PPSA Seminar
Aberdeen 8th November 2017
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i2i Pipelines – the company

- Formed in 2015, links to Manchester University.
- Currently 20 employees, based at the Manchester Science Park & Houston, TX.
- Sensor Technology Company providing Big Data on pipelines via machine learning and digital IOT.
- Core Skills in providing fast solutions for non-disruptive inspection in complex pipelines.
About i2i

- **Our Vision:**
  
  "To simplify pipeline inspection so it becomes a low risk, low cost and regular non-disruptive activity, leading to enhanced integrity management that benefits from big data analytics and digital technologies"

- **Our Objectives:**

  - To build and deploy simple operational tools with smart sensors.
  - To make smart pigging a non-specialist activity, performed by the operator.
  - To develop machine learning for rapid data analysis and automated reporting.
  - To collect big data (including flow assurance and integrity) to allow predictive maintenance strategies.
Technology Gap

Cleaning pigs are run frequently but collect no data.
- Little disruption to Ops.
- Low cost.
- Low risk.

Intelligent Pigs are complex, disruptive and too expensive to be run frequently.
- More risk of getting stuck.
- Require specialist personnel.
- Inconvenience – gauging, cleaning & handling equipment.
- Operating windows, scheduling.

Result:
- Costs are high and inspection is infrequent.
- Less data to monitor or trend anomalies (ILI intervals can 5-15yrs).
- Sometimes no data on critical assets (small diameter or “unpiggable”).

Way Forward:
- Simple Smart tools.
- Combine the benefits of simple design with an inspection capability.
- Inspection without disruption.
- No specialist personnel.
The Inspection Technology

- Based on Electromagnetic Inspection technology:
  - PCBs have a generating coil and receivers.
  - Wired together into any size array.
  - Different sizes allow different levels of stand off.
  - Sensitive to internal defects only.
- Benefits:
  - Can operate at a large stand off and are not sensitive to lift off.
  - Can work in any medium including uncleaned pipe.
  - Less sensitive to speed variations.
  - Very sensitive to pits, internal metal loss and open circumferential cracking.
Case study 1 – a world first?

- **The Challenge:**
  - Inspect 2 x 10” pipelines, platform – FPSO.
  - 4.3Km and 2.5Km.
  - Multiphase.
  - >75°C.
  - WT: 12.7mm.
  - Pipe In Pipe.
  - Flexible riser.
  - Constant operational pig damage.
  - Receive in a pigging valve.

- **The Solution:**
  - SmartFoam™
Pigging history - Operational pig damage

Client routine pig prior to launch

Client routine pig at receive
Client operational pig damage

Client pig c/w impression on nose

Design of pig catcher in valve cavity
Tell-tale marks - showing pig tumbling?

Impression on SIDE of one client pig

Impression on REAR of separate client pig
Tell-tale marks - showing pig tumbling?
Pig design reviewed, suggestions made…

- Produce a dummy tool with a longer sealing length to mitigate tumbling.

- Less pointed nose.

- Ballast the pigs with weights to simulate the on board PV, then proceed to live run.

- Full review of receive process in pigging valve.

- Recommend trials, client offered use of their test loop…
Isometric of client test loop
Pig testing in client test loop

- In dry dock, Tianjin, China
- Multiple diameters
- Multi product
- 700m loop
- Bends / expansion loops / multi dia
- Ability to add wax
Defect spool in test rig for blind test

- Multiple internal defects to POF category
- Client QA’d
- Test conducted blind
- Included inspecting through wax
Test results – client defect spools

- Result: 97% POD
- L, D, W within spec.
- Design and capability APPROVED
Pilot dummy SmartFoam™ (line 1)
Pilot tool at receive (line 1) – tell tale marks on front

- Central hole
- Spider leg
SmartFoam™ overview

**SmartFoam™ Specifications**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Sensors</td>
<td>13</td>
</tr>
<tr>
<td>Sensor to Pipe Wall Stand Off</td>
<td>8mm</td>
</tr>
<tr>
<td>Maximum Sensor Stand Off</td>
<td>25mm</td>
</tr>
<tr>
<td>Minimum Detectable Anomaly</td>
<td>2.5mm - 25mm x 5mm (5/16th Diameter at Max)</td>
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<tr>
<td>Minimum Circumferential Sizing</td>
<td>5.46mm</td>
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<tr>
<td>Minimum Longitudinal Sizing</td>
<td>≤ 41mm</td>
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<tr>
<td>Scan Resolution</td>
<td>1.5mm at 2m/s</td>
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<tr>
<td>Max Run Time</td>
<td>6 HOURS</td>
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<tr>
<td>Additional Features</td>
<td></td>
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<tr>
<td>Pressure Sensor</td>
<td>No</td>
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<tr>
<td>Temperature Sensor</td>
<td>No</td>
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<tr>
<td>XYZ Mapping</td>
<td>Yes</td>
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<tr>
<td>Operating Ranges</td>
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<tr>
<td>Maximum Pressure</td>
<td>140 bar (2000 psi)</td>
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<tr>
<td>Maximum Temperature Rating</td>
<td>90°C (194°F)</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>6m/s</td>
</tr>
<tr>
<td>Minimum Bend Radius</td>
<td>1.5D Bend</td>
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</table>
FPSO (receive)
Receive pigging valve in turret on FPSO
Pigging valve receive procedure

STEP 1
FLOW OUTLET TO SWIVEL

STEP 2
FLOW INLET FROM RISER

STEP 3
Pigging valve receive procedure
Pigging valve receive procedure
Pigging valve receive procedure
Hartmann valve has an interlock that is integrated on the side of the pigging ball valve that is locked and secured through a bayonet system.
SmartFoam™ following recovery
Pressure vessel removed from SmartFoam™ for download
Pipeline Data
Flexible riser data
Case study 1 - summary

- First ever successful intelligent pig run in to an FPSO’s turret based pig valve receiver?

- Data gathered over entire pipeline length in first pipeline with a simple ILI tool based on a foam pig with embedded sensors.

- Report delivered.

- Interesting and unexpected data from the flexible riser.
Case study 2

✦ The Challenge:
  ✦ Inspect 12” x 50Km pipeline.
  ✦ Platform to shore.
  ✦ Badly dented down to 253mm.
  ✦ Short notice due to contracted ILI vendor withdrawing.

✦ The Solution
  ✦ Pioneer™
Gauge plate damage from existing cleaners
ILI vendor Calliper reported very large dent
Offshore launch of Pioneer™

Local technicians trained to commission and load tool in less than 1 day!
Onshore receipt of Pioneer™ tool

Very little debris recovered in front of tool
Pioneer™ following run
Simplistic data download from Pioneer™
Features reported: Dent
Features reported: Internal Metal Loss
To conclude and in summary...

- Cost effective solutions exist for the most challenging inspection needs.

- If you can safely run a cleaner, you can inspect the line.

- Keep it simple, make it Smart.