Dynamic Risk

APPLICATION OF QUANTITATIVE RISK ASSESSMENT

PPIM (30th ANNIVERSARY)

February 2, 2018

PRESENTER: PATRICK VIETH, EXECUTIVE VICE PRESIDENT
DYNAMIC RISK

Introduction

Risk = Probability x Consequences

Why?

Possibly you have been asleep for the past 100 years

Introduction

Why do airlines continue to demonstrate how to put on a seatbelt?

Possibly because you haven’t been in a car since 1963!

Understand the Stakeholders/Audience

Compliance versus Effectiveness

Start With WHY!

Dynamic Risk

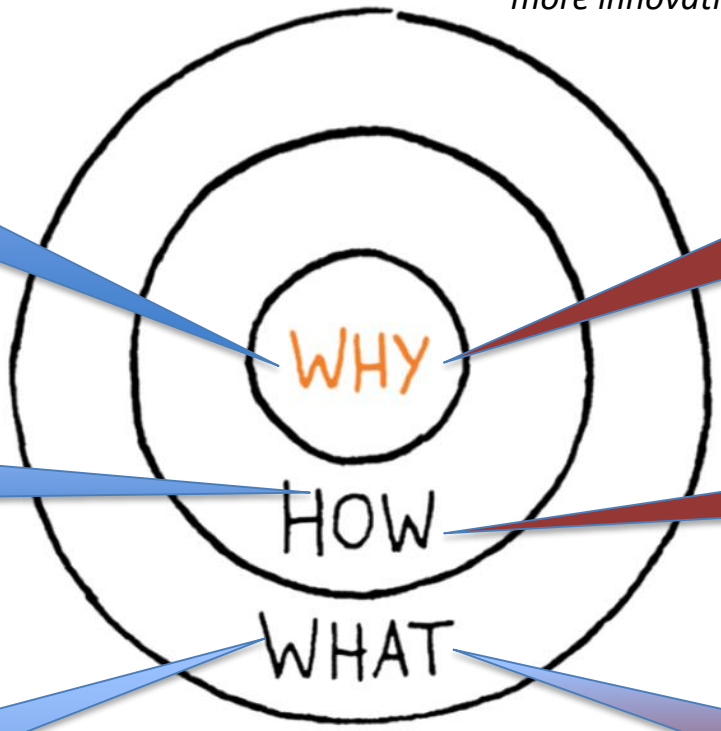
APPLE COMPUTER Marketing

APPLE is a computer company just like anyone else, but they are more innovative than others.

3. Want to buy one?

2. Uniquely designed, easy to use

1. We make great computers



1. We believe in thinking differently in everything we do

2. Beautifully designed, easy to use

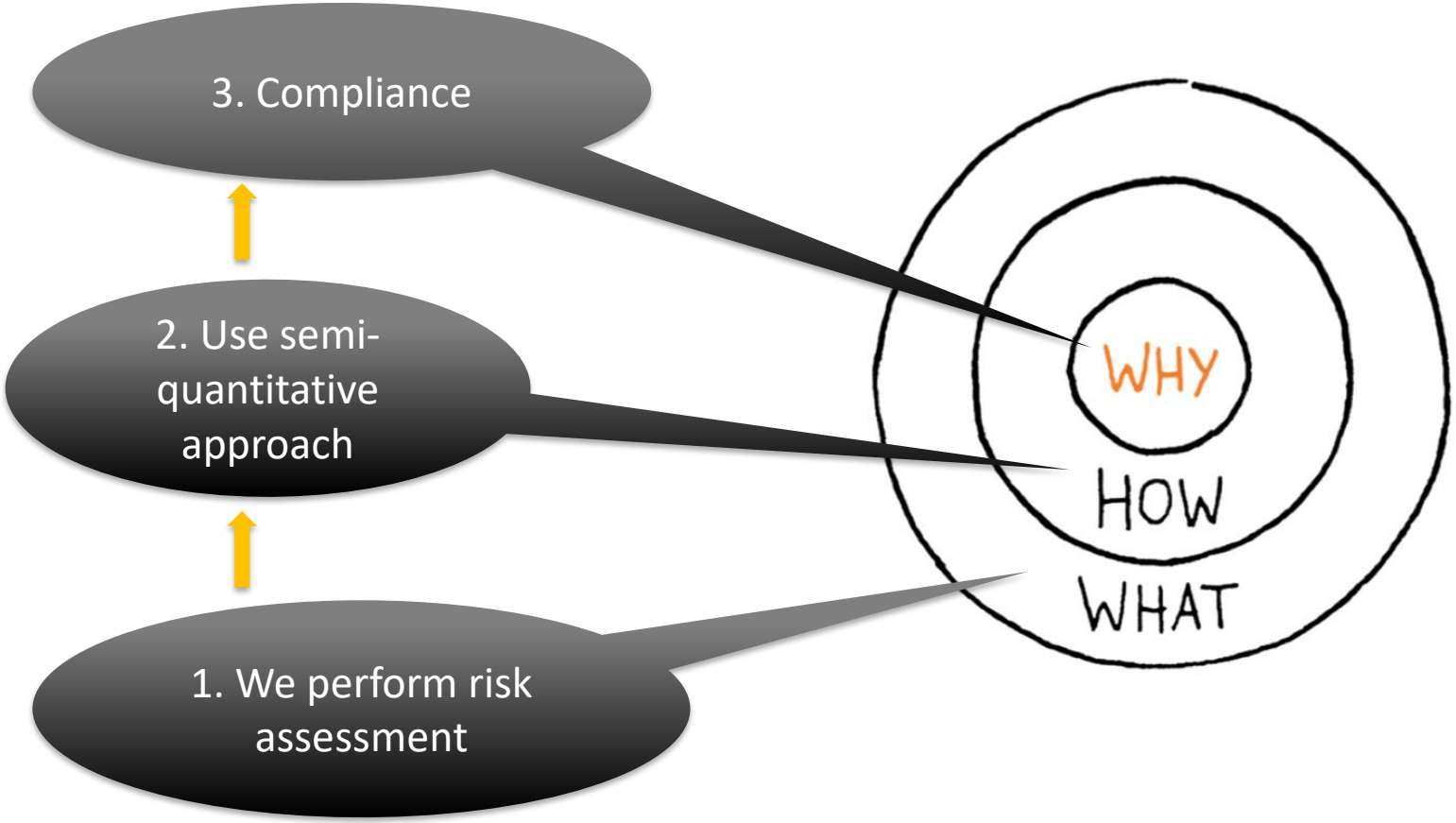
3. We just happen to make great computers. Want to buy one?

Simon Sinek

Risk Management

Dynamic Risk

WHAT-HOW-WHY we do risk assessment, for example



Risk Model – WHAT We Do

Dynamic Risk

- 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
- **Compliance** is a minimum expectation

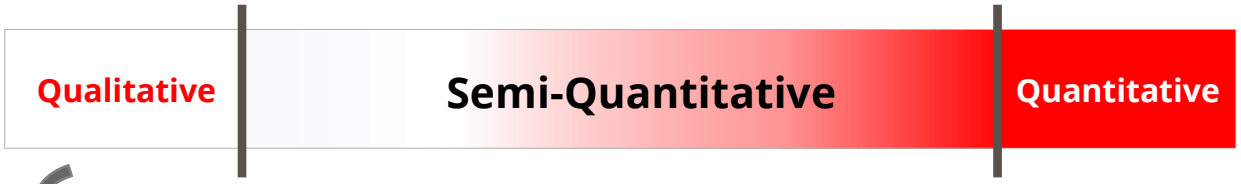
Risk Modeling Is A Continuum
HOW We Do It

Dynamic Risk

- 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

WHY We Do Risk Assessment

Dynamic Risk

- Purpose / Cause:
  - **Safe and reliable transportation of hydrocarbons**
- Demonstrates confidence in communicating pipeline performance to Stakeholders
- Relies upon technical excellence in information analytics
- Creates knowledge to support decision making

Case Study

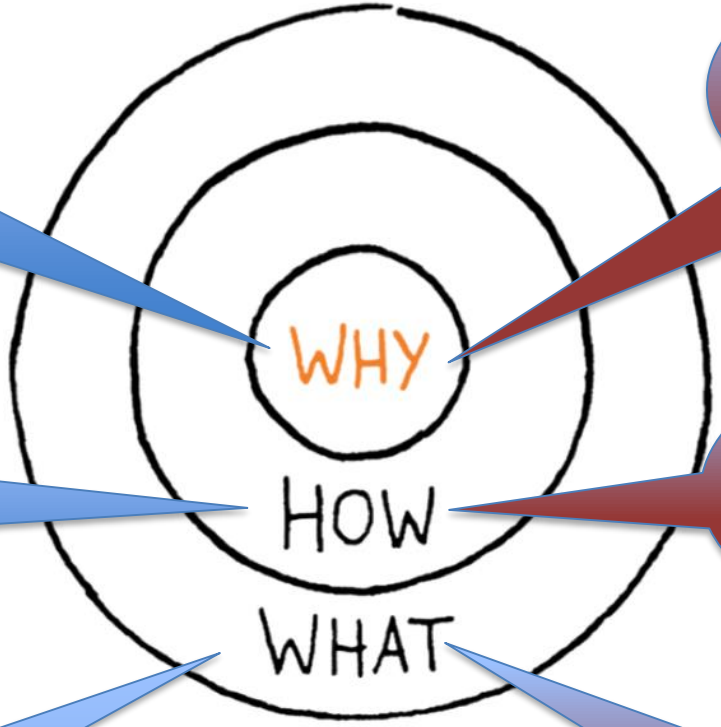
Straits of Makinac

Dynamic Risk

3. Requested by State of Michigan

2. Quantified risks and identified barriers

1. Perform a risk assessment of alternatives



1. Demonstrate the operational reliability of an existing pipeline when compared to various alternatives

2. Fully aggregate all available information and apply demonstrated analytical approaches

3. Provide stakeholders with knowledge to evaluate a complex problem

Case Study

Straits of Makinac

- Analysis of alternatives to the existing Straits Pipelines
- Consider public health, safety and welfare and protect the public trust resources of the Great Lakes
- Does not include a recommendation
- Does include the development of information that can be used by Stakeholders

The SOW (*Alternatives Analysis Contract with Dynamic Risk – July 2017*), the Final Report (*Alternatives Analysis for the Straits Pipeline - Final Report - November, 2017*) and the agreement between the State and Enbridge (*Agreement Between the State of Michigan and Enbridge Energy on Line 5 in Michigan - November, 2017*) can be downloaded from the State's website: https://mipetroleumpipelines.com/resources-reports

Case Study

Straits of Makinac

Dynamic Risk

- Feasibility analysis
- Design-based cost estimates
- Economic feasibility
- Socio-economic impacts (jobs, income, government revenue, social impacts)
- Spill risk analysis
  - compare risk of infrastructure required to replace existing Straits Segments
  - existing Straits Segments considered as base case for comparison purposes
- Components
  - threat assessment
  - spill probability assessment
  - safe and reliable operating life
  - spill release modeling
  - oil spill behavior and impact modeling
  - NGL release modeling
  - spill consequence analysis (safety, environment, economic impact)
  - market impacts

Case Study

Straits of Makinac

Dynamic Risk

Alternative 1: New Pipeline Route ✓

Alternative 2: Utilize Pre-existing Alternative Pipeline Infrastructure ✗

- Partial capacity exists on short segments – not significantly different from Alt 1

Alternative 3: Alternative Transportation Methods

- Water Transport – Tankers / Barges ✗
  - $4.3 billion investment required in tank farms and fleet of vessels
- Truck Transport ✗
  - 1 truck loaded/unloaded every 40s, 24 hrs./day, 7 days/week
  - Dedicated fleet of 3,200 trucks required
  - Public costs, strain & congestion on highway infrastructure + public risk
- Rail ✓

Alternative 4: Replace Straits Crossing

- New Trenched Crossing ✓
- New Tunnel Crossing ✓

Alternative 5: Maintain Existing Straits Crossing ✓

Alternative 6: Decommission and Abandon Straits Crossing ✓

Case Study

Straits of Makinac

Dynamic Risk

	Alt 5 Existing Operations (Base Case)	Alt 4a New Trenched Crossing	Alt 4b New Tunnel Crossing	Alt 6 Abandon Line 5 & Crossing	Alt 1 New Pipeline Route	Alt 3 Alt Transport (Rail)
Principal Threats	Anchor Drag, Incorrect Operations, Spanning, Vortex-Induced Vibration	Anchor Drag, Incorrect Operations	Negligible	N/A	Per Incident Statistics	Per Incident Statistics
Oil Spill Outflow – Rupture (bbl)	2,629	5,859	None	N/A	3,784	Median Spill 462 bbl
Oil Spill Outflow – Puncture (bbl)	N/A	N/A	None	N/A	300	
Oil Spill Outflow – Leak (bbl)	North: 2,902; South: 4527	North: 5,820 South: 9,801	None	N/A	57	
Failure Frequency -Rupture (/y)	3.575×10^{-04}	2.430×10^{-06}	Negligible	N/A	1.84×10^{-02}	2.891
Failure Frequency – Puncture (/y)	N/A	N/A	Negligible	N/A	1.67×10^{-03}	
Failure Frequency – Leak (/y)	1.007×10^{-04}	5.040×10^{-05}	Negligible	N/A	0.187	
Safety Risk (fatalities/y)	2.69×10^{-06}	1.68×10^{-07}	Negligible	0.00	3.66×10^{-01}	2.24
Total Economic Risk ($/y)	41,500[a]	8,870[a]	Negligible	0.00	1,920,000[a]	49,700,000[a]
Monetized Environmental Risk ($/y)	24,900[a]	5,320[a]	Negligible	0.00	841,000[a]	18,300,000[a]

Notes:

[a]results may reflect rounding

Case Study

Straits of Makinac

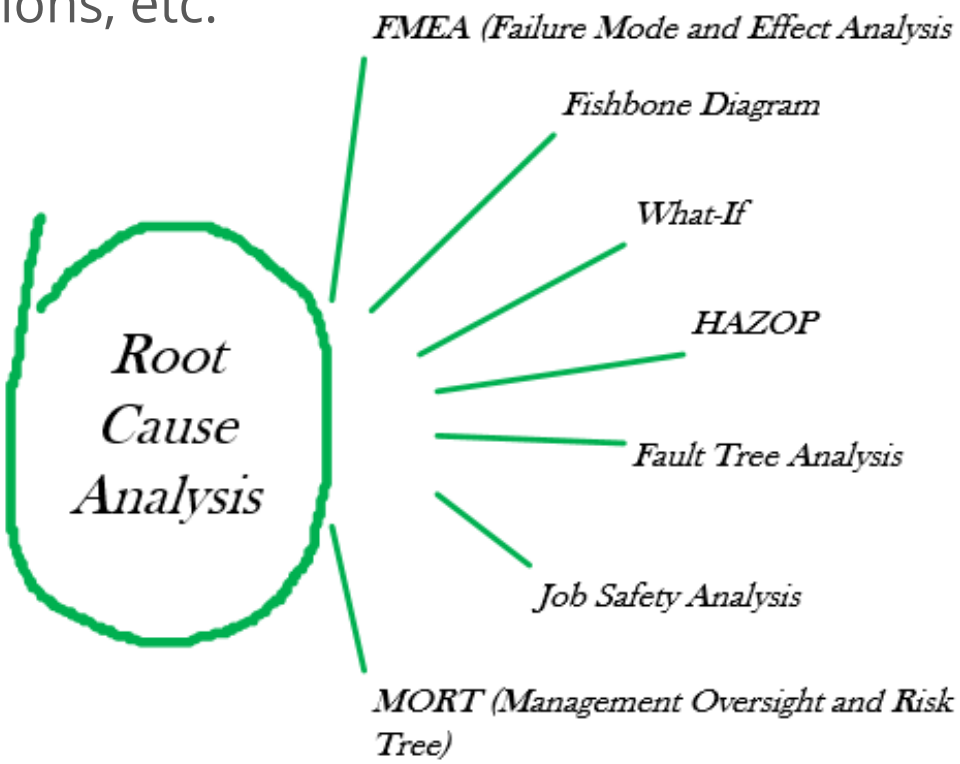
Dynamic Risk

Alternative	Risk Multiple, Relative to Base Case (Existing Crossing)		
	Safety Risk	Monetized Environmental Risk	Total Economic Risk
Alternative 3 (Rail Transport)	830,000 X Base	734 X Base	1,196 X Base
Alternative 1 (New Pipeline)	136,000 X Base	34 X Base	46 X Base
Alternative 4a (New Trenched Straits Crossing)	0.062 X Base	0.214 X Base	0.214 X Base
Alternative 4b (New Tunnel Crossing of the Straits)	Negligible	Negligible	Negligible
Alternative 6 (Abandonment of Line 5 and Straits Crossing)	Zero	Zero	Zero

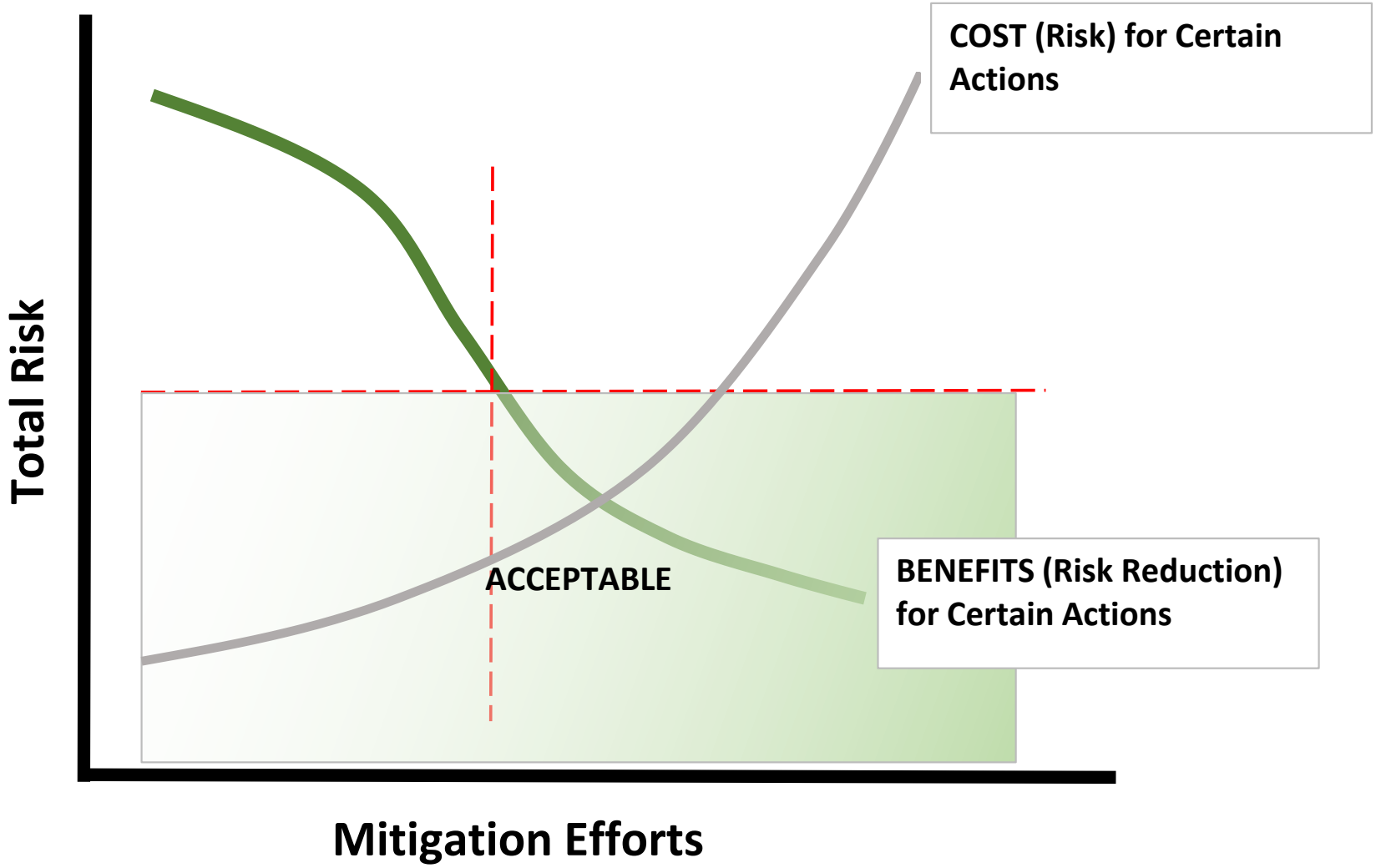
Risk Management Journey

Dynamic Risk

- Direct Cause(s)
  - corrosion, incorrect operations, etc.
- Root Cause(s)
  - **people**, plant, process
- Contributing Factor(s)
  - procedures, training, etc.



Risk Threshold



Full Risk Spectrum

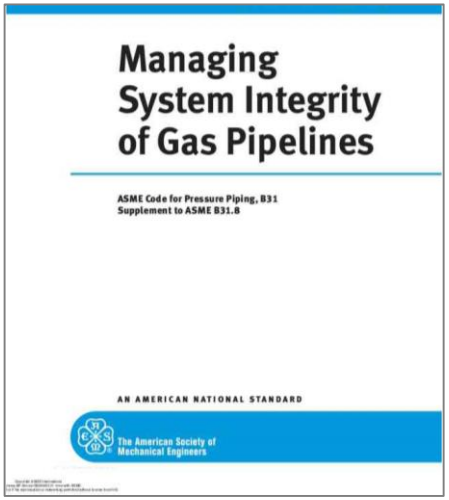
- What is often missing?
- Are all risk attributes considered across the entire risk spectrum of integrity management?

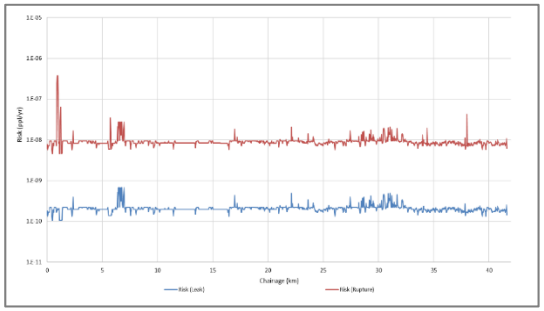
Stakeholders, and Risk Communication

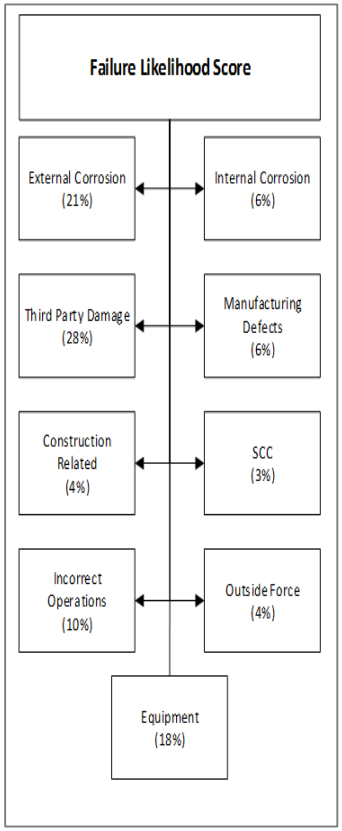
Dynamic Risk

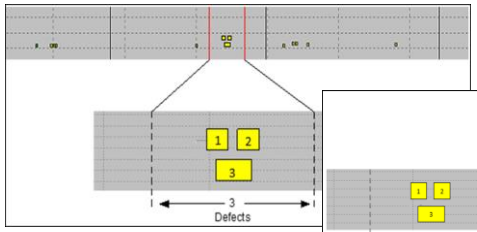
Quantitative Risk Considerations

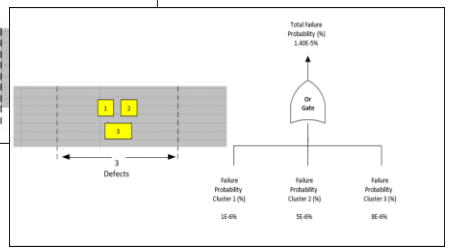
Dynamic Risk

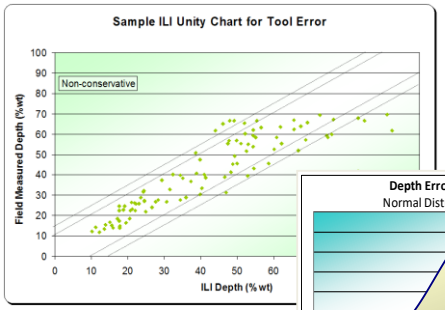


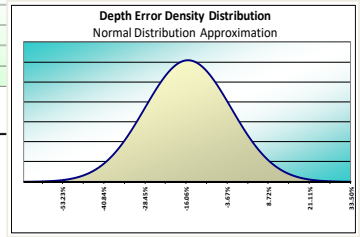


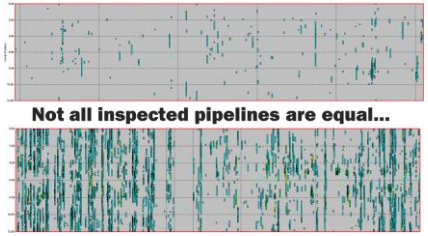












$$S = M \times \left\{ 1 - \left[1 - \left(\frac{B}{10} \right) \right] \times \left[1 - \left(\frac{C_F}{10} \right) \right] \times \left[1 - \left(\frac{FH}{10} \right) \right] \right\} \times A_F$$

PIPELINE INDUSTRY
Risk Management

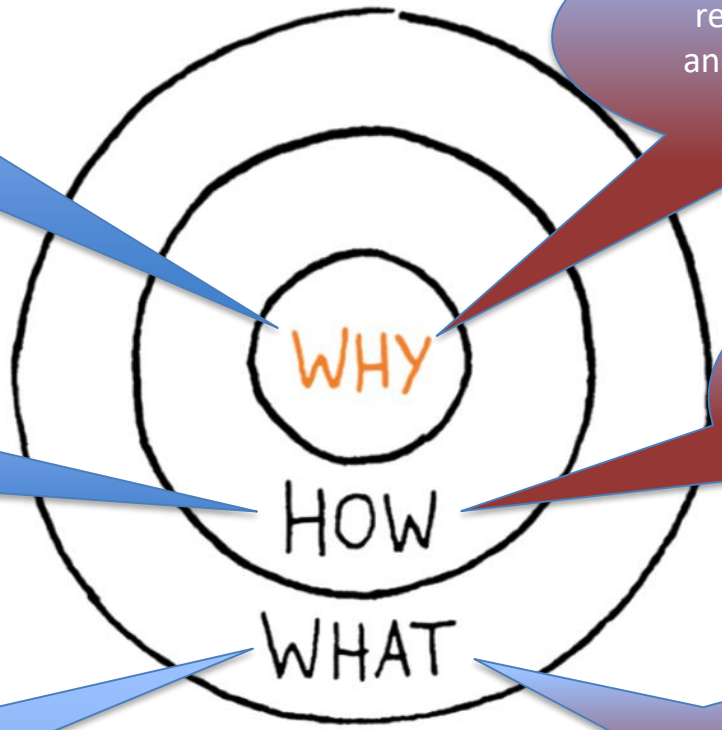
Dynamic Risk

Start With WHY!

3. Compliance

2. Use semi-quantitative approach

1. We perform risk assessment



1. We have an inherent responsibility for the safe and reliable transportation of hydrocarbons

2. We apply a fact-based and method driven approach to evaluate threats and consequences

3. We evaluate and communicate a risk perspective to all stakeholders

Summary

- **WHY** we do risk assessment has changed significantly over the past few years
- **WHAT** we are achieving through risk management is continuing to evolve
- **HOW** we perform risk assessment has considered new data and advanced reliability methods
- There is no correlation between pipeline reliability and the type of risk model
- Each person inherently has a different acceptable risk tolerance

Summary cont'd

Dynamic Risk

- Stakeholders have a growing interest with pipeline risk and safety
- Pipelines are often a focus for those promoting renewable energy
  - Hydrocarbon use is driven by policy and demand
  - Pipeline operators want to transport from Point A to Point B with limited risk
- Risk-informed decision making is an expectation
- **Nothing is free**, mitigation options often have risk
- Performing risk assessment should be driven by **WHY!**