Usability of Operational Performance Support Tools – Findings from Sea Test II

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Test Environment

- Sea Test II, aka NASA Extreme Environment Mission Operations 17 (NEEMO 17) took place in the Florida Aquarius undersea habitat.
- This confined underwater environment provides a excellent analog for space habitation providing similarities to space habitation such as hostile environment, difficult logistics, autonomous operations, and remote communications.
- Aquarius dimensions:
  - 43 feet (13.1 meters) in length
  - 9 feet (2.74 meters) in diameter
  - 2,737 feet³ (77.4 meters³) in overall pressurized volume
Usability Study Objectives

• This study collected subjective feedback on the usability of two performance support tools during the Sea Test II mission, Sept 10-14, 2013.
  – Google Glass
  – iPAD

• The two main objectives:
  – Assess the overall functionality and usability of each performance support tool in a mission analog environment.
  – Assess the advantages and disadvantages of each tool when performing operational procedures and Just-In-Time-Training (JITT).
Method: Operational Tasks

• Two Just-In–Time-Training (JITT) operational tasks were conducted onboard the habitat

• First was an equipment assembly and disassembly task:
  – Used a new prototype exercise machine and Google Glass
  – Each crewmember, without prior knowledge of the procedure, assembled and disassembled this exercise machine
  – Demonstrated the use of new technology for real-world tasks
  – Collected subjective questionnaire data
### Acceptability of Google Glass Display Size for an Assemble/Disassemble Task

<table>
<thead>
<tr>
<th>Acceptability of:</th>
<th>Ratings: Median (Range)</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Reading                               | 3.5 (2, 4)              | • Text size was small but readable  
• Google Glass would time out making it difficult to get back to last slide  
• Only a few words at a time could appear on Google Glass                               |
| Viewing Video                         | 3 (3, 4)                | • Video quality was adequate but audio was difficult to hear in noisy environment  
• Zoomed in videos on Google Glass made it hard to put into context (one recommendation to have Birds-Eye-View before zooming)  
• Eye strain viewing long videos because of looking up and to the right  
• Difficulty viewing small details in videos                                             |
| Viewing Static Picture                | 3 (2, 3)                | • Screen size was noted to be too small for viewing details                                                                               |
| Combined Picture/Text                 | 3 (2, 4)                | • Screen size limited number of words that could be shown together with pictures  
• Scrolling was reported to jump/skip over some slides that were being viewed           |

Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6.
## Results: Google Glass Assemble/Disassemble Task

### Acceptability of Google Glass Physical Controls for an Assemble/Disassemble Task

<table>
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<tr>
<th>Acceptability of:</th>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording a Video</td>
<td>2 (2, 3)</td>
<td>• Easy to start recording video, but if a video longer than 10 seconds, you would need to remember to hit record again</td>
</tr>
<tr>
<td>Picture Taking</td>
<td>2 (1, 2)</td>
<td>• Easy to take a picture</td>
</tr>
</tbody>
</table>
| Changing between Applications      | 4 (3, 5)                | • Google Glass is difficult for users that need to wear glasses at the same time.  
• Requires a lot of scrolling/overhead  
• The operations of Google Glass are not as clear as using PC desktop                                                                                                    |
| Amount of Scrolling                | 4.5 (4, 5)              | • There is a lot more scrolling within a procedure than there would be on an iPAD or laptop  
• Google Glass timed out to ‘Stand by’ mode which resulted in a lot of scrolling back and forth.  
  • This resulted in the need to go back to the beginning of the procedure and scroll back to the desired slide  
  • One person suggested that increasing the time before ‘Stand by mode’                                                                                                                                                        |

Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6.
### Results: Google Glass Assemble/Disassemble Task

Acceptability of Google Glass Wearability for an Assemble/Disassemble Task

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| Comfort           | 3.5 (2, 4)               | • Achieving optimal viewing angle was difficult. It was reported that this adjustment could improve with more experience with Google Glass  
                   |                          | • Unacceptable for anything over 10-15 minutes of looking up and to the right - the view screen is too far out of the normal vision range and causes eye strain |
| Fit               | 2 (2, 3)                 | • This was generally reported to be acceptable, but one person reported that it was a tight fit on their head |
| Stability         | 2.5 (2, 4)               | • It was reported by one person that the Google Glass slipped around, especially if moving his/her head |

Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6.
Method: Operational Tasks

- The second task was an operational habitat maintenance task:
  - The task completed was the ‘Sanitation Tank Purge’ which is done daily inside the habitat
  - Each crewmember, used the procedure with Google Glass to complete the task and then viewed the same procedure on the iPAD
  - Compared how the technologies interacted with the displayed procedural information
  - Collected subjective questionnaire data
# Results: Google Glass and iPAD on Sanitation Tank Purge Task

## Subjective Comments Summary

<table>
<thead>
<tr>
<th></th>
<th>Google Glass</th>
<th>iPAD</th>
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</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>• Hands-free mobility</td>
<td>• Text, video and photos larger and easier to read</td>
</tr>
<tr>
<td></td>
<td>• Some operations are easy (e.g. picture taking)</td>
<td>• Touchscreen is very advantageous – intuitive, easy gestures to navigate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Viewing and recording video and photos were good capabilities.</td>
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<tr>
<td></td>
<td></td>
<td>• Easy to swipe through procedures and navigate between applications</td>
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<tr>
<td></td>
<td></td>
<td>• Screen size to device size a nice balance: Big enough to read and very portable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Screens do not time out</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Small text, video and photos limiting amount of information that can be viewed</td>
<td>• Need to carry from place to place or Velcro to knee</td>
</tr>
<tr>
<td></td>
<td>• Eye strain caused by extended periods of looking up and to the right</td>
<td></td>
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<td></td>
<td>• Scrolling issues (amount and ease of scrolling)</td>
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<td></td>
<td>• Short battery life resulting in Google Glass timing out</td>
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N=4
Conclusions

• Google Glass is a promising technology, but needs to overcome battery life, display viewing, and scrolling issues in order to be an operational useful tool.

• In its current configuration, Google Glass was useful for data collection (e.g. taking a video or picture) but for current operational procedure/task completion, it is not an optimal tool.
Conclusions (con’t)

• The iPAD review demonstrated that the iPAD provides features readily adaptable to support operational tasks.
  – The screen size and portability of the iPAD make it a good candidate for a variety of operational tasks.
  – The focus for improvement for the iPAD as a performance support tool involved the portability of the device, such as attaching it to the knee for hands-free operation, rather than the operations display.
Forward Work

• Participate in NEEMO 18 with two objectives:
  – As with SeaTest II (iterative testing), to assess and compare Google Glass and the iPAD using the Sanitation Tank Purge task to examine upgrades to Google Glass hardware and software.
  – Secondly, to demonstrate Google Glass technology in accomplishing a real-world Tele-Mentoring/Virtual Coaching of crew to complete a flight sampling task.
    • Approximately 5 days later, crew will do the same sampling task after viewing an overview video as a refresher and without a procedure or further training.

• Anticipate participation in NEEMO 19
  – To expand the Tele-Mentoring/Virtual Coaching in a more formal test to understand if this type of training method can assist in reducing pre-flight crew training time.

• Completed a Heuristic Technology/Procedure Design Review using Google Glass and iPAD.
Acknowledgments

• Marc Reagan
  – NASA/JSC Mission Operations Directorate, SeaTest II Project Lead for the JIT Training case study

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  – NASA/JSC Software, Robotics, and Simulation Division for Google Glass and iPAD support/operations

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Questions?