Revisiting Aircraft Flight Simulator Acceptance Criteria

? 1930 ?? 2000 ???

Dean Carico
Rotary Wing Ship Suitability
Naval Air Warfare Center Aircraft Division
Patuxent River, MD., USA

Presentation Outline

- Flight Training Background
- Early Simulation Fidelity Studies
- Existing Simulator Criteria
- US Navy Simulation Initiative
- Modeling Mission Applications
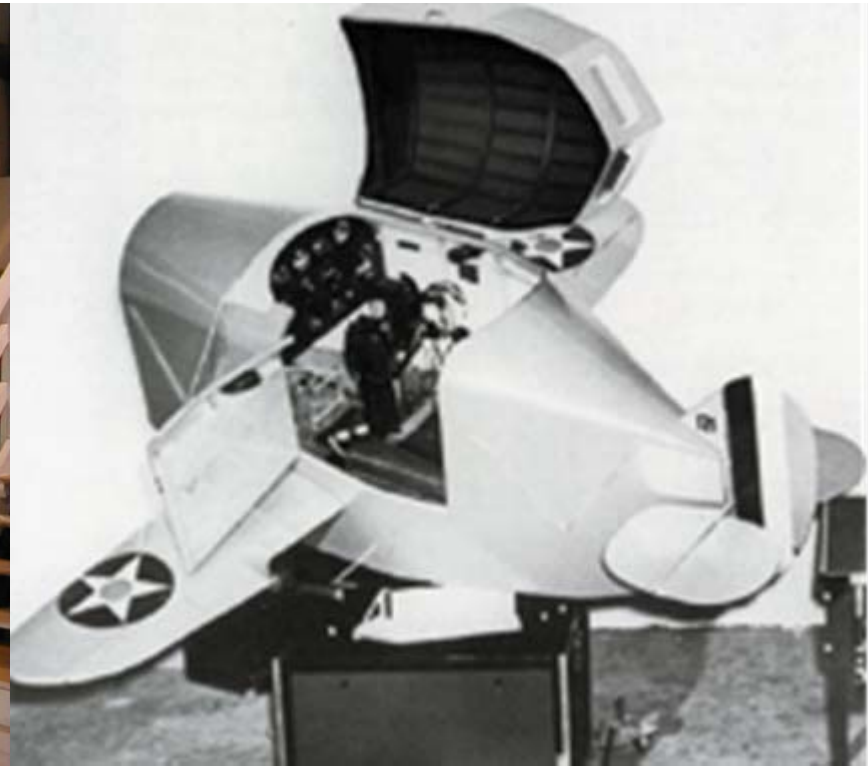- MFOQA
- Summary
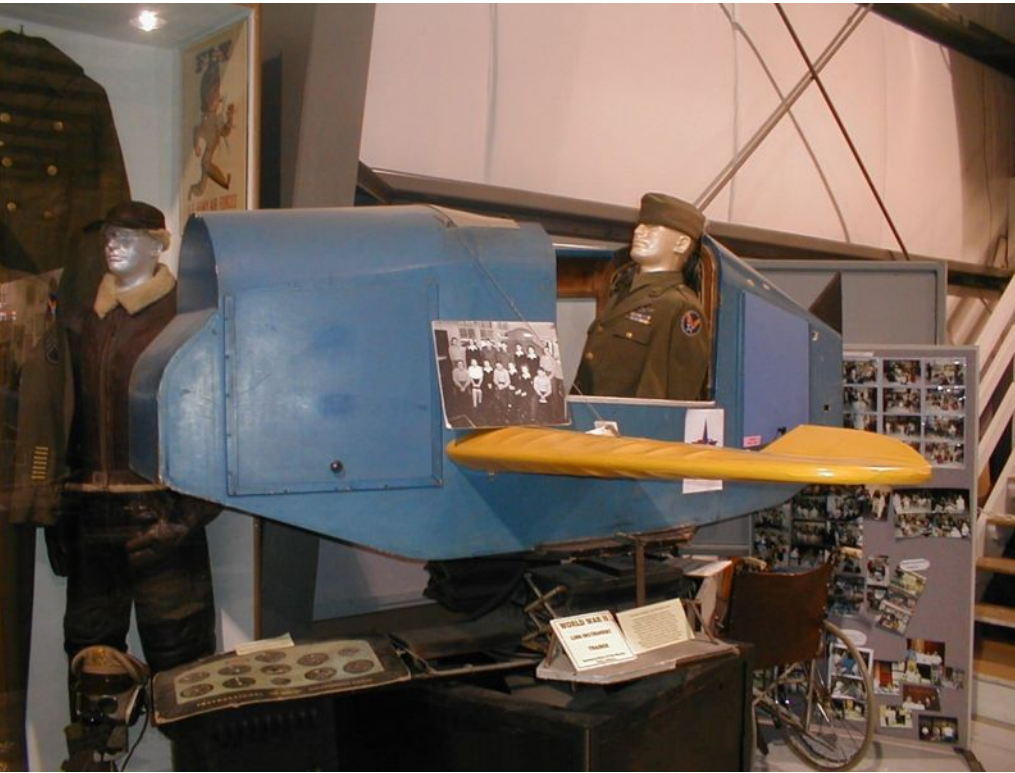
Lilienthal Glider ~ 1894

Wright Brothers First Flight 1903
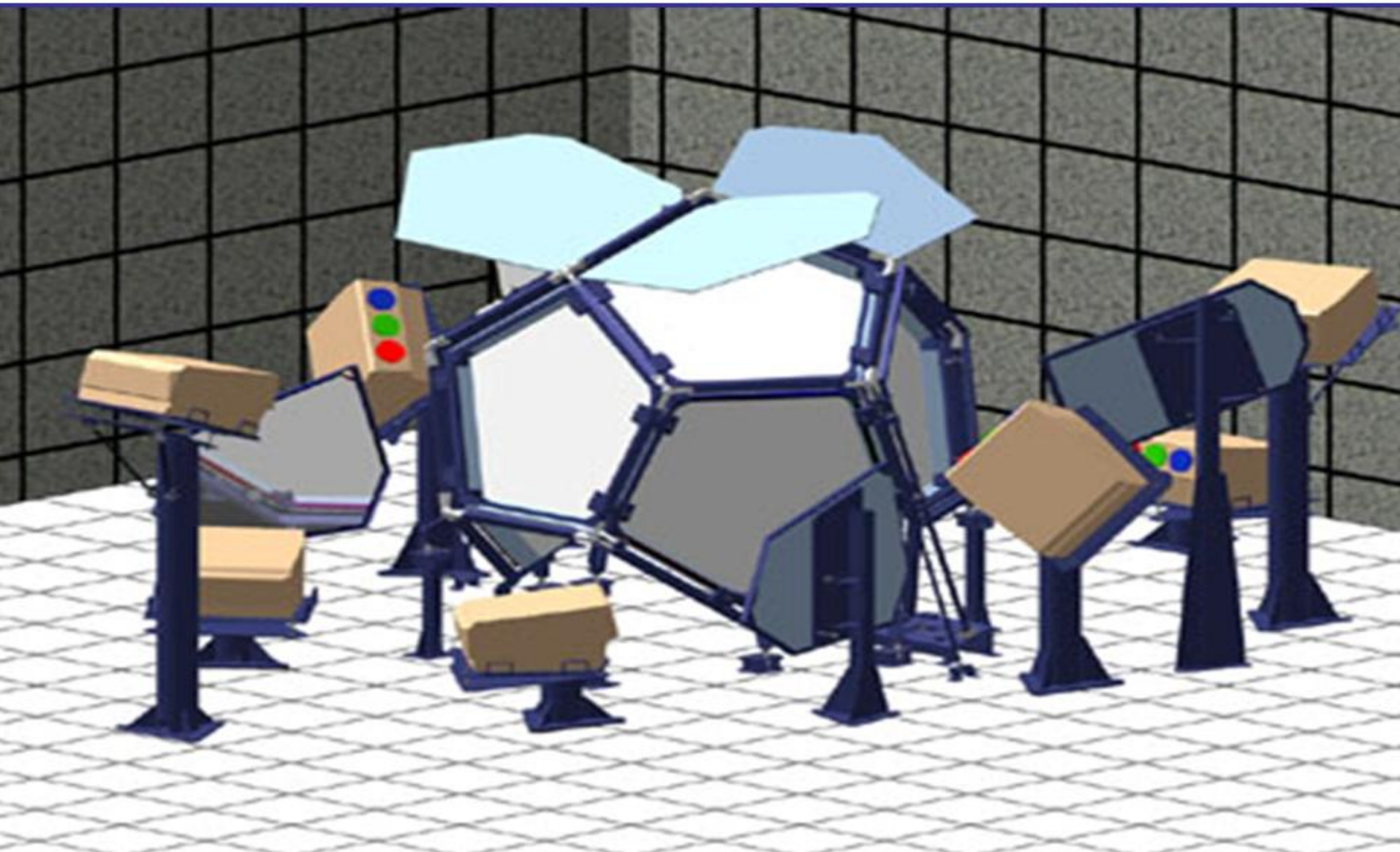
Curtis JN-4 Barnstorming ~ 1919

Link's Blue Box Trainer

Link Trainer ~ 1940s

F-18 OFT Link "SimuSphere" design ~ 2001
External View Point

MH-60R Motion OFT Layout

MFS MH-60R OFT #2

Early US Navy Simulator Experience

- Early US Navy flight simulator evaluated by fleet pilots
- NATC started evaluating OFT/WST with flight test teams using flight test data in the 1970's
    - SH-2F Device 2F106 – First WST tested by test team
- Trainer acceptance criteria developed by NAWCTSD
- Criteria featured as OFT/WST built-in-test options

Early US Army Simulator Experience

- Considerable simulator fidelity work done by US Army/NASA Ames in 1980's &1990's
  - NASA Ames Vertical Motion Simulator (VMS)
  - US Army Aeronautical Design Standard 33
    - Handling qualities focus
- 1984 UH-60 NOE Simulation
  - Aircraft HQR's 1.5 to 2 better than simulator
- Low visibility simulation for hover & low speed
  - Fine-grained micro texture more important than FOV

OFT/WST Acceptance Criteria

- US Navy
  - NAWCTSD Guidelines Rotary Wing Aircraft
  - NAWCTSD Guidelines Fixed Wing Aircraft
- Federal Aviation Agency (USA)
  - AC 120-63 Helicopter Simulator Qualification
  - AC 120-40 Airplane Simulator Qualification
- Joint Aviation Authorities (Europe)
  - JAR-STD 1H Helicopter Flight Simulators
  - JAR-STD 1A Airplane Flight Simulators

Sample Helicopter Simulator Test Criteria

Sample Test	NAWCTSD	FAA AC No: 120-63	JAR-STD 1H
Performance			
Hover Torque	3%	+/- 3%	+/- 3%
Low A/S CP	2% full travel	+/- 5%	+/- 5%
Handling Qualities			
Trimmed CP	2% full travel	+/- 5%	+/- 5%
Critical Azimuth CP	2% full travel	+/- 5%	+/- 5%
Autorotation			
Rotor Speed	1%	+/- 1.5%	+/- 1.5%

Notation: CP – Control Position
A/S - Airspeed

On-Going U.S. Navy
Small Business Innovative Research Project

- Topic N07-033 – Advanced Aircraft Simulator Flight Fidelity Evaluation Measures

- Four six-month Phase I contract awards made in early summer 2007

- Hopefully, two two-year Phase II contracts will be awarded following the Phase I work

- Research topic endorsed by NAVAIR PMA-205 Aviation Training Systems

- NAVAIR PMA-205 manages over 3 dozen OFT/WST, plus numerous other training devices

Simulator Project Focus Areas

- Aircraft type (helicopter, tilt rotor, VTOL, fixed-wing)
- Flight Test Maneuver (USNTPS, ADS-33, Operational)
- Maneuver Aggressiveness (timed non repeatable tasks)
- Control strategy (workload and bandwidth)
- Visual scene (fine grain texture, resolution, FOV, etc)
- Simulator component (visual, motion, aural, cockpit, etc)
- Time or frequency domain analysis options
- Cost and risk (VV&A using risk/benefit analysis)
- Pilot factor (flight time/type/conditions, attitude)
- Mission task element (Navy, Army, Air Force missions)
- Total simulator system fidelity (quantify cueing effects)
- Military flight operations quality assurance (MFOQA)

Potential Virtual Mission Applications

- Air-to-Air Combat
- Air-to-Air Refueling
- Nap-of-the-Earth
- Rotorcraft/Ship or Dynamic Interface
  - Rotorcraft
  - Ship
  - Airwake
  - Ship motion
  - Visual environment

Rotorcraft/Ship Simulation

- NAVTOLAND H-2 VMS Project 1982
  - Inadequate FOV – forward landing circle
  - Lack of texture – ship deck, hangar & sea
    - Caused pilots to rely excessively on HUD
    - HUD was considered ~ + 2 HQR points for task
    - Tried to used "ice floes" to provide ocean texture
  - Airwake model – excessive in magnitude & frequency
- The helicopter/ship landing technology was just getting started at this time

- # Joint Shipboard Helicopter Integration Process (JSHIP)

  - Joint Test & Evaluation Force

  - Sponsored by OSD Deputy Director, Developmental Test & Evaluation

  - Purpose to Increase the Interoperability of Joint Shipboard Helicopter Operations (Army/Air Force Helicopters with Navy Ships)

Dynamic Interface Modeling & Simulation System (DIMSS)

- Define a Process for Establishing a WOD Flight Envelope Using Modeling and Simulation

11/3/1999

- Demonstrate that the Process Works by Validating a WOD Flight Envelope Established by Simulation for the LHA/UH-60A Ship/Helicopter Combination

  – Use Vertical Motion Simulator at NASA Ames

  – Validate simulation against flight test data

  – Investigate minimum cueing requirements (visual, aural & motion)

JSHIP Simulation Results

None of the simulator configurations tested achieved similar subjective ratings as in the aircraft

The simulation results could not be used to generate operational flight envelopes

Military Flight Operations Quality Assurance (MFOQA)

- OSD focus since 2005 to help reduce overall mishap rate
- Builds on commercial aviation practices using operational trend analysis of enhanced flight data to better identify hazards and improve risk management
- Goal for simulator full MFOQA is 2009
- Initial aircraft demo conducted at HSL-41 in early 2006 using H-60 with JAHUMS

MFOQA
Military Flight Operations Quality Assurance

A knowledge management process that uses downloaded flight data after *every* flight
to provide
aircrew, the squadron and the Fleet with *quantitative information*
regarding *aircrew* and *aircraft performance*
to improve
training, operational readiness and *safety.*

Summary

- Pilots have used simulators since the 1930's
- Trainer acceptance criteria same since 1970's
- Questions on comparing FT & simulator data
- Large simulator technology database
- US Navy initiated a program in 2007 to develop advanced simulator flight fidelity measures to enhance flight trainer acceptance criteria
- The program team members will be searching for related reference material during the project life
- Improved virtual models will also have a positive impact for future flight test productivity & safety