The application of CFD at Heerema Marine Contractors

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Presented by: Harald Ottens
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Heerema Marine Contractors
(www.heerema.com)

- Marine Contractor in the offshore Oil and Gas Industry
- HMC transports, installs and removes all types of offshore facilities
- Focusing on complex projects, from conceptual design to completion
- Operating 3 of the 4 largest construction vessels in the world
- New vessel: DCV Aegir (2013)
CFD applications within HMC

- Current Affairs JIP
  - Current loads
  - VIM
- Suction pile lowering
  - Added mass
  - Damping coefficients
- H-851
  - Tow resistance /
    Shape optimization
  - Viscous damping
- Current Loads
  - SSCV
  - Aegir
- Thrust efficiency
Towing resistance: H-851 Modification
Current Applications – H-851 Modification

- Float-over Topsides installation in Woodside Australia
- Modification of H-851
Current Applications – H-851 Modification

- Mid-bow shape
  - Final shape concepts
  - CFD computations to determine which shape has lower resistance

- Results
  - More than 10% tow-resistance reduction
  - Another 3% tow-resistance reduction by applying wing-tanks
Lowering Dynamics – Deep water installation

- Resonance effects on dynamic behavior
  - Load fluctuations in hoisting wires
  - Overload in cranes
  - Slack in wires

- Maximum set-down velocity

3,000m
Morphing mesh used to include effect of bottom
Results - Morphing mesh, h/d = 0.40

Ca-cfd = 1.57 [-], Ca-mt = 1.49 [-]

B1-cfd = 0.043 [-], B2-cfd = 4.63 [-], B1-mt = 0.072 [-], B2-mt = 3.03 [-]
Added mass of ballast module
Validation of thruster efficiency using CFD with available model test data (@ MARIN, The Netherlands)

- Open water thruster
- Thruster-hull interaction with 8 active thrusters
Open water thruster – Force definitions

\( T_{\text{unit}} \): 6 component frame
\( T_{\text{prop}} \) & \( Q_{\text{prop}} \): on shaft
\( T_{\text{nozzle}} \): on support
Open water thruster - Moving Reference Frame

Disadvantage MRF: # Cells

Option: Momentum source
Loss of accurate thrust component using AMS

\[ T_{\text{nozzle AMS}} = 60\% \text{ of } T_{\text{nozzle MRF}} \]

During model tests all force components are measured.

MRF is used.
Thruster wake development below SSCV
Thrust efficiency, 4kn current

\[ C_{TH} = \frac{\sqrt{(F_{X,TH} - F_{X,CUR})^2 + (F_{Y,TH} - F_{Y,CUR})^2}}{\sum T_{OW}} \]
Validation on full scale: *Thialf*
Thialf – data sheet

- Largest Deepwater Construction Vessel
- Tandem lift capacity 14,200t (15,600 short tons)

- Dimensions:
  - Length overall 201.6m (661 ft)
  - Length of vessel 165.3m (542 ft)
  - Width 88.4m (290 ft)
  - Depth to workdeck 49.5m (162 ft)
  - Draught 11.8 – 31.6m (43 – 104 ft)

- Class III Dynamic Positioning System
  - 6 x 5,500 kW – 360 azimuth (Wärtsilä)

- More info: www.heerema.com
Test cases

- All thrusters azimuth 0°
- P1 & S1
- P2 & S2
- P3 & S3
- P1, P2, S1 & S2
- P1, P3, S1 & S3
- P2, P3, S2 & S3
Bar plots ratio's

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<thead>
<tr>
<th></th>
<th>P1 &amp; S1</th>
<th>P2 &amp; S2</th>
<th>P3 &amp; S3</th>
<th>P12 &amp; S12</th>
<th>P13 &amp; S13</th>
<th>P23 &amp; S23</th>
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<td>Case 4</td>
<td>Case 5</td>
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<td>Case 10</td>
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Same trends!
HMC has used CFD (STAR-CCM+) successfully for different subjects
- Towing resistance / current loads
- Added mass & Damping coefficients
- Thrust efficiency

Validation on model scale and on full scale!