THE ADVANTAGES OF USING FLIGHT SIMULATORS TO TEST NEW TECHNOLOGIES AND REFINE BEST PRACTICES TO SUPPORT AIRLINE OPERATIONS

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Presentation Premise

• The use of simulators as a stand-in for live, on-aircraft training has been an important practice for many years.

• Key advantages, of course, include the cost savings of training in a ground-based, controlled environment relative to a live aircraft, as well as the ability to leverage ARINC 610 functions to set and reset flight events, to simulate equipment failures, for upset recovery training, and more.

• We’ve seen the expansion of flight simulator use to support certain phases of aircraft development.

• As the level of operational fidelity between the aircraft and the simulator increases, we see additional advantages to the use of high-end flight simulators in the testing of developing technologies and for refining best practices to support safer and more cost effective airline operations.
Disclaimer/Explainer

• Honeywell is not a simulator manufacturer and we do not intend to get in to the simulation business

• Honeywell’s participation in the business of building simulators (we call them validation facilities--VALFAC, or System Integration and Test Stations--SITS) is entirely self-serving—to validate and verify that our equipment meets the requirements, specifications and design elements expected by our customers

• We build simulators to troubleshoot and do root cause analysis of equipment anomalies that occur in development, or on the aircraft (on the ground, in flight test, or in revenue service, post delivery)

• We build simulators to try out new technologies to test their potential applicability for use in new applications

• We supply simulator software to simulator manufacturers to enable them to exactly reproduce the functionality of our equipment in to their simulator products
It All Begins with a Technical/Cost Problem

• Suppliers of airborne equipment products, particularly highly evolved avionics and integrated aircraft systems, are required to prove that their products meet agreed-to Design Requirements
  - The question the customer will ask is, “How do I know your equipment has been designed to meet the requirements of my aircraft and meet the integrity, design assurance, and fault monitoring and reporting characteristics required by the certification authorities?”

• It starts with engineering design discipline
  - Top level requirements (which are parsed in to)
  - Detailed requirements (which are then parsed out to become)
    - Statements of Work (meant to be conducted by integrated/separate teams)

• It devolves to structured methods of design/test/validation/verification
  - Mathematical modeling is a must, but insufficient
  - Individual LRU testing is inadequate
  - Subsystem testing only gets part way there

• How to meet ARP-4754X/DO-254X/DO178X/other Industry Guidance?

There has to be a way to prove you did what you said you would do.
A Dated Example of the Complexity Challenge

From Diverse Sources, Everything Must Work Together
In the Early Days…

We did the best we could with what we had…
As a Start: Real Equipment Used in Simulators

• Real equipment is expected to behave in the simulator, just as it does in the aircraft (given same inputs, the output should be the same)

• Real equipment could be acquired from the OEM, straight off the production line (but delays for development time do occur)

• Similarly, the equipment should predictably fail in the simulator, just as it would on the aircraft

• However, it was just as expensive as purchasing a piece of the aircraft for test, evaluation, validation and verification work

• And when you broke it, it had to be discarded or repaired, just as it would if it broke on the aircraft
Devolving into Emulation

- A solution for real world challenges is required:
  - Cost
    - Acquisition
    - Repair (and associated down times)
    - Life cycle (how many times can it be used)
  - Physical limitations of production hardware
    - Movement
    - Environmental limitations
      - Heat
      - Cold
      - Humidity/moisture
      - G-forces
  - Repeated tests
    - Time required to reset
    - Stress on equipment
    - Repeatability of test results
      - Same input, same circumstances, same output?
Sometimes It needs to be a Combination

G650 SITS--Real Hardware with Emulation for Inputs
Another Combination—More Complex
This is a B787 SITS
The More you want to test, the Bigger the SITS
SITS Bench

• The SITS (System Integration Test Station) is designed to provide the means for Honeywell to perform real-world system robustness testing, software and system integration and verification in support of TSO process.

• Advantages
  • Testing with real / simulated LRUs
  • Static and dynamic testing capability
  • IO testing capability
  • Bench remote access and IP camera for remote screening of displays
An Example of SITS Architecture

DFZ SITS Architecture

Power Distribution and Control Panel

Real LRUs

Power Buses

RF

RF Panel

Power Buses

Audio

Speakers

Custom Panels

Display Rev Panel

Master Caution Warning Panel

NFC Panel

Power Cycle Panel

Displays & Controllers

* The MAU configuration shown in the image is for reference only
Remote connection

- Internet link between sites
- The entire bench can be observed by easy-to-control camera mounted on the ceiling. The camera can zoom and pan across the bench to capture all display units and control panels. (facilitates integrated, but physically separate engineering team interactions)
Prototype Development (Example)

• For development of OEM specific graphic displays (e.g. synoptic pages, engine window) ESEA team uses I-Data tool.

• Highlights:
  • Rapid prototyping of graphic displays
  • Logic models that specify the behavior of the HMI
  • Generation of runtime prototype before implementation
  • Produced data can be overlaid on the target system
Types of VALFAC/SITS Facilities

• **Static Sub-System Bench**
  - Testing of one or more avionics units with static and manipulation of I/O.
  - May include auto-test capabilities.
  - May have very limited closed loop I/O.
  - Typical of displays or avionics platforms group (sensors, inertials, processing platforms, etc).

• **Dynamic Sub-System Bench**
  - Testing of one or more avionics units or an avionics system with closed loop I/O and dynamic simulation.
  - Typical of FMS or Flight Controls/ Auto-pilot Group.

• **Dynamic Integration facility**
  - Total test and integration of numerous avionics units/systems.
  - May also include non Honeywell avionics.
  - Full Dynamic simulation.
  - Typical of System Integration Group. All product groups may use full-up integration facilities for testing. Capability to switch between real or simulated LRUs.

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And We fly it, and fly it, and fly it some more
I started here. I will end here

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• Honeywell’s participation in the business of building simulators has been entirely self-serving—we use simulation and emulation to validate and verify that our equipment meet the requirements, specifications and design elements expected by our customers

• We build simulators (we call VALFAC or SITS) that enable us to test, to stress, to subject equipment to operational parameters and environmental factors (up to, below, above, and beyond the environment they are expected to face in their on-aircraft lives), including HALT and HASS types of testing

• We build simulators to troubleshoot and do root cause analysis of equipment anomalies that occur in development, or on the aircraft (on the ground, in flight test, or in revenue service, post delivery)
There is More

• We build simulators to try out new technologies to test their potential applicability for use in new applications
  - A precondition is that the simulated/emulated equipment must exactly replicate the real thing

• Based on the work done in our development teams, we supply qualified equipment to aircraft manufacturers that becomes a part of the aircraft manufactured and sold to operators

• Our SITS work done on LRUs, on subsystems, and entire systems can be used by the aircraft OEM to take certification credit for and to replace work that would otherwise have to be done in flight test (with all of its inherent costs and risks)

• We supply resulting functional software packages to simulator manufacturers to enable them to exactly reproduce the functionality of our equipment in to their simulator products for training of pilots and aircraft maintenance personnel
Learnings in Simulator Design

• Our Purpose: Test/Prove Design and Development philosophy

• SITS facilities allow us to meet customer requirements on schedule, within budget (less costly than on-aircraft testing)

• SITS allows QC and V&V functions to prove that engineering has followed repeatable design processes and development practices to ensure the creation of high-quality equipment within configuration control/traceability requirements

• Use of modular components (HW & SW), COTS solutions where possible, helps to minimize custom designs

• Re-use of successful designs enables common SW/HW across multiple facilities and aircraft platforms
Learnings in Simulator Design (2)

• Search for automated tool sets, library of GUI's / virtual control panels, modular simulation models, common scripting language

• Investigate low-cost test solutions, compatibility between desktops and labs with simulations, GUI's, test scripts

• Find ways to implement embedded test functions to minimize external test equipment

• Make the simulator reconfigurable for support of multiple development programs (create a family of equipment across aircraft platforms)

• Auto-test capability (within the simulator itself—self check) helps to shorten SITS development and maintenance cycles