Fuel Efficiency
through Trim Optimisation

Haydn Jones
Marketing Director
Fugro Satellite Positioning
Overview

- Company Introduction
- Marinestar Manoeuvring System
- Dynamic Trim Optimisation
- Case Study – 8000 TEU Container Ship Trial
- Conclusions
Fugro founded 1962.


head office Leidschendam Netherlands

total sales revenue Euro 2.5 billion 2011 (70% oil & gas sector)

Over 11,000 employees

Fugro Satellite Positioning provides Satellite Based Augmentation Services

Marinestar – High Performance Navigation Systems
Fugro’s people, vessels, equipment and facilities expand and develop to meet the demands of new challenges in new regions and provide continuous high quality service that **exceeds the expectations** of our customers.
“A combined receiver, when compared to either the GPS or GLONASS receiver, offers improved availability, integrity, accuracy and resistance to interference…….” - IMO Res. MSC 115 (73)
Fugro Satellite positioning in Norway supplies **ship owners** and **operators** with ‘Marinestar®,’ a high-tech satellite differential positioning solution to aid vessel positioning and berthing.
Marinestar Manoeuvring System

- DGNSS based high performance navigation system
- Combined GPS & GLONASS positioning
- Heading, Speed & Rate of Turn
- Docking System
- Dynamic trim for fuel savings
Marinestar MS- System Concept

Fig. 1

Rate Of Turn
Heading
FORE
AFT
Speed
Port
Starboard

Fig. 2

Stem antenna
Bow antenna

Rev. date: 1st, July 2008
Marinestar MS – Type Approved

Gyro compass alternative

Doppler log alternative
Marinestar MS aids berthing:

- More Quickly
- More Efficiently
- More Safely

Distances to quay displayed to approx. 0.1 m in real time.
Multi-Purpose Navigational Information

Multi-Function Displays Giving:

- Heading
- Rate of Turn
- Ground Speed Ahead
- Transverse Speeds
- Distance Run
- Distance to Quay

Full NMEA Interconnection
Navigation capabilities well proven

Neste Shipping

- “Reliable and accurate position information”
- “Redundancy of satellite navigation”
  - GLONASS as a back-up for GPS
- “Accurate heading information regardless of course and speed alterations”
- “Accurate docking information”
Dynamic Trim Measurement

- Trim Management is a simple tool for bunker fuel optimisation
- Marinestar system measures the trim of the vessel throughout the voyage
- A basis for fuel optimisation
- Fuel savings 2-5% annually
Fuel is the largest cost for most shipping companies.

Typical cost picture for tank and bulk

Bunker Prices
380 cst fuel

Source: Reuters

www.fugro.com
### IMO Mandated Efficiency Measures

<table>
<thead>
<tr>
<th>No.</th>
<th>Energy Efficiency Measure</th>
<th>Remark</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Engine tuning and monitoring</td>
<td>Engine operational performance and condition optimisation.</td>
</tr>
<tr>
<td>2</td>
<td>Hull condition</td>
<td>Hull operational fouling and damage avoidance.</td>
</tr>
<tr>
<td>3</td>
<td>Propeller condition</td>
<td>Propeller operational fouling and damage avoidance.</td>
</tr>
<tr>
<td>4</td>
<td>Reduced auxiliary power</td>
<td>Reducing the electrical load via machinery operation and power management.</td>
</tr>
<tr>
<td>5</td>
<td>Speed reduction (operation)</td>
<td>Operational slow steaming.</td>
</tr>
<tr>
<td>6</td>
<td>Trim/draft</td>
<td>Trim and draft monitoring and optimisation.</td>
</tr>
<tr>
<td>7</td>
<td>Voyage execution</td>
<td>Reducing port times, waiting times, etc. and increasing the passage time, just in time arrival.</td>
</tr>
<tr>
<td>8</td>
<td>Weather routing</td>
<td>Use of weather routing services to avoid rough seas and head currents, to optimize voyage efficiency.</td>
</tr>
<tr>
<td>9</td>
<td>Advanced hull coating</td>
<td>Re-paint using advanced paints.</td>
</tr>
<tr>
<td>10</td>
<td>Propeller upgrade and aft body flow devices</td>
<td>Propeller and after-body retrofit for optimisation. Also, addition of flow improving devices (e.g., duct and fins).</td>
</tr>
</tbody>
</table>

**Table 3 – SEEMP related measures**
How Trim Optimization may help save fuel?

- The hull resistance is influenced by the trim of the vessel.
- The viscous resistance component is linked to the wetted hull surface, which will differ as the vessel changes trim.
- The wave making resistance component is linked to the wave pattern. Waves carry energy, i.e., more waves implies more fuel spent.

Optimal Trim is vessel specific and depends on vessel speed and draught.
Trim and draft optimisation studies
Marinestar Trim Display

Trim at the bow: + 0.34 m
What gets measured, gets done

Energy efficiency requires measuring and analysis

To achieve Trim Optimisation

• Know the optimum trim
• Measure the actual trim
• Flexibility to adjust trim at sea
CASE STUDY

Trim Optimisation trial on 8000 TEU Container Vessel
8000 TEU Container Vessel Trial

- 8000 TEU Cellular Container Vessel
- Marinestar MS installed in early March 2012
- Main interest in Fuel Savings with Dynamic Trim
- Optimum trim studies by DNV
Potential Savings

Potential saving with trim optimisation

Potential Saving [%]

### Savings potential with trim optimisation

<table>
<thead>
<tr>
<th>Analysis Period</th>
<th>Energy loss due to non-optimal trim</th>
<th>Potential HFO savings MT/ year</th>
<th>Potential savings USD/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>02 Aug 2011 to 07 June 2012</td>
<td>3.9%</td>
<td>625</td>
<td>$425,000</td>
</tr>
</tbody>
</table>
Post Marinestar Installation - Leg By Leg Evaluation

Hong Kong – Singapore (23rd June to 26th June 2012)

The operating conditions:
Speed : 16.1 kts to 21.6 kts
Trim : -0.63 m to -0.34 m
Draft: 12.97m

Average potential savings with optimum trim: 1.11%
Potential fuel savings: 3.16MT
Colombo – Suez Canal (01\textsuperscript{st} July – 8\textsuperscript{th} July 2012)

The operating conditions:
- Speed: 16 kts to 21.4 kts
- Trim: -0.99 m to +0.15 m
- Draft: 13.53m

Average potential savings with trim optimization: 1.32%
Potential fuel savings: 8.98MT
The operating conditions:
Speed : 16.3 kts to 22.6 kts
Trim : -1.45 m to +1.18 m
Draft: 13.36 m

Average potential savings with trim optimization: 2.35%
Potential fuel savings: 2.61MT
Conclusions

• Trials on Container vessel reveal a potential savings of 3.9% annually

• Trim Optimisation offers a simple but effective way to fuel savings

In order to achieve Trim Optimisation

Know the optimum trim

Measure the actual trim

Flexibility to adjust trim at sea
Keep trim

Dynamic fore and aft trim measurement by Marinestar can lead to more economical use of bunker fuel.