NEW TECHNIQUES TO REVEAL CRUCIAL SUB-BOTTOM DETAILS

STEMA Survey Services bv

After working for eighteen years with the trailer department of a dredging company, Stef Mars started his own hydrographic survey company in 1985. Working on board of hopper trailer suction dredgers and later as hydrographic surveyor with project management he came across two main problems: a lack of reliable sub-bottom information, and the elusiveness of liquid sediment, or silt.

Stema is known mostly as a hydrographic and geophysical survey company; it is less known as a manufacturer of software. However, we have developed our own tools that may be of interest to readers.

The Company
A team of geologists, hydrographers and a land surveyor form the core of our company. Their dedication and inspiration leads to continuing improvement in our products. We develop acoustic software that is combined with acoustic systems but we are not involved in acoustic hardware. Apart from geophysical surveys for dredging, marine aggregate mining, land reclamation, and construction we also execute wreck detection, cable and pipeline route surveys.

History and Development
Acoustic reflection measurement software â€˜SILASâ€™
Not being satisfied about the results of analogue seismic recordings and echosounder rolls, in 1989 and in close co-operation with the Geological Department of the University of Utrecht we began the development of a programme for digital seismic reflection data recording. The first version of SILAS was DOS-based, and launched in 1992. Since then SILAS has evolved continuously, incorporating experience mainly from pre and post-dredge surveys in the Far East.
In 2000 we started with the development of a Windows version of the software. Thanks to the improved A/D conversion, faster PCs offering the ability to apply new data processing techniques, SILAS software has made a great step forward.
One main objective of the acoustic reflection measurement software is to measure density variations in sub-bottom sediment and produce detailed geophysical information on seabed sediment. Penetration rates depend on the combination of the acoustic system used, frequency and water depth.
The software currently consists of three modules:

- Module 1 for layer tracing in sub-bottom sediments
- Module 2 also includes density computation in liquid silt layers
- Module 3 for sub-bottom sediment classification, is currently in its testing phase

The software is suitable for use with a wide range of acoustic sources,
such as: dual frequency echosounders, sub-bottom profiler (pinger), boomer (see Figure 2) or sparker (linear or non-linear). The software operates in the frequency range between 1 to 40 kHz.
Together with the development of the SILAS software, a tool for calibration and verification of the acoustic reflection recordings had to be developed for defining absolute density and rheological parameter values in areas with liquid sediments. This resulted in the DensiTune insertion non-nuclear densitymeter.

Silt layers in Focus
Polluted Silt layers
When dealing with polluted sediments accurate knowledge of silt layer characteristics is very important. Sediment characteristics such as rheological parameters, horizontal and vertical distribution of the grain size (pollution is attached to a specific grain size), layer thickness, density and depth of the excavation area enable the contractor to select the most efficient dredge method to employ, thus leading to a better estimate of the costs and the time required to complete the job.

Liquid Silt layer; Determination of Nautical Depth
Many ports are expanding rapidly to accommodate bigger ships. Deepening ports and entrances can create an increasing problem concerning accessibility of the ports. Often this problem starts with excessive silt formation causing reduction in the â€˜nautical depthâ€™. Analysing the reflected acoustic signal and deriving density gradients, it is possible to determine both the magnitude of density variations and in-situ density levels in, for example, a layer of liquid silt. The combination of SILAS with density measurements made by the density meter (DensiTune, see below) defines density levels with great accuracy. This system deals, for example, with the phenomenon of density inversions if present in the silt layer.

Determination Tons Dry Solid
Once the relation between silt density and dry solids content has been defined (with simple lab analyses), SILAS is able to convert

silt density into quantities given as Tons Dry Solid (TDS)

DensiTune Silt Density Meter

The DensiTune silt density meter is an accurate, easy-to-operate system for determination of the internal density and/or viscosity values of liquid silt layers. The measurement system is based on the â€˜tuning forkâ€™ principle. One of the legs of the fork vibrates with a specific frequency and amplitude; the other leg responds with a frequency and amplitude depending upon the characteristics, density and rheological parameters of the medium in which the density meter is inserted. The system measures vertical density profiles in liquid silt layers.

The DensiTune (Figure 3) can be used to determine the nautical depth in navigation channels, determine density and viscosity of silt layers in dredge/dump areas and for accurate monitoring of silt formation in ports, marine traffic areas and waters monitored and controlled by water authorities.

The DensiTune software is Windows2000-based, user-friendly and is capable of producing graphical colour presentations (see Figure 4), export of density data to external CAD or DTM package or export of data to the SILAS software for determination of 3D density levels.

Construction Support

Using the most up-to-date survey techniques for construction survey support we provide tailor-made systems and software for a wide variety of on and offshore construction projects. Underwater concrete installation, ground anchor installation, tunnel construction, sheet piling, pile foundations and pre-cast bridge segment installation can be controlled and monitored by the Pile Positioning Software, using RTK/DGPS systems or auto tracking Total Stations. Several years of experience in providing survey support to various kinds of on and offshore operations led us to design a sophisticated system for foundation pile positioning and process monitoring.

The software provides operators with real-time information on rake, heading and positioning (XYZ) while pitching or pile-driving. As an integrated option, a â€˜blow countingâ€™ module is available to allow geo-technical monitoring. All measurement data is integrally stored on hard disk for as-built reporting. The software is Windows2000-based and platform-independent, enabling both land and barge-based operations. The last such project was the second Moerdijkbridge (see Figure 5).

Dredger Positioning and Dredge Display

Designed especially for small cutter suction (stationary) dredgers, we have tailor-made software available for positioning control and dredge progress monitoring. This software provides the dredger operator with real-time horizontal and vertical positioning information. The software accepts data from various sensors, e.g. RTK/DGPS, Total Station, gyrocompass, inclinometer, and angle measurement sensors. The displays show the actual position of the cutting tool in a colour-coded map and cross profile, in relation to the theoretical profile to be cut. The positioning information is displayed as a colour-coded matrix adjusted to the measured position and depth coding each time the cutting tool passes. Maps from a pre-dredge survey and interim surveys can be loaded into the database for up-to-date information. Horizontal position and depth are stored on hard disk for onward presentation (see Figure 6).

Market and Philosophy

Up to now STEMA has only few agents. To support the growing world-wide demand for our products we are looking for more representatives to sell our systems. Our customers are port authorities, dredging and construction companies, survey companies and manufacturers of acoustic sources.

Over the past seventeen years STEMA has been contracted to execute geophysical surveys in the Philippines, Singapore (Tuas and Jurong project), Malaysia, Namibia, Dubai and Europe. Most projects involved enhanced sand searches, pipeline surveys and wreck survey (Wester Schelde).

Customers in various countries have purchased a DensiTune density meter together with the SILAS software for determination of nautical depth, for example in South America, China, India, England and The Netherlands.

STEMA owes its reputation to reliability concerning the collected sub-bottom information, interpretation, customer support, quality and versatility of products. The company has a lot of practical experience and has built up a complete geophysical databank of all projects. The latter may be used for testing new developments in the SILAS software.

Future

Our main objective is continual improvement of products. In the years to come STEMA sees good opportunities in opening up new markets in Europe, the Americas, China and Australasia. Many ports are fighting silt formation. But also environmental dredging projects, infra-structure projects and offshore construction projects are of importance to us. We expect to be of service with our products. SILAS module material classification is a speciality and rather unique. The market is ready for it.