Using Low-Fidelity Digital Twins for High Speed Analysis

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Terms

- **Susceptibility** $P_H$ \quad hit given a threat
- **Vulnerability** $P_{K|H}$ \quad kill given a hit

Reference: wikipedia/commons/thumb/a/a1/F-117_Nighthawk_Front.jpg

Goal

A design tool that can be used to measure the vulnerability of an air vehicle throughout the design process

- Ensures the vulnerability requirements are being met at each phase of the development cycle through continuous assessments
- Allows sufficient time to revise the design avoiding development delays and impacts to program costs/schedule.
- The tool enables predictive assessments vs. the current process of reactive assessments
Business Opportunity

Global Product Data Interoperability Summit | 2018

Design / Development

Model De-featuring / Remodeling (BRL-CAD)

Vul-Analysis

Re-Design

Vul-Verification Analysis

Legacy

6 man-months

6-12 man-months

10X Process

Design/Devel.

Vul-Analysis

Vul-Verification Analysis

Program Savings and Risk Avoidance

*Notional For Light Rotorcraft Program

10X Process Improvement – (From Months to Minutes)
The aircraft is analyzed looking at 26 views typically. All flight critical components are modeled. A grid size is selected and a shot placed either at the center or randomly within the grid square.
Conceptual Kill Tree

Deliverable #1: Surrogate Aircraft Model

Surrogate Aircraft Demonstrates Emerging Capability

Reference: 3D solid and wireframe images of a fictitious aircraft
Deliverable #2: Knowledge Model

Reference: 2D Images of wireframes of a fictitious aircraft
Automated Shot-line Calculations

Reference: 2D Images of wireframes of a fictitious aircraft
Vulnerability Assessment of the Surrogate Aircraft

Vulnerability contributions by system

Aircraft View

Front View, Right View, Side View, Top View, Rear View, Left View, Bottom View
Vulnerability Assessment of the Surrogate Aircraft

Vulnerability contributions by system
Self-sealing fuel lines incorporated

Vulnerability Reduction Quantified

Aircraft Views
PERFORMANCE and SCALABILITY enhancements

1. Filtering of Shot-lines using Advanced De-featuring and uni-directional vector symmetry.

2. Filtering of Parts using UNS naming conventions. Removing skins and structure.

3. Restrict “arena” to Systems only. Concern about systems configuration.

95% Reduction in Boolean Permutation Computations necessary to perform Vulnerability Analysis.

100% of All shot-lines across entire aircraft at given Grid-density.

5% of salient shot-lines
Course Shot-line vector reduction Using Lo-Fidelity Model

Reference: 3D Image of Boolean solids of a fictitious aircraft
• Exceeded the objectives, we can create the presented area calculations of a 50’ aircraft in under 2 minutes

• Developed a working prototype

• Demonstrates its use on a notional aircraft

• 3 Patent disclosures – 2 filings.

• Months- to-minutes improvements