High Energy Management System (HEMS)
Increasing Workplace Safety and Reducing Factory Delays

Peregrin Spielholz, EHS Senior, Manager
Phil Specht, Senior Production Engineer
Marc Nance, Exec (ret.) Program Management
Anilise Larden, EHS Team Lead
Lori Smith, Senior Systems Engineer

June 6, 2024

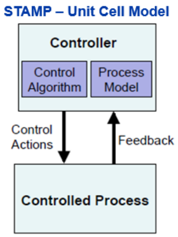
Why High Energy Management?

- High Energy injuries occur during all phases of the aircraft lifecycle.
- Goal is to “build in” new HE management capability into future aircraft
  - Can be used on carts in the factory
  - Functional Testing
  - Maintenance
- The HEMS system could be leveraged for legacy aircraft to gain improvements in reducing likelihood of HE incidents.
- Disruption and delay costs add to direct injury costs.
- The MIT-developed Systems-Theoretic Process Analysis (STPA) is the analysis method being used to generate requirements.

https://www.boeing.com/safety#Our-Commitment

Control Loop Application for HEMS System Concept

Technical approach based on control theory



- **Current state of the system (what systems are on/off) is sent to all key personnel**
- **Alerts for scheduling conflicting, HE tasks**

Sends feedback to the Process Model

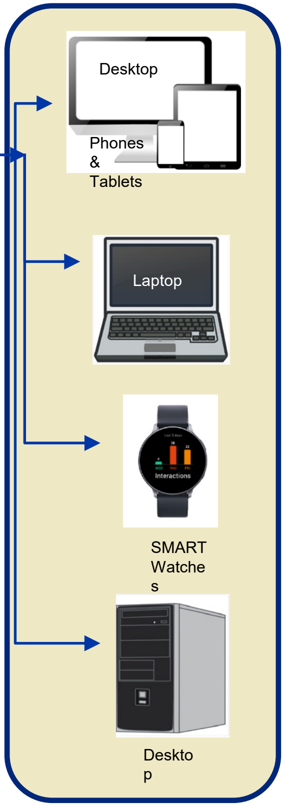
HEMS Process Model

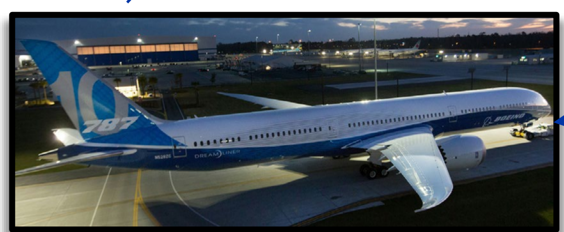
PM sends info to control algorithm on what systems are on/off

A/C Sensors collect data

Control Algorithm

Human decision selection



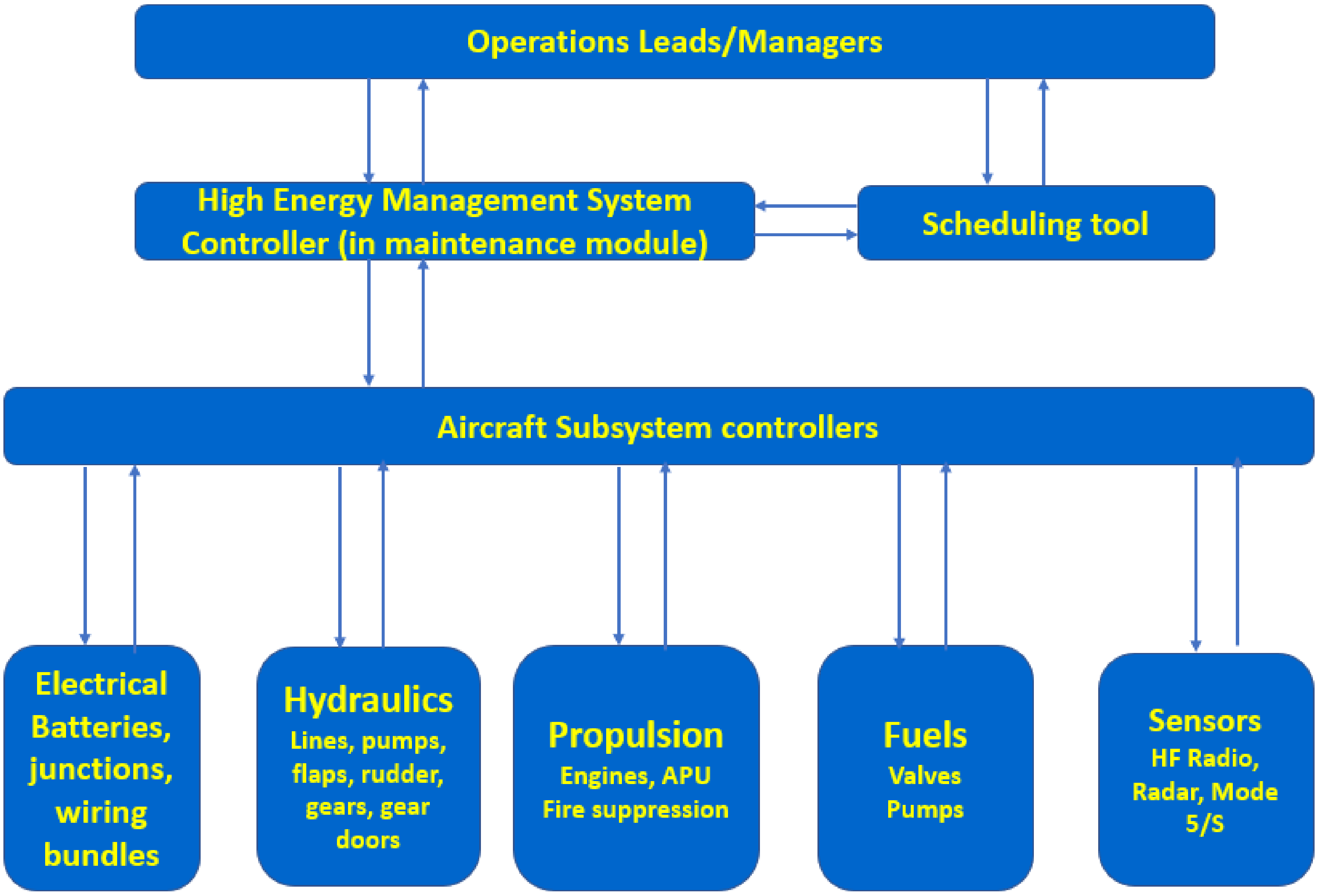


<u>Control Actions:</u>
Turns systems on/off to prevent conflicting systems from being activated at the same time. Automated actions or by humans

Patent pending

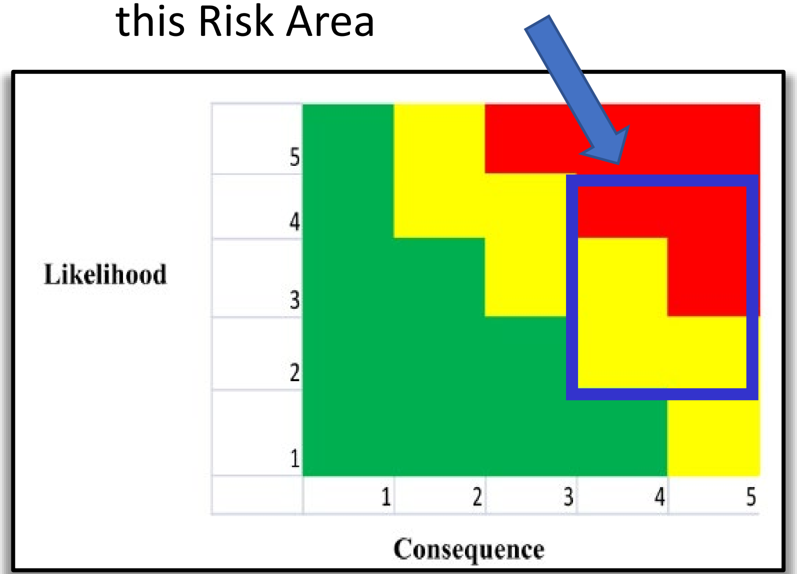
RROI 24-181749-BDS

Control Structure for HEMS System



What did we find using STPA?

Most Requirements Impacted this Risk Area



70+ New DfEHS Hydraulic System Functional Requirements for HEMS

- Hydraulics system can be high risk even when the system is powered off (de-pressurized)
- Control surface positions stored in VMS can be unknown to the worker – surface moves from "droop" position to neutral (stored) position unexpectedly upon pressurization
- The correct amount of hydraulic pressure must be available for the task (pressure – task pairing) for the mechanics and maintainers as they do their work
- Feedback loops to HEMS will be implemented to confirm fitting "striping" or fully torqued positions of fittings before the task begins

Hydraulic Energy Control

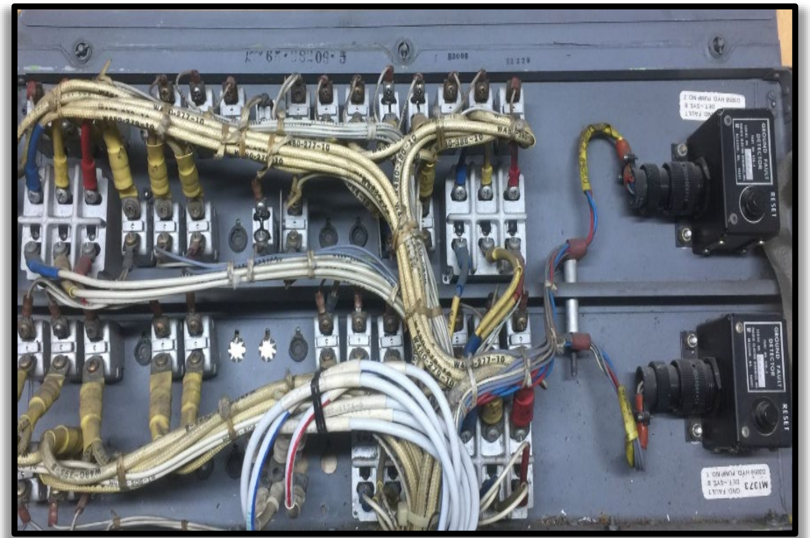
Unsafe system condition: If technician was working on a flap or rudder and wasn't aware of the pressurization state, they could come in contact with the surface and experience unexpected motion.

Unsafe Control Action #1: Providing hydraulic system pressure (HSP) is unsafe when the system is de-energized (de-pressurized state) and a person comes in contact with the surface which moves unexpectedly (wing flap, rudder, etc.) and results in injury to humans by getting caught between surfaces.

Causal scenario #1: A flawed process model in the hydraulics controller believes the system is pressurized when it actually isn't causing the particular surface being worked on to move unexpectedly which could result in workers getting caught between surfaces with serious if not fatal injuries.

A total of 7 HEMS system level requirements from STPA analysis directly address this hazard

Electrical Energy Control



Unsafe system condition: If technician was replacing a connector and happened to come into contact with an energized pin from an adjacent system, the worker could experience electric shock and possible serious injuries.

Unsafe Control Action #1: Providing an electrical subsystem "on" command too early is unsafe when a conflicting electrical subsystem is still powered which could result in electrical shock, injury to humans and damage to aircraft.

Causal Scenario #1: An incorrect process model believes all other, conflicting systems are "off" when they actually are still on which causes the electrical control algorithm to provide subsystem "on" activation too early resulting in damage to the A/C or injury to humans.

A total of 3 HEMS system level requirements from STPA analysis directly address this hazard

https://www.boeing.com/safety#Our-Commitment