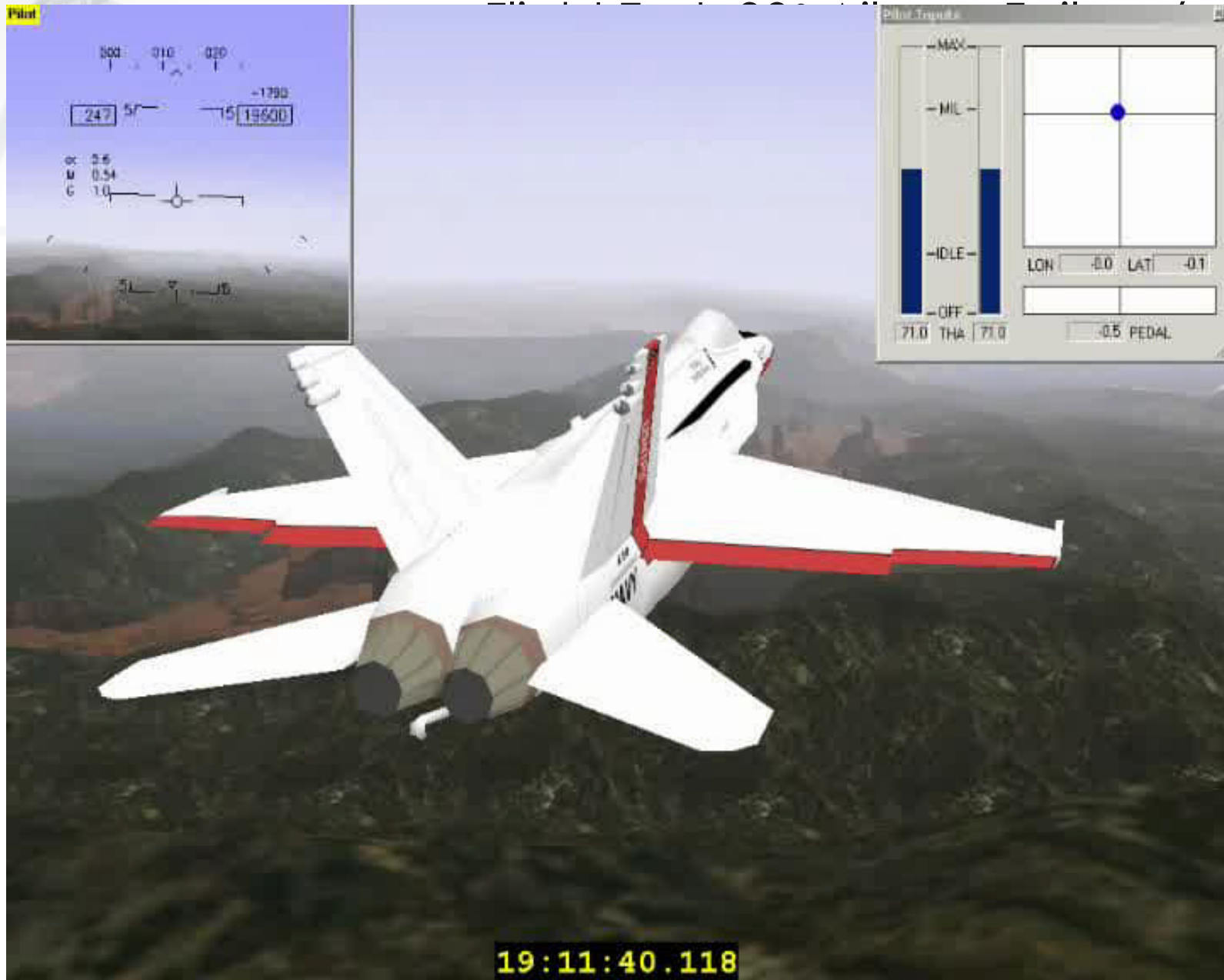

Barron Associates, Inc. Selected Current Research

SAE International
Aerospace Control & Guidance Systems Committee

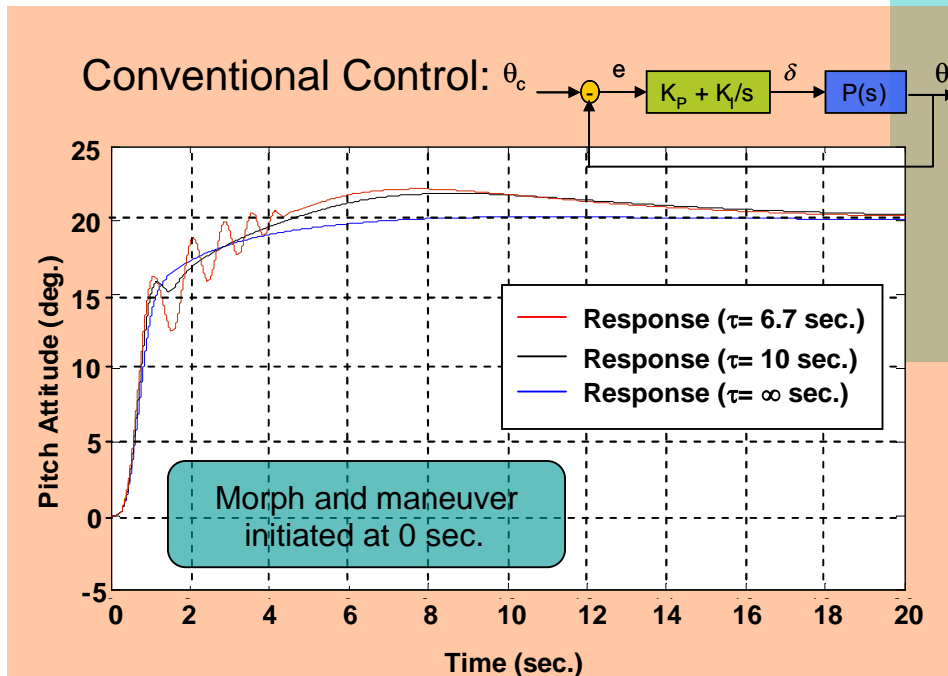
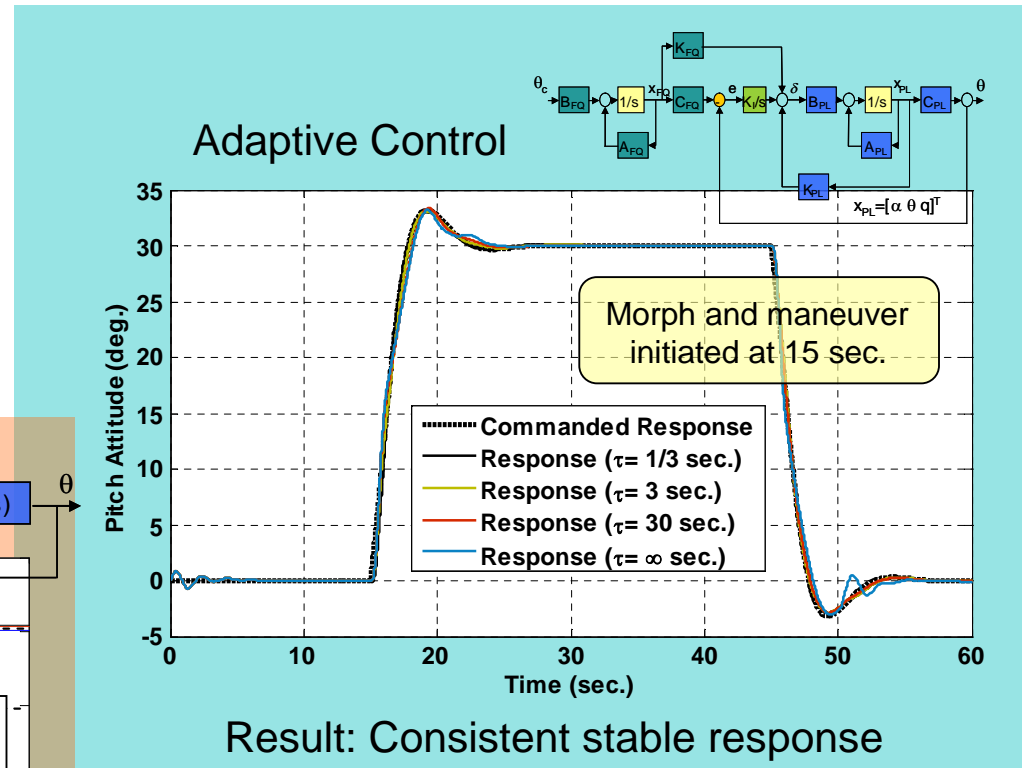
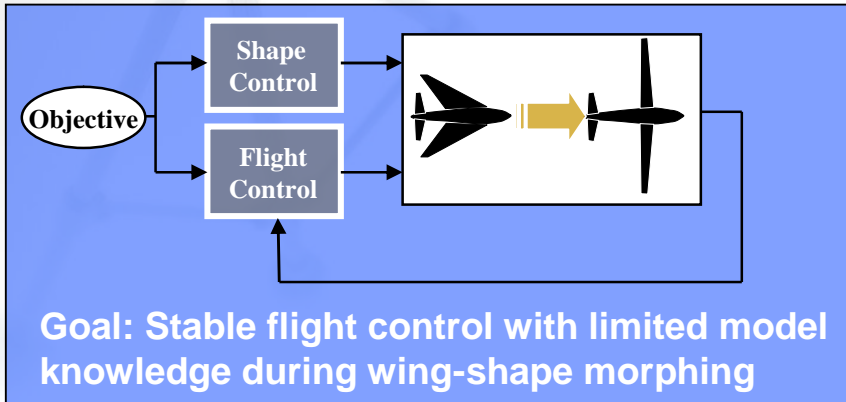
Williamsburg, VA
Oct 11, 2006

David G. Ward
(434) 973-1215
ward@barron-associates.com



10.1)

Adaptive Control of Morphing Aircraft



AF SBIR Phase II

- *With*
 - NextGen / Northrop Grumman / VA Tech
- Bryan Cannon, COTR

Demonstration Goal

- Real-time wind-tunnel demonstration of stable morphing control using N-MAS wing

High-Speed Supercavitating Torpedo

Challenges

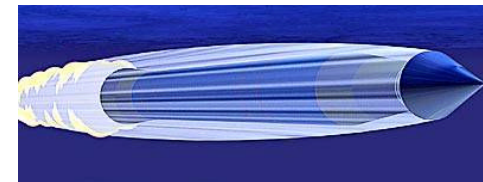
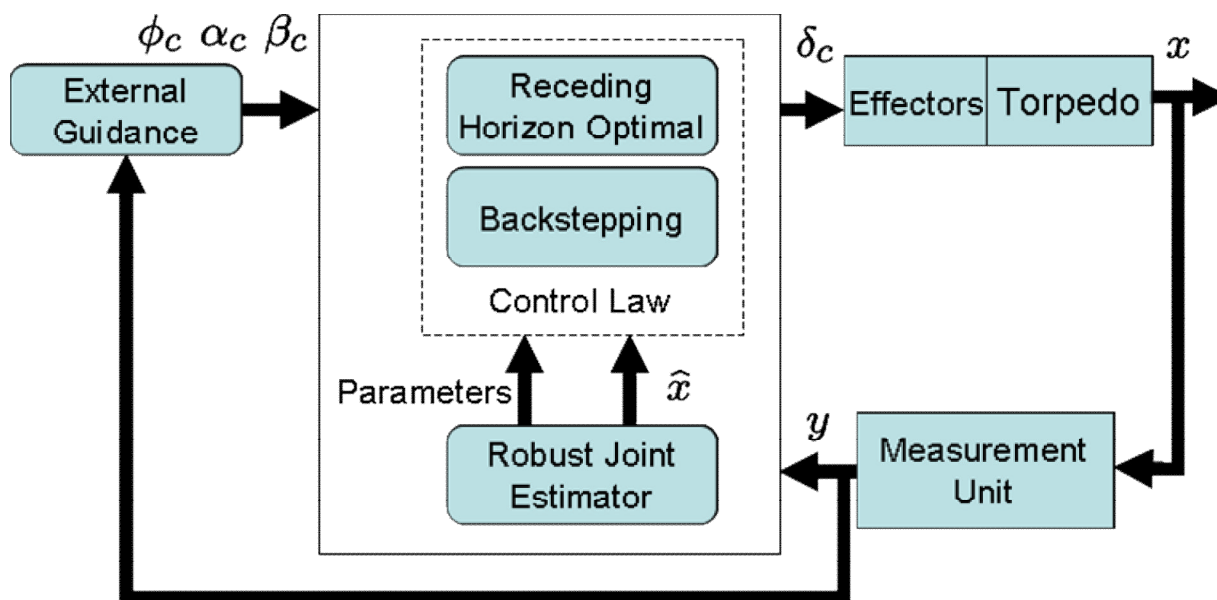
- **Memory Effects:** cavity shape and flow evolve as functions of current and prior motions
- **Output Feedback:** unknown states and uncertain parameters must be estimated
- **Other Important Considerations:** center of gravity aft of center of pressure, absence of lift, etc.

ONR Phase II SBIR

- With Anteon, U. Minn (Balas)
- Kam Ng, COTR

Demonstration Goal

- Real-time HIL water-tunnel demonstration



Adaptive Control of Synthetic Jet Arrays with Unknown Nonlinearities

Preparing for wind tunnel testing at AF Academy

ONR Phase II STTR

- With UVA and U. Wyoming
- Lt. Col Sharon Heisi, COTR, COTR

Collaborators:

University of Virginia

PI: Dr. Gang Tao

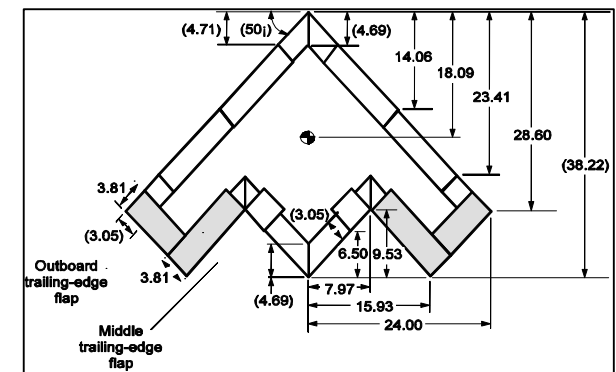
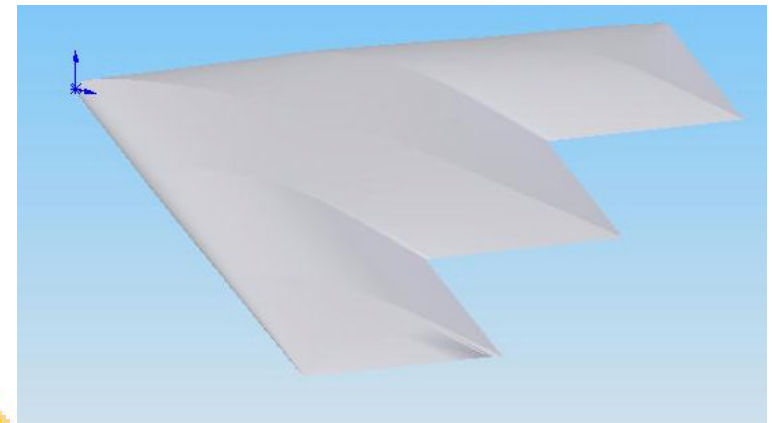
Adaptive Control Development

University of Wyoming

PI: Dr. Douglas R. Smith

Modeling and Experiment Design

Phase II Wind Tunnel Model Design



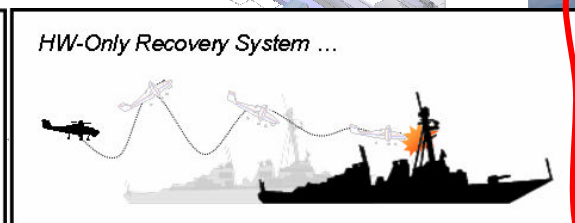
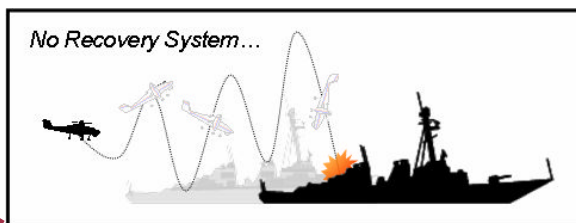
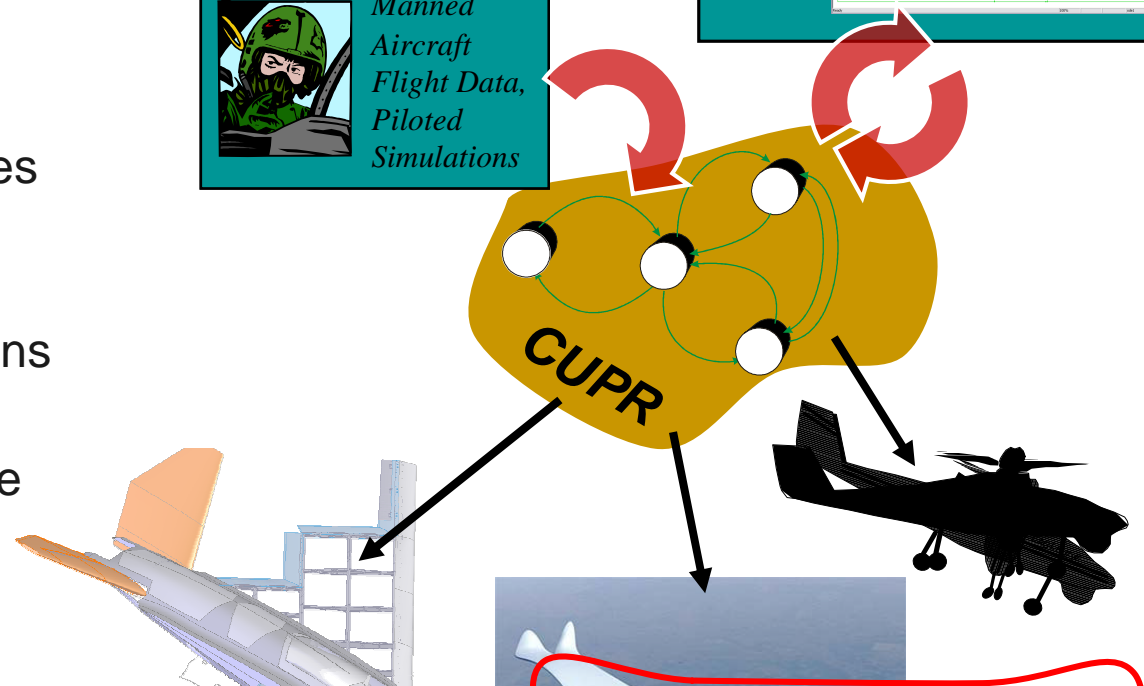
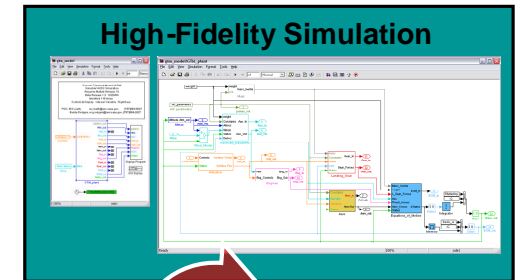
Collaboration w NASA LaRC
(Drs. Christine and Celeste Belcastro)

UAV Upset Recovery Control Systems

COTR: Mr. Jim Busey, NAVAIR

Develop a general-purpose automated-recovery system approach that

- learns appropriate recovery strategies
- adopts/encodes best-practices from the manned aircraft community
- avoids out-of-control conditions to the extent possible
- takes advantage of innovative actuation concepts



Adaptive RLV Guidance, Control, and Trajectory Generation

AF SBIR Phase III Enhancement

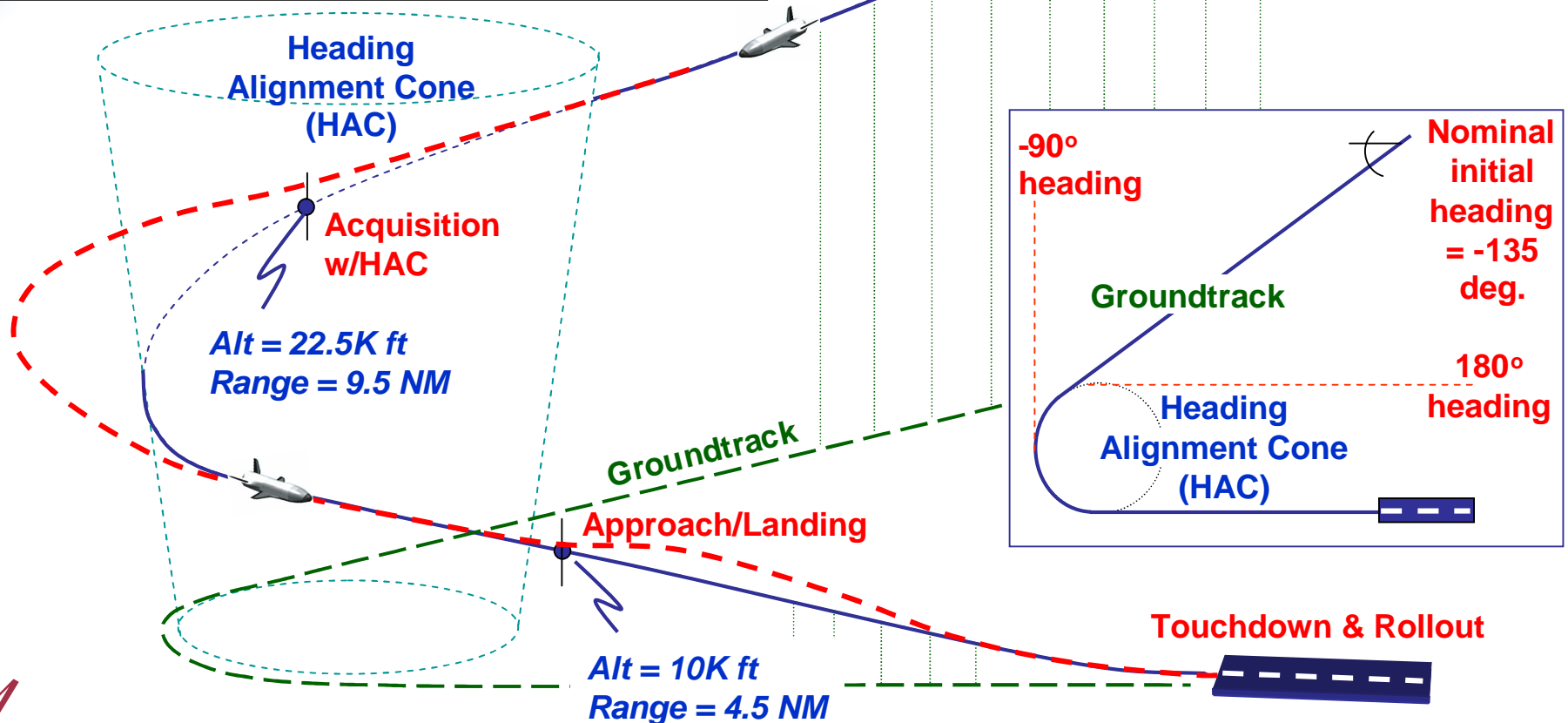
- With Boeing
- David Doman, COTR

Demonstration Goal

- Demonstrated integrated TAEM/A/L reshaping for subsonic X-37 drop test scenarios in Boeing HIL simulator

Separation & Dive

Alt = 40K ft
Range = 18.8 NM



IAG&C for RLV Re-entry

Goals/Objectives

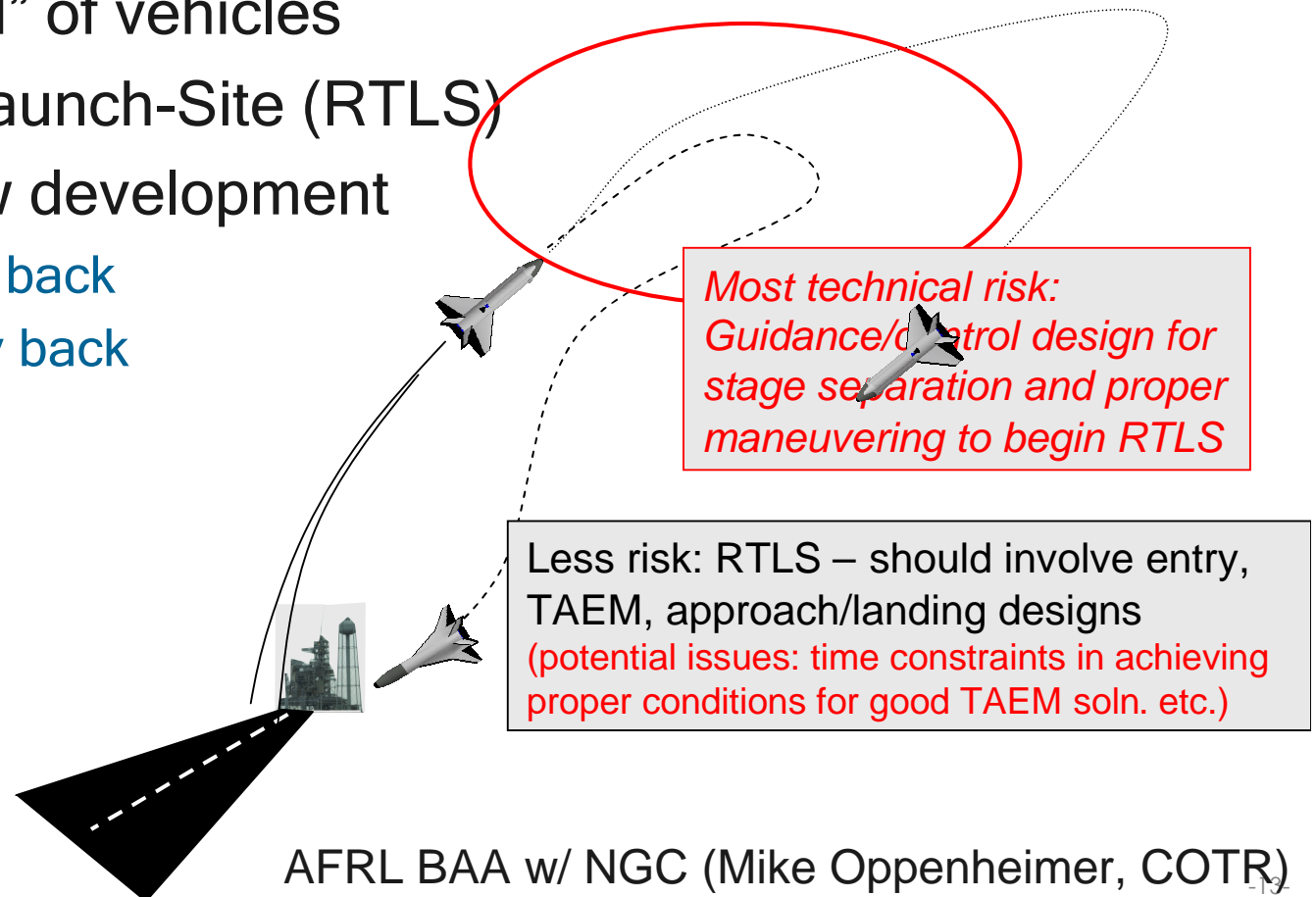
- Adapt for effector failures
- Integrate with existing RCS systems
- Manage heating constraints, etc.



IAG&C for RLVs During Ascent

Develop guidance/path planning for:

- Safe stage separation
- “Turn around” of vehicles
- Return-To-Launch-Site (RTLS)
guidance law development
 - 1st stage fly back
 - 2nd stage fly back



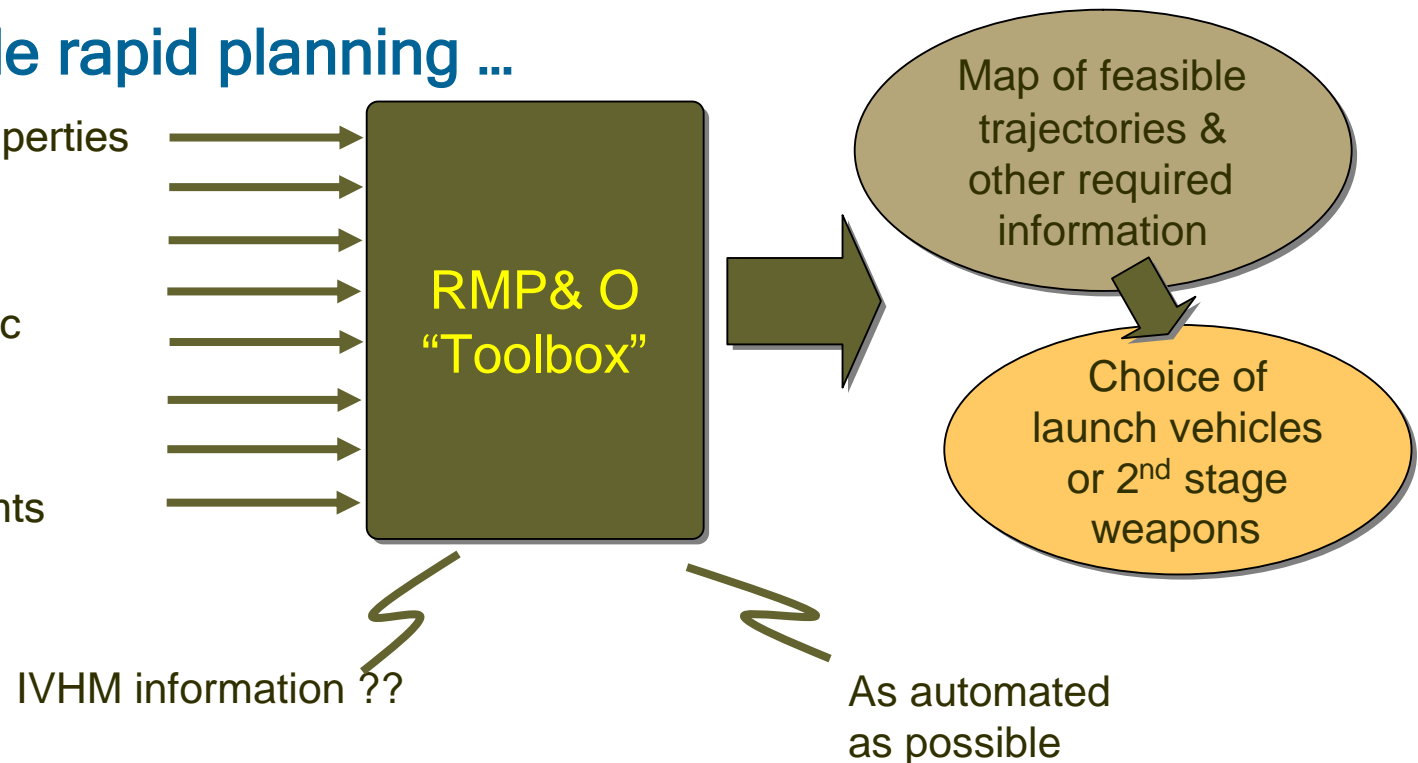
Rapid Mission Planning and Optimization

Rapid, reliable response

- Mission ready within 2 hours, 24 hours a day, 7 days a week

Tool to enable rapid planning ...

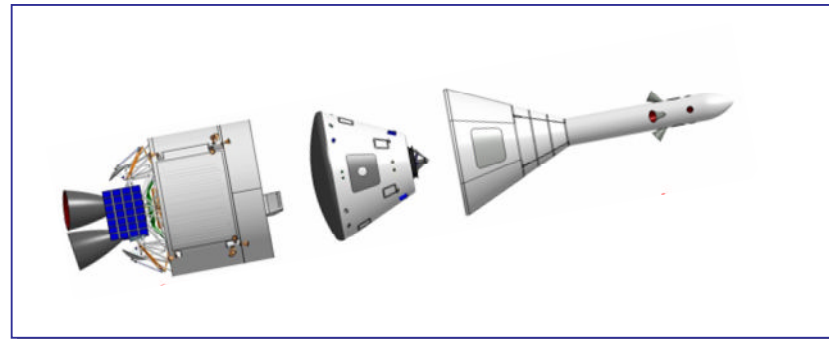
- Vehicle specific properties
- Mission specific parameters
- Current atmospheric conditions
- Other launch conditions/constraints



Crew Exploration Vehicle

NGC / Boeing CEV Contributions

- Conducted NASA directed trade studies regarding emergency ballistic entry of the CEV
- Developed aerodynamic control surface design for CEV
- Investigated c.g. location dispersion analysis and effects on ballistic entry characteristics



High-Speed Vertical Lift Simulation Development

High-speed vertical lift aircraft operated from ships Support Controls Researchers Simulation Development Goals

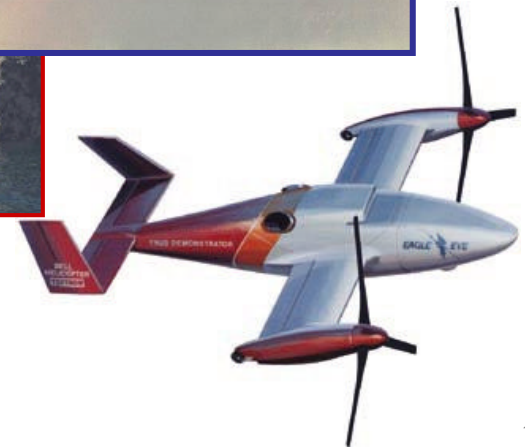
- Matlab / Simulink
- Modular -
 - Multiple vehicles with same/similar interface
- Complexity vs. fidelity
 - Dial-in Fidelity Options
- Publicly Releasable
- Integrate Related Navy Sim/Data
 - Ship airwake
 - Ship motion

NAVAIR

- With U. of Liverpool
- Tony Page, COTR

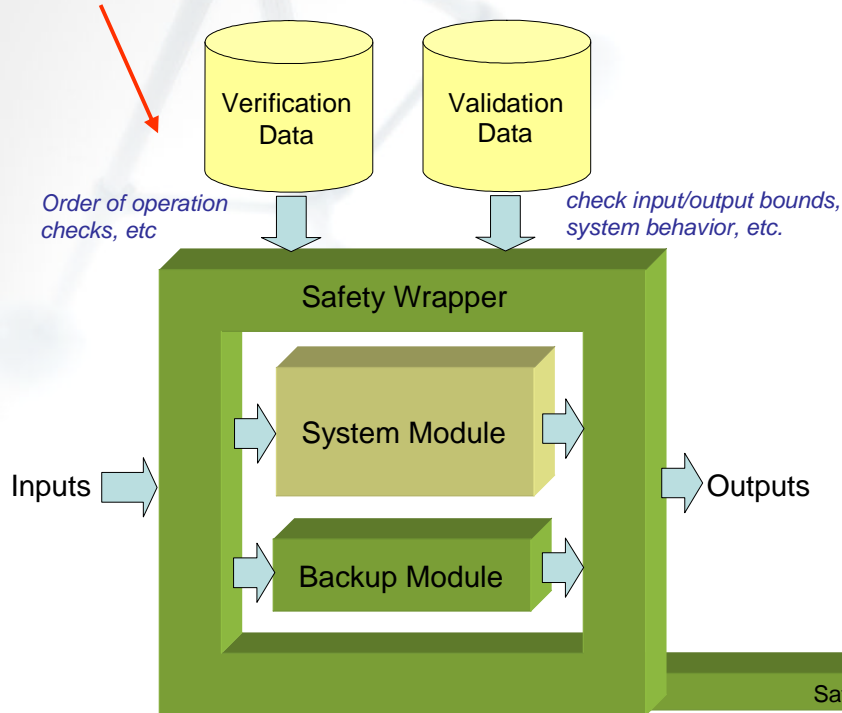
Project Goal

- Publicly-Releasable Controls-Oriented Shipboard Operations Simulation



Generic Run-Time V&V Safety Wrappers

Generic individual safety wrapper for one system module



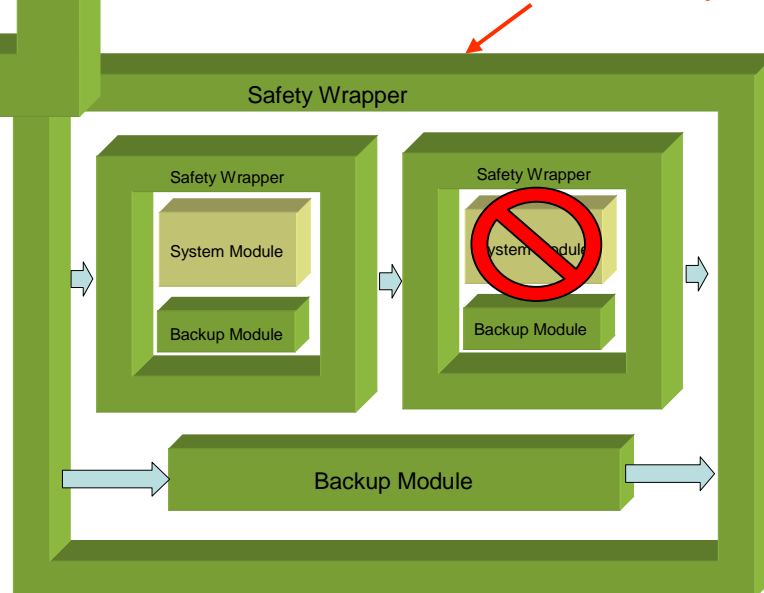
AF SBIR Phase II

- With Lockheed Martin
- Wendy Chou, COTR

Demonstration Goal

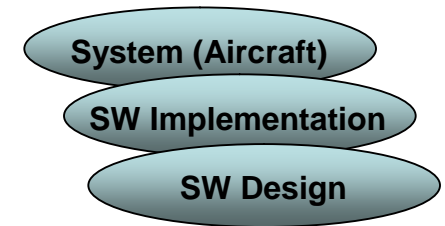
- Real-time HIL demonstration of V&V of intelligent UAV mission planning and control software

Safety wrapper for overall system comprised of a multitude of subcomponent safety wrappers



Incremental degradation: shut down only those sub-components not working, allowing other advanced components to continue operation

Failure Classes that can be Accommodated

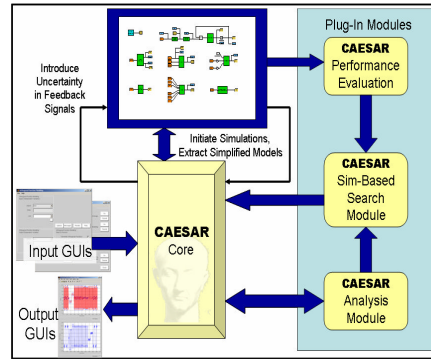
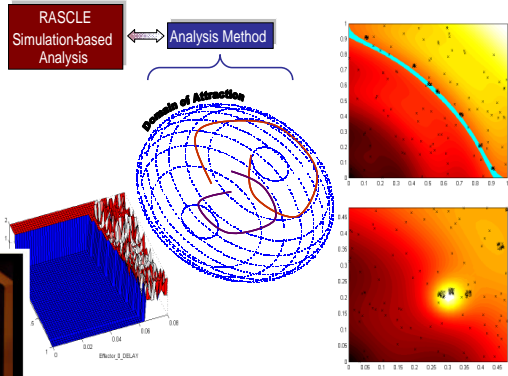


Phase II Enhancements

- Automatic generation of Simulink (autocodable) monitors
- Develop sets of monitors for a variety of *critical parameters*
- Automatically generate parameters/bounds required by monitors
- Monitoring for triplex architectures
- Guaranteed bounds for on-board neural networks

Analysis Methods, Software Tools, and Novel System Designs

V&V Through the Control Law Life Cycle



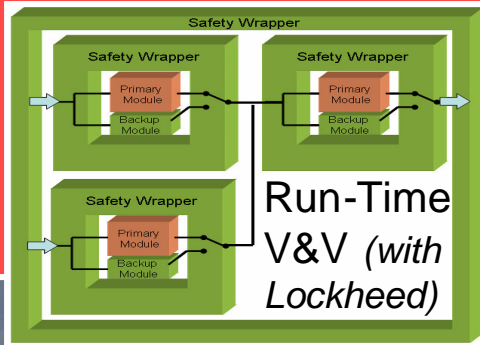
Automated Off-Line Test Of Stability, Robustness, and Performance (with MuSyn)

Real-Time Monitoring of Safety Margins (with MuSyn)

Flight Testing

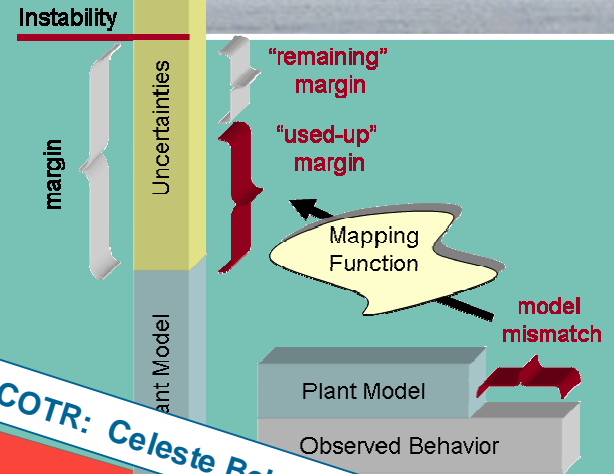
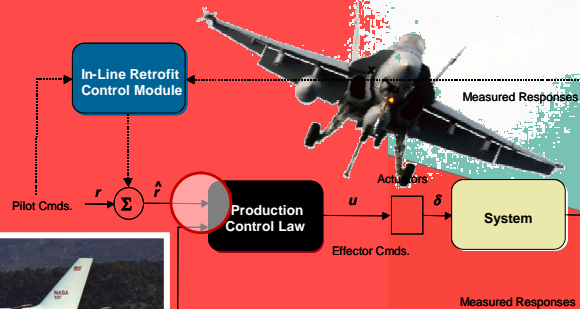


COTR: Christine Belcastro, NASA Langley



Run-Time V&V (with Lockheed)

Retrofit Flight Controls



COTR: Celeste Belcastro, NASA Langley

Production Vehicles - DACS

