Konrad Mech discusses how advances in multimode multi-beam sonar technology are helping to protect ports and shipping from underwater terrorist and criminal threats

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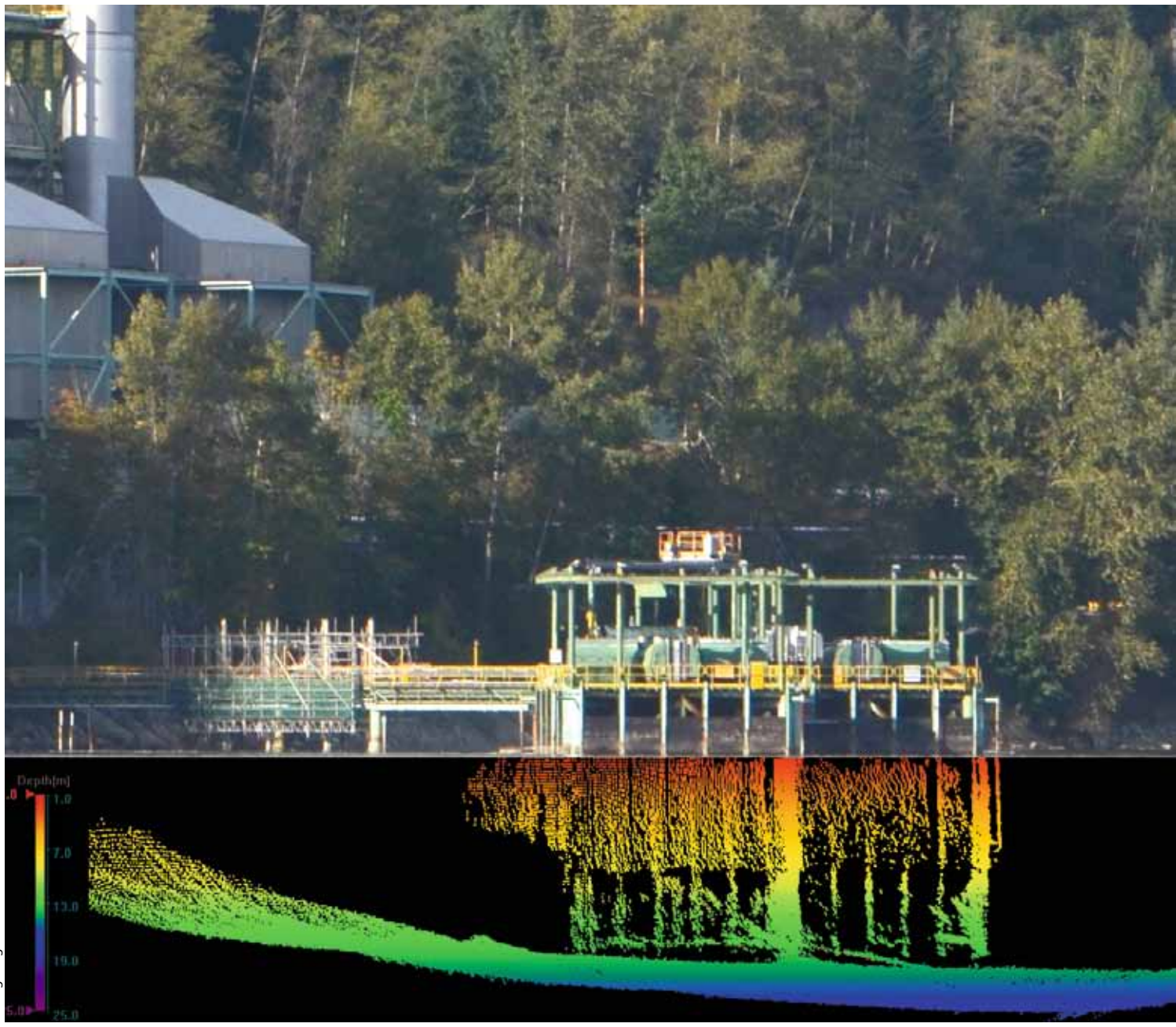
Underwater attacks on ports and ships have been a risk since before the Second World War. Today, waterborne attacks continue to threaten ships, high value assets and piers, which are vulnerable because of exposure to the sea. Recent examples of successful water attacks by terrorists abound, including the 2000 sea-borne bombing of the USS Cole and the 2002 Limburg oil tanker attack, and numerous surface and underwater suicide diver assaults by the Tamil Tigers. The need to protect ports and docked ships from terrorist attacks has never been more urgent.

The underwater environment in harbors has always presented a challenge for security forces dealing with terrorist threats or inbound contraband. The shallow,



Multimode multi-beam sonar can be used to provide a high-resolution view on pilings, pier walls and the nearby seafloor

> **"Multimode multi-beam sonar is a significant new weapon in the ongoing war against those determined to strike at the vulnerable underside of ports worldwide"**

murky water presents significant challenges such as limited visibility, loose sediment and debris. Historically, manual searches have been relied upon as the chief means of safeguarding the harbor's exposed underbelly. Given that they are dealing with devices designed to explode, the risk to the highly trained divers conducting these searches, usually police or military personnel, is substantial.

Even more daunting, the underwater improvised explosive devices (UIEDs) utilised by terrorist groups pose an array of challenges for military and homeland security forces. Just as IEDs up the ante from conventional landmines, so the challenges associated with UIEDs are different and much more perilous than traditional sea mines.

Traditional methods and systems for detecting UIEDs, enemy divers, and unidentified underwater vehicles include both manual (diver) and automated searches. Manual searches are laborious, risky, and time-consuming, when speed is of the essence. Pier inspection divers must examine surfaces both tactilely and visually, often with the aid of diver-held sonar, adding to the complexity and magnitude of the task.

Automated searches, conversely, employ underwater cameras, along with a variety of sonar modalities (sidescan, sector scan, multibeam, or synthetic aperture sonar) that can be fully integrated with above-water radar, cameras, and infra red systems. The coupling of these technologies enables the harbour security command centre to undertake searches and to monitor the entire operation in real-time. By substituting equipment for human labour, this automated approach enormously increases the speed, accuracy, and effectiveness of the search operation or port protection system while reducing the safety risk to personnel.

Current search deployment platforms include surface vessels, towfish, remotely operated underwater vehicles (ROVs) and autonomous underwater vehicles (AUVs). ROVs used in underwater searches for UIEDs are equipped with cameras and, often, sonar.

Once detected, classification and identification of UIEDs and other threats requires assessment by direct visual means, or by remote use of underwater cameras or imaging sonar. Targets are subsequently reacquired and neutralised, a function usually undertaken by EOD diver teams or by the use of underwater robotics employing "one-shot" ROVs that destroy IEDs with an explosive charge or by other means.

Given that enemy divers require only about 30 minutes (12 minutes with assistance) to reach a target from a one-kilometre distance, early detection, made much more rapid and efficient with new advances in sonar technology, is critical. Today, advances in multimode sonar enable searches that are faster, less labour-intensive, and safer for divers.

Multimode multi-beam sonar combines three different modalities (downward profiling, forward imaging, and side imaging) in one easy-to-use product, providing an instantaneous image across a wide field of view that cannot be achieved with single-beam sonar. For example, objects the size of a 200-liter (50-gallon) drum are readily detectable using all three modes of sonar operation. In one test, a small child's backpack containing a metal cylinder used as a target was easily spotted using the sonar's imaging mode.

The new highly portable multimode multi-beam sonar (see case study) also makes it possible to use any available vessel for experienced personnel to set up and deploy equipment – usually within 15 minutes – allowing for rapid deployment and response. Searches and routine scans with multimode multi-beam sonar proceed quickly from a boat at a speed of 1.5–2.0 knots, covering 1,000 linear feet of vertical pier for a single pass in fewer than ten minutes. A two-person team comprised of a helmsman and an operator can accomplish the initial search.

The sonar imaging is valuable in murky water situations where divers are, quite literally, swimming blind. In these situations, control operations on the surface can follow the divers in real time on sonar and direct them away from potential hazards. High-resolution imaging makes sonar the perfect tool to monitor and direct divers. The operator localises suspicious targets by electronically "marking" them. Later, these targets are classified for neutralisation by divers or ROVs. Most importantly, the initial search can be completed prior to dive team mobilisation, with targets and potential hazards identified well before the first diver enters the water.

For objects on the seabed, at the berth and in anchorages in water depths of between eight and 20 meters, profiling sonar images provides clear delineation of pier faces or sea walls. The accessible spaces between pier pilings can be probed using the side imaging sonar setting – a good choice for seabed searches at depths shallower than eight meters, and also preferable for

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High stakes: the consequences of a successful attack on a port or ship could be devastating

searching large areas of the seabed, such as anchorages or approaches. Seabed areas larger in size than a square kilometre can be inspected quickly using the multimode multi-beam sonar's side imaging capability.

Another useful benefit is that sonar images can be stored in an image library and cross-referenced with historical images of the same seabed, pier walls or pilings. This provides a valuable record that allows for anomalies and newly detected unidentified objects to be quickly targeted for inspection.

ROVs can also serve as deployment platforms for multimode multi-beam sonar, and can examine vessels from different angles and aspects not available using traditional methods. ROV deployment of multimode imaging sonar is useful in examining the undersides and sides of ships' hulls for parasitic contraband containers and other attached devices.

The advance of multimode multi-beam sonar facilitates the real-time operations of the harbour protection system and significantly reduces deployment and response times of divers and security personnel. It enables UIED detection operations to be faster and safer than manual searches, reducing risk and saving time, budget, and labour. Overall, it is a significant new weapon in the ongoing war against those determined to strike at the vulnerable underside of ports worldwide.

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Case Study:

Sonar protects US port

The versatility of Kongsberg Mesotech's innovative M3 MARSEC turnkey, shallow-water maritime security sonar system was put to the test recently by an unnamed US East Coast harbour security authority under a confidentiality agreement. Applications for the portable M3 MARSEC sonar include berth clearance, hull inspection, structure inspection, unexploded ordnance, and IED detection. In addition, body or evidence recovery, as well as diver detection and monitoring, are other valuable capabilities. Portability, ease of use, and fast training married with highly advanced multimode multi-beam sonar technology are key features of this entry level product that enables port security personnel, police, and other organizations of any size to make sonar technology a routine cost-saving aspect in their daily operations. The port authority put the sonar through a number of tests in berth clearance, hull inspection, directing and observing divers, and a sea floor scan in different operating modes.

Berth clearance is a key priority for harbours because each ship arrival provides unique security challenges. In this test, the M3 Sonar did two passes around a target 190 meter-long berth and created a real-time image mosaic that delineated extremely small objects. The berth passes were completed in less than 20 minutes and provided composite images for security review and observation in real-time.

Importantly, all berth images can be catalogued and put in an image library for future reference. As technicians become familiar with the library, they can quickly compare archived berth images with real-time views and determine whether or not there are any discrepancies. If necessary, the dive team can be sent out to investigate unexplained anomalies.

Hull inspection involves ensuring that no contraband or explosives are attached to ships' hulls. The port authority selected a target cargo ship moored in the harbour and assigned the M3 MARSEC System to check the hull for any abnormalities. Typical hull checks can be performed quickly, and this one was completed in 12 minutes, providing high-resolution images for review.

The ability to direct divers is critical for operations efficiency; the M3 MARSEC is ideally suited for this task. Safety is also a concern. In the test, a small carry pack with a metal cylinder was tossed overboard and settled on the seafloor. In murky water, the package was easily visible on the sonar and the surface command centre quickly directed the diver straight to the target.

The final assignment was a scan of a sunken boat on the seafloor. Here, the sonar was able to easily delineate the boat in both imaging and profiling modes in real-time.

Overall, the harbour test confirmed the M3 MARSEC System's capabilities in rapid deployment and threat detection, as well as its value as a labour-saving advance in routine harbour infrastructure maintenance. It leverages existing security resources, such as divers, dry land personnel and other surveillance tools by providing them with a robust support technology that can save time, money, and lives.