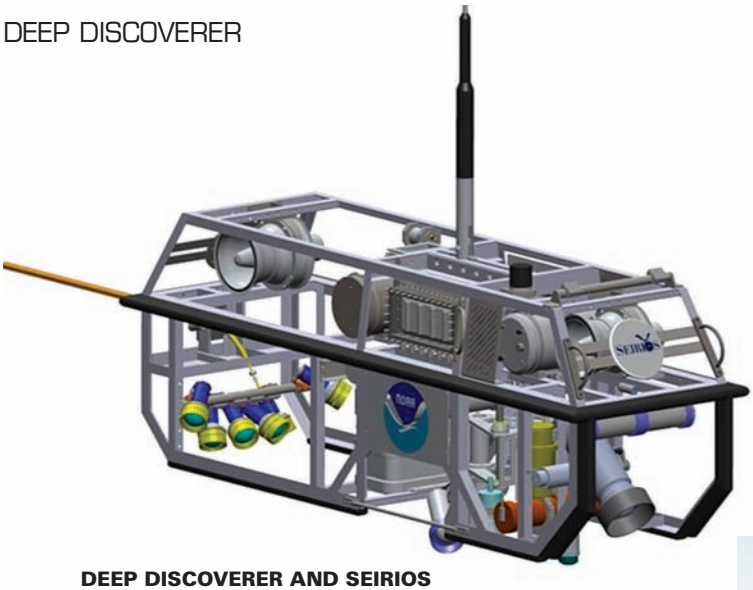
By Daniel R. Rogers Introduction by Siri Wheeler

DEEP DISCOVERER

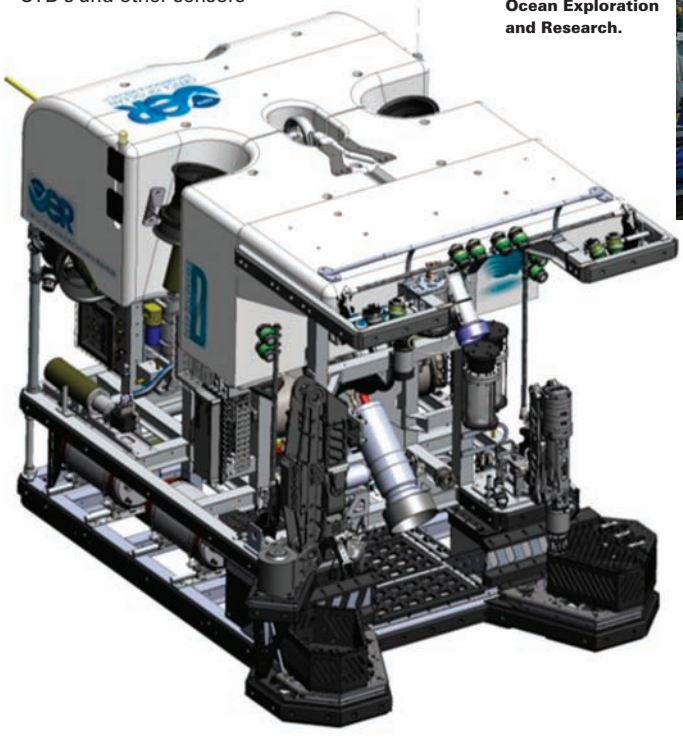
ROV CONNECTS SCIENTISTS AND CITIZENS WITH THE DEEP SEA

The drive to explore and understand our world is an essential quality that we humans credit with our success as a species, enabling us not only to physically thrive on the face of a fickle Earth, but also to feed our thirsty minds and hungry imaginations with new knowledge and inspiration. If the quest for knowledge and discovery is central to what makes us human, the robots we employ in exploration are increasingly responsible for helping to make us who we are. *Robot* Magazine was recently invited to visit with and learn from members of the engineering team at the Global Foundation for Ocean Exploration about one such robotic explorer that brings scientists and regular citizens together to learn more about some of the most remote reaches of our earth.

Deep Discoverer, an ROV (Remotely Operated Vehicle) with advanced sensing, sampling, photography and telepresence capabilities was built and is maintained by the foundation's engineers for the purpose of exploring the sea floor. The ROV and its companion "camera sled", Seirios operate around the globe from the NOAA (National Oceanic and Atmospheric Administration) ship Okeanos Explorer, which is the only U.S. government ship that is solely dedicated to ocean exploration. Through its strong telepresence capabilities, which enable anyone to view real-time video footage of Deep Discoverer's dives through an internet connection, Deep Discoverer puts human beings in touch with the excitement of deep sea exploration like never before.



DEEP DISCOVERER AND SEIRIOS
Dual body system
Rated for 6,000 meters
250,000 lumens LED's
12 cameras (4 HD)
Dual frequency scanning sonars
CTD's and other sensors



DEEP DISCOVERER (D2)
SIZE: ~10'L x 6.5'W x 8.5'H
AIR WEIGHT: 9150 lbs
MAX PAYLOAD: 400 lbs. (in water weight)
HYDRAULIC 7-FUNCTION MANIPULATORS: Shilling "Orion"
Kraft "Predator" w/Force Feedback
LIGHTING: 150,000 lumens LEDs, 8 LEDs on hydraulic swing arms

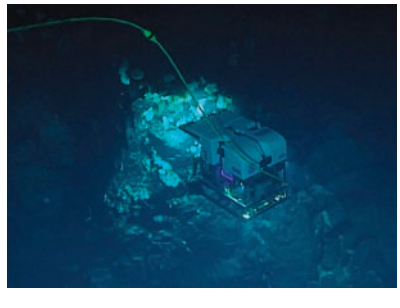
Nine-thousand pounds of equipment. Over three-thousand feet of electrical wiring. Twenty LED lights. Nine video cameras. Depths of nearly four miles and pressures almost six-hundred times that at sea level. Impressively large numbers that describe just a few features of the remotely operated vehicle Deep Discoverer (D2)--our portal to the deep sea.
—Daniel R. Rogers, Global Foundation for Ocean Exploration

We are grateful to Daniel R. Rogers from the Global Foundation for Ocean Exploration who provided us with the following summary of how the technology employed on Deep Discoverer and Seirios enable scientists at research centers around the world and individuals at home to take part in these unique missions to explore the rich diversity of biological, geological and archeological resources that inhabit the sea floor.
"Seirios is directly tethered to the Okeanos by a six mile-long steel cable. It serves to illuminate D2 from above, provide ROV pilots with a wide-angle view of the bottom, and absorb the heaving motions of the ship at the surface so that D2 can safely traverse over sometimes treacherous terrain miles below. Seirios is currently supported by one high-definition camera, one wide fisheye 'bubble' camera, and several standard-definition cameras that provide pilots with situational awareness while exploring dark marine environments.

Engineering Team with ROV Deep Discoverer. Image courtesy of the NOAA Office of Ocean Exploration and Research.

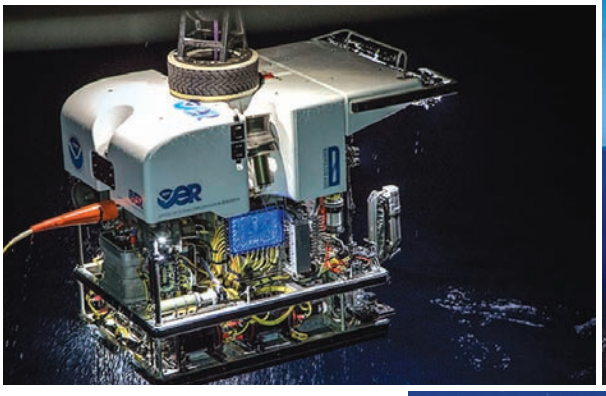
The GFOE team consistently works to expand Deep Discoverer's capabilities and diversify its data collection portfolio. This includes the addition of new sensors and cameras as suggested by the ocean science community. D2 is already providing scientists with high quality imagery and seawater data that gives us valuable insight into complex underwater ecosystems. The high-definition cameras installed on Deep Discoverer are certainly one of its defining features; the 'Zeus Plus' made by Insite Pacific is capable of zooming in on a 3-inch long organism from 10 feet away, bringing us closer than ever to the seemingly alien biology and geology of the deep sea.

The team recently installed a specialized robotic manipulator arm to collect deep sea samples, giving scientists an even better look into these environments when they are brought to the surface. GFOE engineers have trained for many hours to use this $500,000 'Predator II' robotic arm made by Kraft TeleRobotics. It is controlled by manipulating a miniature

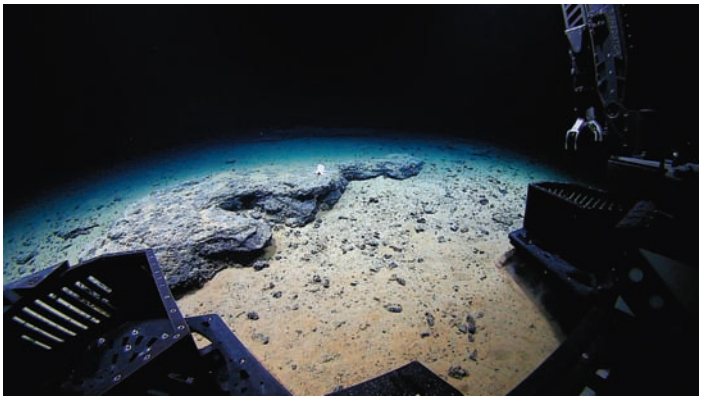


Deep Discoverer imaging a high-density community that included several species that are likely new to science during the 2016 expedition. Image courtesy of NOAA Office of Ocean Exploration and Research.

NOAA Ship Okeanos Explorer uses telepresence technology to transmit data in real-time to a shore-based hub where the video is then transmitted to a number of Exploration Command Centers located around the country as well as to any Internet-enabled device. Access to the video combined with a suite of Internet-based collaboration tools allow scientists on shore to join the operation in real-time, and allows the general public to follow the expedition online. Image courtesy of the NOAA Office of Ocean Exploration and Research.

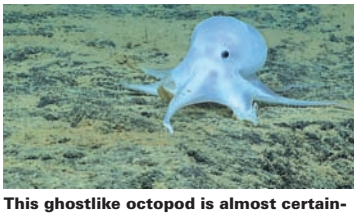


This coronate jelly was seen north of Pioneer Bank in the Papah naumokuAkea Marine National Monument. Image courtesy of NOAA Office of Ocean Exploration.



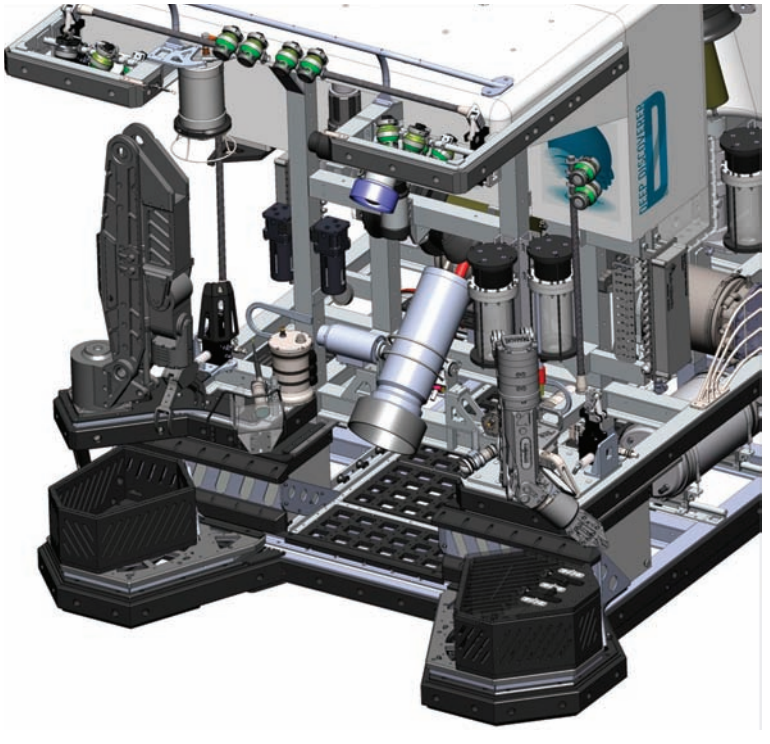
model of the arm whose movements are mimicked by the full-sized version at the bottom of the ocean. The fine level of control that this manipulator offers allows our pilots to clip small sections of generally fragile coral branches and minimize the impact on the rest of the colony.

Modern communication technology connects the Okeanos and D2 to the rest of the world via satellite by transmitting video from the ROV at the bottom of the ocean to your internet browser in 30 seconds or less. The satellite antenna and video feeds are supported by a team of GFOE video engineers that also control the cameras onboard the ROV during operations. The video team ensures that images we capture and the content we produce are of broadcast quality. This 'telepresence' technology allows onboard scientists to interact with dozens of others worldwide who provide scientific context in real-time while we are at sea. Scientists and videographers are instrumental in guiding our ROV pilots along the seafloor and identifying species that are worth collecting and/or imaging.



This ghostlike octopod is almost certainly an undescribed species and may not belong to any described genus. Image courtesy of NOAA Office of Ocean Exploration and Research.

This glass sponge was imaged on an unnamed seamount just outside the Papah naumoku kea Marine National Monument. Image courtesy of NOAA Office of Ocean Exploration and Research.



The ability to broadcast high-quality images from the bottom of the ocean requires an expertly choreographed production of GFOE engineers, NOAA ship crew, and passionate academics both onboard and onshore. To see for the result of these impressive feats of engineering and cooperation, be sure to tune in to the live feed during one of our several annual ROV expeditions."

You can go along for the ride with Deep Discoverer by following the vehicle's dives live online at http://oceanexplorer.noaa.gov/technology/subs/deep-discoverer/deep-discoverer.html ◎