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Open Architecture Simulation in NAS Safety Assessment

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Research Activities

- Implementation of Open Architecture in Airport and Airspace Simulation Models
  - Research funded by ATAC
  - UC Berkeley / Virginia Tech
- Role of Fast-Time Simulation in Assessing Safety Issues in the National Airspace System
  - Research funded by NASA
  - ATAC prime contractor
  - UC Berkeley / MIT subcontractors

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Implementation of Open Architecture in Airport and Airspace Simulation Models

- UC Berkeley
  - Mark Hansen, Geoffrey Gosling & Almira Ramadani-Williams
- Virginia Tech
  - Antonio Trani, Hanif Sherali & Hojong Baik

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Overview

- Open Architecture Concepts
- Review of Existing Capabilities
- Review of *SIMBUS* Concept
- Review of *SIMMOD* Code
- Survey of User Needs
- Experiments with Potential Approaches
- Recommendations

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Open Architecture Concepts

- Better Ways to Define Operational Procedures
- User Access to Intermediate Data Flows
- Interaction with User-developed Modules
- Explicit Modeling of Human Behavior
- Modeling of 4-D Aircraft Flight Paths
- Link Model Inputs/Outputs with Other Tools

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Survey of User Needs

- Three Simulation User Communities
  - Airport planning
  - Airspace planning and operations
  - Research and development
- 15 Responses from 19 Organizations Surveyed
- Findings
  - Broad support for all 6 open architecture features

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Survey Results

Feature	Desirable	Not Required
Better ways to define operational procedures and constraints	14	0
Better access to intermediate data flows	8	6
Ability to develop program modules	12	2
Ability to model the actions of humans	10	4
Accurate 4D aircraft flight paths	9	5
Better links to other tools	11	3

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Experiments with Potential Open Architecture Approaches

- Virginia Tech Study of Airport Surface Movement
  - Prototype object oriented model
- UC Berkeley Simulation of Final Approach Spacing Tool
  - Modification of *SIMMOD* input files

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Recommendations

- Critical Issues
  - Improvement to flight path modeling
  - Capability for rule-based model logic
  - Interface to user-developed routines
  - Access to internal data values
- Three Possible Approaches
  - External shell to control model execution
  - Limited model enhancements
  - Develop new object oriented version

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Role of Fast-Time Simulation in Assessing Safety Issues in the NAS

- ATAC
  - John Bobick, Mike Abkin & Gregg Lougeay
- MIT
  - R. John Hansman & Tom Reynolds
- UC Berkeley
  - Mark Hansen, Geoffrey Gosling & Glenn Blackwelder

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Overview

- Need for Improved Safety Assessment Tools
- System Safety Assessment Process
- Role of Simulation in NAS Safety Assessments
- Potential Role of Fast-Time Simulation
- Representative Problems
- Initial Demonstration of Approach

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Need for Improved Tools for System Safety Assessment

- Increasingly Complex Environment
  - Need to address potential for unforeseen interactions
  - Increasing levels of automation
- Importance of Human Factors
  - Not well handled by existing tools
- Role of Simulation
  - Frequency of occurrence of events of interest
  - Modeling decision processes

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System Safety Assessment Process

- FAA Guidance
  - AC 25.1309-1A *System Design and Analysis*
  - FAA Order 8040.4 *Safety Risk Management*
- Current State of the Art
  - Functional hazard assessment
  - Failure modes and effects analysis
  - Fault trees / Probability analysis
  - Simulation

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Role of Simulation in NAS Safety Assessments

- Past Focus on Real-Time Simulation
- Assessment of New Technology or Procedures
- Measurement of System Safety Performance
  - NAS performance
  - Controller performance
  - Pilot performance

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Potential Role of Fast-Time Simulation

- Use of Existing Models
- Explicit Representation of Safety-Critical Elements
  - Separate logic for ATC and pilot decisions
  - Model communication channel and task loading
- Analysis of Decision Processes
  - Cognitive behavioral models
  - Dependent on information flows

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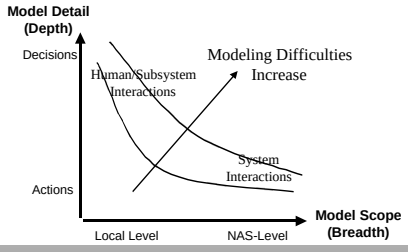
Model Detail and Scope



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Representative Problems

- Impact of Proposed Technology or Procedural Changes
  - CTAS, ADS-B, AMASS, etc.
  - Low Visibility Landing and Surface Operations
  - Separation standards
  - Controller-pilot datalink
- Safety of Current Operations
  - Runway incursions
  - Controlled flight into terrain
- Effect of Traffic Growth

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Runway Incursion Study

- Evaluate Effectiveness of Proposed Measures
- Develop Baseline Simulation
  - Analysis of runway incursion scenarios
  - Modify behavioral parameters to generate relatively frequent incursions
- Analyze Impact of Proposed Measures
  - Estimate impact on behavioral parameters
  - Determine change in runway incursion rate