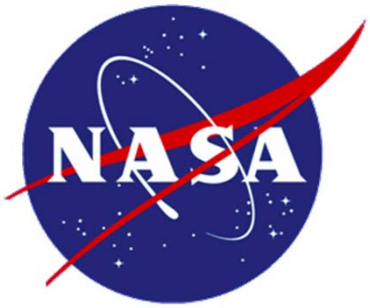

Usability of Operational Performance Support Tools – Findings from Sea Test II

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Test Environment

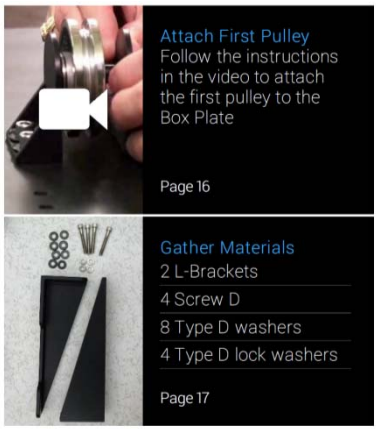
- Sea Test II, aka NASA Extreme Environment Mission Operations 17(NEEMO 17) took place in the Florida Aquarius undersea habitat.
- This confined underwater environment provides a excellent analog for space habitation providing similarities to space habitation such as hostile environment, difficult logistics, autonomous operations, and remote communications.
- Aquarius dimensions:
  - 43 feet (13.1 meters) in length
  - 9 feet (2.74 meters) in diameter
  - 2,737 feet^3 (77.4 meters^3) in overall pressurized volume

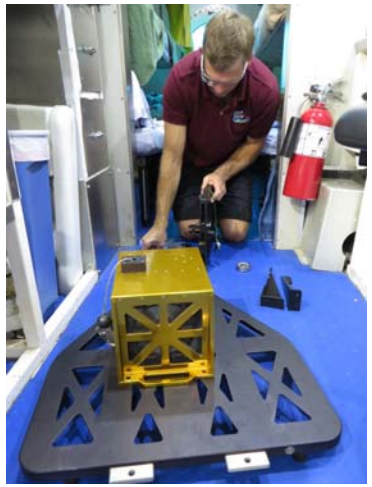
Usability Study Objectives

- 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





Results: Google Glass Assemble/Disassemble Task

Acceptability of Google Glass Display Size for an Assemble/Disassemble Task

Acceptability of:	Ratings: Median (Range)	Comments
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

Acceptability of:	Ratings: Median (Range)	Comments
Recording a Video	2 (2, 3)	• Easy to start recording video, but if a video longer than 10 seconds, you would need to remember to hit record again
Picture Taking	2 (1, 2)	• Easy to take a picture
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

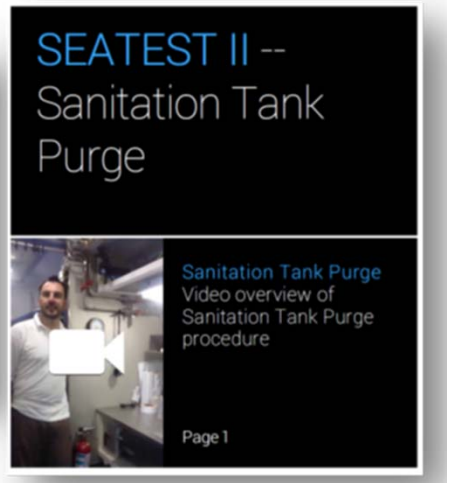
Acceptability of Google Glass Wearability for an Assemble/Disassemble Task

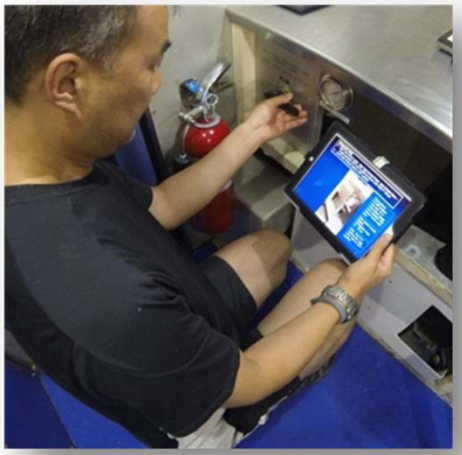
Acceptability of:	Ratings: Median (Range)	Comments
Comfort	3.5 (2, 4)	• Achieving optimal viewing angle was difficult. It was reported that this adjustment could improve with more experience with Google Glass • Unacceptable for anything over 10-15 minutes of looking up and to the right - the view screen 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

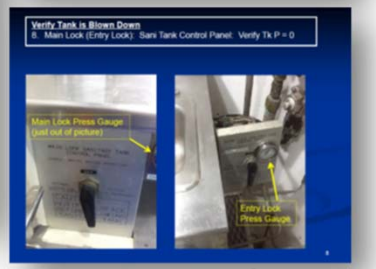
Ratings of 1 = Totally Acceptable to 5 = Totally Unacceptable) for N=6.

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

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

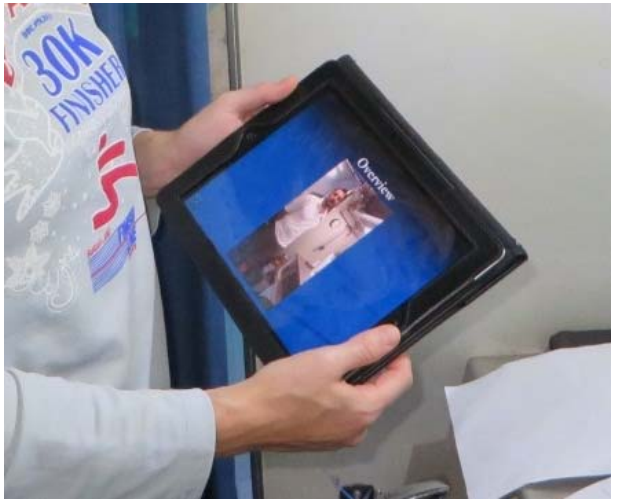
N=4

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?