Delta Bathymetry Mapping With Four Beam ADCPs:

Tradeoffs, Tools, and Techniques

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Why Map Bathymetry?

• Navigation
• Pre or post dredge assessment
• Study fundamental processes
  – Bed-form mapping
  – Sediment transport
• Generate model inputs
• Predeployment reconnaissance
Bathymetry Needs
Model Inputs; Garbage in, garbage out!

Potential users of improved bathymetry:
• Si3D
• RMA
• DSM2-CSDP
• REALM
• TRIM3D
• Contracted projects, e.g., Hydroqual

What does this list imply?

Huge variability in data requirements!

– Inputs range from DEMs to sparse cross sections
– Model runs range in scale from $O(10^2)m$ to $O(10^5)m$!
The Key Question:
What defines a good bathymetry survey?

- Accuracy of data points
  - Depth, position
- Density of data points
  - Multibeam standard?

balanced against...

- Survey Speed
  - Cost/Unit Area
- Survey Turnaround Time
The Optimal Survey

An engineering geek might define a Survey Number (SN):

\[ SN = \frac{m}{n} \]

- \( m \) = amount of data collected
- \( n \) = minimum amount of data needed for the target model(s) to capture driving physics

- \( SN << 1 \) = bad model runs
- \( SN >> 1 \) = wasted time/money
In pursuit of $\text{SN}=1$

Some observations:

- The survey process can be optimized!
- $n$ depends on model run requirements, and bathymetry (but we haven't measured this yet)
- For most cases, 100% insonification is a waste
  - Irregular grid size is good
  - Interpolation will happen
How do we optimize bathymetry collection?

This requires…
  • Rapid turnaround between acquisition and survey processing/assessment
  • Automatic data filtering
    – Scan by scan doesn’t cut it!
    – Multi beam standard?
  • Ability to navigate to pre-selected areas

Iterative data acquisition process
1. Rough primary survey (30%-50%)
   • Analyze to find areas of interest
2. Focused secondary survey (40%-60%)
   • Survey areas of interest (red boxes)
   • Reprocess and assess data
3. Quick tertiary survey to fill in last gaps (0%-10%)
BathMapper
Developed to optimize iterative acquisition

Basics of the BathMapper system
• RDI ADCP provides depth and geometry data
  – Four independent depth measurements (40 deg square)
• Trimble Ag GPS provides position
• Matlab and LabView software for control and processing
  – Software timed acquisition
  – Real time navigation and ping processing
  – On-the-boat DEM generation
BathMapper Software
Multithreading for software timed acquisition

• Each major process has its own thread and priority
  1. Instrument control
  2. Data processing / filtering
  3. Data storage
  4. Data visualization and navigation display

• Software timed acquisition
  – Data acquisition is timed by software calls (User sets data rate <5Hz)
  – More accurate synchronization of position and ping data

• Real-time filtering, navigation, and ping feedback
  – Real-time processing occurs during acquisition down time
BathMapper Software
Rapid DEM generation and evaluation

• Automated DEM generation (1-5 minutes)
  – Assigns survey data to regular grid points
  – Determines wet and dry grid points
  – Interpolates to the empty wet grid points

• DEM evaluation
  – Distance from real data (m)
  – 2D Gradient (m/m)
  – Grad*Dist metric (m)

• Select and mark points for further acquisition

Change is important!
15m-17m from good data

Grad*Dist of 2-3m

Gradient of 0.3-0.4 m/m
In the end…
(Lessons learned from BathMapper development)

• Ultimately, bathymetry collection is a means to an end (Accurate model runs, optimal instrument placement, etc.)
• No matter what tools you use, bathymetry acquisition can be optimized!
• An iterative acquisition approach is useful
• Consider the data interpolation when driving your boat!
• Use meaningful specifications for data acquisition (outcome based!)