

## Market and Technology Trends in Underwater

# Sensors & Instrumentation

By

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**U**nderwater sensors and instrumentation have been developed for a broad range of activities – including mapping the seafloor, communicating underwater, locating underwater objects, and observing underwater animals and plants – carried out by government, industry, and the scientific research community. The Duke University Center on Globalization, Governance & Competitiveness (CGGC) recently completed a study on the global value chains of ocean technologies, including underwater sensors and instrumentation, for a consortium led by Nova Scotia's Department of Economic and Rural Development and Tourism (ERDT). Excerpts from the report on the market and technology trends in acoustic and non-acoustic underwater sensors and instrumentation are provided in this article.

### Market trends in sensors and instrumentation

[Please note: trade information for underwater sensors is captured by the Harmonized System (HS) code 9014 and 9015 of the United Nation's Comtrade database. Unfortunately, these data are

inextricable from data tracking "above-water" sensors; HS 9014 and 9015 capture all navigational and survey instruments. Thus, all trends in trade that we report are for both underwater (acoustic and non-acoustic) and above-water sensors.]

**The world's exports of navigational and survey instruments nearly doubled in 2001-2011, from \$7.5 billion to \$16 billion. In 2011, 63% of the exports, \$10.1 billion, were accounted for by surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances, while navigational instruments represented 37%, or \$5.8 billion.**

As shown in Table 1 (page 36), the United States was the world's leading exporter in navigational and survey instruments, representing 22% of exports in 2011. It was followed by the United Kingdom, Germany and France. Canada was the world's fifth largest exporter of underwater instruments in 2011. In navigational instruments, Germany, France, the United Kingdom and the United States form the leading group of exporters. In surveying instruments, the United States (26.4%) is the leader in exports,

**Table 1: Leading exporters of navigational and survey instruments, 2011**

Total (HS 9014 & 9015)		Navigational instruments (HS 9014)		Surveying instruments (HS 9015)	
<b>World Exports</b>	<b>\$16.0 billion</b>	<b>World Exports</b>	<b>\$5.8 billion</b>	<b>World Exports</b>	<b>\$10.1 billion</b>
USA	21.6%	Germany	16.4%	USA	26.4%
United Kingdom	13.4%	France	13.9%	United Kingdom	13.4%
Germany	11.3%	United Kingdom	13.5%	France	9.5%
France	10.7%	USA	13.3%	Germany	8.3%
Canada	5.1%	Italy	9.5%	China	6.3%
		Canada	4.2%	Canada	5.6%

Source: Duke CCCG, compiled from UN Comtrade

**Table 2: Leading importers of navigational and survey instruments, 2011**

Total (HS 9014 & 9015)		Navigational instruments (HS 9014)		Surveying instruments (HS 9015)	
USA	17.4%	USA	18.0%	USA	17.0%
United Kingdom	10.8%	United Kingdom	12.2%	United Kingdom	9.8%
Germany	7.0%	Germany	9.3%	China	8.7%
Canada	6.7%	France	8.6%	Canada	5.6%
China	6.6%	Canada	8.3%	Germany	5.3%

Source: Duke CCCG, compiled from UN Comtrade

followed by the United Kingdom, France and Germany. Canada accounted for 4.2% of the navigational instrument exports and 5.6% of the surveying device exports in 2011. Among the top 20 exporters, Germany, China and Canada increased their share in the world market in 2001-2011 by 6%, 3% and 2% respectively. Meanwhile, the United Kingdom and the United States lost market share during the same period by 10% and 7%, respectively. China's exports of surveying instruments in 2001 was only a half of what Canada exported, but in 2011 the value of China's exports surpassed Canada's exports, accounting 6.3% of the world exports.

In terms of imports, the United States is the largest import market for navigational and surveying instruments, representing 17.4% of the world imports in 2011. It was followed by the United Kingdom (10.8%), Germany (7.0%), Canada (6.7%), and China (6.6%). For each subgroup of product, the United States and the United Kingdom are the two largest import markets, while China imported more surveying devices than navigational instruments in 2011. Canada represented 8% and 6% of the world imports in each sub-category (see Table 2, page 38.) Among the top 20 importers, China's and Singapore's markets have expanded the most in recent years. Their share of world imports increased in 2005-2011 by 2.2% and 1.4%, respectively. Meanwhile, import markets for underwater instruments in the United Kingdom and France declined during the same period in terms of their share in world imports by 4.6% and 1.3%. Overall, these figures demonstrate the dominant position of Western economies in navigational and survey instruments as both exporters and importers.

However, developing countries are becoming important markets for underwater sensors and instrumentation. The most rapid market growth for navigational and surveying instrumentation is found outside Western developed economies. Table 3 (below) shows the countries with the fastest growing markets for underwater instruments in 2005-2011. Among the top 20 importers in 2011, Colombia's imports grew fastest over the period, recording a 452% import increase, followed by Indonesia (279%), Russia (245%) and Brazil (158%). In navigational instruments, China, Russia and Hong Kong experienced the most rapid growth of their import markets, while Colombia, Norway and Russia have emerged as rising markets of surveying instrumentation. Brazil will likely be a strong growth market for underwater acoustic technologies such as side-scan and multibeam sonars in the near future as it develops its offshore oil resources. China has significantly expanded their imports, and, to a lesser extent, their exports, in the past decade. Some global lead firms have started to manufacture sensors in emerging markets to tap into the growing demand for acoustic and non-acoustic sensors and instrumentation. One example is Kongsberg Maritime's sensor factory in China, which was established in 2009 to sell its products to a growing number of customers in China and across Asia.

#### Technology trends in underwater sensors and instrumentation

New market demands, technology development, and firm consolidation have changed the global market for underwater sensors and instrumentation. Technology and manufacturing advances

**Table 3: Fastest growing overseas markets for navigational and survey instruments, 2005-2011**

Total (HS 9014 & 9015)	2005-11 Growth% (2011 imports)	Navigational instruments (HS 9014)	2005-11 Growth% (2011 imports)	Surveying instruments (HS 9015)	2005-11 Growth% (2011 imports)
Colombia	452% (\$144m)	China	259% (\$251m)	Colombia	544% (\$100m)
Indonesia	279% (\$163m)	Russia	225% (\$59m)	Norway	264% (\$257m)
Russia	245% (\$341m)	Hong Kong	200% (\$74m)	Russia	249% (\$282m)
Brazil	158% (\$202m)	Singapore	96% (\$253m)	Indonesia	241% (\$141m)
Norway	149% (\$356m)	Italy	69% (\$366m)	Germany	123% (\$432m)

Source: Duke CCCG, compiled from UN Comtrade

have led to the miniaturization and increased energy efficiency of instruments. A greater number of devices are integrated and deployed on single platforms to increase the functionality of the platforms while reducing operational costs. Advances in research and development (R&D) and manufacturing are driven both by consolidated multinational firms, who offer a wide range of products for different end-markets, and by small and medium sized enterprises (SMEs), who meet the needs of narrow market segments or provide niche products that integrate with other firms' platforms and systems. We briefly discuss each of these trends below.

**Miniaturization and power efficiency:** The global underwater sensors market is seeing a remarkable trend towards smaller and more energy efficient technologies. Firms increasingly are using advanced manufacturing technologies, such as MEMS (Micro-Electro-Mechanical systems) and nanotechnology, to reduce the size of instruments. As several navies today are employing smaller naval vessels, future military underwater acoustic technologies will likely be smaller, lighter, and easier to deploy and recover than the devices currently available. Additionally, increased energy efficiency allows longer deployments of underwater instruments. Since deployment and retrieval of underwater sensors can often be very expensive (i.e., ship or aircraft time, ROV/AUV operations), extending the operational duration of instruments underwater is a major factor pushing innovation in the industry. In addition to miniaturization and power efficiency, the market for underwater sensors is focused on developing shallow-water applications and devices with high resolutions.

**Integration and deployment of multiple sensors on single platforms:** Another key trend is the bundling of numerous sensors and instruments on a single platform, and consequentially, the importance of system integrators in the underwater sensor value chain. Systems integration is rapidly evolving. Improvements in software and hardware have facilitated the integration of multiple sensors on single platforms. Integrators are combining instruments into "sub-systems" to develop measurement, wireless/satellite communication, and data collection/processing/storage sensor suites. Integrators also are pushing the development of modular "plug-and-play" technologies easily integrated with a number of platforms brands and types (i.e., ships, moorings, and ROVs/AUVs).

**Rugged sensors and instrumentation:** The expansion of human activity in the Arctic Ocean and the deep sea has led to a demand for sensors and instrumentation capable of surviving extreme conditions. For work in these environments, end-users will increasingly demand equipment with greater energy efficiency, longer mission life, and capable of automated or remote control. The key technology challenges are increasing the reliability and resilience of sensitive instruments on ships, underwater vehicles, and other marine platforms to allow for continued remote operation with minimal maintenance, repair or human supervision.

**Market consolidation:** An additional trend is the growing consolidation of the marketplace. In an effort to provide a wide range of products for many different end-markets, some large firms are buying smaller firms. Acquiring smaller, more specialized firms enables technological acquisition and helps firms to attain scales of economy in research and development, marketing, and end-market coverage. This trend will likely continue in the future, especially as a way for large firms to acquire innovative technology.

One example in the industry is Teledyne Technologies (profiled in the September issue of *Marine Technology Reporter*).

Since 2005, it has acquired 26 firms: in 2005, Cougar Components, RD Instruments, Benthos; in 2006 Rockwell Scientific, Ocean Design, CollaborX; in 2007, D.G. O'Brien, Tindall Technologies, Judson Technologies; in 2008, Impulse Enterprise, TSS International, Judson Technologies, Webb Research, Filtronic Plc (defense electronics), Cormon, Odom Hydrographic Systems, Demo Systems; in 2010, Optimum Optical Systems, Inteltek plc, Hafmynd (Gavia's AUV maker), DALSA Corporation, and Nova Sensors.

In 2012, Le Croy, PDM Neptec, Blueview Technologies, and VariSystems were acquired by Teledyne Technologies.

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