Energy Efficiency through Innovation in Cruise Ship Design & Operations

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Royal Caribbean Cruises Ltd.

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Eniram

Helsinki
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Evolution and Success of the Cruise Industry

- Global Mature Industry Today
  - Song of Norway 1970 - 18,000 GRT
  - Today 300+ cruise ships, 19M GRT
  - 23 million guests annually
  - Average newbuilding size - 180K GRT
  - 40+ ships currently on order

- What the cruise industry delivers that no other can
  - High guest satisfaction
  - Value for money
  - Convenience
  - Innovative product
  - Broad itineraries and destinations
  - Experience you can’t get on land
Royal Caribbean Cruises Ltd.

- Second Largest Cruise Company
- 44 ships - 102,000 guests - 60,000 employees
- 11 Newbuilds
- Extensive AEP / Scrubber Retrofit Program
- Extensive Revitalization Program
- Global operation - 480 Destinations
- Six Strong Brands
Culture of Innovation and Safety

Fleet Evolution

Quantum of the Seas
4,180 D.O. / 167,800 GRT
2014

Oasis of the Seas
5,400 D.O. / 225,282 GRT
2009

Freedom of the Seas
3,600 D.O. / 154,407 GRT
2006

Radiance of the Seas
2,100 D.O. / 90,090 GRT
2001

Voyager of the Seas
3,100 D.O. / 137,276 GRT
1999

Legend of the Seas
1,800 D.O. / 69,130 GRT
1995

Sovereign of the Seas
2,300 D.O. / 73,192 GRT
1987

Song of America
1,400 D.O. / 37,584 GRT
1982

Song of Norway
700 D.O. / 18,000 GRT
1970
Innovation and Continuous Improvement
Imbedded in our DNA

- Never-ending quest to provide the best vacation to our guests
- Based on consumer demands and feedback
- Economies of scale provide cost advantages and opportunities
- Building upon our innovative mind-set with a strong focus on:
  - Safety
  - Guest Experience
  - Environment
  - Energy efficiency
  - Lifecycle

*There is no silver bullet; it’s all about culture and process*
Environment

- Consistent emphasis on advancing environmental solutions with suppliers
- Technical qualification & fit for purpose integral part of development
  - Industry leader on Advanced Wastewater Purification (All waste treated in AWP)
  - Proactive working on Advanced Emission Purification (AEP) – SOx
  - Ballast Water Treatment
  - 19 ship AEP program with 42 units being installed
  - Selective Catalytic Reduction (SCR) – Nox
  - Waste Oil and oily Sludge collected in tanks and landed to be treated onshore
  - Introduced Save the Waves program in 1992
  - Sustainable design and selection of materials

*Engineer workable solutions that are heading toward acceptable emissions*
Energy Efficiency

A central focus for each new class of ships with ambitious goals to reduce environmental impact

- Set a goal in early 2000 to improve fuel efficiency
- Every class is 20-25% more efficient than predecessors
- 3-5% improvement for existing vessels every year
- Well structured and focused process with hundreds of initiatives

Reduce consumption and emissions by burning less fuel
Energy Efficiency  Air Lubrication System

Continues to improve savings since introduction on Celebrity Reflection and has become standard on most newbuilds

- One fourth implementation showed savings 1-3%
- Full scale deliveries on current newbuilds expected to reach savings in range of 3% to 7%
- Air bubble layer will reduce propeller induced noise
- Further development of propeller design can potentially lead to 10% savings
- Retrofitting full or partial ALS is also planned for the existing fleet
Overcoming Complexities  Our Approach

- Strong in-house design and project management capability
- Partner and review with industry leaders, designers and consultants
- Rigorous risk assessment process, risk centrality
- Utilization of state of the art technical and design technology
- Continuous improvement and feedback loop

...one team, one goal, one vision...
Future Trends in Cruise Ship Design & Operations

- Average cruise ship size will grow, maximum size stable
- Novelty in architectural design solutions (open spaces, atriums, indoor-outdoor areas)
- Strong focus on safety and the environment
  - Holistic risk-based approach and lifecycle (design, operation, emergencies)
  - Advanced emission purification systems
  - Improved efficiencies with focus on alternative fuels
- Technology an integral part of design and ship features
What has Enabled us to Achieve This?

- Innovation sown into corporate values
- Competence and knowledge - People!
- Partnerships and collaboration
- Investing in research and its outcomes
- Elevate knowledge with computing capability and tools
- Develop/implement ahead of legislation
- Opportunity always there, journey still underway

**SAFETY – ENVIRONMENT – ENERGY – LIFECYCLE**
ENIRAM at Royal Caribbean Cruises Ltd. Today

With Royal

Team of 12

36

210M per day

$16M per year

75

275

1B+ per day

$60M per year
DATA
ONBOARD:
- SENSORS
- SYSTEMS

ONSHORE:
- FORECASTS
- KNOWLEDGE BASES

INSIGHT
STATISTICAL MODELLING
MACHINE LEARNING
SIMULATION
PREDICTION
OPTIMIZATION
DATA ENRICHMENT

ACTIONS
OPTIMIZED:
- TRIM
- HULL FOULING
- SPEED & ENGINE
- ROUTE
- OPERATIONS

Gather accurate real time data
Gain insight with advanced modelling and analytics
Provide guidance to improve performance
# Savings Case on Royal Caribbean Cruises Ltd.

<table>
<thead>
<tr>
<th>ELEMENT</th>
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<th>SAVINGS TO DATE</th>
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<td>Route optimization</td>
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<tr>
<td>Operations</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>4 %</strong></td>
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<td>USD 16 M per year</td>
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<td><strong>Additional 10 %</strong></td>
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<td>USD 16 M per year</td>
<td>USD 40 M per year</td>
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Thank You