L.A. Mapper – HYPACK® / HYSWEEP® Integration Testing - September, 2010

By Mike Kalmbach

The L.A. Mapper is a new multibeam survey boat operated by the USACE, Los Angeles District. Built under contract to eTrac Engineering.

- **Summary:** The integration of survey equipment (R2Sonic 2024 multibeam sonar and Applanix POS/MV 320 inertial system) to HYPACK® / HYSWEEP® software is described below. System connections and timing checked out OK. Successful patch and performance tests were run. The R2Sonic option to rotate the sounding sector worked fine. Testing of snippet imagery was inconclusive. The sounding data was somewhat noisy and it's hoped that R2Sonic can provide sonar settings to improve quality.
- **Survey Equipment**
  - **R2Sonic 2024 Multibeam Sonar:** The sonar head is in a moon pool with a simple crank operated raise / lower mechanism. When fully lowered, a set of stops force the sonar head into the same position every time. The moon pool is located 1/3 boat length forward of stern. This location was chosen as optimal pivot point for pitch rotation.
  - **Applanix POS/MV 320:** The IMU is located just forward of the moon pool, very near the boat Center of Gravity (CG). This is chosen as the HYPACK® reference point. The primary GPS antenna is mounted directly over the IMU.

  This arrangement of devices is one of the best possible for small boat multibeam sonar. One would expect very good data quality.
- **Interfacing and Time Tagging:** All interfacing is via Ethernet. Both the R2Sonic and the POS/MV transmit data with UTC time stamps. These time stamps are used for data time, so HYPACK® does not apply time tags to anything. For timeouts and other low resolution timing, the HYPACK® PC is synchronized to the POS/MV network synch message (group 7).

  After an initial glitch, time tagging was found to be spot on.

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- **Dock Testing:** One of the best and easiest ways to test the timing of one system (sonar) vs. the other (boat motion) is to roll the heck out of the boat at the dock, then check that there are no roll artifacts in the data. This was done. Findings:

  With R2Sonic roll stabilization on, no artifacts were seen and the outer edges of the swath did not move. Check, OK.

  With R2Sonic roll stabilization off, no artifacts were seen although the swath outer edges shifted back and forth with roll. Check, OK.
- **Configuration errors:** Two unnoticed mistakes invalidated most of today's testing.

  POS/MV Ethernet messages. For HYPACK® to work correctly, it must receive groups 3, 7, 20 and 102 from the POS/MV. Some of the groups were missing. This caused position time tags to be a couple of seconds off.

  Meters vs. Feet confusion. Although the project was configured for meters, the device offsets were entered in feet. You can't mix units like that in HYPACK®. The offsets can be corrected in editing, but we repeated the patch test anyway.

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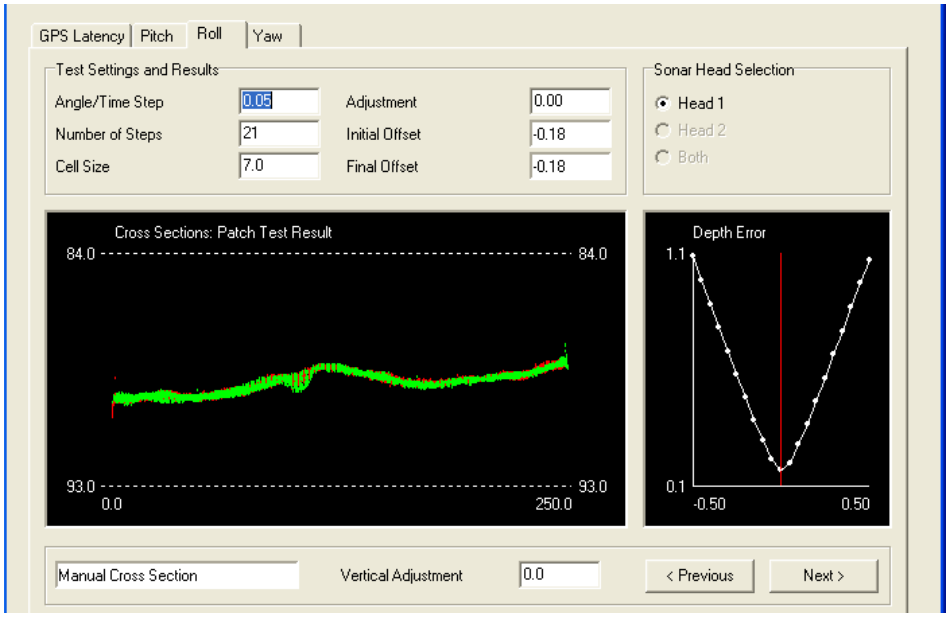
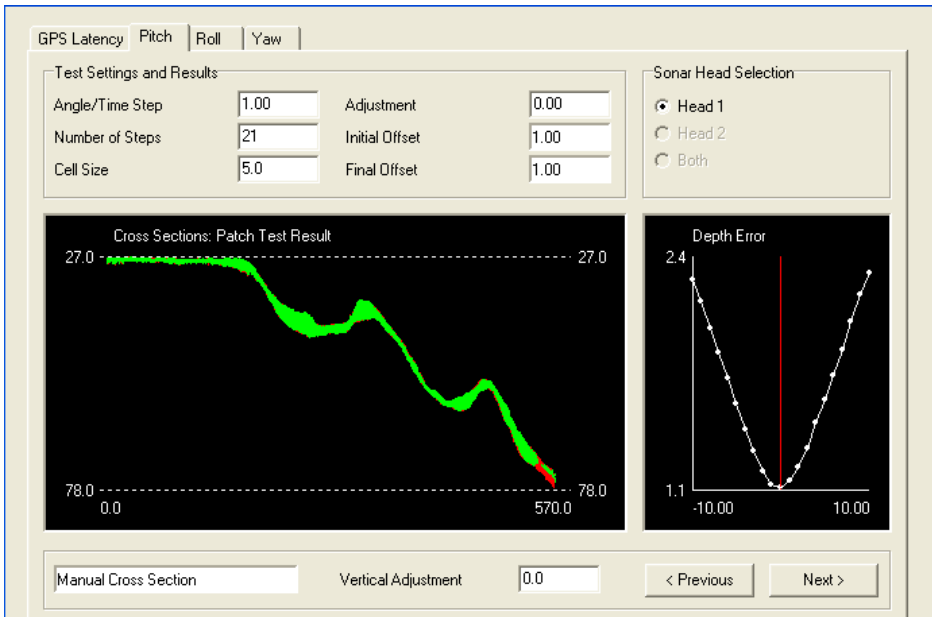
- **Patch Testing** was done using DGPS. Patch testing will be repeated in a couple of weeks when RTK GPS is available. Testing with RTK GPS gives better results.
  - **Latency Test**: Latency testing wasn't done for a couple of reasons. First, both sonar and position are reported with UTC time tags, so latency is assured to be zero. We checked that by rolling the boat at the dock. Second, DGPS errors often lead to a false latency offset, which just confuses things.
  - **Roll Test**: Averaging of multiple cross sections gave a final roll offset of -0.18 degrees.

FIGURE 1. *Roll Test*



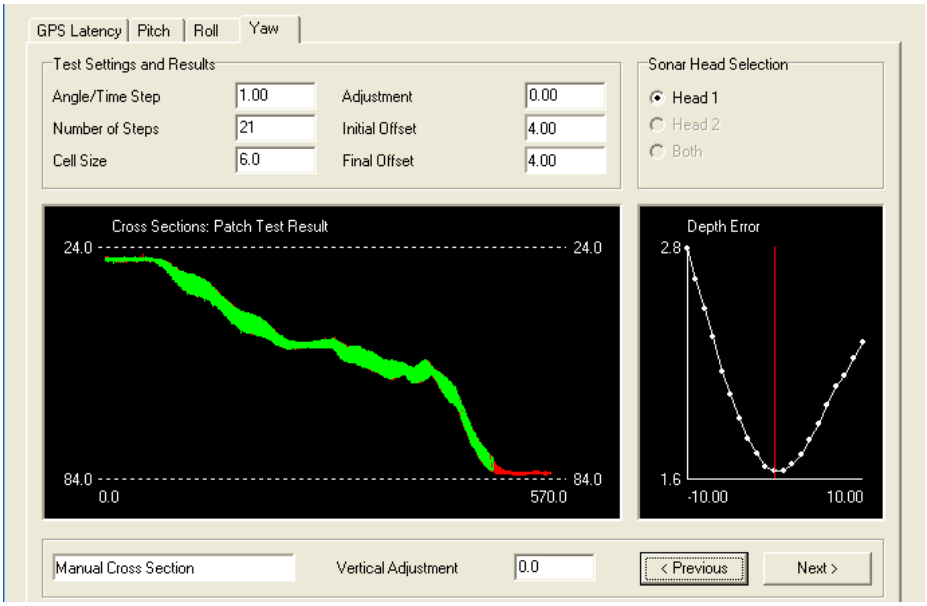
  - **Pitch Test**. Pitch offset is 1.00. Trying for better than one degree resolution in a single test with DGPS is pointless.

FIGURE 2. *Pitch Test*



- **Yaw Test**. Yaw offset is 4.00 degrees to one degree resolution.

FIGURE 3. *Yaw Offset*

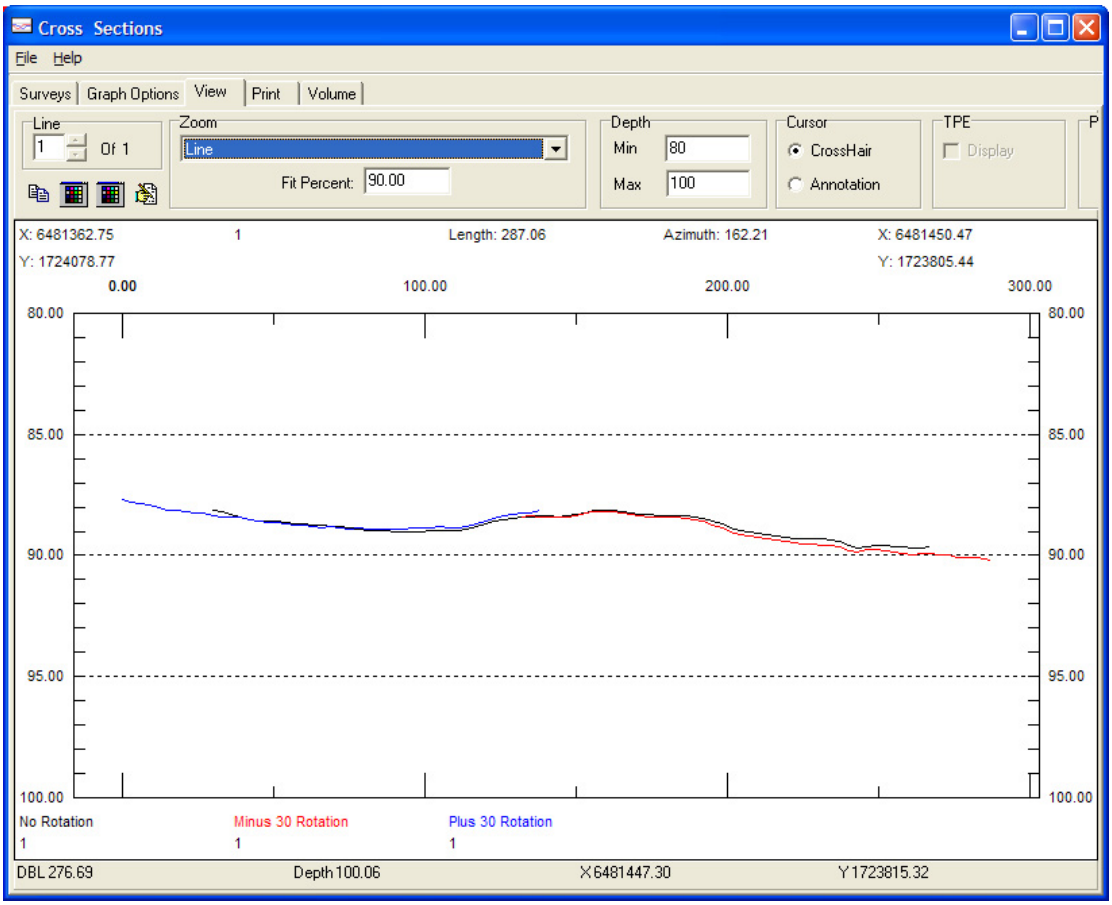


- **Bar Check:** A bar check verified sonar draft measurement to 0.1'.
- **Head Rotation Check:** A nice feature to the R2Sonic multibeam is the ability to rotate the head electronically. That is, using a mouse instead of a wrench. A simple test was devised to check this feature. Compare 3 lines in cross section, (1) no rotation, (2) -30 degree rotation and (3) 30 degree rotation.

  What we find is this. At -30 degrees rotation, sounding difference is 0.2' at -55 degree beam angle. At +30 degree rotation, sounding difference is 0.1' at +55 degrees. That

leads to the conclusion that R2Sonic electronic head rotation works fine on the LA Mapper.

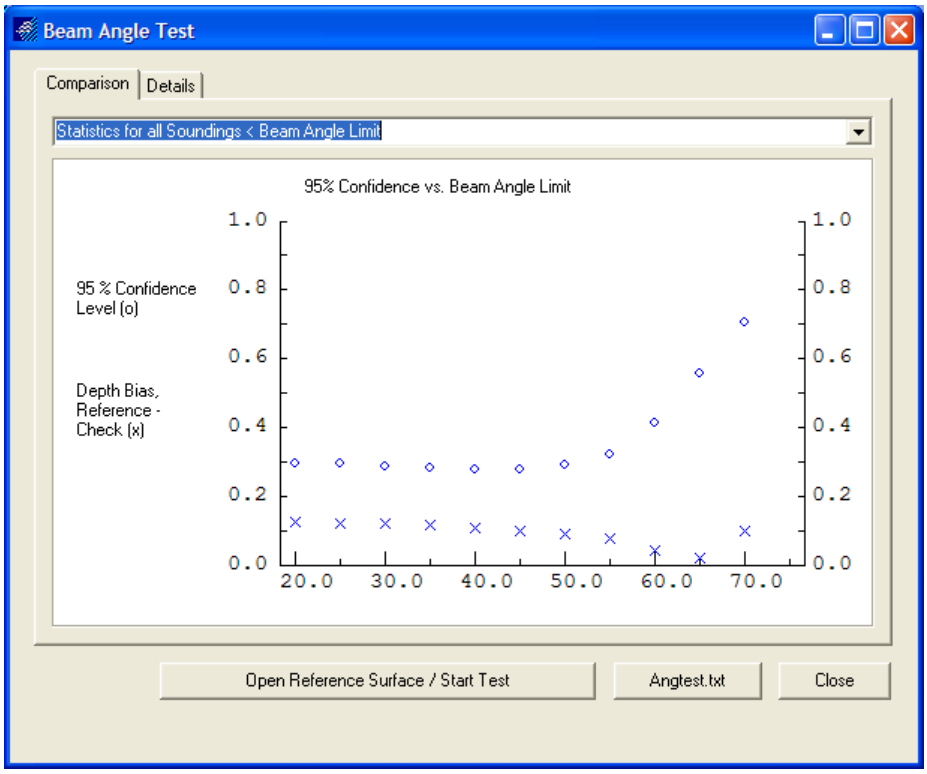
FIGURE 4.



- **Performance Testing:** We ran the HYSWEEP® Beam Angle Test on a reference area with 60’ water depth. Results show the R2Sonic sonar to be repeatable within 0.3’ out to 55 degrees. Beyond that, repeatability degrades rapidly. This is comparable to other high quality multibeam sonar systems.

  Different results might be expected with optimal sonar settings. No one involved in testing knew what those might be.

FIGURE 5.

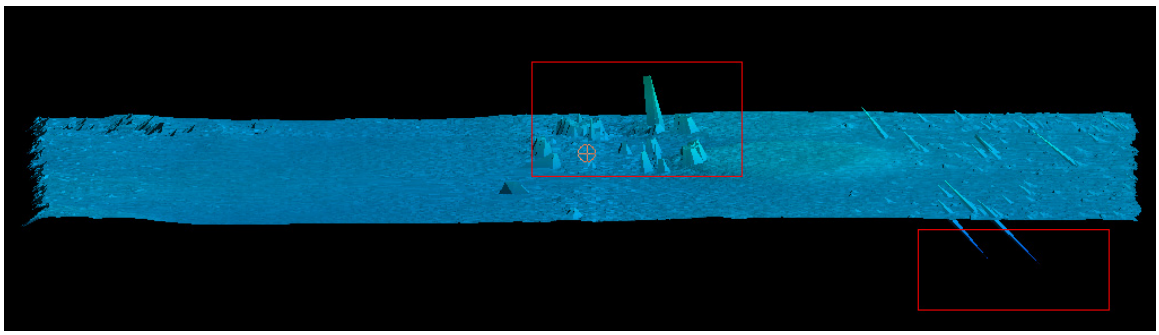


- **Data Editing:** There are a lot of spikes in the data, both large and small. The large spikes can be explained by aeration or schools of fish, and are easy to remove.

  The small spikes (outlined in red below) are of unknown origin and do not represent any seafloor feature. If one is editing carefully, with an eye toward ship strikes and accurate volume computations, they are difficult and time consuming to remove. (If one is interested in a median mapping surface, the editor or HYPACK® CUBE can easily remove them. However, that is not typically the USACE mission.)

  I think it's important to clean up the raw data. Perhaps a follow up with R2Sonic. Spending so much time editing negates some nice features of the sonar.

FIGURE 6.



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- **Imagery Testing:** The final testing was to find if we could locate some mounds seen in bathymetry with R2Sonic snippets. Thinking that the mounds are composed of a different material than the surrounding harbor floor.

  Result: The mounds were not detectable in the imagery unless one knew exactly where to look. Perhaps there was no difference in composition. HYPACK® processing of R2Sonic snippets is new, and there might be some improvements to make there.

FIGURE 7.