Looking Above the Water:
Rapid Delivery of Subsea Intervention Technologies

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Rapid Delivery of Subsea Technologies

• How do we deliver faster and more reliably?
  – Process Driven Product Design
    • Understand the Problem
      Decompose and solve sub problems
    • Search Internally
      Does it already exist for subsea?
    • Search Externally
      Does it exist in another industry?
  • Explore and Reflect on the solutions

• Case Study: ROV Installable Ultrasonic Gas Flowmeter
Product to Market

Subsea Engineered Solutions
• <1-12 weeks to operating in field
• 1’s to 10’s of units
• Specialists in subsea, generalists otherwise
• Customers bring needs to you
• Testing conducted to the specific instance, analysis and conservatism for fatigue and cycling.
• Small group of users

Traditional Markets
• 2-5 years to market
• 1000’s to 1,000,000’s of units
• Many Specialized Roles such as injection molding experts
• Have to search for Unmet Customer Needs
• Long and expensive testing and development cycles depending on industry
• Broad group of users
Benefit of looking at Analogous Fields

Why does size matter?

- Able to specialize in specific areas
- Larger Development Budgets
- Longer timeline for product development
- Competitive landscape where enhancements provide differentiation
- Product Lifecycle Management
- Economies of Scale
  - Engineering is diluted across millions of products
  - Spare parts are more readily available
  - More efficient manufacturing processes used for bulk manufacture
- All of these contribute to a cheaper, more reliable product.
How to look at analogous fields

- Talk to suppliers with cross-industry coverage
- Trips to Bunnings
- Google! (especially image search)
- Pyramid Search
- Talk in a common language
Importance of Problem Decomposition

Why decompose problems?

- It’s easier to find solutions to individual sub problems that can later be combined into the final concept
- Enables engineer to search other industries
- Allows communication in a common language with other experts
- Allows stakeholders to digest and/or implement “radical ideas”
**Case Study: ROV installable Ultrasonic Gas Flowmeter**

**Understand the Problem**

- Non-intrusively measure gas injection rate to an individual well while adjusting the choke to optimize Sealtite injection during an ROV campaign
- Flowmeter should not damage pipeline
- Production System barrier cannot be breached
- Measurement within 50,000 scfd on between 250,000 to 1,000,000 scfd
- Line size – 101.6mm dia x 6.4 WT with 3LPP coating external (5mm WT )

- **Critical Sub-Problem:** Measurement Sensor
Case Study: ROV installable Ultrasonic Gas Flowmeter

Search Internally

- Review of engineering vaults found topside installed flowmeters and flow loops for measuring directly but no ultrasonic flowmeters
- Oceaneering has experience in ROV subsea ultrasonic testing of wall thickness and corrosion mapping and know that transducers can work up to a depth well beyond this requirement.
- Identified internal expertise in UT and PAUT NDT, electronics, and ROV communications

Search Externally

- Searched for manufacturers and vendors for ultrasonic flowmeters. Ultrasonic flowmeters extensively used topside but not subsea
- Found Flexim Clamp-On Flowmeters distributed by Aquip who understood needs of Oil and Gas and their product in detail.
- Consulted with Aquip and Flexim Engineering on failure modes, efficacy through coatings, general design of equipment, density of pipe contents
- Gathered information on ultrasonic measurement principle to better understand how it works
## Case Study: ROV installable Ultrasonic Gas Flowmeter

Explore Systematically

<table>
<thead>
<tr>
<th>Attach Sensor</th>
<th>Position Sensors against pipe</th>
<th>Measure Flow</th>
<th>Communicate back to Surface</th>
</tr>
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<tbody>
<tr>
<td>• Clamp</td>
<td>• Spring</td>
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<td>• RS232</td>
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<td>• Clip-On</td>
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Case Study: ROV installable Ultrasonic Gas Flowmeter

Reflect on the Process

- Are we confident we have full explored the solution space?
- What risks are there technically and commercially?
  - Sensor is confirmed to have a hard failure in the sense that it will not communicate a flowrate unless it is properly setup and transducers talking properly (soft failure being that it communicated bad data and we didn't know)
  - Flexim have reviewed the parameters and specified a system that would normally work for this. The flowrates/temp/pressure are not extreme cases and have sufficient density for good measurement.
  - UT transducers are 0.5 MHz shear wave probes set at an angle
  - UT transducers are set up similar to TOFD (used successfully on Oceaneering Neptune and Trident systems)
  - Vendor (Aquip) will have an engineer/technician experienced with Flexim UT Gas flowmeters offshore with the system to ensure setup is correct and operate it
Case Study: ROV installable Ultrasonic Gas Flowmeter

Early Concept

- ROV handle to operate locking clamp, can supply D or T handle
- Toggle clamping mechanism
- Spring loaded carrier for dual UT sensors, prevents damage during install
- Aluminium lightweight construction for deployment in manipulators
- Adjustable probe spacing, set on deck

Final Product
Case Study: ROV installable Ultrasonic Gas Flowmeter

Results

• Worked first time offshore
• Identified the choke wasn’t fully closed and could be closed two further steps
• Provided valuable data
• Tool was easy to use by ROV
• Great Collaboration between Aquip, Flexim, and Oceaneering
• Winner of Oceaneering Chairman’s’ New Product or Service Award
Conclusion

• Just because it’s not originally designed for subsea doesn’t mean it won’t work subsea

• Decomposition of Adjacent Technologies allows for rapid product development in the subsea industry for great reliability and fraction of the cost.
Connecting What’s Needed with What’s Next™