Design, manufacture, servicing and usage of FerryBox systems

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Abstract

Ferrybox is a European funded project designed to gain better understanding of water quality over both temporal and spatial scales. In order to achieve this, sensors in flow through systems have been fitted to eight routinely operating European Ferries. The data sets obtained will provide a comprehensive source for assessment of long-term trends in coastal water systems and aid the development of operational and ecological models on water transport and environmental parameters. The Chelsea Technologies Group has been providing Ferrybox type equipment to both the Military and Civil markets for over 20 years and can demonstrate how these systems have evolved to meet both scientific and survey requirements, developing and utilising key technologies as they have become available. Examples are presented of early systems which store data to local dataloggers, progressing to the latest systems available which provide data transmission from ship to shore. Servicing of these systems is a key issue to their successful operation, and methods adopted to reduce service intervals are discussed. Challenges such as biofouling of such systems are addressed, and a number of solutions which are currently being adopted are presented. Examples of different data presentation methods and styles along with their respective merits are discussed. Examples of Ferrybox data are presented, and their value to different stakeholders, including scientists, monitoring agencies, surveyors and educators are identified. It will be demonstrated how such data is directly addressing the needs of European Environmental legislation. Investment issues of such systems are also addressed, including how public outreach using the data generated can be used as a catalyst to contribute funding and goodwill from ferry companies.

Background

The Chelsea Technologies Group (CTG) are involved in the development of opto-electronic instrumentation mainly for environmental monitoring and Life Science applications, but also work in both the offshore and process engineering sectors. More recently expertise has been acquired in acoustic transducer design and a full range of hydrophones and projectors are now also offered.

CTG are generally more associated with in-situ flourimeters, offering a range of underwater fluorimeters mainly for the measurement of chl-a, and more recently for the actual analysis of photosynthesis within water systems. The original Aquatracka was a development from joint work with what was formally the Institute for Oceanographic Sciences (IOS), now the National Oceanography Centre, Southampton.

CTG are also associated with towed undulating vehicles, after working with IOS on the SeaSoar and with Plymouth Marine Laboratory on both the AquaShuttle and more recently the NuShuttle.

Past Flow Through Systems

However, in the past CTG have designed and supplied a number of flow through water monitoring systems for both military and environmental monitoring applications. This included the Sea-Surface Monitoring System (Figure 1) for the UK Ministry of Defence, which allowed the Subpack, a multisensor package designed for operation on the Navies submarine fleet, to be operated on a surface vessel. The Sea-Surface Monitoring System (SSMS) consisted of Salinity, Temperature, Chl-a fluorescence, Hydrocarbon fluorescence, Gelbstoffe fluorescence, Bioluminescence sensors. The system also included a De-aeration System and Laminar Flow System, and was deployed successfully many regions including arctic and Mediterranean waters.

Figure 1: The Sea-Surface Monitoring System, developed for the UK MOD

Figure 2: The CT Flowcell, operated on UK fisheries vessels

A smaller system was also developed for what was the Ministry of Agriculture, Food and Fisheries (MAFF), now the Centre for Environment Fisheries and Aquaculture Science (CEFAS), which used conductivity and temperature sensors as used on what was the Chelsea AquaPack, an in-situ Conductivity, Temperature, Depth and Fluorescence logging unit. The flow cell (Figure 2) itself was a titanium fabrication, which needed to avoid dead space where possible, yet be large enough so the titanium wall did not interfere with the Inductive conductivity head. A number of these units were operated by MAFF on their own vessels for many years.

CTG had also developed a flow through unit which accommodated the AquaPack CTD-F and other *in-situ* instruments to allow these instruments to be easily fitted and removed, to provide deployment flexibility offering the user either *in-situ* or flow through mode. This system was supplied to the UK Environment Agency who operated this system on one of their coastal vessels.

Current Ferrybox Instrumentation

The CTG range of in-situ instruments had been updated with the arrival of the MiniPack CTD-F, the successor to the AquaPack CTD-F. The unit is small and offers high performance, and was considered at an early stage for adaptation into a flow through system. It has the capability of accepting a large number (16) external analogue sensors and can be used as either a real time or internally recording device. The specification, although not WOCE, is still of a high standard and covers the demands of coastal and ocean monitoring. This unit takes the role of the hub of any other our instrumentation systems, and takes in a large number of other analogue sensors.

The onboard fluorimeter can be configured in factory to measure a variety of different fluorophors. Generally the on-board fluorimeter on the MiniPack is configured to detect chl-a. If further fluorophors are required in a system, our Minitracka II can be supplied and connected.

There are certain benefits gained from adapting in-situ sensors for flow through operations. As they are designed for in-situ operation, they are robust which is an advantage when they are to be fitted within engine rooms of commercial ferries. By careful design of flow manifolds, the heads of the sensors themselves can be easily exposed for checking and cleaning. They also do not have to be dedicated solely to flow through operation, but can be used for in-situ operation when required.

EU Funded FerryBox Programme

The EU Framework V funded programme Ferrybox covers three Scientific Fields, Eutrophication, Transport of Sediments and Stability and transport of water masses. The Scientific / Technical Objectives include Cost effective relevant information, Provision of reliable monitoring and management system and Provide real time data to improve accuracy of numerical models.
The various instrumented Ferry routes within the consortium demonstrates the main interest lies within the North sea and Baltic sea. Two of the Ferry routes, the Portsmouth to Southampton P&O Ferry as well as the Southampton to Cowes Red Funnel Ferry which has been in operation for a good number of years before the European programme.

Project Activities involving CTG include Inter-calibrations and comparisons of available Ferrybox systems

- Derive relevant information for monitoring, assessment and scientific understanding
- Provide end-user community with relevant application information on these systems
- Public Outreach presenting information in an informative way
- Offer possibilities to detect environmental impacts on large scales

Other Project Activities include

- Collect data, prove applicability, reliability and operability
- Produce easily acquired, quality controlled, inter-comparable data-sets
- Provide validation and ground-truth measurements for remote sensing

Work has been conducted with the National Oceanography Centre, Southampton on Ferrybox systems for a number of years prior to the commencement of the EU project. A flow through manifold for the Minitracka II fluorimeter had been developed, which had mainly been adopted by the water supply companies, and found these generally worked well. However, when addressing the requirements for the Isle of Wight FerryBox system, there was a clear requirement to try and reduce the dead volume within the flow cell, as this would avoid possibilities of sediment entrapment within the flowcell which would directly effect readings. There was also a requirement from the Ferry companies themselves to maintain a pressure integrity to 10 Bar, for safety reasons. Both these requirements were addressed in the design of a new flow through manifold for the Minitracka II, and a similar but slightly larger manifold was designed for use with the MiniPack CTD-F.

The four core parameters being measured by all partners within the project include Salinity (Conductivity), Temperature, Chlorophyll-a and turbidity. On the NOC operated Pride of Bilbao (P&O Ferries) vessel, these parameters are being measured by the MiniPack CTD-F and a Minitracka II, configured for measurement of turbidity.

For both these Ferries CTG had provided the instrumentation, and offered the data as a straight forward RS232 signal. NOC's technical team addressed the issues of data transmission from ship to shore, using ORBCOMM, and have also set up a web based system which presents the data in near real time.

One of the key requirements within the project is to offer systems that have relatively low costs of ownership, yet maintain certain standards when it comes to quality of the data itself. Biofouling is a critical issue in all aspects of environmental *in-situ* monitoring, and remain a problem when it comes to Ferrybox systems. There are also problems of taking in highly turbid and sometimes contaminated waters within ports. CTG had already developed flush windows for the fluorimeter, both for Minitracka II and MiniPack CTD-F for flow through systems. Previously, these windows were recessed within the window bezel, to assist in ambient light rejection for in-situ applications, but this recess allowed sediment entrapment in this critical area. The flush window design has now overcome this, and also allows easier cleaning of the window during maintenance.

Tasks relating to biofouling prevention, within the project, include:

- Investigating with the view of implementing automatic cleaning systems which will automatically trigger when the ferry enters port.
- Developing Secondary Solid Standards which can be easily offered to on board CTG fluorimeters to check levels of biofouling
- CTG are also partners within another EU Funded programme, BRIMON, which is specifically looking into techniques for combating biofouling. Work conducted under this programme has now provided a number of alternative technologies that can be adopted in biofouling prevention

Commercial FerryBox Systems

Future commercial FerryBox systems will need to be flexible to address the many varieties of craft they may be fitted to. There will also be differing requirements when it comes to such details as data handling. The approach which has been taken within the company is a modular one, not just for sensor selection but feature selection also.

Some systems will need to offer basic features, where the client's data management requirement simply dictate that the data to be recorded locally to memory for subsequent downloading. For example, a system that had been provided to the PNIRO in Murmansk, within the Russian Federation. This is operated from a Research Vessel rather than an actual Ferry, and therefore had no requirement for a passenger display. The system entailed the MiniPack CTD-F and Minitracka II, fitted to a standard 'FerryBox' frame which included a flow through system based on ½" (12mm) bore tubing, with Check Valve, Pressure Gauge and isolation valves.

Other systems will require further features in relation to data handling. For systems to be fitted to commercial ferries, data transfer to remote stations is required to avoid regular visits to the system whilst in port. This can be achieved by use of either Radio, GSM of Satellite communications. FerryBox systems should be capable of simple integration to any of these systems. A recent system developed for the Marine Laboratory Aberdeen (MARLAB) stores the data to a local disk during passage. When the ferry comes into port, a base station receives all data in one transmission automatically. Such a system prevents excessive data transmission costs of continuous transmission during passage.

The MARLAB system (Figure 3) also includes a passenger display that shows the Ferry passengers where they are on passage and also flicks to a display of oceanographic data taken in real time, and explains the relevance of the data. The exact Ferry onto which this will be fitted is as yet to be confirmed, but it is envisaged that the route shall be from Aberdeen to the Hebrides, and possibly later to Norway.

Figure 3: FerryBox system as delivered to the Marine Laboratory, Aberdeen

The Future

Great interest in FerryBox systems has already been received via the Chelsea network of agents throughout the world, not just for fitment to commercial ferries, but also for fitment to Cargo Vessels, vacational cruise liners as well as inland waterway vessels. Experience has already shown that Ferry companies are willing to work with such systems, providing their maintenance is not onerous and as long as their passengers can see clearly their companies commitment to environmental concerns via such facilities as the passenger display. It is important that FerryBox operators continually discuss between themselves their operations, as this will assist in further FerryBox routes to be taken up by sharing their experiences in ferry operator relationships. Chelsea Technologies see such systems as offering real value when it comes to costs of environmental monitoring and we plan in the coming months to promote such systems to monitoring authorities, scientists and Ferry operators. Through the EU funded programme, we can demonstrate that costs of ownership are attractive against high demands from tight budgets from national governments. These systems offer an attractive solution to the demands now imposed by such drives as the Water Framework Directive and Clean Seas Directive.

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