NEEMO 16

Mission Days 3 & 4 - Status Report

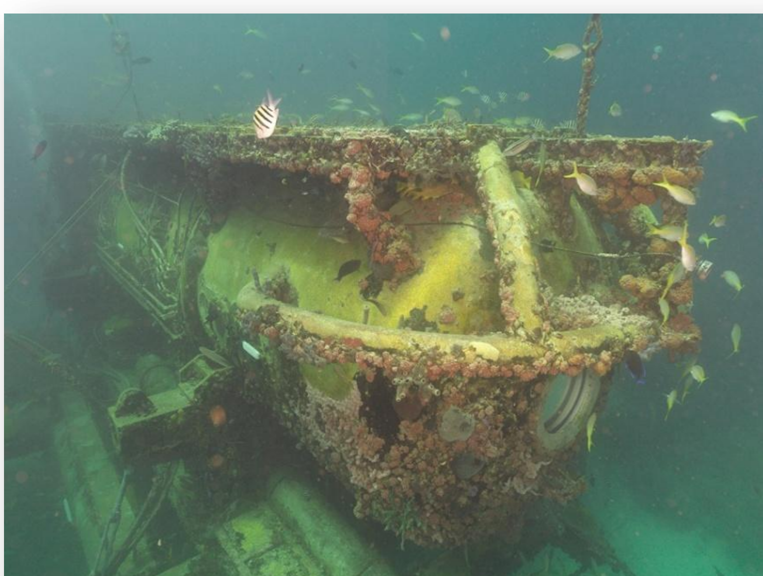
Aquarius Reef Base, Key Largo, FL

June 13-14, 2012

Enabling Space Exploration

NASA's concept for exploring a Near Earth Asteroid (NEA) contains several elements: a Deep Space Habitat (DSH) that the crew lives in during their journey to the asteroid's proximity, a smaller Space Exploration Vehicle (SEV) that can carry two or three crewmembers from the DSH directly to the surface of the NEA, and the ability for one or two crewmembers to don space suits to conduct Extravehicular Activities (EVAs). By simulating the challenges of such a mission in a high fidelity environment, we will be able to understand operational concepts that will enable us to design and build those vehicles for mission success.

An example of an operational constraint that guides design is the aspect of crew size. A vehicle designed for three people will be larger than one designed for two people, it will cost more to construct, and it will require more propellant to put into space. However, if we cannot accomplish significant exploration operations safely with only two people, then it will be necessary to have a larger crew size. The NEEMO 16 mission is designed to help address these types of architectural trades in order to provide NASA with data crucial to the successful design of next generation spacecraft.



The Aquarius Habitat is the home to our NEEMO 16 crew.

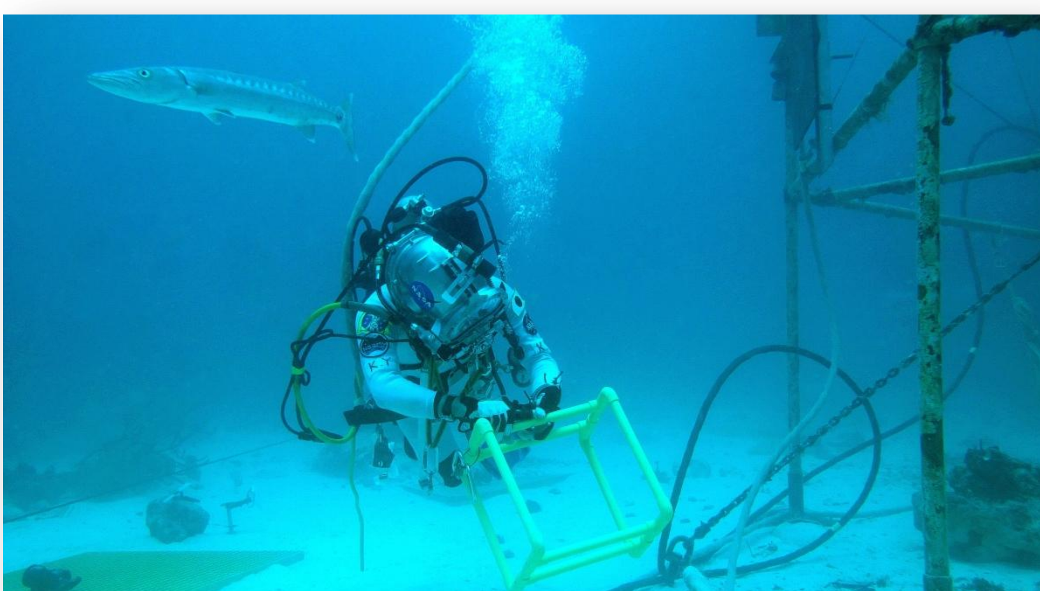
Simulating an Asteroid Mission

For this mission, the Aquarius Habitat performs the role of the DSH while our mini-submersibles act in the role of the SEV. Back on land, we have a Mobile Mission Control Center (MMCC) manned by a team of NASA European Space Agency (ESA), and Japan Aerospace Exploration Agency (JAXA) professionals who carry out the actions that the Mission Control Centers (MCC) would conduct during an actual asteroid mission.

Aquanaut Steve Squyres prepares to leave the habitat to conduct an EVA.

To conduct an EVA, two of our aquanauts don their suits, leave the Aquarius Habitat, and head out to the representative EVA circuit we established on the ocean floor. The aquanauts do tasks solo or as a pair, and are neutrally buoyant to mimic a microgravity environment. Back in the habitat one of the aquanauts performs a role of overseeing and directing the EVA aquanauts, akin to an asteroid mission in which a crew member could oversee the EVAs while stationed in the DSH. During an asteroid mission, the EVA astronauts and the crew member in the DSH would be close enough to communicate without a time delay, but the MCC, back on earth, would have an estimated 50 second time delay communicating with them.

Aquanaut Kimiya Yui conducts an EVA with a barracuda standing watch.



Obtaining Critical Data

NEEMO 16 is providing NASA with important information on how to operate a mission with a time delay. Everything that the MMCC asks or tells the crew takes 50 seconds to get to them, then it takes time for the crew to answer, and then an additional 50 seconds is needed for the reply to return to the MCC. It's nearly two minutes, at a minimum, from the time one side asks a question to when they can expect to hear a reply.

To address the time delay aspect of operations, we have learned to set a 100 second timer after each call to the aquanauts, so that we can be ready for their response. While waiting for a response we would switch focus to other activities, so the timer became useful as a reminder to return focus to the crew's response.

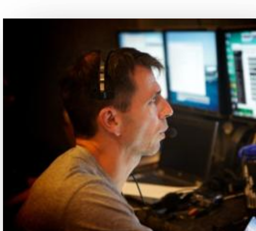
Manning consoles in the MMCC during an EVA.

The Mobile Mission Control Center

Herve Stevenin (ESA) in the role of Capcom.

A large difficulty associated with time delayed operations is the aspect of interruptions. Since the MMCC is hearing the crew 50 seconds after they speak, it is very difficult for the MMCC to respond to questions without interrupting the crew. One approach we are exploring to alleviate that is the use of text software that enables the MMCC to send text messages which are then voiced in real time to the habitat crew.

Another technique that has proven valuable is to give a preamble call to gain the crew's attention, followed by a short pause, and then the full communication. This provides the crew with a few seconds to stop what they're doing, pay attention, and get ready to copy the information that is about to be communicated. We have found that this technique reduces the amount of missed communications and required call-backs that force the conversation into another round of delayed communications.



Zeb Scoville, EVA Task Lead, on console in the MMCC.

The NEEMO Mission Management and Topside Support Team

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