Sentry de-brief summaries – 2011/2012

Three cruises*:

- 1 *Sentry/TowCam*
- 1 *Sentry/TowMag*
- 1 *Sentry/Jason*

**All cruises were post-refit*

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Pre-Cruise Planning:

- For two cruises – everything was fine and went well
  - For 1 cruise - planning began just one month prior to proposal submission, and cruise took place just a few months later
  - *Sentry* team was pro-active in securing the engineering time required to test and evaluate the sidescan sonar
- For one cruise which involved deep water work, pre-cruise planning was extensive (prior to proposal submission) & included specific conversations re: vehicle's depth & nav capabilities. Despite planned vehicle upgrades that would enable planned work, inadequate pre-cruise testing resulted in operational issues.

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Mobilization:

- Generally went well
  - Despite challenging conditions (strong winds) which limited access and delayed mobilization by 12 hours, mob was successfully completed within narrow time window.
  - Other cruise was easy mobilization, and didn't even use an agent.
- One problem was a missing set of bolts for assembling the USBL pole -- agent helped to resolve.
- Coordinating/communication issues with ship caused significant mobilization issues on one cruise which impacted Ops Teams, and resulted in a lost day of mobilization.

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Demobilization:

- Generally, demob went well:
  - Despite short transit and need to disembark an entire class of undergraduates demob completed in < 3 hours after arriving at the dock.
  - With help of Science Party and Ship's Crew, off-loading of the *Sentry* gear was completed by early afternoon of the day the ship docked.
- Cruise that had mob issues also had demob issues (but not as a result of *Sentry* Team)
  - wrong crane delayed demob by a day + illness

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Operations - Vehicle:

- *Sentry* worked very well throughout one cruise - completed all the dives required to achieve science goals.
- Multiple successful cases of joint dives between *Sentry*/*Jason*, operating within a few hundreds of meters of one another at water depths of 400-900m.
- On one cruise, weather concerns led Ops Team and Science Party to cooperate to achieve science and engineering objectives during initial dive.
- Periodic slippage in the planned launch time because of glitches in the mission planning but this was not seen as a problem by the PI – no impact on science

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Operations – Vehicle

- During first dive of one cruise issue with vehicle not following the intended course (heading ~12° counter-clockwise)
  - Periodic acoustic commands were used to compensate for this, but at the expense of CTD ops.
  - Later determined issue due to incomplete self-calibration of PHINS -- had not been powered up long enough before the start of the dive to calibrate for location. During the course of the dive, the issue sorted itself out and acoustic commands were used to ensure suitable survey coverage.
  - Despite these problems most important ~75% of survey was accomplished

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Operations – Vehicle

- Multiple operational problems with *Sentry* and the USBL navigation during one cruise resulted in:
  - Completion of only 2 full dives + 2 partial dives out of 12 funded dives
  - Acquisition of data along only 127 km of planned 800 km
  - Large proportion of *Sentry*'s deployment activity was given over to a series of 4 engineering dives which were not part of the PI's funded NSF program
  - Significant time (2 days) also spent on deck addressing mechanical issues

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Operations - Vehicle:

- Multiple operational problems with *Sentry* and the USBL navigation include:
  - Lost vehicle tracking and/or intermittent nav fixes at depth
  - Vehicle unable to follow straight line at certain speeds, and instead drove in circles
  - Vehicle drove down into soft mud and continued to try to keep driving forward until its "deadman" command ended the dive (thruster failure)
  - Failure of multiple vehicle tracking systems on 2 dives resulted in 2-4 hours searches for vehicle at end of dives

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Operations - Vehicle:

- Apparent sources of vehicle performance issues:
  - Limitations of the USBL navigation system
  - Impact of apparent acoustic noise of ship on LBL & USBL
  - Apparent problem with the servo actuators on the dive planes, impacting *Sentry*'s ability to make progress at depth

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Operations - Vehicle:

- At-sea response to vehicle performance issues:
  - Try relay transponder mounted on TowMag as a way of re-establishing USBL navigation capability on *Sentry* at 6000m depths which required planning revised (closer-spaced) parallel survey lines for *TowMag* & *Sentry*.
  - Attempted to use LBL navigation via relay transponder from *TowMag*
  - Keep the ship very close to the *Sentry* position as it moved along track – ultimately accomplished tracking
- The final dive was the only one for the whole cruise in which the vehicle operated as planned. Tracking was intermittent but not lost completely at a survey depth of 5100m.

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Operations - Vehicle:

- Problems with mission planning software:
  - One dive aborted during the early stages of descent. Re-launched after ~3 hours of down-time, the vehicle was re-launched. Completed all but final ~2h of survey before it aborted again in the same way.
  - Failure to drop weight at 1600m for shallow test-dive, resulted in continued descent of vehicle until abort command was sent.
  - During test dive vehicle did not get to planned depth before mysteriously self-aborting the mission and coming straight back within 6 hours.

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Operations – (Mis)communication with Ship's Crew

•Maneuvering of the ship involved a steep learning curve:

- During one launch, ship maneuvered the directly over vehicle
- During one recovery (on another ship) the ship ran over the vehicle damaging both the thrusters and an acoustic tracking sensor on *Sentry*.
- Solution was to station at least one member of the *Sentry* team on the Bridge during recovery
- One one cruise, not clear that an optimal location was established for person driving vehicle toward ship during recoveries.

•Recurrent delays due to misunderstanding of "30 minutes prior to launch" notification:

- *Sentry* team was ready to proceed with a launch but forced to wait for key ship's personnel (e.g. the crane driver)

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Operations - NDSF Equipment:

- USBL
  - Generally worked well with exception of nav issues in deep water
  - However, some issues noted apparently linked to retro-fitting the USBL to *Atlantis*. This issue did not impact ops but did bear on final navigation. As far as PI was aware, this issue was not resolved by end of cruise.
  - On one cruise, decision was made to not perform USBL calibration because of time constraints and adequacy of uncalibrated nav for exploration objectives of cruise.
- Sidescan
  - Generally worked well

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Operations - NDSF Equipment:

- Sub-bottom profiler worked well
- Multibeam sonar worked well
- Camera system generally worked well
  - Noted that resolution (e.g. when zooming in within individual photographs for biological purposes) was not as good in comparison to what could be achieved from the TowCam 16 MB images.
- Lighting worked well and images were well-illuminated

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Operations - NDSF Equipment:

- Three 3-component magnetometers deployed on *Sentry* yielding precise and sensitive magnetics data – superior to *DeepMag* towed array
- Noted that data acquired with *Sentry* were much noisier than data previously acquired with *ABE*
  - Regularity to the noise shows a capacitor-like response charging up and discharging over a 6-second cycle but also with a less marked 2-second response.
  - There is also an apparent interference with the DVL system on the vehicle that may draw down energy?
  - While data can be filtered to render it acceptable, this is currently a step backward from the data previously delivered by the same team using ABE and needs to be addressed.

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Operations – User-provided Equipment:

- 3-D camera system
  - First-pass 3-D photo mosaics draped over bathymetry within a matter of hours of processing post-dive
  - Some technical glitches with set-up, but overall hugely successful
  - Results were valuable not only to the science party but also helped the ROV team visualize where they were working on the seafloor
- In-situ mass spectrometer
  - Worked well
- Eh sensor
  - Signal-to-noise ratio in the Eh sensor data string was not as good (i.e. there was more electrical noise on this cruise) as when the same kind of Eh sensor used to be deployed on *ABE*

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Data Handover

•Data were provided in timely fashion throughout the cruise on a per-dive basis

•Full data distributions were provided at end of cruise, or soon after.

•During one cruise, there was only a 10h transit from last dive and the science party departed nearly immediately (within 2-3 hours of reaching port). As a result, there was insufficient time to finalize the data distribution. In this case, three 2TB drives were FedEx'ed to the PI immediately following the cruise -- prior to the *Sentry* team flying home.

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Recommendations:

•*Sentry* and *Jason* worked well together in parallel operations.

•*Sentry* should be equipped with a "park" mode of operation like ABE used to have, whereby it can descend to the seafloor at the end of its programmed mission and await an acoustic command to come back to the surface.

•Equipping *Sentry* with better lighting and a new higher quality digital still camera would improve basic imaging capabilities

•3D imaging capability was impressive and should be standard. Cautioned that this would require:

- additional hardware on the vehicle
- additional hardware required aboard ship
- skill-set needed among the *Sentry* team to process the data in a timely fashion in the way that it was done on this cruise.

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Recommendations:

•Due to the need to re-process various data files, issues/confusion arose due to file naming conventions. The PI suggests implementing a more systematic approach to add the same date-based notation, or a version number to **all** *Sentry* files, starting with the original.

•Currently, vehicle tracking map and other key information including elapsed time, depth, projected time to mission end, etc. is embedded only in the Sentry Team watch-leader station but is difficult for Science Party to access. Developing a simple user-friendly interface that could be fed to a terminal/screen somewhere readily accessible to Science Party would facilitate communication and science planning.

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Recommendations:

•In future all NDSF vehicle upgrades should **require** a post-improvement set of engineering test-dives prior to use for funded science program. Even 1 or 2 dives would been invaluable to reveal concerns and issues that impacted the entire cruise.

•NDSF and DESSC should work together to establish a training schedule to strengthen the operational team.

•*Sentry* can deliver the right sensors to the right part of the ocean to conduct the cutting edge research proposed, but the quality of some data needs to be addressed.