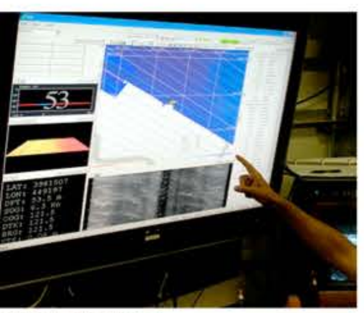
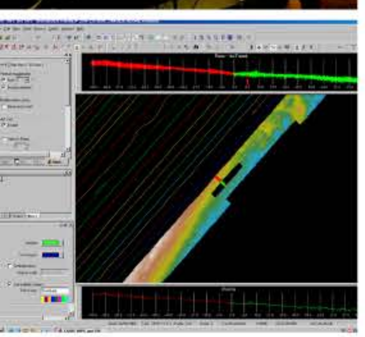
THE technolgy OF WHERE

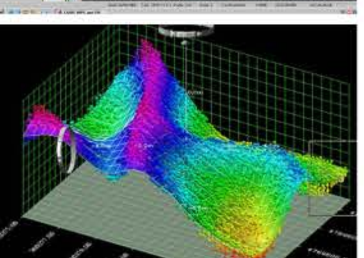
ABOVE
RPM's Jeff Royal aboard R/V *Hercules*

BELOW
On-screen representation of data being collected from the seafloor

All images courtesy of
RPM Nautical Foundation





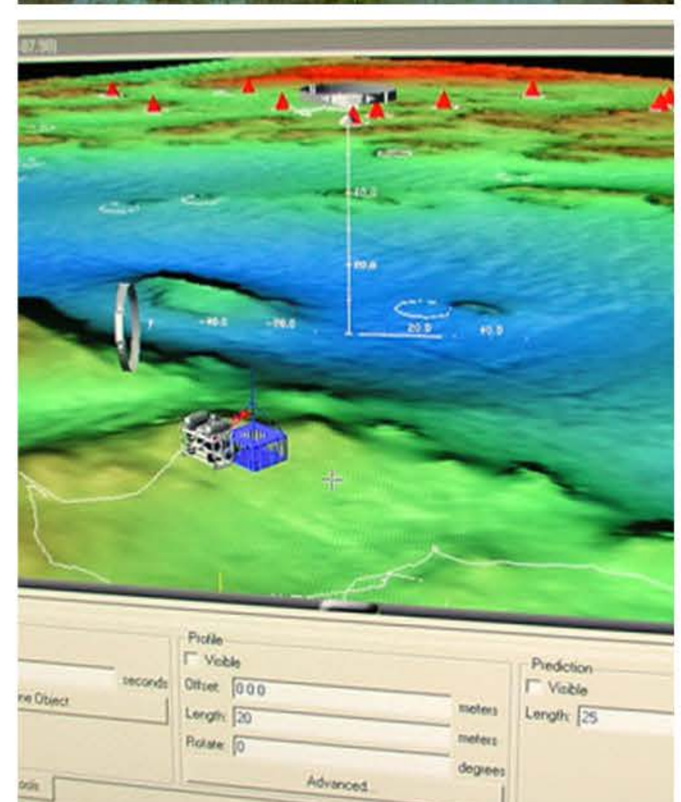


When I was asked to write an article for this issue about the use of technology in archaeology, I began to think about the myriad of systems utilized in field work each season. Between the research vessel, guidance and steering systems, the ROV, remote sensing equipment, array of video feeds, data processing systems, display graphics, etc. a wide variety of technical explanations and themes readily present themselves. What came to mind is one of the crucial questions technology is used to answer… "Where is it?"

Determining the location of a site seems simple enough, however working underwater increases the difficulty of doing so and is further complicated when working beyond diver depths. It is surprising how often archaeologists don't know the answer to "Where is it?" Data on the location of a site should begin with one or more sets of coordinates, accurate coordinates. All too often when the time comes to re-visit a site ~~the~~ archaeologist begins divining the location on the surface from the positions of houses on shore, a point of land, or memories of nearby rock formations. Unfortunately, official reports ~~are~~ also ~~encountered that use~~ such location references. Without an accurate location on the surface, the location of the site lying on the seafloor below remains unknown. These situations result in a new search by systematic survey, and if the last site visit was years ago it is sometimes never found.

Differential GPS (DGPS) is a crucial component in the technology of determining location; this system tells you where you are on the earth. Although studies are ongoing for the accuracy of DGPS, it has generally been found to be accurate to within 1-2 meters. The accuracy is partly a function of distance to broadcasting stations, and given ~~the size of~~ the Mediterranean accuracy is typically around a meter or less. A well-maintained DGPS system will very accurately provide position information for a vessel on the sea's surface; however, sites are on the seafloor, so several methods are typically used to determine position on the seafloor. A tried-and-true method in shallow water, calls for divers to raise some form of buoy to the surface on a line where its position can be determined by the research vessel. The amount of error in this method occurs in how vertically straight the line between the point to be measured and buoy can be maintained, and how carefully the distance from the DGPS receiver to the buoy is measured. The deeper the water the more difficult it is to maintain a straight line and the greater amount of error. It is usually an adequate method in shallow water when coupled with a depth reading for the point and recording accurate representation of where on seafloor the point falls. Problematically the error from the buoy line's deviation off vertical is not consistent, nor is the buoy position calculation; hence, comparing multiple points, of scattered artifacts or the limits of a site for example, is less reliable. Once fixed absolute points are determined on the site, relative position data can be taken with a variety of methods that utilize measuring tapes, a compass, and datum points. These measurements are then processed in software to determine relative position information.

A more labor intensive, costly, and technical method is to produce a high-quality bathymetric map of the seafloor. It is a precise and accurate method for determining location, can be utilized far beyond diver depth, and has a variety of other capabilities that include 3-D modeling and an indication of sediment types. Bathymetric maps are produced from data gathered by multibeam echosounder sonar systems. The sonar part of the system shoots hundreds of soundings multiple times per second at the seafloor, in a fan shape from the research vessel, and records millions of depth measurements. Each individual depth measurement is coded with a position calculated from many inputs including the research vessel's position via DGPS, the angle of the beam, and the beam's depth measurement. Each of the millions of individual depth measurements used to create the bathymetric map has a coordinate and a depth measurement and can be individually represented. As the maps are three-dimensional, the absolute position of any point on a site can be accurately and precisely determined. Additionally, it is possible to measure between points, which allows relative positions and absolute distances to be measured.



Another method for gathering location data in deep water utilizes an ROV fitted with a transponder beacon, as well as additional beacons placed by the ROV. A beacon on the ROV communicates with the research vessel, and systems on board calculate the beacon's position based on the relative position~~,~~ coordinates~~,~~ of the research vessel. As the distance of the beacon from the research vessel increases, the potential error increases; hence, keeping the beacon still over a period of time can assist in honing its location. Beacons can also be placed on datum poles or near artifacts, which assists in accurately mapping sites and the artifacts within them. Knowing the relative position of the beacon to objects, where it is on the ROV, or how high it is attached to a pole assists in the depth measurement calculation. The position information from the beacon can also be integrated into the bathymetric map in order to track it, and thus the equipment carrying it, in real time so that you know where you are and where you have been. Using a beacon affixed to the ROV, or one that is placed, is a very good method for mapping individual finds on the seafloor, as well as taking check points on the extent of sites and specific artifacts within them. This method was used extensively during excavation with the ROV of the Levanzo I wreck in Sicily.

As discussed, the systems that assist in determining location are numerous, varied, and highly integrated. For work in deeper water, this complex system allows us to achieve high standards in location documentation and utility. For example, it is important to have the ability to document the position of an individual amphora lying among rocks 8 km offshore of the Egadi Islands at 80 m of depth, return a year later, and relocate the amphora in minutes for retrieval. Only through these complex technological systems working in unison to provide precise and accurate location data can we hope to attain the accuracy required for archaeological research, and answer the question "Where is it?"

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LEFT (from top)
Photo-illustration of sonar soundings fanning out from the research vessel to the wreck site below.

Tried and true measurement techniques for determing relative position.

On-screen bathymetric map generated from the beacon allowing real time positional tracking.

BELOW
Beacon and equipment used in accurately mapping the position of the wreck site and the artifacts within it.

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RPM Nautical Foundation