresholds and Margins**
  - –Quantification of Uncertainty

C

M&S to Determine Maximum Credible Event (Combined Hazard Insult to Propellants)



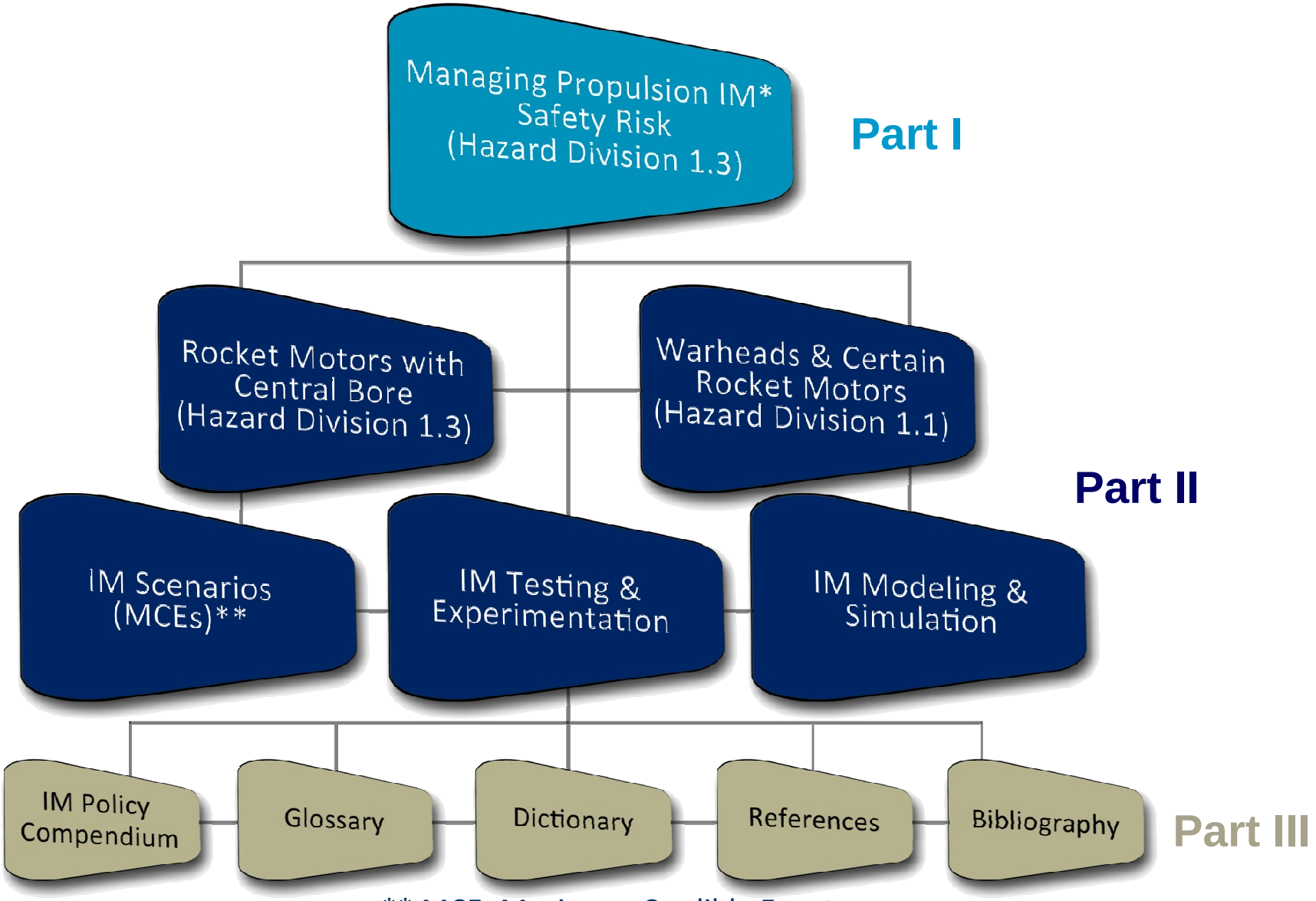
Quantification of Ignition Thresholds / Margins and Hazard Avoidance / Mitigation Benefits

…for Achieving Propulsion Performance AND IM Safety Margins

PROGRAM MANAGER'S GUIDE TO PROPULSION IM SAFETY RISK

A PRACTICAL KNOWLEDGE STRUCTURE FOR QUANTIFYING UNCERTAINTY ABOUT SAFETY MARGINS AND ASSESSING BENEFITS OF AVOIDANCE AND MITIGATION

Knowledge Structure Organization



Asking the Right Questions…

What is unique about my weapon system & munitions?

- Stockpile to target sequence
- Environments, threats & hazards
- Service life, affordability of surveillance
- Weight-space margins, feasibility/affordability of avoidance & mitigation measures
- Contribution of weapon system & platform to protection
- Consequences of possible reactions

What configurations to test, how to employ M&S?

…Preventing Unintended Ignition and Violent Reactions

Summary

- A Knowledge Structure will equip Program Managers and Project Teams to better incorporate M&S tools and specialists
- Best Practice for management of global risk--achieve propulsion performance AND safety compliance AND protection
  - System approach and methodology
  - Uncertainty quantification of ignition thresholds/margins by experiment-anchored numeric trials
  - Quantification of avoidance/mitigation approaches, e.g. add-on/design-in layered protection

M&S Initiative + Knowledge Structure evolves toward Common Best Practice & Toolset

THE END…THANK YOU!