Subsea Technology Outlook to 2030 and the Role of Industry Technology Development in Getting There

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Agenda

1. Before looking forward....
2. Technology Challenges
3. Technology Wins
4. Where are we going by 2030?
5. What we’ve learned
Before Looking Forward

- To understand what's achievable by 2030 – 17 years ahead...
- There's value in understanding what we've achieved in the last 17....

....so let's go back to 1996.
Remember 1996?

- **Kofi Annan** is elected to be the United Nations secretary-general
- **Mad Cow Disease** hits Britain
- **Braveheart** wins the Best Picture Oscar
- **Nintendo 64** is released
- **Sea Empress** runs aground in Wales, spilling 70,000t of crude oil
1996-2013

How Far Have We Come?
Before Looking Forward

And in Offshore Engineering.......
# Technology Challenges (1996)

(Ref: SPE Forum)

<table>
<thead>
<tr>
<th>Top 10</th>
<th>Size of Gap</th>
<th>Complexity to Close</th>
<th>Success 1996-2013?</th>
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<tbody>
<tr>
<td>1. HPHT</td>
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<td>Evolution</td>
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<td>2. Subsea Power Gen &amp; Distribution</td>
<td>M</td>
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<td>Evolution</td>
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<td>3. Ultra-deepwater Riser Solutions</td>
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<td>H</td>
<td>Evolution</td>
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<td>4. Subsea Fiscal Metering</td>
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<td>Evolution</td>
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<td>5. Lower Cost Subsea Well Intervention</td>
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<td>M</td>
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<td>6. Cold Flow</td>
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<td>H</td>
<td>Revolution</td>
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<tr>
<td>7. Dual-gradient Drilling</td>
<td>M</td>
<td>L</td>
<td>Evolution</td>
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<td>8. Advanced Materials</td>
<td>M</td>
<td>M</td>
<td>Evolution</td>
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<tr>
<td>9. Artificial Lift</td>
<td>M</td>
<td>L</td>
<td>Evolution</td>
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Technology Wins (1996-2012)
Deepwater Floating Production

- First SCR at Shell Auger (1994)
- First Production Spar at Neptune (1996)
- First Hybrid Tower Risers at Girassol (2001)
- First Deepwater Risers to 8,000ft WD (2007)
- First FLNG Project Approved (2011)
Technology Wins (1996-2013)

FLNG

• **1994-1998: First FLNG JIP**

• A development planned 19 years ago
  - 1997: Mobil develop FLNG production concept
  - 2012: Shell begins construction of the Prelude FLNG project
  - Potential to meet 117% of Hong Kong’s annual natural gas demand.

• **The future….**
  - Larger, more complex LNG/LPG vessels
  - Smaller FLNGs using simpler LNG processes with minimal LPG production
Technology Wins (1996-2013)
Dual Gradient Drilling

- **1996-2001:** Subsea Mudlift Drilling (SMD) JIP
- 2001: Field trial conducted in GOM
- 2012: Pacific Santa Ana – world’s first drillship designed for DGD begins operations

**Future:**
- DGD deployment with:
  - continuous circulation, borehole strengthening, wired drillpipe, geo-steering
  - borehole imaging, casing drilling technologies
- Goals: safer drilling operations, more on-bottom time and fewer casing strings
Technology Wins (1996-2013)  
Flexible Pipe Technology

- **Key enablers for FPSO floating production:**
  - *Early technology development* and patent by French Institute of Petroleum (IFP)
  - *Commercialisation* by Coflexip
  - *Industry acceptance*, fuelled by JIP that published 1st Industry Standards & design rules

- **Flexible Pipe Spec JIP (1994-96)**
  - Over 20 participant operators, regulators, contractors and manufacturers
  - JIP Deliverables:
Technology Wins (1996-2013)

HPHT

- Subsea HIPPS
- Production to >15ksi
- R&D Programs Continue
  - Deep Oil 20ksi / 350 ºF
  - Deep Gas 30 ksi /350-450 ºF

Source: Mokveld
So what about the Future?
Outlook – Supply & Demand

Supply Side:
• “Oil and Gas UK estimate that between 15-24 billion barrels of oil and gas equivalent could still be recovered from the UKCS as a whole”
  – *Oil and Gas Analytical Bulletin – Scottish Government, March 2013*

Demand Side:
• “By 2030, global energy demand will be almost 35 percent higher than in 2005….. Non-OECD energy demand rises by more than 60 percent……… demand for natural gas will be more than 55 percent higher than in 2005.”
  – *The Outlook for Energy through 2030 – ExxonMobil, 2009*
Where are we going by 2030?

Subsea Technology

• **Compression / Pumping:**
  – Wet Gas Compression (operating on well fluids)
  – Subsea Gas Compression (marinized dry gas comp, separation first)

• **All Electric**
  – Electric Trees / Subsea Processing
  – Long Distance Power Cables
  – Downhole safety valves (Technology Gap to fill?)

• **Power**
  – Long Distance DC Power Transmission
  – Local Power Generation – revolution, but big challenge

• **Field of the Future**
  – “Subsea Factory under Ice” (Ref. Statoil)
  – Separation, pumping, power, storage?

• **Condition Monitoring……and Reliability.**
  – Intelligent subsea systems
## Arctic Technology Challenges …
### Future Technologies Impacting Arctic Operations


<table>
<thead>
<tr>
<th>Technology Challenge</th>
<th>Time Frame</th>
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<tr>
<td>1. Arctic to beach technology</td>
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<tr>
<td>2. High Definition 3D Seismic</td>
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<tr>
<td>3. Increased amount of drilling accomplished in narrow weather window</td>
<td>L</td>
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<tr>
<td>4. Digital processing revolution, modelling capacity</td>
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<td>5. Drill cutting disposal, grind and inject thermal absorption or other</td>
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<td>6. ESP evolution – extended run lives</td>
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<tr>
<td>7. High gas volume fraction multiphase pumping</td>
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<tr>
<td>8. HP gas transmission in arctic conditions</td>
<td>M</td>
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<tr>
<td>9. Improved underwater leak detection</td>
<td>M</td>
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<tr>
<td>10. Increased communication capacity</td>
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<tr>
<td>11. Longer distance MP flow + reliable modelling, incl. hydrates and freezing</td>
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<td>13. Lower cost of subsea pipeline construction &amp; protection in ice-scour areas</td>
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Where are we going by 2030?
Field of the Future

- **Digital evolution**
  - Higher bandwidth coms. – fibre optics
  - Increased processing power

- **Applications**
  - Subsea Reservoir Monitoring (4D Seismic)
  - Subsea Integrity & Condition Monitoring
  - Subsea Production Optimisation
  - Trend Analysis
  - Virtual Metering
Where are we going by 2030?
IM & Monitoring

- Much more information available and required from monitoring programs, given subsea infrastructure investment
- Significant evolution of Leak Detection and other inspection / monitoring technologies, especially real-time monitoring
- Alternatives to Inline Inspection
  - Especially for dead legs
- Better at avoiding unplanned events
  - Avoiding costly downtime
Where are we going by 2030? Iceberg Scour

• Key Questions

1. With What?

2. How Deep?

....Renewed industry focus can produce step-change from where we are.

(Source SMD Hydrovision, 2007)

(Source Rocksaw, 2004)
Where are we going by 2030?
Environmental Protection & Oil Spill Response

• Focus on
  ➢ Oil-spill preparedness
  ➢ Intervention - capping stack and related hardware
  ➢ Ability to intervene in any season
  ➢ Multiple initiatives for GoM, N Sea, Worldwide
Where are we going by 2030?
Some Gains.....

Source: Statoil
JIPs
An Enabler to Future Industry Developments

Delivering value to multiple clients through Joint Industry Projects...

Technology Development is the driving force behind the solutions that Wood Group Kenny provides to the energy sector. We have a long association with technology development and JIPs, playing a key role in investigating new technologies, developing new capabilities and software tools, and introducing best practice through new Industry standards and guidelines.

- Flexible Pipe Technology (FPT) JIP
  - Developing solutions to API Spec 17J and API RP17B, the industry specification and IP for Unbonded Flexible Pipes. A project led by Wood Group Kenny and supported by Tornado Pipeline, including operators, manufacturers, and regulators.

- Integrated Design, Risers & Risers & Mooring JIP
  - Led by Wood Group Kenny and supported by Vessels. Developed a framework for the design and condition management of flexible pipes.

- Flexible Pipe Integrity Management JIP
  - Led by Wood Group Kenny and supported by Wintershall. Developed a framework for the design and condition management of flexible pipe.

- API 19D
  - A joint industry initiative to update the API 19D standards.

- Pipeline Design & Installation
  - Wood Group Kenny

- Integrity Management
  - Wood Group Kenny

- Integrity Management
  - Wood Group Kenny

- SCRAM
  - Streamlined Riser and Manifold Assessment Methodology

- Pipeline Design & Installation
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- Integrity Management
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- SCRAM
  - Streamlined Riser and Manifold Assessment Methodology
What have we learned from the past?

- Industry breakthroughs from new technology are usually planned many years in advance.

- More *Evolution* than *Revolution* – incremental development and adoption is more common than step-change.

- *Evolution* is characterised by incremental technology development, often over several years.

- *Revolution*, even when it occurs, typically results from
  - Step-changes, often resulting from a combination of more than one technology development (e.g., Shale gas, unlocked by combination of hydraulic fracturing and horizontal drilling)
  - Unanticipated events (e.g., Macondo and industry initiatives in oil-spill preparedness)

- *Revolution* often comes from *Need* + *High Investment*
Summary

• Key Global Technology Themes:
  – Safety, Environment,
  – Increased Recovery (IOR/EOR)
  – Remote developments, Subsea Processing, Power, Pumping
  – FLNG evolution
  – Reservoir Characterisation
  – Lower Cost Drilling,
  – Field of the Future, Integrity & Condition Monitoring

• Collaborative development and JIPs will continue to play a valuable role in technology development

• 2030 is more visible than you think.
Thank You

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