A Framework for Vulnerability/Lethality Modeling and Simulation

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Presentation Outline

◆ Introduction

◆ The Framework Concept
  ● Base Fuze Class

◆ The PILR Architecture

◆ Endgame Framework Benefits
Current M&S Deficiencies

- Monolithic software - not configurable
- Data driven
- No synergy
- Empirically-based
- Lack visualization
- Cannot link to other models

- High/redundant maintenance
- Expert-friendly
- Platform specific
- Lack V&VA
- Inconsistent units
- Geometry-specific

“Technical frameworks must be developed to ensure appropriate interoperability across different simulations; reuse of simulation components; insertion of new technologies; and flexibility to respond to changing requirements.”

DoD 5000.59-P
What is a Framework?

A collection of classes that abstract the common functionality needed by similar applications.

Provides general solution mechanisms for a set of similar problems.

Desirable properties:
- Consistent
- Extensible
- Flexible

**Framework Core**

**Framework Library**

Unused Library Classes

**Application Custom Extensions**

CUSTOM APPLICATION
Endgame Framework

Common Library
- Model Objects (Fuzes)
- Property Sets
- Behaviors
- State Change Objects

Framework Core
- Executive Controller
- Geometric Model
  Information Server
- Common User Interface
- PILR Module Interface

CUSTOM APPLICATION

Application Extensions
Endgame Framework Vision

Common Tool Set Supporting Independent Methodology Through Established APIs
- Incorporate “Best of breed” legacy effects models
- Technology to enable new effects methodology
- Combine ground fixed, mobile, airborne, DE domains
PILR Behavior Methods

◆ Propagation
  (damage mechanism)
  ● Penetrator, fragment, blast wave
    ▪ Ray traced or time stepped
  ● Determine impact conditions
    ▪ Impact angles (in/out), surface normal, etc.

◆ Interaction/Load
  ● Based on component type or material type
  ● Determine and apply load to component
    ▪ KE load, pressure, thermal transfer, etc.
    ▪ may include damage mechanism
PILR Behavior Methods (cont.)

◆ Physical Response
  ● Determine component physical response to applied load
    ▪ Breach hole, spall generation, fracture, igniting, etc.
    ▪ May include damage mechanism (Fragment breakup, warhead failure, etc.)

◆ Functional Response
  ● Based on damage applied
    ▪ Simple Pk
    ▪ Initiate method for leakage
    ▪ Initiate method for component failure or degraded performance
PILR Architecture

◆ Behavior Module
  - Template for phenomenology development
  - Registration of PILR methods
  - Provides event generation

◆ Standardize low-level interfaces
  - Interface between interaction and response methodologies
    - Allows higher fidelity physics-based representations
  - Loose coupling between behavior methodology and component property sets

◆ Extensible design
  - New methodologies require new state change information
    - New load types
    - New physical change types (damage, temperature, pressure, …)
    - New functional change types
Behavior Module Interface

- Kernel interactions
- Interrogate Geometry
  - Ray trace, geometric primitive info
- Get/Set Spatial Info
  - Location/orientation/kinematics
- Submit Events
  - Automated within behavior module
  - Understanding of PILR tables
- Apply State Changes
- Get Model Properties
  - Materials, dimensions, others
PILR Example

Detonation
(System Behavior)
PILR Example

Detonation
(System Behavior)

Propagation
(Blast Wave, Fragments)
PILR Example

Detonation
(System Behavior)

Propagation
(Blast Wave, Fragments)

Interaction
(DM vs. component)
PILR Example

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Physical Response
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(Blast Wave, Fragments)

Interaction
(DM vs. component)

Physical Response
(component damage)

Functional Response
(component $P_K$
start leakage, etc.)
Endgame Framework Features

◆ Software Architecture
  ● Object Oriented
  ● Improved target interrogation
  ● Time-stamped events & component state history
  ● Improved stochastic capabilities
  ● Dynamic object creation

  ● Modern software design
    ▪ C++/OpenGL based
    ▪ GUI: Qt based
    ▪ Cross platform code & libraries

◆ Methodology Benefits
  ● Based on physics (PILR)
  ● Collision detection
    ▪ Wires/hydraulics
  ● Synergistic effects
    ▪ Multiple weapons
  ● Probability distribution w/ confidence bounds
  ● Secondary spall

  ● Lower support costs
    ▪ Extensible standards
    ▪ Enhanced visualization
    ▪ Portable
      ▪ Windows & Linux
Summary

◆ Framework ready for adaptation of existing V/L legacy applications
  ○ Immediate benefits gained
  ○ Existing conventional legacy M&S applications currently undergoing transformation

◆ Developer’s Release allows third party participation