Ship Simulation and its Application to Port and Channel Design

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Example
Use of Vessel Handling Simulations

Training - Cadets – Basic Rules of the Road
- Mates to Master / Pilots / Tug Masters
  - Vessel Handling
    - Generic
    - Port Specific
  - Bridge / Crew / Team Resource Management (Interactions)
Use of Vessel Handling Simulations

Engineering
- Port and Channel Design
- Risk Assessment/Navigational Safety
- Down Time Prediction
- Larger Vessels in Existing Facilities
- Proof of Concept

Provide platform for consensus
Types of Vessel Handling Simulations

- Fast Time
- 2D
- 3D
- Part Task
- Full Bridge
What Does a Ship Simulator Do?

- Current
- Wind
- Seastate Tide
- Anchor
- Tug
- Propeller
- Rudder
- Own ship
- Engine
- Control - Revs - Pitch
- Bow thruster
- Mooring Pier Dolphin
- Shallow water
- Bank effects Channel
- Passing effect

Result:
- course
- speeds
- rolling
- pitching
- yawing
Requirements for Simulation

- Ship Model
- Environment Model
- Operator
- Pilot/Master Mariner
- Port Engineer/Designer
- Harbour Master, other stakeholders
Ship Model

- 6 DOF – Surge, Sway, Heave, Pitch, Roll, Yaw

- Based on real ships – engine power, rudder size, sea trial data, towing tank tests

- Pilot/master expectations – issues with conditions being modelled compared to real life

- Should be developed by experienced Naval Architects rather than generic modelling packages
- Need accurate data on LOA, Beam, Draft.
- Simple descriptions such as Handysize, Handymax, Panamax, Capesize are not enough
- FORCE have database of over 500 ships, but still frequently don’t have exact model
- Effect of incorrect draft – change in windage, underwater area, mass, bank and squat effects
Environment Model

Simulation results are only as good as the data you put in!!!

- Discuss with local pilots first
  - If site has strong currents – get good data then hydrodynamic model

- If site has wave issues – get good data then hydrodynamic model
Environment Model - Layers

- Should always have existing as base.
- Bathymetry, banks
- Currents
- Waves
- Land
- Fenders
- Aids to Navigation
Environment Model - Depth


- Design – Declared or actual depths?
- Overdredging, siltation allowance, channel profile all increase UKC
- Safety requires using most conservative (declared)
- Vessel handling significantly different than actual

![Figure 5.8 - Turning Radius as a Function of Rudder Angle and Water Depth](Based on Single Screw/Single Rudder Container Ship)
Operator/Engineer

- Manages process, what runs are done when
- Starts/stops runs
- Handles engine/rudder/tug/anchor orders
- Modifies environment as required
- Modifies ship only if actual data available
- Understands issues being investigated – not just an IT specialist or administration person
- Conducts debriefing and “manages” human factors
Pilot / Master Mariner

- Issues actual commands
- “Panel of Experts” – PIANC 1996
- Preferably have local experience at the site
- Needs to become familiar with simulator
- Don’t normally do high frequency, high difficulty manoeuvres – fatigue management
- Don’t like to fail – set guidelines for acceptance
- Opportunity to explain issues to non-mariners
Port Engineer/Designer

- Observe where issues are and provide immediate feedback on any proposed modifications
- Gain better understanding of what pilots do, and why in other meetings they ask for certain allowances
- Great opportunity to explain constraints of site with respect to port design eg rocky areas, historic sites, possible wave/current effects
Harbour Master and other Stakeholders

- HM – graphically show issues to shore based workers
- Observe “real life” pilotage – better understanding of actual process
- “Feel” stress in difficult areas – full rudder, large engine orders, full tugs and still heading to danger
Process - Familiarisation

- Explain design / simulator / process
- Initial familiarisation with simulator - existing port and ship combination, “typical” conditions
- Familiarisation with design - existing ship, “typical” conditions
- Familiarisation with design ship - “typical” conditions
- Take as long as required
Process - Design

- Set failure criteria – close to physical limits of channel, running aground, excessive engine / rudder / tug orders, too high berthing velocity

- Increase environmental conditions – generally one at a time

- Conduct full debrief following each run

- Determine limits, if possible, repeat with at least one other pilot
Process - Debrief

- Allow all present to comment and discuss
- Ask questions based on PIANC guidelines
- Provide replay / time history plots
- Determine if modifications required to simulator, ship or environment

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PIANC 1996

**Figure 6.9 - Suggested Check List for Real time Simulation Exercises**
Process - Modifications

- If possible, modify simulator immediately
- Only modify design if engineer/designer agrees
- If small, may modify design immediately, note down and continue - expensive to keep everyone waiting.
- At end of day, simulator should make modifications
- If too large, may need to delay additional simulations, or concentrate on different areas
Process - Meetings

- End of day - Summarise results of day
  - Discuss findings and any modifications
  - At least pilots and engineer/designer
  - Determine tasks for tomorrow

- Whole Team - Summarise results and status
  - Allows major stakeholders input /review
Outputs – Time History Plots
Outputs – Ship Track Plots

- Run 1
- Arrival
- Ship 3018: 310 x 47 x 8.5m
- Tide: 2m CD Flood
- Wind: 6 Knot North Westerly
- Start Speed: 7 Knots
Outputs – Swept Path Plots
Outputs – Swept Path % Plots
Outputs – Text

- Reflect the comments of the pilots “Panel of Experts”
- Contain summary of inputs and rationales
- Contain table of each run, relevant inputs and result
- Contain all debriefing notes
- May contain discussion of findings
- Recommendations/Conclusions
- Tugs, ship handling, windage, currents, squat, banks

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Questions