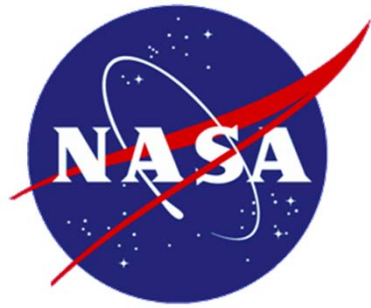




# Usability of Operational Performance Support Tools – Findings from Sea Test II

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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 an 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<sup>3</sup> (77.4 meters<sup>3</sup>) in overall pressurized volume





# Usability Study Objectives

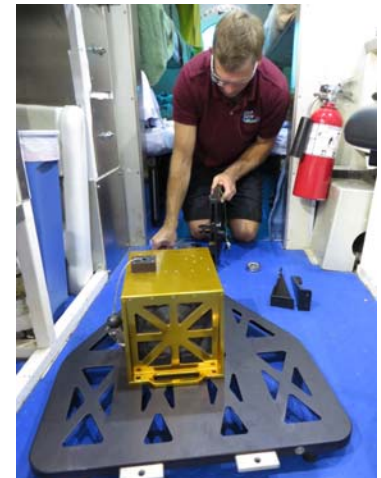
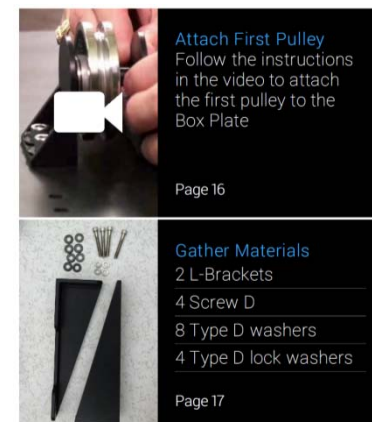
- This study collected subjective feedback on the usability of two performance support tools during the Sea Test II mission, Sept 10-14, 2013.
  - Google Glass
  - iPad
- The two main objectives:
  - Assess the overall functionality and usability of each performance support tool in a mission analog environment.
  - 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)              | <ul style="list-style-type: none"><li>Text size was small but readable</li><li>Google Glass would time out making it difficult to get back to last slide</li><li>Only a few words at a time could appear on Google Glass</li></ul>                                                                                                                                                                    |
| Viewing Video          | 3 (3, 4)                | <ul style="list-style-type: none"><li>Video quality was adequate but audio was difficult to hear in noisy environment</li><li>Zoomed in videos on Google Glass made it hard to put into context (one recommendation to have Birds-Eye-View before zooming)</li><li>Eye strain viewing long videos because of looking up and to the right</li><li>Difficulty viewing small details in videos</li></ul> |
| Viewing Static Picture | 3 (2, 3)                | <ul style="list-style-type: none"><li>Screen size was noted to be too small for viewing details</li></ul>                                                                                                                                                                                                                                                                                             |
| Combined Picture/Text  | 3 (2, 4)                | <ul style="list-style-type: none"><li>Screen size limited number of words that could be shown together with pictures</li><li>Scrolling was reported to jump/skip over some slides that were being viewed</li></ul>                                                                                                                                                                                    |

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)                | <ul style="list-style-type: none"><li>• Easy to start recording video, but if a video longer than 10 seconds, you would need to remember to hit record again</li></ul>                                                                                                                                                                                                                                                                                                                           |
| Picture Taking                | 2 (1, 2)                | <ul style="list-style-type: none"><li>• Easy to take a picture</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Changing between Applications | 4 (3, 5)                | <ul style="list-style-type: none"><li>• Google Glass is difficult for users that need to wear glasses at the same time.</li><li>• Requires a lot of scrolling/overhead</li><li>• The operations of Google Glass are not as clear as using PC desktop</li></ul>                                                                                                                                                                                                                                   |
| Amount of Scrolling           | 4.5 (4, 5)              | <ul style="list-style-type: none"><li>• There is a lot more scrolling within a procedure than there would be on an iPad or laptop</li><li>• Google Glass timed out to 'Stand by' mode which resulted in a lot of scrolling back and forth.<ul style="list-style-type: none"><li>• This resulted in the need to go back to the beginning of the procedure and scroll back to the desired slide</li><li>• One person suggested that increasing the time before 'Stand by' mode</li></ul></li></ul> |

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

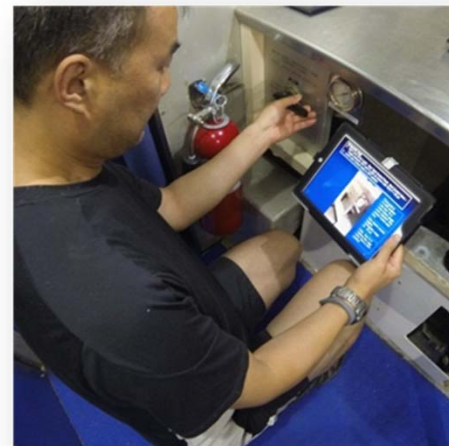
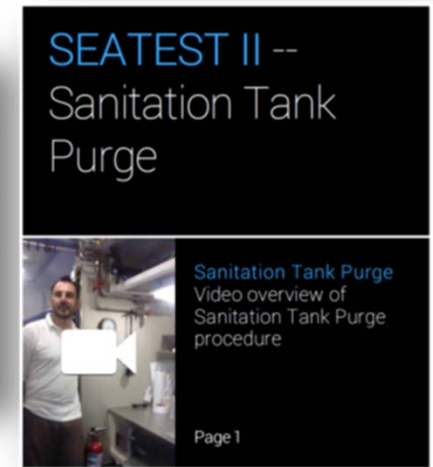
| Acceptability of: | Ratings: Median (Range) | Comments                                                                                                                                                                                                                                                                                                                                                       |
|-------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Comfort           | 3.5 (2, 4)              | <ul style="list-style-type: none"><li>Achieving optimal viewing angle was difficult. It was reported that this adjustment could improve with more experience with Google Glass</li><li>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</li></ul> |
| Fit               | 2 (2, 3)                | <ul style="list-style-type: none"><li>This was generally reported to be acceptable, but one person reported that it was a tight fit on their head</li></ul>                                                                                                                                                                                                    |
| Stability         | 2.5 (2, 4)              | <ul style="list-style-type: none"><li>It was reported by one person that the Google Glass slipped around, especially if moving his/her head</li></ul>                                                                                                                                                                                                          |

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                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Advantages</b>    | <ul style="list-style-type: none"><li>• Hands-free mobility</li><li>• Some operations are easy (e.g. picture taking)</li></ul>                                                                                                                                                                                                              | <ul style="list-style-type: none"><li>• Text, video and photos larger and easier to read</li><li>• Touchscreen is very advantageous – intuitive, easy gestures to navigate.</li><li>• Viewing and recording video and photos were good capabilities.</li><li>• Easy to swipe through procedures and navigate between applications</li><li>• Screen size to device size a nice balance: Big enough to read and very portable</li><li>• Screens do not time out</li></ul> |
| <b>Disadvantages</b> | <ul style="list-style-type: none"><li>• Small text, video and photos limiting amount of information that can be viewed</li><li>• Eye strain caused by extended periods of looking up and to the right</li><li>• Scrolling issues (amount and ease of scrolling)</li><li>• Short battery life resulting in Google Glass timing out</li></ul> | <ul style="list-style-type: none"><li>• Need to carry from place to place or Velcro to knee</li></ul>                                                                                                                                                                                                                                                                                                                                                                   |

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

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Questions?