Nautronix

Improving Hydrographic Rate of Effort

Presented by
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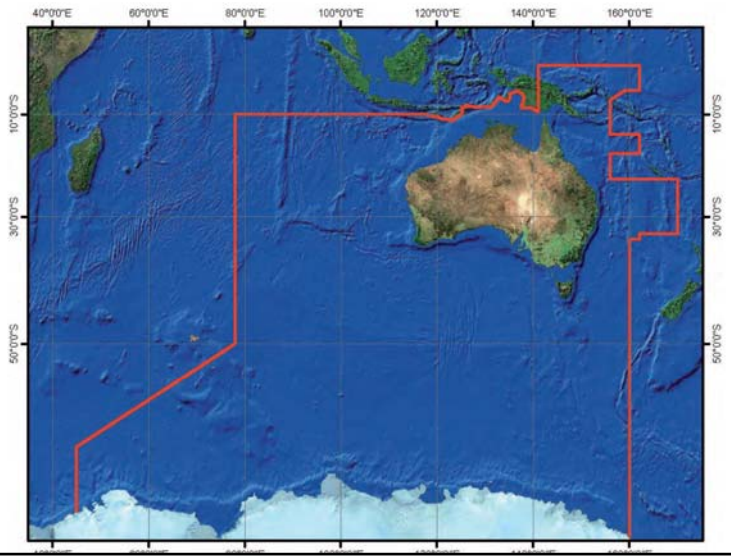
Australia's Surveying Responsibility

Hydro 2010
Rostock-Warnemunde
Germany



Source: http://www.hydro.gov.au/business-publications/hydroscheme-2010-2012.pdf

RAN Hydrographic Vessels

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- Two LEEUWIN class Hydrographic Ships (HS)
- Four PALUMA class Survey Motor Launch's (SML)
- SML specialty is shallow water surveys
- Prior to 2009, SML's main sonar sensor was a Single Beam Echo Sounder
- A higher level of data accuracy and at a faster rate of effort – the Survey Motor Launch Hydrographic Survey System Upgrade Project was imperative

Survey Motor Launch Hydrographic Survey System Project

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- The SMLHSS was developed by L-3 Nautronix for the Royal Australian Navy
- Prime Objective – achieve a Rate of Effort from each SML platform of 7 sq NM per 12 hour survey day collecting ZOC A2 data in depths between 20m and 50m
- Secondary – Collect ZOC A1 data and detection of $1m^3$ features in depths between 5 and 50

ZOC A2 Survey

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- ZOC A2 Survey:
  - "*Full area search undertaken. All significant seafloor features detected have had depths measured*"
- Full area search achieved by:
  - Side Scan Sonar (SSS) OR
  - Multibeam Echo Sounder (MBES)
- Modern MBES provide excellent bathymetry data. Tempting surveyors to obtain 100% bathymetric coverage (ZOC A1). However swath coverage is limited in shallow water significantly reducing Rate of Effort
- Prior to MBES traditional survey methods for ZOC A2 would achieve better Rate of Effort using a Single Beam Echo Sounder and Towed Side Scan Sonar

Rate of Effort Approach

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- L-3 Nautronix approach was to combine the old and new methods.
- To maximise ROE the MBES is used as a gap filler in conjunction with a high resolution side scan sonar
- The sonar combination provides full coverage for feature detection at the required resolution.
- The MBES provides bathymetry on all detected features.

Primary Design Considerations

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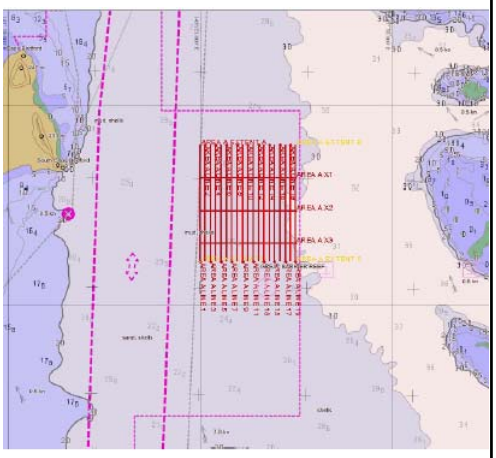
- To Achieve ROE:
  - 250m line spacing
  - Platform speed of at least 8 knots
  - At least 3 pings required for Feature Detection
- A Side Scan Sonar with 300m range allows for a 50 overlap in swaths with nadir gap of 30m
- Feature Detection (coverage) in the nadir region of the SSS would be provided by the MBES
- No time to stop for SVP's



Primary Design Considerations - SSS

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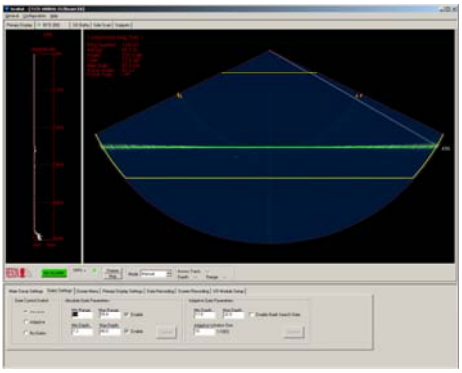
- Klein 5000 Side Scan Sonar satisfied required resolution and feature detection capability at 10 kts with proven swath widths of up to 300m tested in cooler North American waters
- Far North Australian waters (22 to 28 degrees C), the attenuation of the signal is significantly greater, reducing the sonar travel distance thus reducing the swath width
- Non-recurring engineering was undertaken to modify the Klein 5000 transmitter, receiver and array to increase signal to noise ratio and higher sonar transmitter energy output were undertaken

Primary Design Considerations - MBES

- Reson Seabat 7125 Multibeam Echo Sounder satisfied the require accuracies in the associated water depths
- Ping rate of the MBES is dependent on the Vessel Speed and range setting of the MBES
- As the depth increases the range setting of the MBES must be increased, which decreases the ping rate
- The Reson 7125 in 20m water depth would detect a $1m^3$ feature at a maximum speed of 6 knots only due to limitation in ping rate

Primary Design Considerations

- Reson 7125 - improve feature detection capability by increasing the ping rate thus sacrificing the outer swath
- In this mode the Reson 7125 can be used at a speed of 8kts (depths between 20 and 50m) detecting a minimum size $1m^3$ feature



9 Different Transmitting Sonars

- To achieve ROE the MBES and SSS had transmit to simultaneously without interference
- Further the Customer Specification required 9 different transmitting sonars, 8 were hull mounted. Complicating the potential for interference.
- Acoustic Interference can occur between sonars due to similar frequencies of operation, where the transmit spectra of one sonar overlaps the receive spectra of another.

SMLHSS Sonar Suite

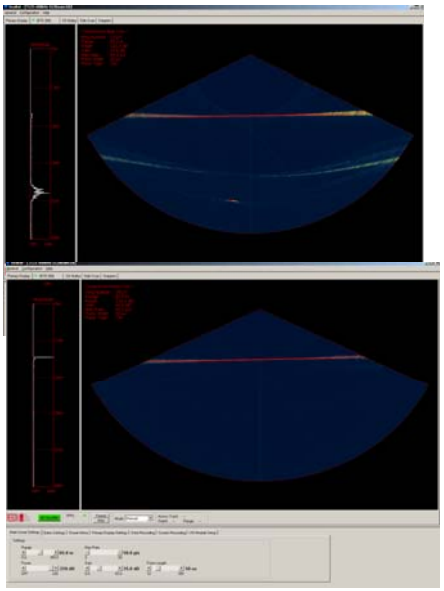
Priority	Sonar	Rational
1	Thales Three Dimensional Forward Looking Sonar	Government Furnished Equipment that could not be externally triggered. Primarily used for collision avoidance.
2	Reson Seabat 7125 MBES (400kHz/200kHz)	Provide feature detection in the SSS nadir region and bathymetry.
3	Klein 5000 SSS (455kHz)	Provides high resolution backscatter data (seafloor characterisation) and feature detection for ROE
4	Kongsberg EA 600 SBES (15kHz/120kHz)	Single Beam Echo Sounder (SBES) for Vessel for depths 5m to 6000m
5	Kongsberg EA 600 HSSS (210 kHz)	Hull mounted side scan sonar (HSSS) used in shallow depths for feature detection
6	Furuno DS80 DVL (1000kHz)	Government Furnished Doppler Velocity Log (DVL)
7	Reson SVP-70 (2000kHz)	Sound Velocity Probe (SVP), providing SVP data at MBES transducers

Acoustic Interference

- Reducing acoustic interference:
  - shifting one or more of the frequencies of operation of a particular sonar
  - positioning on the hull to minimise/stop interference with other sonar
  - optimise performance of the sonar and by incorporating a sonar control system, to control acoustic transmissions
- Shifting Frequencies:
  - Single beam and hull mount side scan sonar frequencies were moved for least interference

Sonar Control System

- L-3 Nautronix designed a Sonar Control System (SCS) which determined when the MBES, SSS, HSSS, and SBES transmitted
- The SBES was triggered at least 1 Hz with the SSS operating at an integer multiple of 1 Hz and the MBES operating at an integer multiple or fraction of the SSS

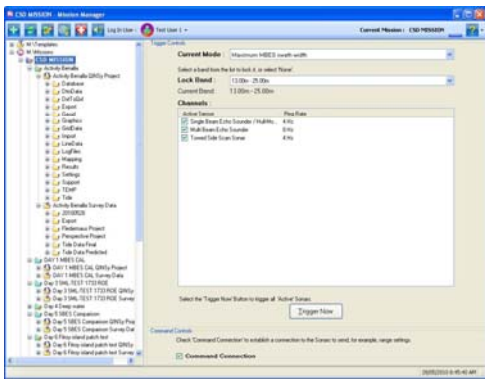


Secondary Design Considerations

- The technology had the potential to cover the 7 sq NM a day but did the platform and the crew?
- Designed to solve the time to setup and maintain a survey
- The SML are deployed with a limited number of hydrographers on board and each member has a range of different tasks other than hydrographics

Survey Setup Time - SCS

- Sonar Control System was synchronising the sonar
- Built as an expert system.
- User to select the type of survey they would like to achieve (for example, ROE Survey) and the SCS controls the ping rate and range of the Sonar.
- With a depth interface the SCS automatically changes the ping rate and range with depth.



Survey Setup Time - Calibration

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- MBES hull mounted, patch test not required at the start of each survey
- Mechanical roll and pitch offsets were measured during the installation

Maintain Survey Time - Acquisition

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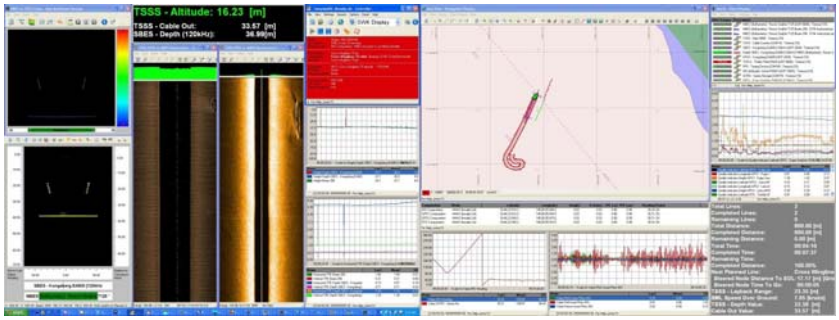
- Real Time QC using QPS QINSy
- NRE to automatically export raw files rather than manually exporting at end of survey
- Real time processing of survey on a line by line basis



Maintain Survey Time – Mission Manager

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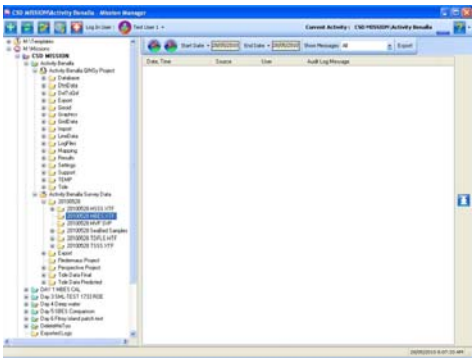
- Mission Manager designed by L-3 Nautronix
- Mission Manager creates the file structure and survey parameters required for each survey
- Mission Manager contained a Diary for User Input and Audit Log
- A full deployment of 12 week survey would collect 11 TB of data, there a management of the data would be crucial.
- Mission Manager automatically distributes the acquired data to central store, on a line by line basis



Maintain Survey Time - MVP

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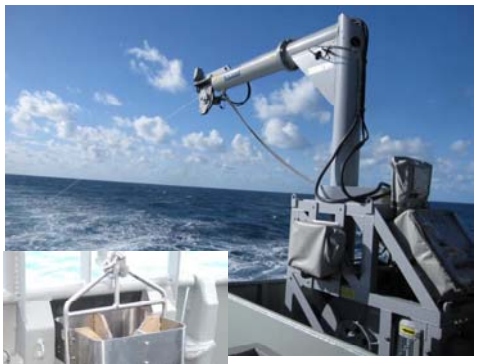
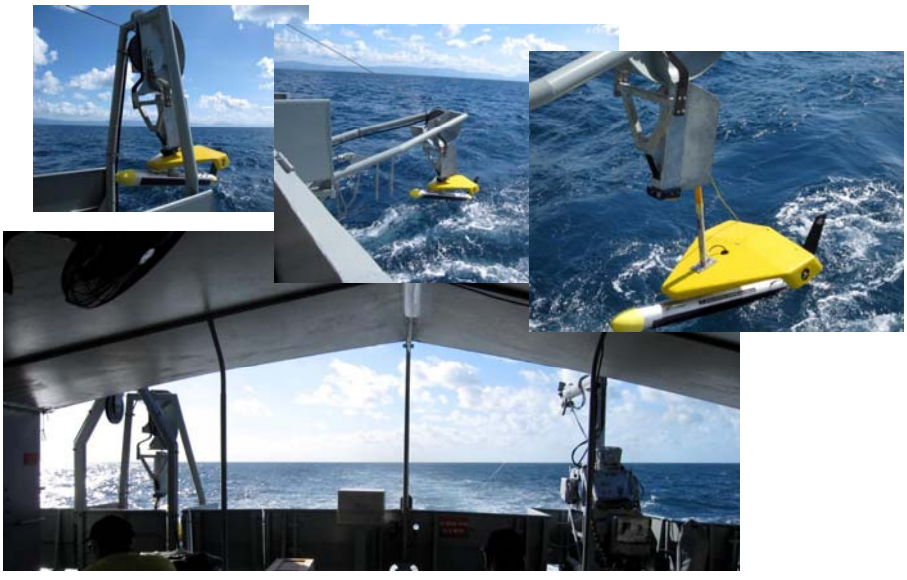
- Timely exercise during a survey is to conduct a Sound Velocity Profile.
- A Moving Vessel Profiler was installed by the then Odim Brooke Ocean.
- The CTD is installed in a Single Sensor Free Fall Fish (SSFFF), which can be towed up to 10 kts and allow SVP casts at 10 kts.
- No Vessel Stopping!



Maintain Survey Time – SSS deployment System

- The Side Scan was deployed using a winch and A-frame.
- Key considerations:
  - tow the SSFFF and SSS simultaneously,
  - SSS positioning,
  - time taken to conduct line turns.
- SSFFF at 10 kts requires ~40m of tow cable in the water
- Side Scan was towed with a depressor, meaning at 30m water depth, approximately 30m of cable out. Minimise chance of entanglement.
- Satisfied accurate positioning Side Scan as close to the Vessel

The Deployment Systems



The Bridge

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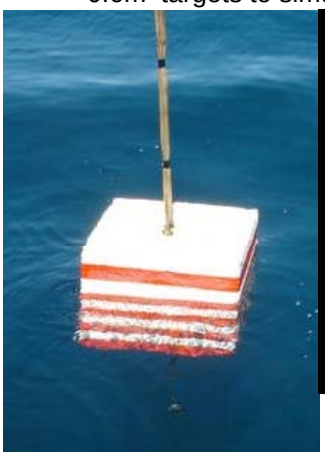
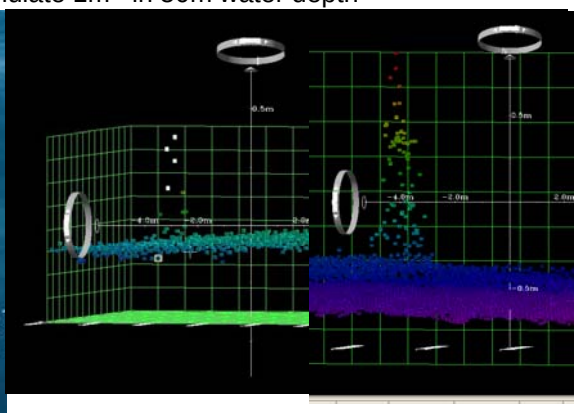
SMLHSS Trials Results

- The SMLHSS was commissioned in June 2009 on HMAS MERMAID.
- Further sea trials were conducted on HMAS PALUMA, HMAS SHEPPARTON and HMAS BENALLA
- Sea trials were conducted in a variety of conditions from Sea State 1 to Sea State 4, verifying all functional performance specifications with all sea acceptance tests passing.
- Two phase approach:
  - Position and depth accuracy trials conducted off Cairns
  - Naval Test Areas

Concrete Blocks

- Concrete blocks were deployed:
  - $1m^3$ features in 30m water depth
  - $0.6m^3$ targets to simulate $1m^3$ in 50m water depth





Concrete Blocks

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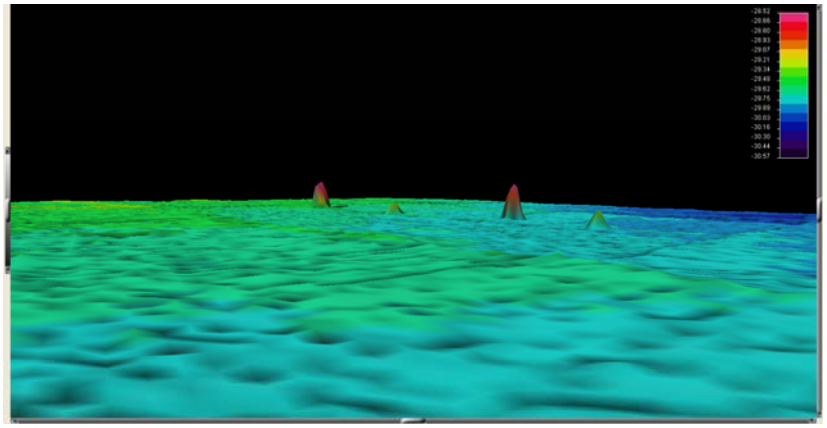

Wreck - Green Island, Cairns

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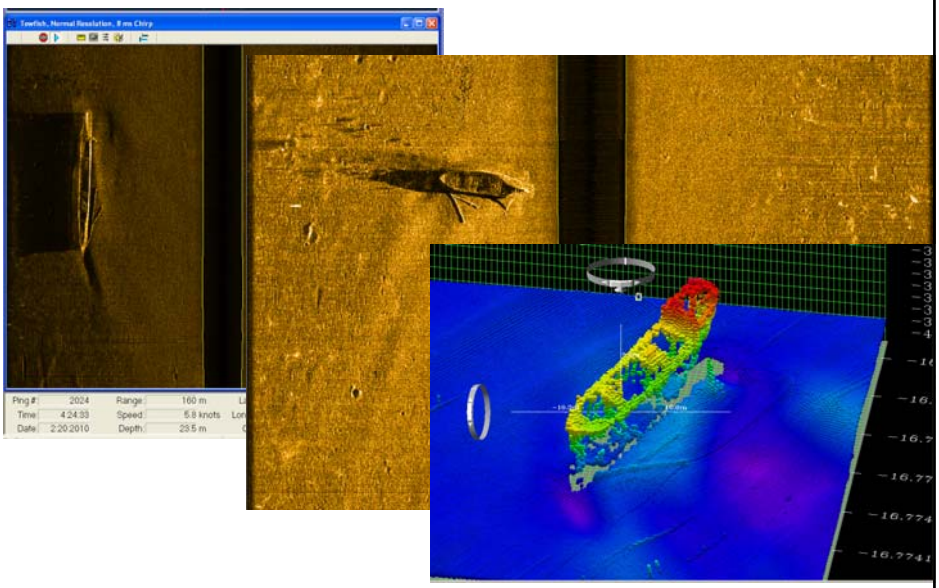

Rate of Effort

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- A ZOC A2, 7 sq NM survey was conducted in a Survey Area situated immediately adjacent to Cape Bedford, 28 km NE of Cooktown
- The survey was repeated for two consecutive days. Survey coverage greater than 7 sq NM was achieved on both days.
- The Survey was completed in 10.5 hours on Day 1, and it took 9.6 hours on Day 2.
- Test Area contained 19 lines and has a total area of 7 sq nm. Water depths range from 26m to 33m.

Rate of Effort – Achieved!

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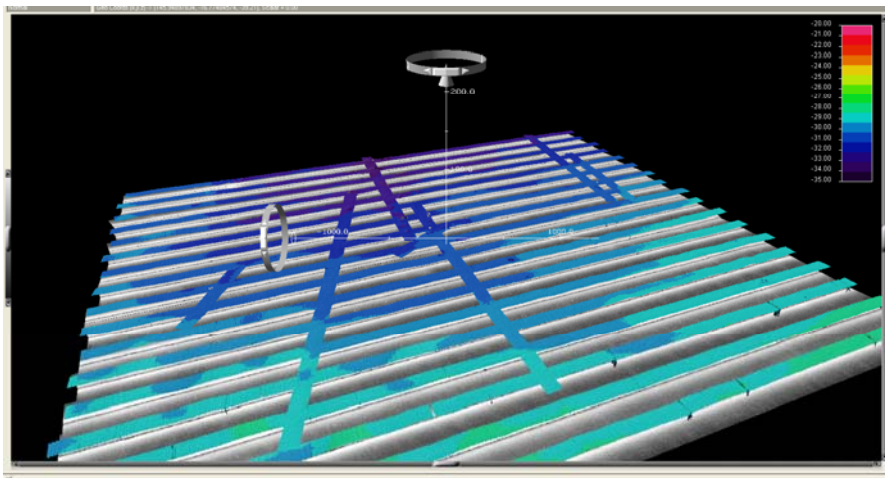

Initial Operational Release

- SEA 1401 Survey Motor Launch Hydrographic Survey System Phase 3 Upgrade Project finalised 30th April 2010
- Initial Operational Release achieved 22nd June 2010