



Engineered Resilient Systems

Power of Advanced Modeling and Analytics in Support of Acquisition

2020 Outlook

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Systems 2020, 10-Year Vision

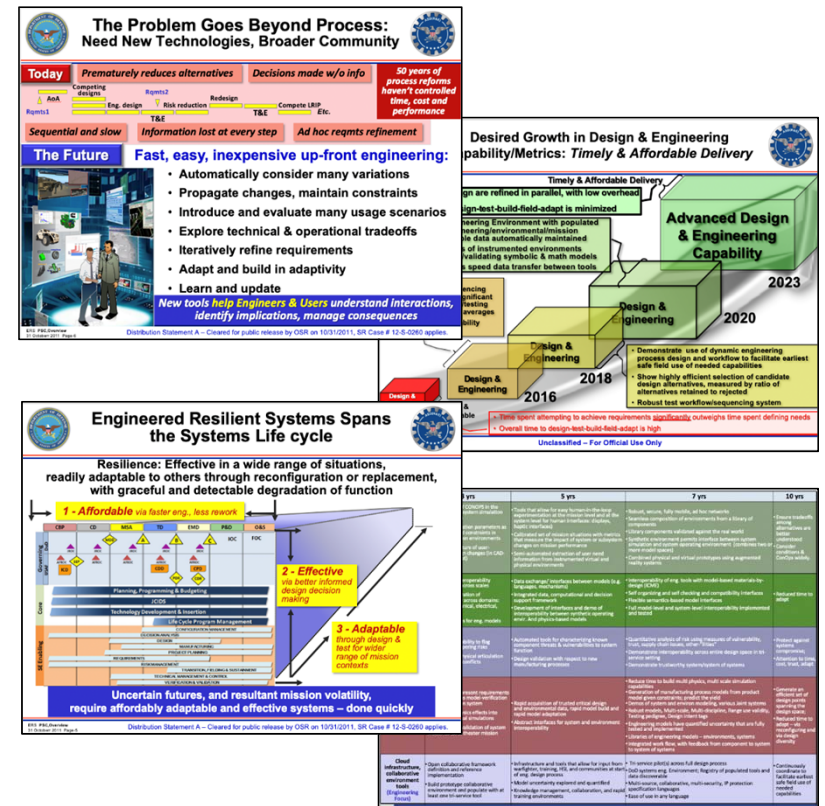


10-Year Major Gaps (from 2010)

- Tool interoperability, flexible model interfaces
- Multi-scale, multi-fidelity modeling
- Model manufacturing
- Automated analyses
- Integrated data and decision-making framework

Greatest Strides made in:

- DoD cultural acceptance
 - DoD Digital Engineering Strategy
 - DoD-industry-academia partnerships
- Reduced time for engineering analyses, trades
- Number of alternatives analyzed, refined requirements
- Easier incorporation of models like cost and other “-ilities”



From ERS & Systems 2020 Briefings
Bob Neches





2020 – 2025 ERS Vision



- **Biggest Gaps**

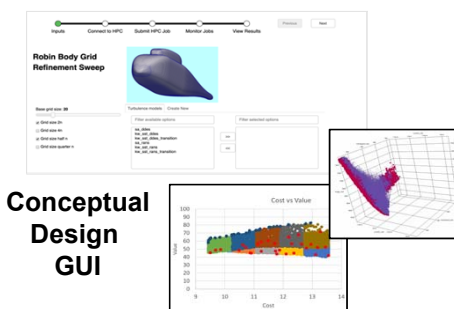
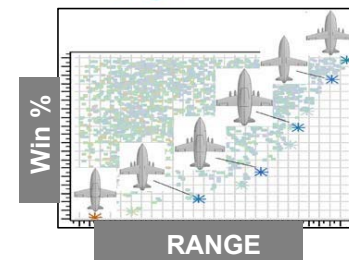
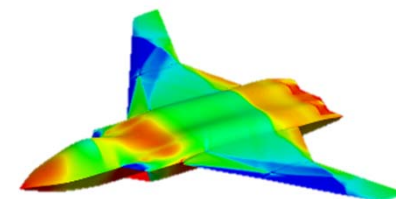
- Computing environments – commercial cloud, mixed classification, etc.
- Computational processes – speed, linked tools/software, portability
- Ubiquitous model usage in ALL stages of acquisition

- **Biggest Promises**

- Physics-informed machine learning – fast physics
- High-performance data analytics – machine learning on massive DoD datasets
- Decision support tools – linked conceptual design and mission modeling

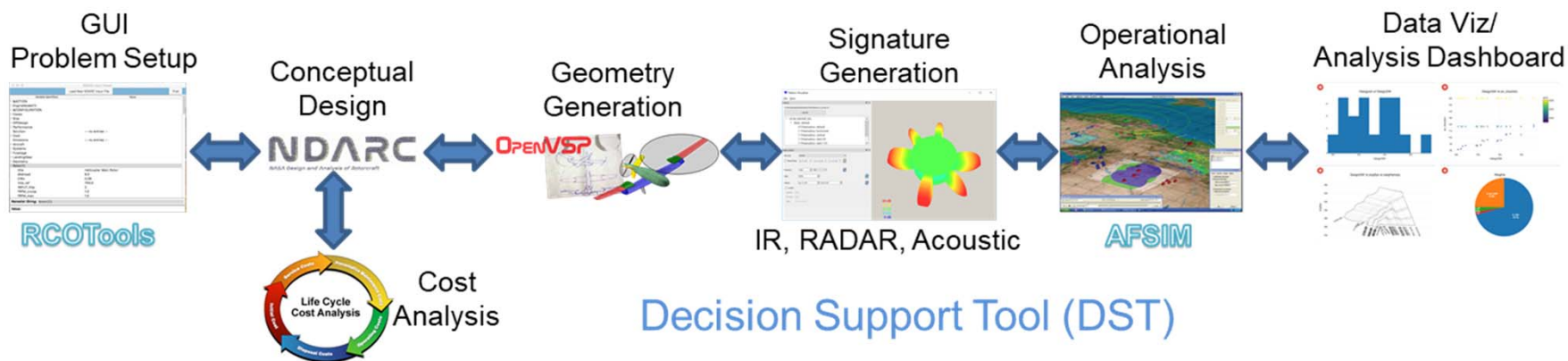
- **ERS Approach**

- Focus on DoD priorities (AI/ML, Hypersonics, Directed Energy)
- Data analytics ecosystems on DoD HPC
- Set-based design – risk reduction through trades, accuracy





Decision Support Tool



Challenge: Current requirements generation do not include combined analysis of conceptual design, cost analysis, signature generation, and operational analysis.

Solution: ERS is developing a decision support tool that effectively assess sensitivity of rotorcraft design to operational effectiveness and cost.

10,000x More Options Identified and Assessed

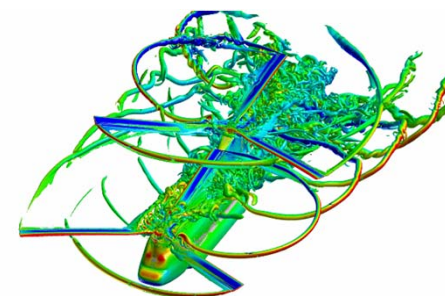
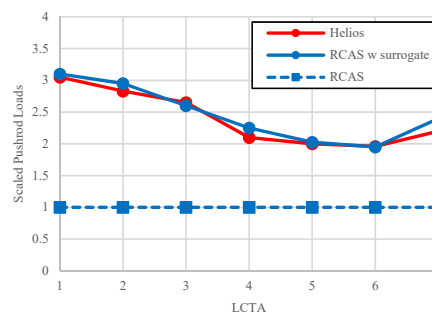
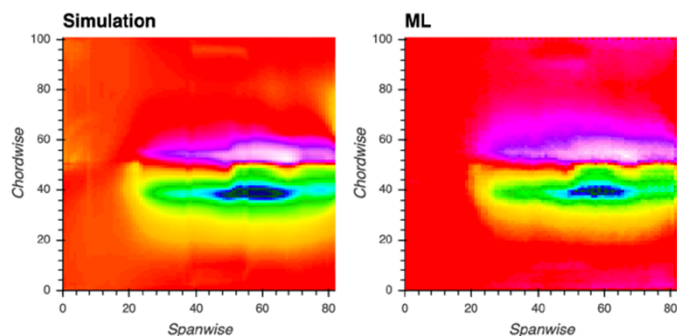




Physics Informed Machine Learning – Fast Physics



Forward Flight Dynamics



Challenge: High-fidelity simulations take much too long for design. The V-280 tiltrotor full span 20-30 revolution hover takes 30 days on ~1000 cores.

Solution: New methods utilizing machine learning algorithms promise dramatic improvements in speed with similar simulation results.

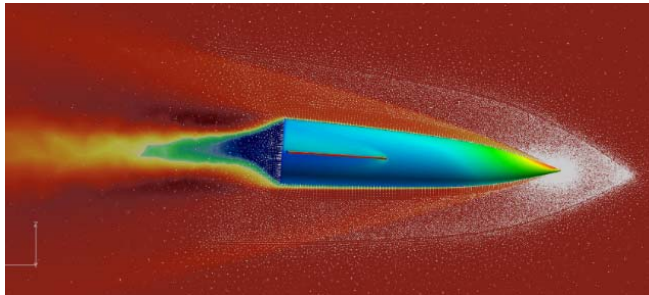
20,000x Faster Simulation



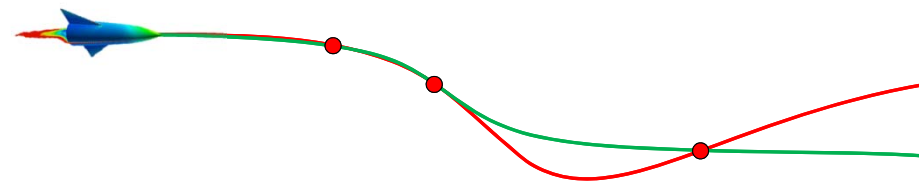
Hypersonic Modeling with AFRL & Lockheed Martin



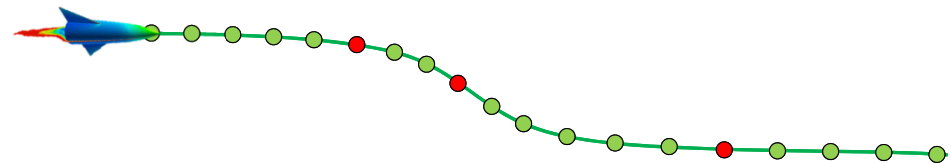
Hypersonics M&S is hard,
Testing and Evaluation is harder.



● **Current approach: six months per trajectory point**



Hypersonic Trajectory



● **New approach: six days per trajectory point**



Challenges:

- Currently: six months per trajectory point
- Solution times preclude high-fidelity usage
- Low-fidelity solutions not informative
- Doesn't inform T&E and decision makers

Solutions:

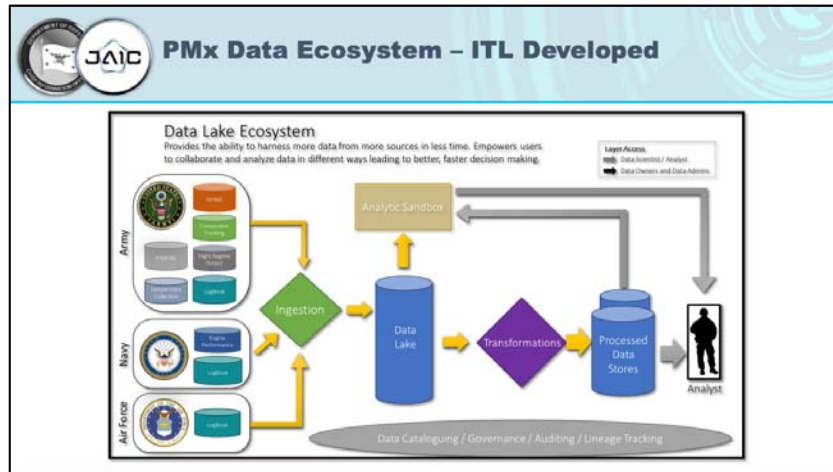
- Automated engineering analyses reduces labor cost
- Optimize and couple high-fidelity codes
- Increase accuracy to impact decision making
- Use M&S to inform T&E and decision makers

Fail Fast – Learn Fast





High Performance Decision Analytics (DA/AI/ML)



PMx Virtual Desktop - ITL Developed

- Access to Army, Navy, & Air Force H60 data
- AI Development Software
 - Anaconda
 - PyTorch
 - Tensorflow/TensorBoard/TensorRT
 - H2O Machine Learning Platform
 - R/R Studio, Apache Spark
 - Dask/Distributed
 - Keras
 - iRODS
 - Jupyter Notebooks
 - Galaxy Simulation Builder
 - HPCMP Launcher
- Established: June 1st
- Internal Testing: July 1st
- External Beta Testing/Release: August 1st
 - Incremental updates through FY19

The screenshot shows a virtual desktop environment with the JAIC logo and the text: JOINT ARTIFICIAL INTELLIGENCE CENTER, PREDICTIVE MAINTENANCE MISSION INITIATIVE VDI.

Challenge: Data creation is growing faster than organizations have capacity to store and utilize. Data is siloed within organizations and not shared.

Solution: ERS developed a digital engineering and analysis infrastructure, including a prototype data lake architecture and VDI access, that has become the foundation of the JAIC PMx NMI.

Ability to Process Gigabytes to Exabytes of Data



Challenges Ahead

Technical Area	Challenges 2020 - 2025
Computational Processes	Solution times – Surrogate model training data requirements – End-to-end, fully coupled, model execution
Computational Environments	Environments are still in development – Cultural acceptance – Gov/OEM should utilize same tools
High Performance Data Analytics	Tera-, peta-, exabyte data lakes – Mixed classification of data – Dirty data
Set-based Design	Properly sized sets for accurate tradespace exploration – Cost modeling – Accurate physics
Decision Dashboards	Portability to environments (classification) – Disconnected workflows – Spotty network connectivity – Unique stakeholder processes – Mission engineering integration



Questions?