SEA TECHNOLOGY® REPRINT
WORLDWIDE INFORMATION LEADER FOR MARINE BUSINESS, SCIENCE & ENGINEERING

Modern Towed Systems

New Developments for Multipurpose Platforms

By Christian Haag • Christian Dreyschultze • Raúl A. C. González

www.sea-technology.com
Facebook.com/seatechnologymag • Twitter.com/seatechnology
• www.linkedin.com/company/sea-technology-magazine

Modern Towed Systems

New Developments for Multipurpose Platforms

By Christian Haag • Christian Dreyschultze • Raúl A. C. González

In the world of ROVs, AUVs, landers and other vehicles, towed systems are often forgotten or their usefulness underevaluated. Dropcams and towed systems were born long before ROVs and AUVs appeared because they require less electronics and controls. Towed systems are still in use, and for some types of operations and scientific applications they are more cost efficient than other platforms.

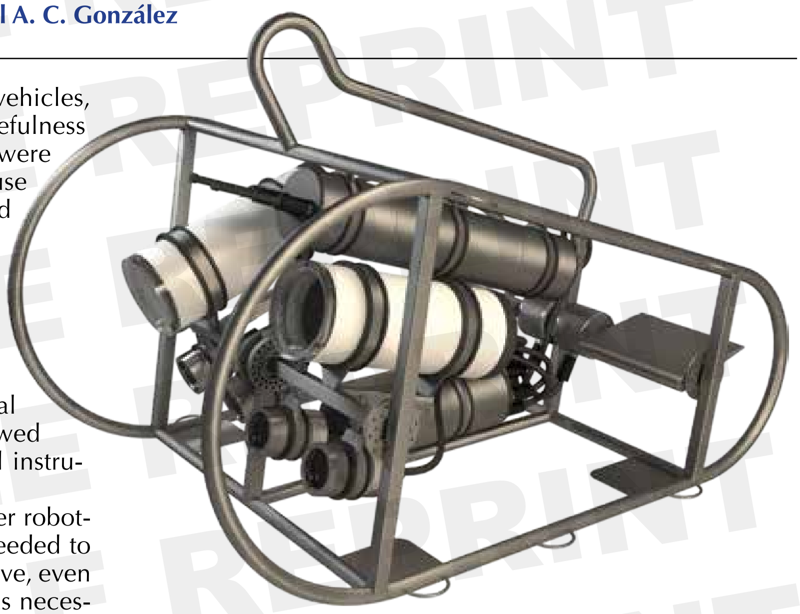
Application of Towed Systems

There are many different applications of towed systems. From simple flat-water surveys for coastal zone management to surveys in trawl nets, towed systems can be used with numerous sensors and instruments.

Towed systems were invented when underwater robotics was science fiction and scientists primarily needed to obtain underwater images of large areas. Divers have, even with scooters, a limited range of actions, so it was necessary to attach a camera to some kind of towing frame.

With the ongoing development in electronics, towed systems have developed into multipurpose, multifunction platforms without propulsion but with some type of actuators. Applications are clearly in science, where large areas can be inspected in short cruises and from relatively small boats and vessels. Thanks to microelectronics, HD cameras, LED lights, fiber optics, and a large number of sensors, sniffers and water quality samplers, it is possible to carry out surveys related to coastal zone management, EOD recovery and debris search with high cost efficiency; for example, searching for bombs and mines from WWI and WWII in the Baltic and Northern Seas.

ROV operations often require big vessels, normally with type two or three dynamic positioning. Due to the necessity to operate in any kind of environment, ROVs need strong thrusters, which mean a lot of energy consumption. Depending on the kind of ROV, the additional components like generators, winches, technical staff and others on surface not only increase the ship size but the operational costs. Obviously, there are strong arguments for the use of ROVs when you need to stay on a spot or stop at one site and operate a tool. But when you are searching for something in a high-current environment, for example during salvage operations, a towed system can be the better choice.



Side view of the Observer III with HD cameras, laser pointers, LED lights and electric-driven depressors.

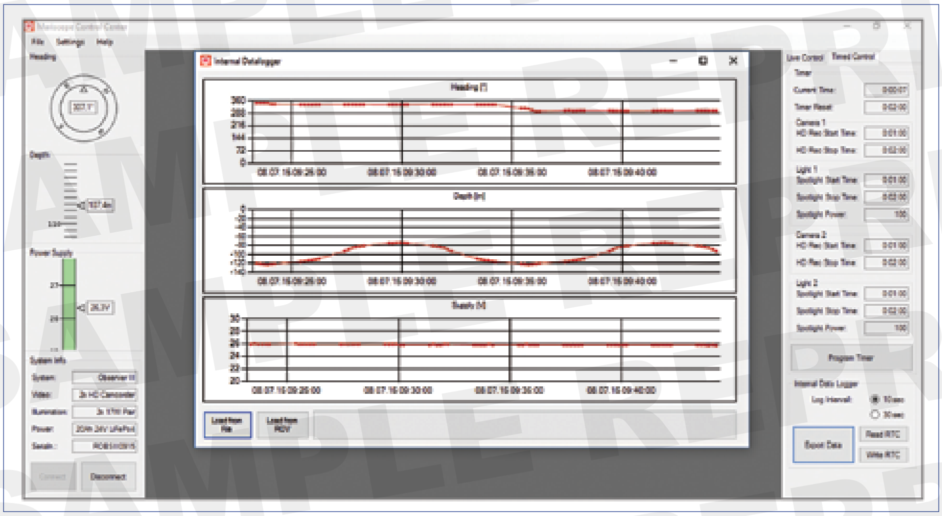
Ongoing Developments

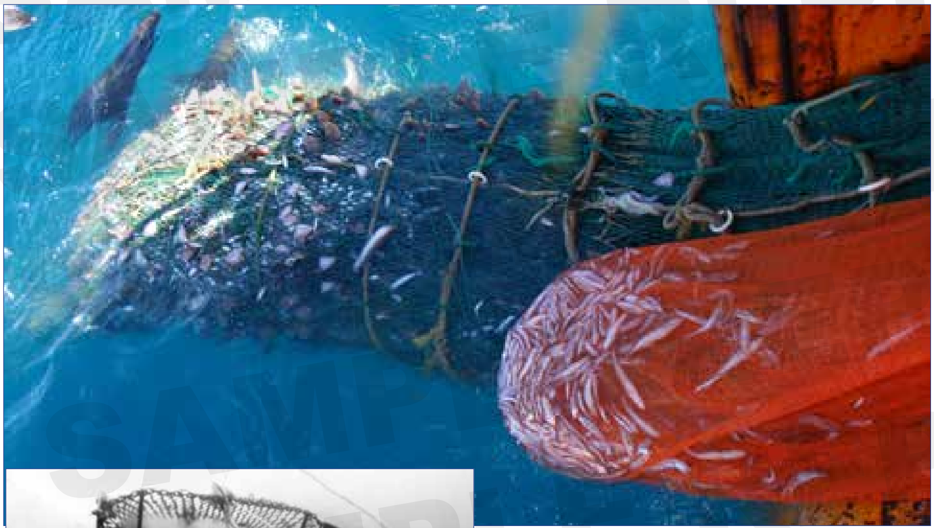
Towed systems for the inspection of trawl nets have been in use for several decades. Mariscope got into the game with the development of the Magnus Tow for the German Bundesanstalt für Fischrei in Hamburg in 1995. This system used Magnus rotors instead of propellers to position itself in the trawl net during the trawl. This system was a hybrid since propulsion was used to position the unit at the right place during the operation within the net.

The company has developed a new hybrid system without rotors: the Observer III. The first application is a stand-alone system to be attached inside a trawl net during operation. Here, the position is fixed, but the system needs to automatically start and stop recording and control the lights and other sensors in order to reduce power consumption.

System Details and Software

In the stand-alone version, the Observer III receives its power supply through lithium-ion or Li-Po battery packs. The packs are sized according to the sensors, cameras, lights and the duration of the deployment. Since the system operates autonomously in this mode, all functionality can





(Top) Control software showing undulation of the system. Typical trawl net used in Argentina. (Bottom) The bottom trawl.

be programmed in advance. A scheduler allows periodic recording of videos, switching of cameras, regulating of illumination, and control of additional equipment. The high-definition videos are stored on SD cards within the system, and an internal data logger simultaneously records all sensor values annotated with RTC timestamps. After recovering the system, the data can be merged into the recorded videos for the purpose of documentation or processed separately.

The system can easily be converted into an online towed system. The same frame and components are used but turned upside down in order to use the predisposed towing hook. In online operation mode, all functionality can be accessed directly from the same software running on any PC or notebook. In this case, a live video (FBAS) is transmitted to provide direct feedback to a pilot. The live video, including a freely customizable overlay, can be recorded to a connected PC or notebook. The Observer III is equipped either with a manually movable depressor or with an electric-actuated one. This allows determination of the towing speed and the ability to change it even during operation. Furthermore, the electric-actuated depressor enables the system to operate in a closed-loop with the navigation devices. Autopilot functions such as stabilization of the horizontal and vertical movement or the automated following of predefined paths are possible.

This closed-loop control makes for easier use of the towed system. The auto-depth function can be used to hold the system at a specific depth, while the towing speed may vary. In conjunction with an installed altimeter, an auto-height function enables the system to keep a fixed height above the seabed.

Since the system follows the reference value for the depth/height automatically, a movement path may be defined by varying the reference value with time. This allows, e.g., an undulated movement of the towed system without changing the towing speed or interaction of a pilot. With an undulated movement, data samples from specific depths can be acquired easily. The data acquisition may be triggered automatically when reaching specific depths. In this way, a wide depth range can be surveyed in a single run.

Since the system is either attached to a trawl net or towed behind a vessel, its geographical position can be determined easily. The depth measurement and the length of the deployed umbilical or trawl net is enough to calculate the offset to reference GPS data at the surface. No expensive baseline system is necessary, although one can be attached to the system.

Frame Concept

As usual for all the systems designed and built by Mariscope, the frame is manufactured of stainless steel and hand-welded with TIG procedure. This allows customizing each unit according to the individual application and needs of the users. Moreover, the frame involves all the components of the system, including the depressor. This reduces the risk of damaging the system in case of a collision, when the special hook rail allows the system to overturn and not get entangled. Entanglement is the most common reason for the loss of a towed system.

The modularity of the mechanical parts continues with the modularity of the electronic interfaces. A specially designed mainboard serves as the host for a wide range of daughter boards with interfaces to all subsystems. Available daughter boards include analog front ends for sensor data acquisition, analog video transmission, digital communication interfaces (RS232, RS485), Ethernet communication including IP video, dimmable LED driver, and irDa interfaces for emulation of infrared remotes.

The power supply is selected to fit the requirements of the installed equipment. Unlike typical AUVs, the system

Control software for programming the system.

does not need to supply thrusters, and a LiFePo battery pack with 500 Wh is already sufficient for 8 to 12 hr. of operation with maximum power consumption. Furthermore, the power consumption can be greatly reduced with the use of the scheduler. When sampling data, the system does not need to run continuously, and a periodic triggering of the subsystems, including video and illumination, extends the available deployment duration by magnitudes. In towed operation mode, the system can be supplied through the umbilical.

Cable and Reel

Depending on the length of the cable, different configurations are offered. For flat-water applications with cable lengths up to 600 m, a multipolar cable with Kevlar-reinforced shield (2,000 kg of tensile force) is offered. Normally these units are deployed from small vessels or boats, and the cable is drummed on a hand-driven reel. This configuration is easy to use, cost efficient and easy to transport.

For deeper-going applications, electric winches or hydraulic driven units are necessary. Often, steel armored cable is necessary, and for lengths above 1,500 m a fiber-optic component is imperative. Depending on the ship and its equipment, there is the possibility to use existing winches or capstans; customization is necessary.

Additional Equipment

The Observer III can be equipped with any kind of modern sensors or camera systems. For example, HD cameras with integrated laser pointers are becoming standard tools on these vehicles. In addition, CTDs, carbon dioxide sensors, methane sniffers or Chla sensors can be installed on these units. Imaging sonars, obstacle avoidance sonars or other acoustic equipment are also perfectly adaptable.

Case Study

The School of Marine Science of the National University of Comahue, located in San Antonio Oeste city (Río Negro province, Argentina) has recently incorporated one Mariscope Observer III underwater system for supporting research activities and programs in San Matías Gulf (northern Patagonia). This system is being used in scientific and technological projects dealing with the assessment of fishing resources and marine biodiversity, as well as with innovation in fishing gear designs to reduce the discards, bycatch and seabed impact of trawl nets.

Among the various applications of the Mariscope equipment are video recording of the reactive behavior to the ...nt fish species, crustaceans, mollusks and ... For this purpose, the Observer III system ...onomous mode, attached into the square ...nsion piece of bottom trawl nets, or de...bed near the fishing gear operating area in ...obile fishing gear. The studies are focused ...ets targeting hake and shrimp, bottom and ...nes, crab traps and gillnets. This aims to ...f reaction to fishing gear from the species, ...ed to develop technological solutions that ...ng unwanted and small size (noncommer... ...nd improve the efficiency of the gears.

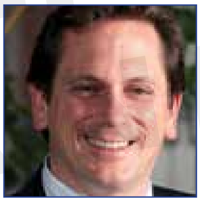
...the marine benthos and seabed, the Ob...ed in towed mode (live operation) with the ... The video records obtained in this mode ...ough an image analysis software and used ...g with the assessment of benthic and demersal biodiversity, estimations of abundance (density) and mapping of fishing resources. This information is also used to identify areas of high ecological sensitivity where there is the presence of species vulnerable to the impact of fishing gears. With this knowledge, the design of spatial management measures (i.e., non-take fishing areas) is possible.

The Observer III is also used as a complementary tool to hydroacoustic systems measuring the dynamic parameters (i.e., distance between wings, vertical opening) and 3D deployment of trawl nets. Video records obtained during fishing trials allow identification of the performance of different structural designs and the effectiveness of various selectivity devices such as square mesh panels and selective grids. These studies aim to reduce environmental impact and improve the efficiency of fishing gear and selective devices. For these activities, the Observer III is also attached to the fishing nets and operated autonomously or with an umbilical connection to the surface.

Conclusion

Modern towed systems are multipurpose and multifunctional platforms that allow fast and cost-efficient deployment in numerous applications. With the integration of state-of-the-art sensors and equipment, these systems can be deployed autonomously or with live operation. Due to modern power supplies and microelectronics, towed systems are experiencing a comeback in many operations. **ST**

Christian Haag is a physical oceanographer who founded Mariscope Meerestechnik in Kiel, Germany in 1994. He is also the founder of Mariscope Ingeniería in Chile in 2001 and of Mariscope Argentina in 2013.



Christian Dreyschultze is a development engineer at Mariscope Meerestechnik and specializes in automation processes and robotics.

Raúl A. C. González is an independent researcher at the National Council of Scientific and Technological Research, School of Marine Sciences, National University of Comahue in Argentina.