Human Factors Operability Timeline Analysis to Improve the Processing Flow of the Orion Spacecraft

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Problem Introduction

- Orion vehicle goes through several areas and stages of processing before its launch at the Kennedy Space Center.
  - In order to have efficient and effective processing, all of the activities need to have a human factors engineering analysis.
  - Corresponding Human factors requirements and design solutions needed to be defined.

- Areas of Processing
  - MPPF (Crew module and Service module)
  - Vehicle Integration Building (VAB) (Crew module/Service module to Launch Vehicle and Ground Support Equipment)
  - Launch Pad
Solution

- Developing a written timeline of events that included each activity within each functional flow block
- For each activity, develop computer animation videos and pictures of the human and hardware
- The HFEAT was improved by modifying it to include the timeline of events.
  - See IEEE paper 1-G Human Factors for Optimal Processing and Operability of Ground Systems up to CxP GOP PDR
- Each activity was analyzed by operability experts and human factors experts with spacecraft processing experience
- The HFEAT was used to define the human factors requirements
- Design solutions were developed for these requirements
Solution

- The HFEAT was modified to include column inputs for:
  - Location
  - Human Interface
  - Task
  - FFBD Event and Number
  - Task Issues and Actions
  - Team Actions
  - Comment for Video
Example

Functional flow block diagram

2.1 Transport Short Stack to MPPF
2.2 Receiving and Handling
2.3 Establish Access and Services
2.4 PEPC (Cargo/FCE) Integration
2.5 Crew Equipment Interface Test (CEIT)
2.6 Powered PEPC (Cargo/FCE) to Orion Interface Verification Tests
2.7 Un-powered Non-Time Critical PEPC (Cargo/FCE) Installation
2.8 Potable Water Servicing

Short stack pallet
Example

- Location – MPPF
- Human/System Interface - Short stack pallet
- Task/Issue/Action
  - Task: Move short stack pallet into and out of servicing bay
  - Issue - (Communication, visibility by operator to pallet corners): Alignment of pallet into bay
  - Action - Assure method to prevent contact and misalignment of pallet with existing bay structure during installation/removal of short stack pallet
- FAA Requirement - Users shall be protected from making errors to the maximum possible extent
- Potential Recommendation - Install guide rails on floor
- Team Action – Team Members to assess this human factors item and respond to team lead
Suggested Applications

- Where ever there is a timeline of activities to operate, maintain, or assemble hardware

- Where FAA requirements are required for design engineers.

- Other NASA Centers, Johnson Space Center, Marshall Space Flight Center, Etc

- Non government companies
Advantages and Disadvantages

Advantages
- Time line is logical way to analyze the human activities
- Includes the engineering FFBD approach
- Promotes collaborations with human factors engineer and operations engineers
- This method ensures the capture of sequence of tasks at each processing location
- Includes the other capabilities from the HFEAT, such as the FAA requirements
- Includes use of human visualization techniques

Disadvantages
- Time consuming, but it is thorough.
Recommendations

For Tool improvement

- Improve the method for selection of FAA requirements so this is less time consuming
- Improve the method for selecting; Location, FFBD numbers, tasks, issues and actions
- Improve the functionality of the tool by making it a software or web-based instead of an excel spreadsheet
- Improve the tool so it will promote capturing lessons from design solutions for use in future designs
Summary

Continue to use the timeline method to successfully map out the processes and to perform human factors operability engineering analysis, and to derive applicable human factors design requirements and design solutions