TPE CALCULATOR

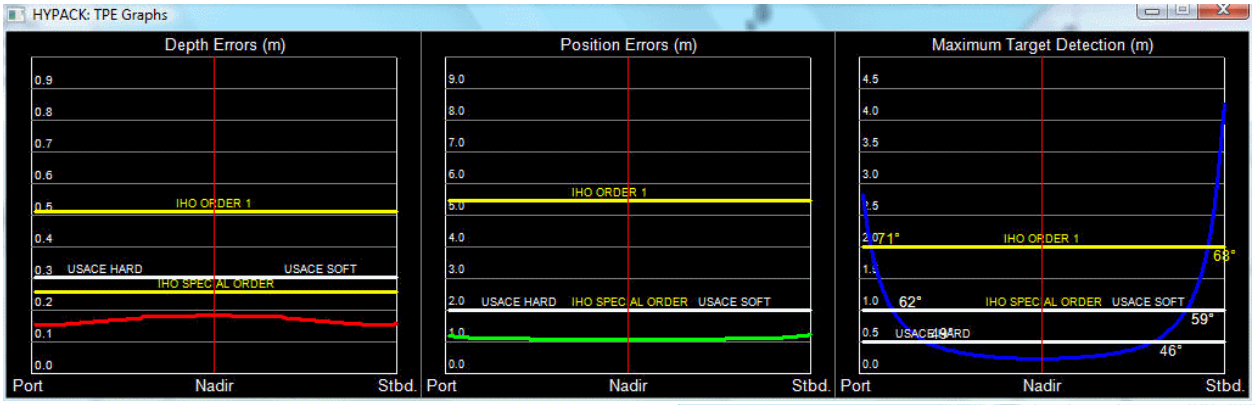
By Pat Sanders

Total Propagated Error (TPE) provides hydrographers with important details about the expected performance of their multibeam system. Agencies such as the IHO and the USACE have published standards for your multibeam survey, based on the estimated 95% confidence levels of horizontal and depth accuracy. Several people have worked hard to quantify the total error. When I started fumbling around with TPE, I was fortunate to receive assistance from Rob Hare of the Canadian Hydrographic Service. Rob had written several papers on TPE and was very supportive in helping us by providing algorithms and examples.

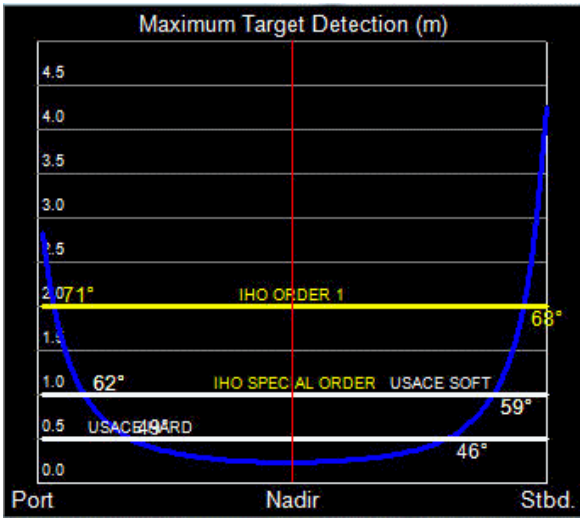
Dave Maddock of HYPACK and I worked to build the TPE algorithms into HYSWEEP SURVEY. In the HYPACK 2008 release, we can provide a real-time display of the Depth Error, Position Error and Maximum Target Detection Size versus Beam Angle.

Over the Christmas break, things were pretty quiet at HYPACK and I decided to dust off my old programming skills and see if I could write a TPE CALCULATOR that could be used as a planning tool and help our users learn how different factors affect the TPE calculations.

TPE Graphs



Based on your system parameters, the program graphically displays the computed Depth Errors, Position Errors and Maximum Target Detection size for each beam. In the window to the right, we are looking at the maximum target detection size.



The blue line shows the computed maximum target detection size. The IHO requirements (IHO Order 1 and IHO Special Order) are drawn in yellow and the USACE Hard Bottom and Soft Bottom are drawn in white. (In this example, the USACE soft bottom has the same value as the IHO Special Order and the

white line draws on top of the yellow line.) You can turn the IHO and USACE requirement lines on and off.

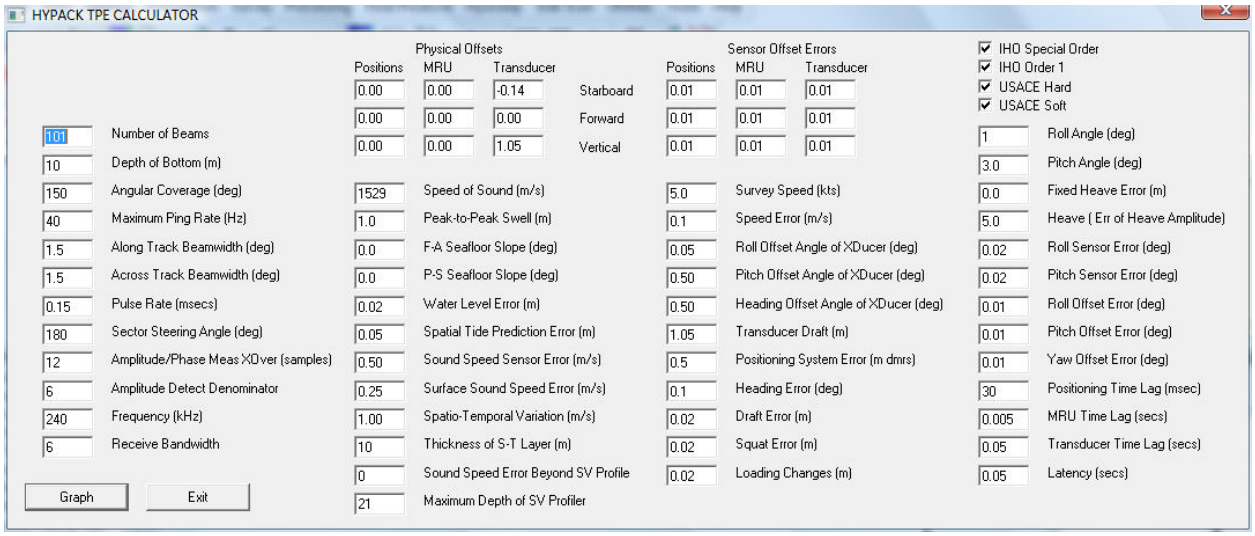
The port calculation does not equal the starboard calculations because you can enter the anticipated roll. In this case, I specified a roll of 3 degrees. (The port side rolls 3 degrees towards nadir.) For the USACE soft bottom, the Maximum Target Detection requirements are met out to 62 degrees from nadir on the port side and out to 59 degrees from nadir on the starboard side. Based on this information, in order to meet the USACE soft bottom requirement, I would limit my multibeam survey beams and only use beams less than 59 degrees.

If I was trying to meet the USACE hard bottom requirements, I could only use beams out to 46 degrees.

Note: In the current implementation of the TPE CALCULATOR, all input parameters and resulting error graphs are based on metric values. Maybe I'll allow you to input metric or foot values in a future version.

TPE Parameters

What is most interesting to me about the new TPE CALCULATOR is that it allows you to visualize how the estimated errors change as you change the parameters.



The parameters used are entered in the large form shown above. Up in the top right, yo can select which survey requirements (IHO or USACE) you would like graphed. Some of the more interesting parameters are as follows:

- **Depth of Bottom:**
  An average depth value used in the computation.
- **Water Level Error:**
  How accurately can you measure the tide?
- **Maximum Depth of SV Profile:**
  There are errors involved by surveying deeper than your SV profile.

- **Sound Speed Error Beneath SV Profile:**
  How accurate is your estimated SV versus the actual SV when you can't measure it?
- **Roll, Pitch & Heading Error of XDucer:**
  How accurate is your patch test?
- **Positioning System Error (dmrs):**
  DGPS or RTK? You'll be surprised how it changes your results.

As a Christmas present to HYPACK users (and non-HYPACK users), we are making this little program available free of charge. It does not require a HYPACK dongle. You may download a zipped file of the executable by clicking on the following link:

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