Helmet Mounted Display Technology for EVA Training in NASA's Neutral Buoyancy Lab

Daniela L. Davalos[1], Lauren I. Cox[2], Katie Heinemann[3], Janine Moses[1], Jeffrey T. Somers[2], Stephen K. Robinson[1]
[1]University of California Davis, Davis, CA; [2]JES Tech, Houston, TX; [3]GeoLogics Corporation, Alexandria, VA [4]NASA Johnson Space Center, Houston, TX.

Introduction

- Future NASA exploration missions will require an increase in crew autonomy due to time-delayed communications with mission control
- Before introducing novel display technology to EVA operations, it can be demonstrated in an Extravehicular Activity (EVA) training environment
- A spacesuit Helmet Mounted Display (HMD) is being developed to enhance astronaut situational awareness during underwater EVA training at the Neutral Buoyancy Lab (NBL)
- HMD is capable of showing real-time biofeedback (astronaut metabolic rate), EVA procedure aids (phase elapsed time), and EVA parameters (tool settings) to the crewmember during training
- Test Series Phases:

  Phase I: Perform a technology demonstration and obtain user feedback
  Phase 2: Test new display modes and more formal assessments to collect user feedback
  Phase 3: Evaluate the effects that access to bioinformatics through HMD has on astronaut training and performance at the NBL

Fig. 1: HMD Welcome screen.

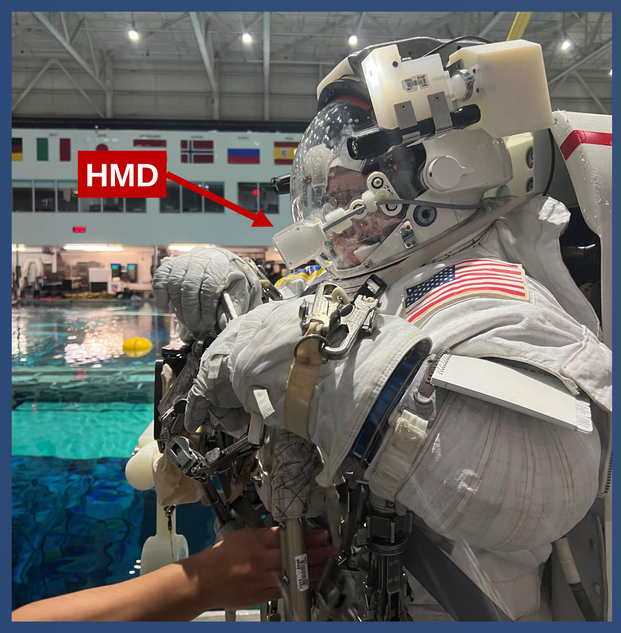

Fig. 2: HMD mounted on EMU spacesuit helmet used during EVA training at the NBL.

Phase 3 Test Objective & Protocol

- This phase of testing involved situational awareness metrics such as a go/no-go time response task
- Test Dates: September – October 2022
- 2 NBL runs (both experienced crew members)
- High metabolic tasks (APFR, SSRMS, ICR)

Test Objective

Determine the relationship between PET, EVA task, and response time from peripheral signal stimulus

Test Protocol

Days Before NBL Run
- Install hardware in Portable Life Support System (PLSS)
- Brief crewmember (EV) on HMD

Morning of NBL Run
- Connect HMD cables to umbilical
- During suit donning, mount HMD on visor

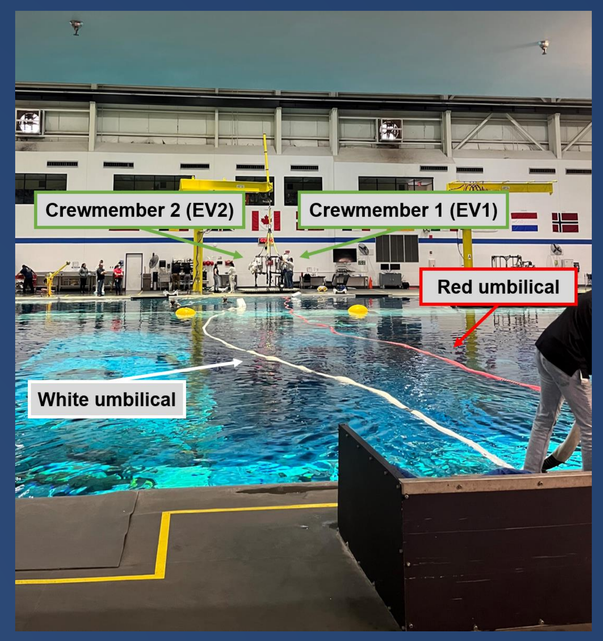

Fig. 4: HMD cables running through NBL umbilicals.

During the NBL Run
- Work with test conductor (TC) to determine when to send go/no-go task (see Fig. 3l)
- From TC room, HMD started a timer once the stimulus was sent and stopped it once/if EV responded to go/no-go task
- Note: EV and TC were free to interact with HMD display modes via voice control or through MAESTRO

Immediately After NBL Run
- Remove HMD hardware from helmet/PLSS
- Collect crewmember feedback via surveys

Display Modes

Fig. 3:
a) Average Metabolic Rate
b) Dual Met Percent and PET
c) Bolts
d) Percent of Maximum Metabolic Rate
e) Timer
f) Articulated Portable Foot Restraint (APFR)
g) Phase Elapsed Time (PET)
h) Pistol Grip Tool (PGT)
i) NASA Zero Gravity Lever (NZGL)
j) Fluid Quick Disconnect (FQD)
k) Welcome Screen
l) Over-Under Cognitive Task

Results

- Phase 1 and 2 feedback indicated HMD was readable, un-obtrusive, and the available display modes had potential to be useful and enhance EVA training
- Phase 3 feedback indicated the crewmembers found the display to be helpful but warrants additional modifications, adjustability, and displays modes

Future Work

The knowledge gained from HMD testing will be used to inform future bioinformatics solutions and displays for crew training and operational use

Acknowledgements

Support from the H-3PO Lab and the UC Davis HRVIP Lab, as well as the NBL personnel is gratefully acknowledged.

References

1. Cox, Lauren. (2022). Test Plan: NBL Class IIIW EMU Helmet Mounted Display.
2. Moses, J. R., Stoffel, J. R., Houchens, R. Z., Dunn, J. T., Robinson, S. K., & Abercromby, A. F. (2021). Helmet-Mounted Display Technology for EVA Training in NASA's Neutral Buoyancy Lab.