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INFORMATION PRESENTATION

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

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ABSTRACT

The goal of the Information Presentation Directed Research Project (DRP) is to address design questions related to the presentation of information to the crew. The major areas of work, or subtasks, within this DRP are: 1) Displays, 2) Controls, 3) Electronic Procedures and Fault Management, and 4) Human Performance Modeling. This DRP is a collaborative effort between researchers at Johnson Space Center and Ames Research Center.

DISPLAYS – Visual displays

FY08 Studies

Label Alignment

Three studies investigated the effects of label alignment in small and large data groupings: 4, 8, and 16 label/value pairs, as well as high fidelity displays. The task was to find a value that corresponded to a target label.

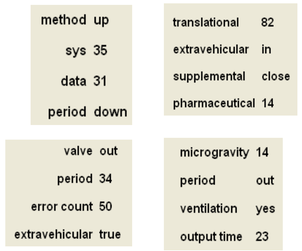

Figure 1. Examples of labeled data columns using left and data-alignment

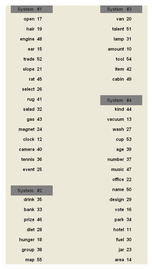

Figure 2. Example of a high fidelity display

- For large data groupings, such as the 16-label group, data-alignment is faster than left-alignment
- In high fidelity displays, there was no difference in search times between left and data-aligned labels.

Label Orientation

The purpose of the study was to investigate the effects of label orientation.

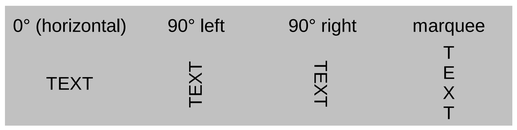

Figure 3. Examples of labels in different orientations.

- Horizontal labels improve reading time compared to vertical labels
- Additional label orientation studies are needed and being planned so that a solid design recommendation can be made

Studies Planned for FY09

Follow-up on alignment studies from FY08, further investigating left-aligned versus data-aligned labels for performance differences. The experimental task will be varied, and eye tracking will be used to gather higher precision data.
• Investigate methods of distinguishing between labels and values, such as colons, spaces, and bolding.
• Investigate methods of indicating “clickable” areas on a display.
• Investigate tradeoffs between color-coding on text versus color-coding on an associated symbol/icon.

Readability under vibration

Follow-up on the FY08 vibration study to examine the effects of different fonts and sizes, line spacing, and color.
Complete preparations and training for the Vibration Readability DSO (first flight scheduled for Feb 2009). Perform a detailed comparative analysis between data collected in a vibration only condition with data collected in g+ vibration (from separately funded effort occurring in Fall 2008) to determine the added value of the centrifuge, and the data lost without the high-g environment. Investigate the feasibility of performing eye tracking under vibration.

DISPLAYS – Auditory displays

- Three studies examined the suitability of candidate alarm sounds for four types of alarms: class 1 emergency (fire-smoke and depressurization), class 2 warning and class 3 caution. Crew participants were asked to rate the sounds on a 5-point suitability scale.
- **Emergency (Class 1):** This is the most serious type of event. It is used in a life threatening condition that requires immediate action in order to protect the crew.
- **Warning (Class 2):** This is less serious than emergency. It is used in a situation hat requires immediate correction to avoid loss or a major impact to mission or potential loss of crew.
- **Caution (Class 3):** This is a situation of a less time critical nature, but with a potential for further degradation if crew attention is not given.

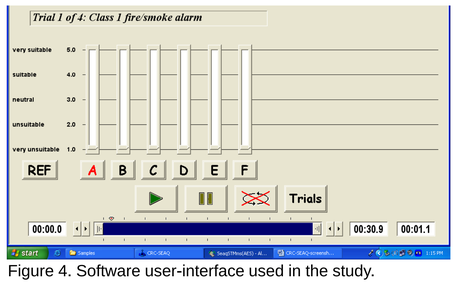

Figure 4. Software user-interface used in the study.

- Results indicate that the most suitable alarm sound types are based on currently-used alarms.
- Crew results differed from the non-crew slightly (different caution alarm was selected).
- Recommended alarm sounds will be modified per ISO recommendations to reduce the startle effect and accommodate sleeping crew.

Studies Planned for FY09

FY09 studies will build on FY08 experiments, attempting to validate previous results, compare results with speech alarms, and examine the impacts of hearing these sounds in a suit.

Speech Communication under Vibration

This is a new area of work that will begin in FY09. The question of interest is: To what extent will the intelligibility of crewmembers’ speech communication with ground control during launch be degraded as a result of vibration? If speech communication intelligibility from crew to ground is degraded severely enough, there are important implications for developing displays for non-verbal means of communication during launch. The need is particularly severe during launch since solutions to off-nominal conditions may require descriptions of situations and acknowledgment of commands under high vibration conditions.

CONTROLS

FY08 Studies

Cursor Movement

The study examined three cursor movement modes: continuous, discrete, and gravity well, using trackball and a 4-way castle switch, with and without EVA gloves.

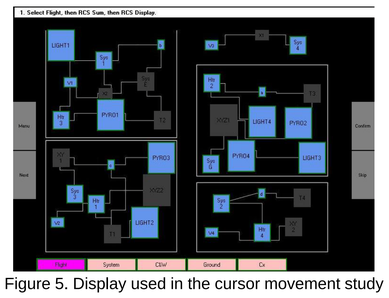

Figure 5. Display used in the cursor movement study

- Discrete mode and gravity well provide the most accuracy regardless of device.
- Continuous cursor mode is fastest if the device is a continuous device (e.g., trackball).
- Gravity well mode improved accuracy rates with the trackball and castle switch.

Dual-task Study

The study examined single-task and dual task comparisons with a cursor control and a hand controller.

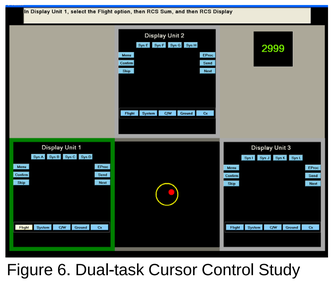

Figure 6. Dual-task Cursor Control Study

- Requiring subjects to perform multiple actions sequentially in time results in poorer performance and higher levels of perceived difficulty than allowing them to perform these actions simultaneously.
- Coordinating motor movements across the hands only results in a decrement in accuracy of operations, not in task completion times.
- Requiring subjects to perform more than one task with the left hand while performing a concurrent task with the right hand results in poorer performance and higher levels of perceived difficulty than only performing one task with the left hand, or all tasks with the right hand. The former scenario should be avoided whenever possible.

Studies Planned for FY09

Cursor control device investigations will continue under vibration and in microgravity.

EVA OPERATIONS

Study on HMD use in lunar lighting

Figure 7. Head Mounted Display

- Collaboration with Orion lighting expert in the lighting lab
- First study to look at HMD in lunar lighting conditions

Gloved Dexterity and Tactility

Figure 8. EVA gloves

- First study to look at glove dexterity in high pressure environment

Demonstration of spatially localized beacons

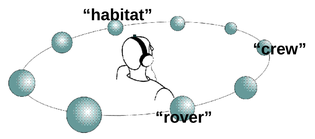

Figure 9. Spatially localized beacons

- Concept prototype for localizing critical mileposts such as lander, habitat, crewmember

VIBRATION STUDIES

- Orion-Ares exposure will be at levels that may exceed the 0.25 g limit imposed by earlier programs during ascent
- There is a serious risk that higher vibration will cause unacceptable degradation of human performance, due in part to decrements in visual function
- Present study began the process of quantifying this risk by examining how different vibration levels impact ability to make speeded yes/no responses to alphanumeric symbology while in a semi-supine position
- 5 blocks of 60 self-paced trials, 40 with vibration, 20 without
- Each block at one vibration level: 0 gx, .15 gx, .30 gx, .5 gx, or .7gx

Figure 10. Apparatus used for the vibration study.

Letter processing task (8 participants)
- Orient to magenta box
- Do the three letters in the middle row form a word or a non-word?
- Press one button for “Yes”, another for “No”

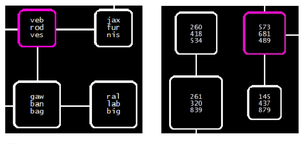

Figure 11. Letter task and digit task stimuli

Digit processing task (8 participants)
- Orient to magenta box
- Is center digit intermediate in magnitude between flanking digits?
- Press one button for “Yes”, another for “No”

Results

- Errors increased with increased vibration
- There were more errors for smaller compared to larger font
- Vibration effects appeared at smaller vibrations levels for 10 pt font than 14 pt font
- No significant differences between vibration effects on lexical decision and magnitude comparison tasks
- No effects of vibration on follow-up trials
- Response times showed very similar pattern to errors

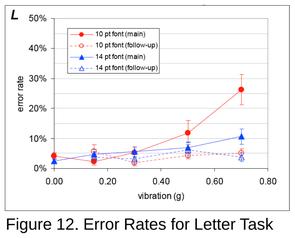

Figure 12. Error Rates for Letter Task

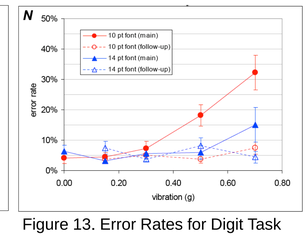

Figure 13. Error Rates for Digit Task

Conclusions

- For both number and letter processing, performance is significantly worse at both 0.5 g and 0.7 g for 10 pt font and at 0.7 g for 14 pt font.
- Vibration levels above 0.3 g (0-to-peak) will significantly compromise the processing of alphanumeric symbology in the currently anticipated Orion display viewing conditions.