INFORMATION PRESENTATION

Human Research Program - Space Human Factors & Habitability
Space Human Factors Engineering Project

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PURPOSE

The goal of the Information Presentation Directed Research Project (DRP) is to address design questions related to the presentation of information to the crew on flight vehicles, surface landers and habitats, and during extra-vehicular activities (EVAs). Designers of displays and controls for exploration missions must be prepared to select the text formats, label styles, alarms, electronic procedure designs, and cursor control devices that provide for optimal crew performance on exploration tasks. The major areas of work, or subtasks, within the Information Presentation DRP are: 1) Controls, 2) Displays, 3) Procedures, and 4) EVA Operations.

CONTROLS – Cursor Control

The unique environmental conditions encountered by crewmembers on space missions (vibration, varied g-levels, vacuum requiring pressurized suits) translate into special design requirements for crew interaction with information presented on computer displays. Cursor control devices (CCDs) must be specially designed to function under the variable, harsh conditions of space.

Test battery

(Status – beta complete; revisions in work)

One of the first goals of the Information Presentation project was to develop a computerized test battery that could be used to evaluate a number of different types of cursor control devices. The test battery provides a standard methodology for measurement, and will be of use to any researcher interested in evaluating cursor control devices.

A collection of 7 tasks measuring CCD pointing and dragging time and accuracy. Many of the tasks are based on ISO 9241-9.

Example task displays including simple target acquisition of various sized targets, text selection, dragging, and interaction with standard interface components.

Gloved cursor control device evaluation

Four devices were evaluated using the test battery, with and without EVA gloves: an aircraft trackball, a Kensington trackball, a Logitech trackball, and a Hulapoint mouse. Recommendations for usability with a gloved hand were developed based on the results.

Pressurized gloved cursor control study

A study was performed in collaboration with the Orion Cockpit Working Group using EVA gloves in a pressurized glovebox at Johnson Space Center. Recommendations were developed for the design of a cursor control device for Orion.

Cursor movement study

In addition to investigating cursor control device hardware, the behavior of the cursor on the computer screen is an area of investigation as well. An upcoming study will experimentally compare task performance with a cursor in the following modes: continuous, discrete, gravity well. Later studies will examine advantages and disadvantages of type of cursor movement under different environmental conditions: vibration, microgravity. These studies will yield recommendations for cursor movement under different environmental conditions.

IMPACT

The cursor control device work described above has supplemented concurrent work on Orion cursor control device definition. Results of these studies have aided Orion device down-selection, and software developed for this effort is being used for Orion cursor control device evaluations. Results from these studies will yield Constellation and NASA-wide standards and requirements for cursor control devices.

SHFE RISK TARGETED: Poor human factors design

DISPLAYS - Label orientation

0° (horizontal)	90° left	90° right	marquee
TEXT	TEXT	TEXT	T E X T

Display designers sometimes have to use vertical text when real estate is limited. The goal of this study was to examine the impact of different styles of vertically oriented text using short words, acronyms, and abbreviations.

Results

Text orientation

1) Participants could read the horizontally oriented text faster than the rotated and marquee text. This confirms that horizontal alignment is the preferred orientation for labels.
2) Inconclusive results on differences between vertical orientation, but marquee was subjectively rated the worst.

Scan Patterns

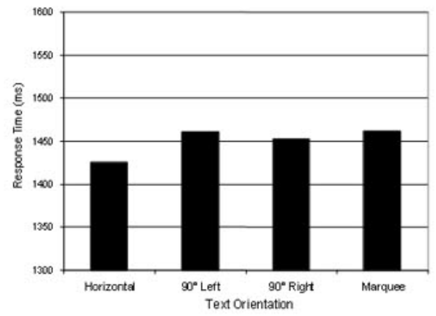
It appears that when participants are engaged in visual search of a text item they follow a specific pattern, moving from left (top to bottom) to right (top to bottom).

Next Steps

Additional studies need to be done to further evaluate vertical text styles, incorporating more complex displays, additional practice, and time pressure.

IMPACT

Results from these studies will yield display standards for the Orion Display Format Standards document, and other NASA-wide requirements documents.



Response time by orientation type

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DISPLAYS - Label alignment

Vehicle displays are often made up of many columns of labeled data values. Design direction on alignment of these columns of data conflicts in the literature. The goal of this study was to experimentally compare different types of label alignment.

Shutter forced	11
Sys	24
Access closure	43
Exit	54

Left-aligned

Cooling unit	69
Nominal force	79
Vent	11
Fan	34

Data-aligned

Nominal force	79
Shutter forced	17
Access closure	43
Analog input	23

Wrapped

Results

1) There was a small response time advantage for data-aligned labels.
2) Wrapped labels were responded to more slowly than unwrapped labels for mixed displays (group of long and short labels).

Next Steps

Additional studies need to be done to further evaluate label alignment, incorporating more complex displays, additional practice, and time pressure.

IMPACT

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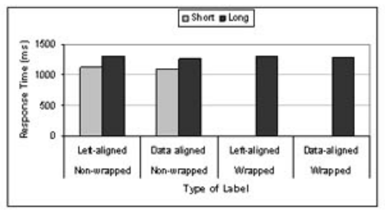
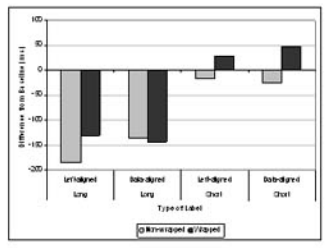


Response time for homogenous displays as a function of label length, alignment, and wrapping.



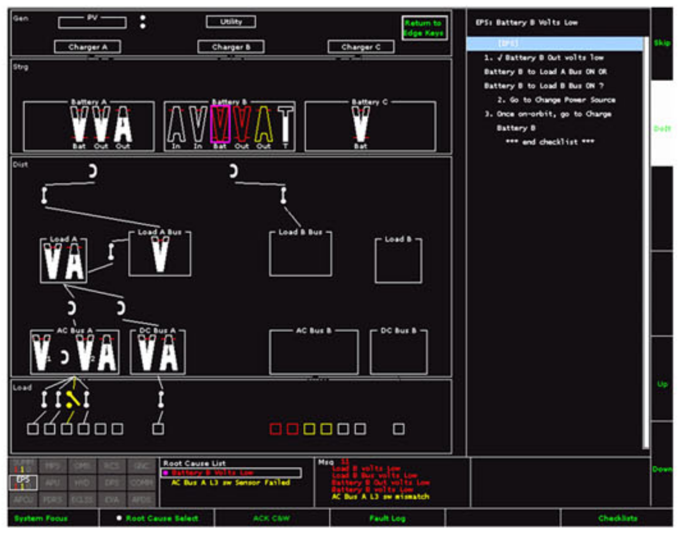
Response time difference from baseline for mixed displays as a function of label length, alignment, and wrapping.

SHFE RISK TARGETED: Poor human factors design

PROCEDURES – Fault Management

An Electronic Procedure Viewer (EPV) is one of the most operationally critical interfaces for next-generation crewed space vehicles, particularly for real-time fault isolation and recovery operations.

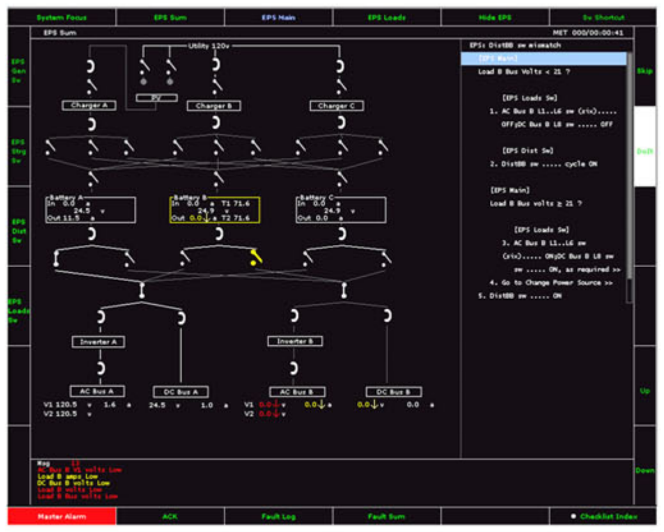
A human-in-the-loop evaluation of two fault management concepts was completed -- one (BESI) where the EPV is functionally integrated with an advanced Caution and Warning (C&W) System, and another less advanced concept (ELSIE) with no functional connections between the EPV viewer and the C&W system.



BESI Fault Management Display

- Advanced Caution and Warning System interfaces include "Root Cause List," where automated malfunction diagnosis is provided
- Magenta box highlights system component associated with automated diagnosis
- Original list of C&W messages available for verification of automated diagnosis (if desired)
- Fault management display shows the point where participant has accepted and selected the automated diagnosis, which has automatically brought up the appropriate checklist in the EPV

➔ Number of steps reduced compared to ELSIE due to automated checks for sensor failures



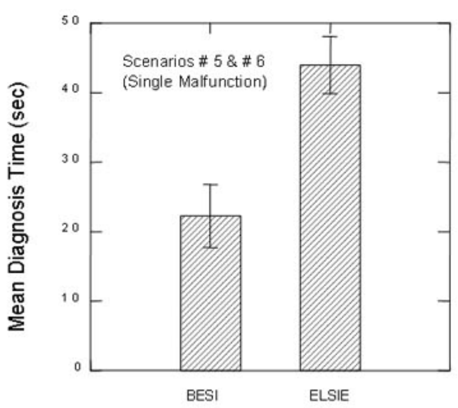
ELSIE Fault Management Display

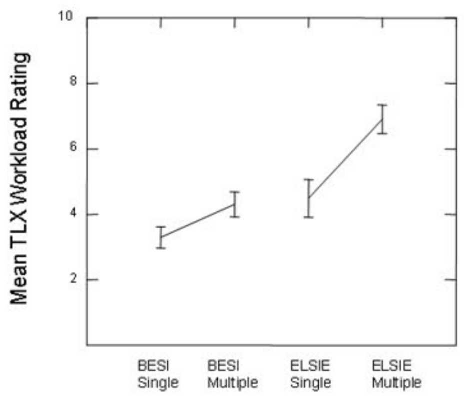
- Participants made fault diagnosis by integrating information from C&W fault messages (lower left section of display); color-coded off-nominal indications on system summary display (upper left section of display), and list of system faults in EPV (upper right section of display)
- Fault management display shows the point where participant has diagnosed malfunction and is starting to work procedures through the EPV
- Blue ("current focus") line is one of many cues to help operator navigate through the steps in the procedure checklist

IMPACT

Results from these studies will yield Constellation and NASA-wide standards and requirements for fault management displays and electronic procedures.

Results





SHFE RISK TARGETED: Poor task design

DISPLAYS - Auditory alarms

The goal of this study was to investigate optimal semantic mapping of sounds to alarm classes using suitability ratings.

Class 1 Emergency: fire/smoke
Class 1 Emergency: depressurization
Class 2 Warning
Class 3 Caution

Stimuli

Within each trial, there was one sound representing the existing alarm used on current space vehicles, and five alternative alarm sounds based on results from a previous alarm study by the same authors.

Results

Of the four alarm classes tested, only one of the sounds from the existing set were rated the best; new sounds were rated highest for the remaining alarms.

Status and Next Steps

Crew participants are currently being run in the study. A validation study will be done to confirm the results before recommendations are made.

IMPACT

Results from these studies will yield Constellation and NASA-wide standards and requirements for alarms.

Screenshot of the software used for the study.

SHFE RISK TARGETED: Poor human factors design

EVA OPERATIONS

Working in a pressurized, suited environment poses great challenges in terms of displays, controls, and suit informatics, especially in the harsh lunar environment. This is a new subtask for Fiscal Year 2008.

Work is beginning in the areas of:

- suit display design
- tactile feedback and fine-motor control during gloved operations
- near-eye and auditory displays

SHFE RISK TARGETED: Poor human factors design