A Convenient Testbed for Applying Marine Technology to Shipwreck Investigations

And a Tool for Contagious STEM Focused Education in Marine Exploration and Research

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***Abstract*—**A previously undetected shipwreck was imaged using seafloor mapping and geophysical technologies in the Chester River, near Chestertown Maryland. More important than its historic significance, the site is being used to create a hands-on program where students can use technology normally reserved for graduate students to explore a real archaeological site. The STEM lessons are integrated with other disciplines to make the delivery more palatable. A board game is also being devised as a fun test of marine sciences, sea technologies, and practical knowledge.

Keywords—Shipwreck, seafloor mapping, geophysical investigation, STEM Education, Ocean Exploration

I. MAKING STEM REAL

STEM education in K-12 should be delivered "invisibly" [1]. Starting a lesson with "Today we're going to be covering physics, acoustics, or the Pythagorean theory" will likely cause the eyelids of most students to drop with a "thud". Replay this classroom introduction with a scenario, a statement and a question; As such; the educator would read an actual excerpt from the Maryland Gazette from 1759. "A disastrous accident took place in Chestertown on Saturday, May 5, 1759 when the Brigantine "Sophia," was consumed by fire to the water's edge. The blame for this misfortune was laid against the Ship's carpenter who, after finding it impossible to go ashore to heat the pitch pot, had the imprudence to heat it on board the "Sophia"." Assuming the remnants of "Sophia" are still present, the students are challenged; "What tools would we need to find it?" Watch the students lean forward with anticipation of "what's next".

II. SHIPWRECK LIKE TARGET

In 2012, the, apparently, upright and intact hull of a ship-like target 100ft long, with a measured beam of 15ft, was discovered while testing an EdgeTech 400/900 kHz Side Scan Sonar (Figure 1). An exaggerated acoustic shadow imaged opposite of the north/northeast nadir suggests that the ship's deck may be canted. This would explain the narrow beam measured on the side scan record. The linear shadows projecting perpendicular to the hull axis may reveal the shorn stumps of two masts. The hull and mast shadows are products of the low angle of incidence caused by the shallow water and the towfish being close to the bottom. The alleged shipwreck is located within ½ mile of the Washington College, Chestertown, Maryland, Chester River waterfront, which is located about 25 miles from its confluence with the Chesapeake Bay. Despite setting in only 25 feet of water this artifact is visually concealed beneath tannin rich, turbid, tidally affected waters. Even in the dead of winter, with water clarity at its maximum, it is hidden from direct view. The photograph of the hull portion (Figure 2) was gathered in February while testing the University of Delaware's Outland ROV.

III. GEOPHYSICAL INVESTIGATIONS

In the summer of 2013 several technologies were deployed to further investigate it. A Geometrics 881 Cesium magnetometer was used to map the presence of ferrous masses. An EdgeTech 216 sub bottom profiler determined if there was a definitive acoustic signature between the sediments and the ship's hull structure. An Odom Hydrotrac single beam

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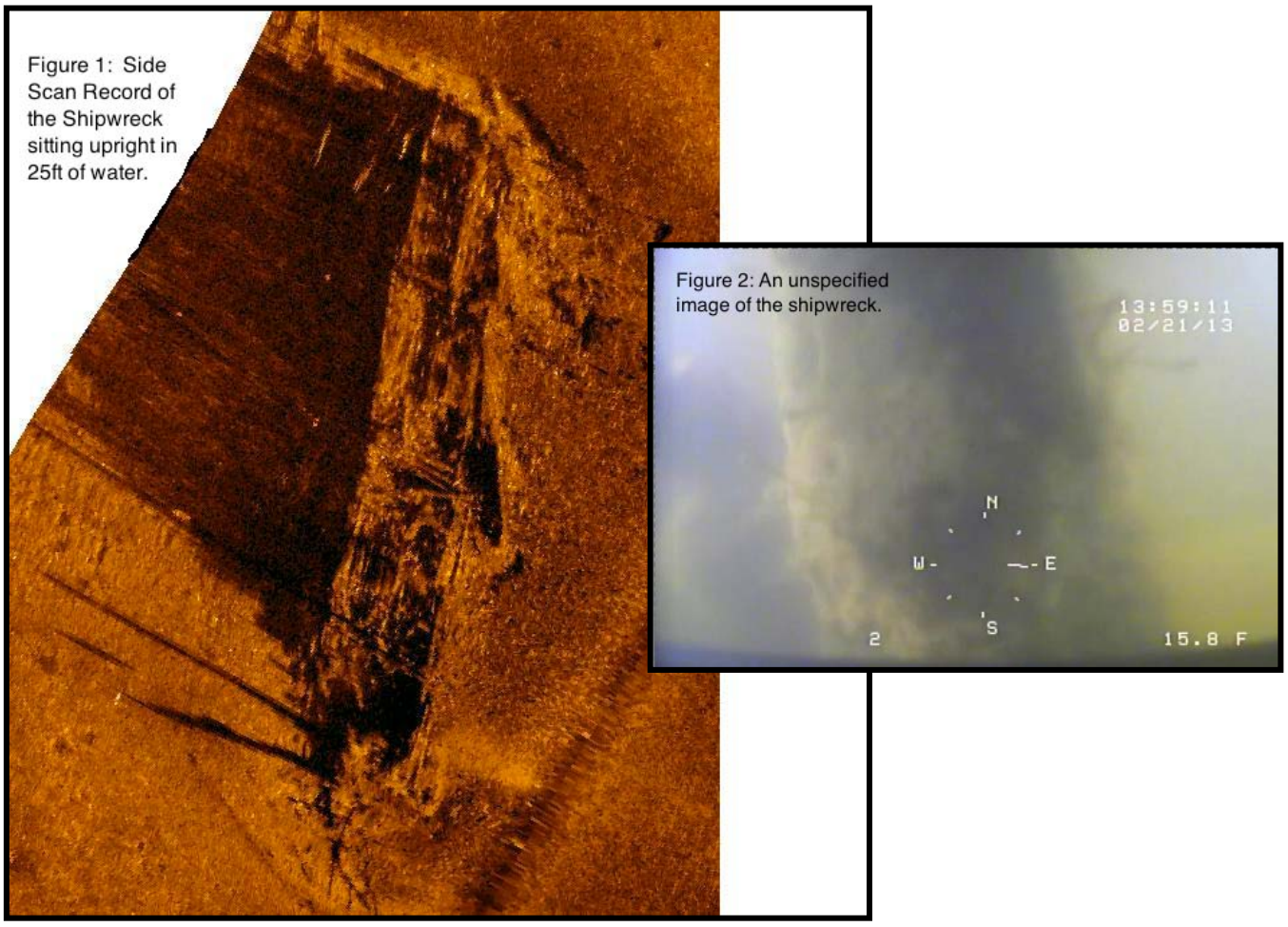
echosounder was used to create the bathymetric signature of the ship over which the Side Scan data was draped. In partnership with the University of Delaware, a Gavia AUV and tethered Outland ROV equipped with a multibeam was "flown" over the wreck.

After analyzing and all of the mapped geophysical data, a grid was developed. An underwater camera was systematically dropped from a boat secured in place by a three-point anchor system. By loosing and tightening on the different lines the camera was "walked" over the entire ship and a complete set of (not mosaicked) imagery was gathered. From the dataset, a comprehensive understanding of the ship's condition has been cataloged. The geophysical data and the imagery were used to attempt a positive identification of the ship.

exercises. Undergraduates will be provided with the scenario of an abandoned ship. They will be apprised of the technologies that are available to them to locate its likely resting point [2]. The students will design the search pattern and use the technology aboard the College Research Vessel to test the hypothetical location of the (known) shipwreck. Associated lesson plans will also be created and integrated down to the 4th grade.

The shipboard, hands-on experience, is limited to the 5-person capacity of the research boat. To translate the experience to the classroom, simulations will be created that can be streamed to classroom projectors in real time (telepresence), or as pre-recorded vignettes.



IV. EDUCATION INTEGRATION

The benefit of this serendipitous discovery is less in the cultural find than in the pedagogical opportunity. The full data set has been fashioned into a series of educational modules that support K-16 STEM education related to ocean exploration and research. Washington College will be incorporating the shipboard experience into "classroom"

These will duplicate the boat operations, allow for desktop data viewing and analysis, and be accompanied by discussion questions and worksheets that review the process and procedure. Topics for the programs will include, but not be limited to; Direct and Indirect Data, Underwater Archeology, Research Vessel Operations, Global Positioning Systems, Side Scan Sonar, Sub Bottom Profiler, Single Beam Echosounder, Magnetometer, Remotely Operated Vehicle, Autonomous

Underwater Vehicle and Underwater Cameras. The students will also be involved in Aquabotz, a program that affords students the opportunity to design, build and launch working underwater robots (Tethered ROVs) in a little more than an hour [3]. The hands-on programs instill a sense of ownership in the students engaged in the Ocean Exploration lessons. To enhance learning aspects of this program a board game is being devised that provides an engaging opportunity to apply what has been learned in a competitive environment. The game board will be made available on a 1:1, full size, vinyl billboard fabric for outdoor use, a tabletop version and one that can be completed online.

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