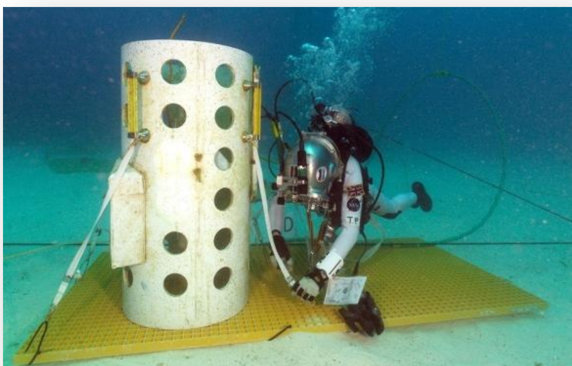
NEEMO 16
Mission Days 5 through 7 - Status Report
Aquarius Reef Base, Key Largo, FL
June 15-17, 2012

NEEMO EVA Tools

A critical aspect of a Near Earth Asteroid (NEA) mission is the tools necessary for conducting Extravehicular Activities (EVAs). Since the objectives of the NEEMO 16 Mission include assessing NEA operations associated with both translation and geologic sampling, our tool kit includes a wide variety of equipment.



Aquanaut Tim Peake deploys a large orbital replacement (ORU) unit during an EVA.

The NEEMO 16 NEA EVA Tool Kit includes mockups for both large deployable instruments as well as small complex geophysical devices that necessitate detailed tasks and specific assembly procedures. For translating between locations on an asteroid, we built tools that enable us to evaluate several different methods of moving around. These tools include crew-worn modular workstations, equipment tethers and hooks, foot restraints and tensioned translation lines with line grabbing equipment.

For evaluating sample collection methods, our EVA tool kit includes hammer blankets, loose soil grabbers, core tubes, geology hammers, sample canisters, and individually numbered sample containment bags along with the necessary dispenser to organize those bags. Since no space agency has ever conducted a manned mission to obtain asteroid samples, the Analog Team has had to design many of these new EVA tools from scratch.

Aquanauts use a hammer blanket to obtain a sample.

Asteroids have a microgravity environment, which means that if an astronaut were to attempt to obtain a sample by hammering off a piece of an asteroid, then as soon as the piece was chipped away, it would attain escape velocity and quickly speed off into space. Thus, there is a need to not only break off a sample but also to contain it and keep it from being lost in space.

As a result, hammer bags were developed for our previous mission, NEEMO 15. These bags were specially-engineered, malleable pieces shaped like bags embedded with studs so that astronauts could surround a rock outcropping with the bag, then hammer on the studs to chip off samples and capture the loosened samples in the bag.

The hardware development team briefs the NEEMO 16 crew and dive team on hardware protocols.

Through testing of the concept in NEEMO 15, we found that the bag, whose shape entailed having to fit a constrained opening over a rock outcropping, was difficult to use in operations. Thus, we matured the concept for NEEMO 16 by switching to a blanket shape that can easily be placed over any rock outcropping. Thus far in the mission, we have found that these hammer blankets are very efficient and easy for the crew to use.

EVA Tools Engineer Jesse Buffington implements a real-time modification

This is just one example of the extensive suite of tools that we have developed and modified for this mission, in order to learn how to do the complicated task of exploring a planetary body in zero-g.

One of the extremely challenging aspects of preparing all the tools for NEEMO 16 is designing them so that they are able to survive the salt water environment while performing as the actual hardware would in space. This requires that each of the tools be neutrally buoyant --neither sinking nor floating in the water—to provide the crew with an accurate experience of using tools that would be free floating in space.

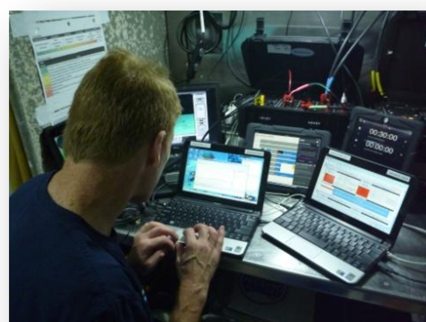
Additionally, all of the hardware components that we use during the mission were selected and manufactured to be modular, allowing for the greatest possible flexibility in crew use during the mission, and reconfigurable, enabling us to facilitate changes in technique while in the field. Because we have a team of very skilled engineers in the field, we are able to accomplish efficient, real-time hardware design, in which crew members suggest new concepts or modifications that the engineers can construct overnight and have available to test the next day.

Communication Delay Challenges: Impact on Individual and Team Performance

On Mission Day 5, the Behavioral Health and Performance Element (BHP) of the NASA Human Research Program (HRP) conducted a research study that examined the impact of different intervals of an experimental communication delay on individual and team factors and outcomes, including performance as well as related perceptions of autonomy. To date, very few studies have observed teams in remote environments that perform with restricted communication with a control center, and no such studies have been conducted during long-duration expeditions or missions.

Communication delays that were assessed during the mission include zero (baseline), five minutes and ten minutes. These two delays represent intervals that will occur during a mission to Mars. These multiple delay scenarios tested in a high fidelity space analog will provide data points to better understand the relationship between the amount of delay and the potential changes in individual and team performance and cohesion likely to occur during longer duration, more autonomous missions from Earth.

The MMCC communicating with the IV Crew during an EVA.



Tim Peake performs in the role of IV Crew.

For the NEEMO 16 mission, pre-assessment measures were collected from all participants, including the aquanauts, habtechs and the Mobile Mission Control Center (MMCC) personnel on duty. During the experiment, participants completed three tasks: one task was completed under zero communication delay between the crew and MCC, one task under a 5 minute one-way delay, and one task under a 10 minute one-way delay.

Data gathered from this study will be used to help inform an upcoming International Space Station (ISS) Testbed for Analog Research (ISTAR) study that will examine the impact of communication delay on performance and well-being in the environment of low-Earth orbit.

Communication Delay Challenges: Medical Operations

Flight Surgeon Ben Douglas (Wyle, ESA) on console.

Communication delays impact our ability to provide the crew with medical care. Thus far in the mission, the routine medical conferences have been easier than anticipated in some ways, but there have been some interesting findings. One example is the etiquette of communicating via a delay. Lack of eye contact in a real-time conversation can indicate disinterest or rudeness but is normal for delayed communications, particularly when the participants are utilizing the delays to accomplish other tasks.

During the emergency medical simulation conducted on Mission Day 5, we identified some very important issues, such as the video feed being an unreliable indicator of the crew receiving information from mission control. When the crew and the MMCC team are both following their trained emergency procedures, it can appear that the two teams are acting in concert, when actually they are completely disconnected. Overall problems that would be rapidly addressed in real-time have been found to take dramatically longer to identify with a communication delay. The data gathered during this simulation has uncovered operational aspects that we will need to address prior to a deep space exploration mission.

Mission Manager Bill Todd piloting a submersible around the Aquarius habitat.

The NEEMO Mission Management and Topside Support Team

Follow us at:
http://www.nasa.gov/neemo/
http://www.facebook.com/NASANEEMO
https://twitter.com/#!/NASA_NEEMO