The Future of Pipeline Risk Management
Content Considerations

- Are we missing obvious reliability indicators using relative ranking models?
- How do we identify and optimize risk reduction activities?
- How to migrate a relative model to a quantitative model?
- How to use data to verify and identify improvement opportunities?
- Understanding the disconnect between past performance and future results.
- What do we do about low frequency, high impact events?
Key Takeaways

1. The evolution of risk analysis – what’s changed?
2. A new definition of risk models – thinking beyond an Either/Or
3. The performance break-through
The Evolution of Pipeline Safety

I. Before IM
- Cathodic protection
- Pigging
- Digging

II. Early days
- Framework of IM plan
- Event not a process
- Disconnected workflows

III. Maturing
- Relative risk models
- Ranking of HCA's
- Data aggregation

IV. Current
- Data integration
- Consequence modeling
- Calibration of risk models
- Looking beyond HCA

V. Desired
- Risk-based decision making
- Enterprise Risk Management
- Corporate Sustainability

Enabling changes
Technology
Data Integration
ILI Inspection Results
Risk Model - Objectives

- Identify highest risk pipeline segments.
- Highlight pipeline segments where the risk is changing.
- Calculate the benefit of risk mitigation activities (P&M measures).
- Identify gaps or concerns in data quality and completeness.
- Support decision making and program development.
- Improve system reliability.
- Eliminate high impact events.
Risk Modeling is a Continuum

• Small number of pure qualitative or pure quantitative risk models.
  ➢ Most have some elements of both.

• Redefine our terms to include only:
  ➢ Qualitative
  ➢ Semi-quantitative
  ➢ Quantitative

Probabilistic Reliability Models Stochastic

Index Models Relative Risk Ranking Models
Qualitative Risk?

Failure Likelihood Score

- External Corrosion (21%)
- Third Party Damage (28%)
- Construction Related (4%)
- Incorrect Operations (10%)

- Internal Corrosion (6%)
- Manufacturing Defects (6%)
- SCC (3%)
- Outside Force (4%)

Equipment (18%)

Managing System Integrity of Gas Pipelines

ASME Code for Pressure Piping, B31
Supplement to ASME B31.8

American National Standard
The American Society of Mechanical Engineers
External Corrosion, Typical

\[ S = M \times \left\{ 1 - \left[ 1 - \left( \frac{B}{10} \right) \right] \times \left[ 1 - \left( \frac{C_F}{10} \right) \right] \times \left[ 1 - \left( \frac{FH}{10} \right) \right] \right\} \times A_F \]

Where:

- \( M \) = Material Type Score (0 or 1);
- \( S \) = External Corrosion Score (0-10);
- \( B \) = Baseline Susceptibility Score (0-10);
- \( C_F \) = Stray Current / Interference Factor (0-10);
- \( FH \) = External Corrosion Failure History Score (0-10); and,
- \( A_F \) = Integrity Assessment Mitigation Factor (1-10)

**Baseline Susceptibility Score \([B(0-10)]\)**

The Baseline Susceptibility Score is determined on the basis of a number of weighted factors – each assigned a score from 0 to 10.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor</th>
<th>Fractional Weighting</th>
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<tbody>
<tr>
<td>Age</td>
<td>AF</td>
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<tr>
<td>Corrosion Allowance Factor</td>
<td>CAF</td>
<td>0.05</td>
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<tr>
<td>Coating System Type Score</td>
<td>MCT</td>
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<tr>
<td>CP Compliance Score</td>
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<tr>
<td>Coating Condition Score</td>
<td>CC</td>
<td>0.20</td>
</tr>
<tr>
<td>Casings</td>
<td>CAS</td>
<td>0.05</td>
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</table>
10 mile pipeline – 122 anomalies, 2 digs, zero anomalies remaining below 1.39

Not all Inspected pipelines are equal...

10 mile pipeline – 7,274 anomalies, 7 digs, zero anomalies remaining below 1.39
External Corrosion – with ILI data

Sample ILI Unity Chart for Tool Error

Field Measured Depth (% wt) vs. ILI Depth (% wt)

Depth Error Density Distribution
Normal Distribution Approximation

-3.23% -40.84% -28.45% -16.06% -3.67% 8.72% 21.11% 33.50%
External Corrosion – with ILI data

\[ P_{Tot} = 1 - \left[ (1 - P_{f,i}) \cdot (1 - P_{f,i+1}) \cdot (1 - P_{f,i+2}) \cdot \ldots \cdot (1 - P_{f,n}) \right] \]
External Interference

\[ \text{External Interference} = \text{Hit Susceptibility (H)} \times \text{Failure Susceptibility (S}_f\text{)} \]

Failure of a pipeline due to third party damage is the product of two independent factors:

- The susceptibility of the pipeline to incurring a hit by a third party (‘H’); and,
- The susceptibility to failure of the pipeline, given a hit (‘S_f’).
# Impact Frequency

<table>
<thead>
<tr>
<th>Modeled Impact Frequency (hits/mile-yr)</th>
<th>Value of “F”</th>
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<tbody>
<tr>
<td>&lt; 8.0E-4</td>
<td>1</td>
</tr>
<tr>
<td>≥ 8.0E-4 to &lt; 1.3E-3</td>
<td>2</td>
</tr>
<tr>
<td>≥ 1.3E-3 to &lt; 1.7E-3</td>
<td>3</td>
</tr>
<tr>
<td>≥ 1.7E-3 to &lt; 2.2E-3</td>
<td>4</td>
</tr>
<tr>
<td>≥ 2.2E-3 to &lt; 2.7E-3</td>
<td>5</td>
</tr>
<tr>
<td>≥ 2.7E-3 to &lt; 3.1E-3</td>
<td>6</td>
</tr>
<tr>
<td>≥ 3.1E-3 to &lt; 3.6E-3</td>
<td>7</td>
</tr>
<tr>
<td>≥ 3.6E-3 to &lt; 4.1E-3</td>
<td>8</td>
</tr>
<tr>
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<td>9</td>
</tr>
<tr>
<td>≥ 4.5E-3</td>
<td>10</td>
</tr>
</tbody>
</table>
Consequence – Impact on Population
Impact Summary (Weighted)

Impact Score = 50% ($S_F$) + 30% ($E_F$) + 10% ($E_cF$) + 10% ($RF$)

= 6.9

Impact Score:
- Safety: 8.6
- Environment: 6.2
- Economic: 3.0
- Reputation: 4.5
Impact Summary (Or Gate)

Impact Score = \{ \left[ 1 - \left( 1 - \frac{P_Q}{RS} \right) \times \left( 1 - \frac{U_Q}{RS} \right) \times \left( 1 - \frac{UV_Q}{RS} \right) \times \left( 1 - \frac{W_Q}{RS} \right) \right] \}

= 9.8
Risk Mitigation Benefit

Cost-Benefit - Mitigation Programs

Hurdle Rate – 1.5
• Identify highest risk pipeline segments.

• Highlight pipeline segments where the risk is changing.

• Calculate the benefit of risk mitigation activities (P&M measures).

• Identify gaps or concerns in data quality and completeness.

• Support decision making and program development.

• Improve system reliability.

• Eliminate high impact events.
Low Frequency, but High Impact Events

- Goal for the Industry, Regulators and Public
- Focus and identify locations of possible “high impact” events
- Ignore the likelihood of the event occurring (initially)
- What barriers or activities for that specific “high impact” event could be undertaken to eliminate that outcome
- Think Fire Triangle - eliminating just one, eliminates the outcome.
Dynamic Risk has developed and implemented risk analysis on more than 400,000 miles of pipeline in North America.

We have designed and implemented 50+ company unique algorithms.

We have used quantitative risk for all aspects of the pipeline life-cycle.

Many of the these companies have reportable incident rates of less than ½ of the industry average.

A number of these companies have virtually eliminated high impact events.

And there is no strong correlation between this result and the type of risk model they use!
Performance Break-through

- There is a strong correlation with asset reliability performance and with this one activity...

Companies that use risk analysis to support IM planning and decision making consistently achieve the best reliability record.
To learn more about the future of pipeline risk management contact us at:
info@dynamicrisk.net