SOME CURRENT PERSPECTIVES

Bryce Brown
Group Strategy Management
The ROSEN Group
CONTENT

• Motivation
• Metal Loss
• Crack/Crack-Like
• Materials
• Data Analysis/Reporting
• Field Verification
• Collaboration
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THE MOTIVATION

Safety & Compliance

Asset Performance & Efficiency

Asset Lifetime

Safe, Reliable, Economic operation
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Similar constraints have prevailed in medical imaging …

X-Ray

3D CT

… until these were resolved by a step change in technology.
METAL LOSS

… and with MFL
ILI provides data points and line plots ...

... with increased resolution, now delivers realistic Pipeline Imaging

- Increased resolution
- Triaxial
- Improved sensor suspension,
  (optimized girth weld passage)

Pipeline Imaging close to that of Laserscan:

1.6mm (0.06”) circum. spacing x 1mm (0.04”) axial sampling rate

<table>
<thead>
<tr>
<th>MFL Step Chg.</th>
<th>MFL Step Chg.</th>
<th>UTWM</th>
<th>Laserscan report</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6mm</td>
<td>High Res.</td>
<td>Pitting</td>
<td>1mm</td>
</tr>
<tr>
<td>4-6mm</td>
<td></td>
<td>4mm</td>
<td></td>
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</tbody>
</table>

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SOLUTION – INCREASED RESOLUTION

Current MFL
SOLUTION – INCREASED RESOLUTION

Zoom-in reveals detail

Current MFL

Step Change
Necessary improvements to High Resolution MFL to inspect for, analyze and characterize certain anomaly/defect types:

- **Pinhole** anomalies/defects
- **Complex corrosion** anomalies/defects
- **Girth Weld** anomalies/defects

- Further enabled pressure based assessment and other integrity analyses
- Enhancing the ability to reduce the number of digs
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CRACK/CRACK-LIKE

EMAT

UTCD

MFL-C
CRACK/CRACK-LIKE IDENTIFICATION PROCESS

- Toe cracks
- SCC (stress corrosion cracking)
- Hook cracks
- Mill feature
- Corrosion
- Superficial cracking

Inspection Report

- Other/not reported
- Crack reported
• conservative analysis
• pipeline specific reporting threshold
• assurance of crack types
• 360° field verification
• combined technologies
FRAMEWORK FOR CRACK ASSESSMENT

- Data Gathering
- System Selection
- In-Line Inspection
- Preliminary Reporting
- Final Reporting
- Update Risk Assessment

- Data Management
  - Defect Critical Size
  - Root Cause Analysis
  - Susceptibility Analysis

- Immediate Crack Assessment
  - Fitness for Service

- Complete Crack Assessment

- Field Verification
- Pipeline Repair

SCC Training
Risk Assessment Training
Software Training
Tendency in the industry is run a combination of a crack detection technology and magnetic flux leakage metal loss technology for a significant improvement of POI.

From Classification based sizing …
… to Depth based sizing …
… what’s next?
[e.g. “river-bottom” profile?]
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Focus is on “Step 11” and validating/establishing Material Documentation.
MATERIALS – FROM ILI, PIPE GRADE DETERMINATION

Schematic view

WT measurement from MFL

Pipe Grade ILI Color Scan

Median in circumferential direction of Pipe Grade ILI

Pipe Grade ILI response clearly independent from WT

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**MATERIALS - INTEGRATED APPROACH**

Gap Analysis:

- Categorization of Pipeline Network for Pipelines applicable to IVP process.
- Screening of Pipelines for records available and verified for MAOP validation process.

Closing the Gap:

- Data Collection, Integration and Alignment of available records.
- Extended data analysis routines and processes on conventional ILI technologies to potentially retrieve more out of historical ILI’s.
- Pipe Grade ILI, determination of those lines missing the yield strength.

*(Reliable) Verifiable, Traceable, Complete*
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focused utilization of neural network/machine learning

• Significant step changes for the common ILI data processing/analysis.
• Coming very close to elimination of human factors/errors.
• Applying Neural Networking to process huge amounts of data in seconds.
• Applying pattern recognition algorithms to identify and cluster anomalies and installations while automatically eliminating false calls.
• Integrated machine learning ensures continuous improvement process with each performed data analysis.
• Delivery of Comprehensive Results within a few days (currently for MFL).
• Mind-set change.
• Standardized Reports?
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FIELD VERIFICATION

Increased significance placed on Field Verification Activity

- Understanding quality of ILI reported results
  - Adaptation for improved characterization (continuous improvement)
- Advanced NDE technologies being employed
  - Some destructive testing, in addition
- Written practices (standards) needing to be developed
- NDE Technician qualifications being questioned/reviewed (competence)
- Validating the ILI Performance in the specific pipeline
- Robustness of Machine Learning database
- Consideration of “Sharing the Data”, next step
QUALIFICATION OF PERFORMANCE SPECIFICATION

ILI Process
- Select System
- Prepare/Run Tool
- Validate Operation
- Data Analysis
- Reporting

Update Integrate Review

Pipeline Specifics
- Inspection/Pipeline History
- Pull test Full Scale Characterization
- Field Validation

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QUALIFICATION OF PERFORMANCE SPECIFICATION

Data

Process Operation

Decision

P/L ILI  Pipeline Inline Inspection
MTN III  Final Tool Function Test
CAL  Calibration
Norm Data  Normalized Data
F_j  Functional Characteristics of the Tool
SM_{j,(k,i)}  Sizing Model for Application Case k of jth Iteration

\[ \alpha, \beta, \gamma, \delta \]

Measured by quality (the higher the better)
\[ \alpha_{(i)} \cdots \alpha_{(n)} \] Tool Quality Parameters (of Tool i)
\[ \beta_{(i)} \cdots \beta_{(n)} \] Tool Essential Variables (of Tool i)
\[ \gamma_{(i)} \cdots \gamma_{(n)} \] ILI Essential Variables (of ILI i)

\[ \delta \]

Performance

\[ \delta_0 \]

Specified Performance at specified minimal quality (\( \beta_{min}, \gamma_{min} \))

\[ \delta > \delta_0 \quad \text{yes} \]
\[ \gamma > \gamma_{ref} \]
\[ \delta < \delta_0 \quad \text{no} \]
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Collaboration is vital to success.

- **Customer, Project and Market driven**
- Establish relationship, understand needs (wants), capabilities (limitations)
- Validation of Technology
  - Performance Testing
- Specific Developments (to the threat and/or pipeline)
- Establishing Confidence (with Transparency)
COLLABORATION

Collaboration is vital to success.

• Continuous Improvement
• Field Verifications
• Increased Feedback
• API 1163 (process ↔ application)

• Supporting Industry (AGA, API, INGAA)

• Participating in Industry R&D (PHMSA, PRCI)
• Understand Gaps (access to data)
• Study Gaps with appropriate simulations
• Develop Process/Framework
THANK YOU FOR JOINING THIS PRESENTATION.

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empowered by technology