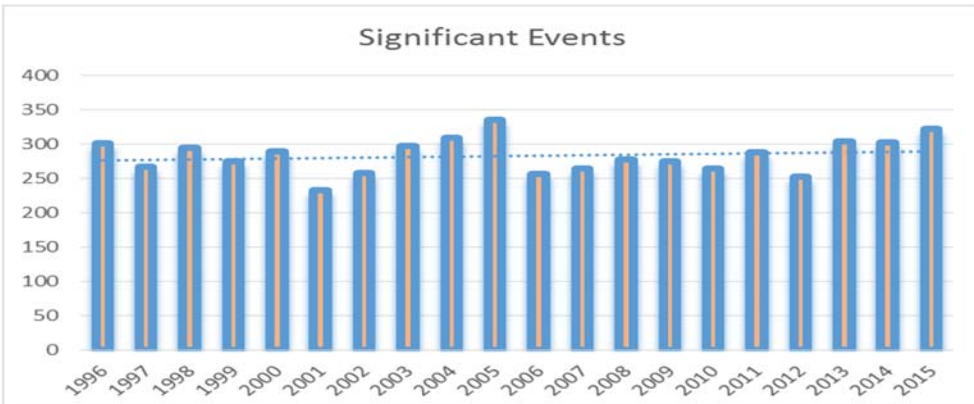
INTEGRATED RISK MANAGEMENT – APPLICATION TO PIPELINE SAFETY

This paper is co-authored by Doug Dale and Jeff Cummings of UMS Group, an international utility management consulting firm founded in 1989 to serve the global utilities industry. More detail regarding their backgrounds and contact information is provided in the section below: "About the Authors."

The natural gas industry is on track to invest between three and five billion dollars annually on system expansion and replacement of aging and deteriorating infrastructure. However, as the capital budgeting practices used to prioritize investments and develop spending programs have not changed, there is little reason to believe that the 20-year trend of significant events (i.e.; *gas* explosions and fatalities) illustrated in Figure 1 below will change.

Figure 1: Significant Events (1996 through 2015)



Source: Pipeline and Hazardous Material Safety Administration (PHMSA) Data

This relatively consistent number of significant events year-over-year, independent of investment level, points to a gap between the targeting of investment and actual risk. This gap has been costly in terms of the public safety consequences of these significant events. Contrasting the dollars invested in replacing cast iron and steel pipe in recent years to reduce the threat of leaks and corrosion with the causes of these major events (i.e., primarily excavation and other external force damage) demonstrates the mismatch between perceived and actual risks.

The cost to the industry of addressing significant events over the past 20 years has exceeded $7 billion ($6 billion since 2006). Yet, investment has primarily been targeted on corrosion (i.e., reducing leaks) which is the cause of less than 5% of these events.

The bottom-line is that a multi-dimensional view of "risk" needs to be the main focus of technical decisions and drive the allocation of capital investment. Termed by one gas pipeline operator as "asymmetrical risk" (i.e.; the mathematical comparison and ranking of risks with different failure mechanisms), the ability to compute, compare and trend this form of risk and related health scores is of paramount importance in:

- Addressing the gap described above,
- Discovering the next major critical investment category (based on data) for pipeline operators,
- Serving as a fact-based argument for deferring regulatory driven actions and reallocating funds to other higher value added investments and spending programs, and
- Supporting requests for recovery of costs.

An NTSB Safety Study – NSTB/55-15/01 states that although the current Integrity Management Programs (IMP) required by PHMSA was keeping significant events low, no real improvement has been realized. Their recommendation was to "double-down" on the current practices with more focus on in-line inspections (which are not practical on the majority of the pipes that transport natural gas from wellheads to customer meters) and improvements in asset condition data collection. Although these practices will maintain the status quo, a more comprehensive focus on risk reduction-focused investment strategies will not only drive down significant events, but identify future failure mechanisms as they begin to emerge. More directly stated, the natural gas pipeline industry needs to adopt a risk reduction investment strategy supported by a data driven investment methodology. The litmus test for the relevance of this discussion is an answer to the following question: "Does our current approach suggest a strategy to reduce leaks or a strategy to prevent significant events?"

Historical Perspective

Even though the intent of the "IMP" rules is to reduce risk by identifying pipeline threats, threats and risks for many operators appear to have become synonymous terms. In fact, they should represent a cause-effect relationship. Continuing to use these terms interchangeably will likely lead to sub-optimal investment decisions.

Fifteen years ago, Congress passed the Pipeline Safety Improvement Act of 2001. This was the first act that specifically directed PHMSA to implement IMPs, including requirements to identify threats and evaluate for specific risks to public safety. PHMSA established separate transmission and distribution rules for gas:

- The Transmission Integrity Management Rule specified how operators must address these risks, with its initial focus on High Consequence Areas (HCAs) – recently proposed changes will expand this focus significantly, and
- The Distribution Integrity Management Rule specified a similar, but less prescriptive approach to managing risk on distribution systems.

In response to these IMP requirements, the industry started to look at threats to the gas pipeline and created models and programs to verify the severity of each threat and initiate risk mitigation actions as appropriate. These threat mitigation actions focused primarily on corrosion, resulting in investments that can best be described as "no regret" actions to reduce, if not eliminate, events resulting from corrosion. And, though, as a result of these actions, leaks on the pipelines have been reduced (certainly a factor to maintaining a safe system), risk in the truest sense, has not been the driving factor in assigning these actions. Threats are inputs to the risk identification process, and Risk deals with the potential consequences of each threat on a specific asset and the likelihood that each potential consequence will become a reality. A risk score for each asset or segment can then be computed and used as an input to a comprehensive investment and spending strategy.

Compliance alone will not assure public safety. And, any challenge to the effectiveness of proposed regulation can only succeed if backed by quantitative and objective analyses.

Thus, in complying with the IMP requirements, gas pipeline operators, regulatory agencies, and the public they serve have not gained assurances that their highest risks have been mitigated. To achieve the full intent of the PHMSA rule:

- A more holistic approach to risk management and related capital investment prioritization needs to be applied,
- The focus of the operators needs to lean less on reactive program compliance, and more on proactive problem identification, and
- The way that operators and regulators measure performance requires adjustment. A review of the data shows that a decrease in the number of leaks has not resulted in a reduction of catastrophic failures, and hence, has not reduced risks associated with operating the pipeline.

The utility industry has all of the tools to ensure that risk reduction investments can occur. They just need to be bundled together properly to get the desired result that the IMP programs are attempting to achieve.

Proposed Solution

Asset Management Model

ISO 55000 establishes a framework and approach to manage critical assets, assuring the proper balance of three important perspectives: Operational Performance, Efficiency (Cost), and Risk.

The presumption is that we cannot afford to eliminate risk in its entirety due to practical limits on capital and resource availability, and even if we could, the reduction of risk would still need to be addressed in a systematic and prioritized fashion.

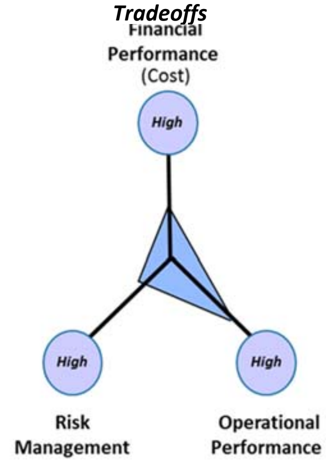


Figure 2: Asset Management Tradeoffs

Our view is that in applying the basic tenets of these Global Standards, we will not only deal with the “unknowns” implied in the aforementioned discussion (and thereby support more prudent spending), we can also increase the transparency of system embedded risks and progress attained in mitigating these risks, and thus reduce any ambiguity regarding the litmus test posed above.

Risk Management and Its Implications

For the purpose of this discussion, we will narrow our definition of risk to that related to assets (*i.e.;* threats that could manifest themselves in the form of events due to the fact that the assets exist). These threats exist from the creation of each asset through to and beyond the point when it reaches end of life. What changes, often over time, is the probability that a threat will materialize into a consequence, typically driven by a number of factors, including:

- Age and Condition of an asset, which includes the existence of manufacturing defects, the effectiveness of maintenance programs and environmental impacts,
- Damage, where a sudden intervention (*e.g.;* excavation or vehicle damage) can result in a leak or failure, well in advance of the normal degradation of the asset, and
- System Design and Operation, which includes material, construction standards, operating parameters, operator qualifications, and proximity of other facilities.

Therefore, risk management begins with an understanding of the threats and their relevance to each asset, a determination of the potential consequences, the calculation of a probability of occurrence, and finally identification of a strategy and/or action to remediate the risk, if necessary.

This expanded view of risk as an output of a comprehensive assessment of all threats and as an input to identifying specific spending programs, results in:

- More balanced approaches to risk mitigation where multiple threats are simultaneously addressed, although weighted in importance based on the risks related to a specific asset in the system,
- Multi-variant analyses to validate and enhance subject matter expertise to assure the proper identification of remediation actions,
- Well-targeted spending plans based on objective pre-established investment and program evaluation criteria, and
- Greater transparency on which to justify major investments and increased program spending levels for consideration by key stakeholders; and a thorough understanding of the risks should these investments be deferred.

As such a program matures, gas pipeline operators will be able to adopt a more proactive approach to risk remediation with the expectation that the number of serious incidents related to failures and leaks will decrease, and the extremely costly “brute force” approaches to risk mitigation will be eliminated.

Governance Regarding Risk Management

As gas pipeline operators shift to a risk management approach similar to that outlined above, it is important to note that the dynamic on how the inherent trade-offs between operational performance, efficiency (cost) and risk are made must change.

- Traditionally, Executive Management has provided overall governance through the establishment of annual budgets; and the planning and scheduling of specific actions has been largely defined by managers and well-established subject matter experts. Thus, the cut-off for any remediation or mitigation of the threat has been determined by the funding limit, and any discussion around asset-related risk is at best, anecdotal.
- Within the context of the approach being proposed in this discussion, the budget is still established by Executive Management, and their role has expanded to defining a pre-established Risk Management Threshold Criteria (i.e., a risk deemed unacceptable by Executive Management). It may be that a specific investment will remain unfunded, but the decision will be made with full understanding of the risk being managed by the business. The Integrity Management group will no longer unilaterally manage system risk.

Figure 3 (below) provides an illustrative framework to a method used by some organizations to communicate where Executive Management intervention is required.

Figure 3: Risk Management Threshold Criteria Framework

Probability			Consequence (Effect)				
	Likelihood in Next Yr./Horizon		Minor	Moderate	Major	Severe	Catastrophic
Certain	90% (9 in 10)	L	ML	M	MH	H	H
Frequent	50% (1 in 2)	L	ML	M	MH	MH	H
Probable	25% (1 in 4)	L	ML	M	M	MH	MH
Occasional	10% (1 in 10)	L	ML	ML	M	M	M
Unlikely	1% (1 in 100)	L	L	ML	ML	ML	ML
Negligible	0.1% (1 in 1000)	L	L	L	L	L	L

Illustrative Example

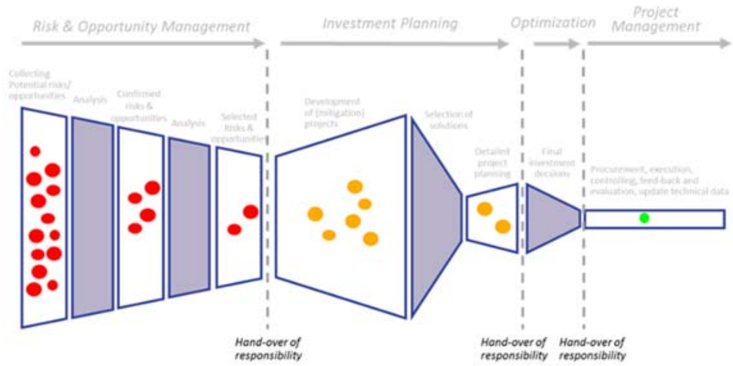
Investment Optimization

Implicit in the Risk Management process outlined above is the identification of mitigation actions that require funding. These actions, identified as individual projects or programs, can be scored based on value (risk reduction should the project or program be funded) and risk (what could happen if the project or program is not funded). Subject to budget/resource constraints and an Executive Management-driven risk tolerance framework (aligned with that of External Stakeholders), an optimum spending plan can be developed:

- Doing so requires an evaluative framework that assures scoring consistency, maximizes reliance on objective data and information, and links actions to overall business strategy.
- The risk identification process uses scenarios (consequences and related probabilities) to arrive at proposed investments to mitigate risks which allows this process to evaluate numerous scenarios the portfolio level.
- Given the multi-variant nature of the factors that drive investment decisions, an approach that assures optimization (in contrast to prioritization) is preferred.

Figure 4 (below) illustrates this process, with the caveat that it does not replace the role of the subject matter expertise in assessing trade-offs; rather it provides more data-driven information to support their analysis.

Figure 4: Investment and Spending Program Optimization



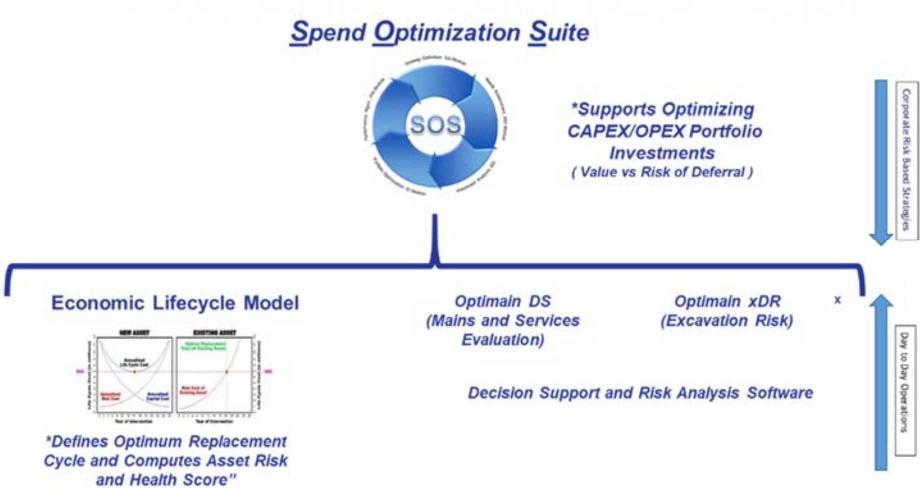
In applying this approach, gas pipeline operators will be able to:

- Have full transparency into the risk embedded in its system,
- Evaluate its proposed investment portfolio based on the amount of risk mitigated, and communicate any latent risks that remain as a result of funding limitations, and
- Trend progress, or lack thereof, in mitigating risk over time.

Decision Support Tools

The complexity implied in identifying “threats,” evaluating the risk they impose on specific assets, and scoring proposed actions from both a value and risk perspective, calls for the use of decision support tools that can programmatically evaluate options as a supplement to the assessment of subject matter experts. This is particularly true as the emphasis shifts from portfolio prioritization to an approach that optimizes the trade-offs between operational performance, efficiency (cost), and risk. There are a number of products and practices already in use within the gas industry that can provide the type of support required, the capabilities of which are summarized below:

Figure 5: Decision Support Framework



Decision Support Tools (Figure 5):

- Optimain DS addresses any confusion regarding the relationship between threats and risk. It starts from the premise that threats, if they remain unmitigated, can lead to failure of the asset to perform its intended function, including causing an unintended release of a hazardous product. Optimain DS strives to accurately assess and model all threat types so that it can accurately predict likelihood of those failures. Optimain DS also models consequence, by recognizing that each type of failure can result in a wide range of consequences. Optimain DS factors in a large array of pipe and other asset attributes, failure and pipe condition reports, and location specific information to support objective, data-driven risk remediation decisions (*e.g.;* increased surveillance, rehabilitation, repair and replace).
- Optimain xDR uses data and trends (e.g.*;* historic underground facility locate requests and associated excavation damages) to highlight active locate requests that have the highest overall risk (likelihood and consequences of damage), thus facilitating proactive identification of opportunities to prevent excavation damage; and in so doing, optimize the assignment and activities of damage prevention resources.
- Economic Lifecycle Modeling assigns a Benefit (Risk Reduction) / Total Cost score for each asset and defines the optimum replacement cycle based on "economic" life. Key inputs include age, condition and vintage of specific assets and criticality to pipeline safety.
- Capital Investment / O&M Spending Portfolio Optimization (branded "SOS") establishes annual investment plans, optimizing the trade-offs between value (risk reduction) and risk of deferral. Key aspects include the use of scoring criteria that assure consistency across all proposed investments and spending programs and the ability to accept as inputs, the outputs of the aforementioned decision support tools.

Additional Inputs/Sources for Establishing Optimum Portfolio:

- Results from In-line inspections and Direct Assessments which can be inputs to Optimain DS.
- Asset and Asset Risk Registers act as repositories for critical data and information to be used in establishing an objective basis for asset-related decisions.

Summary

Integrated Risk Management understands that:

- Threats and risks are not synonymous; rather they are part of a "cause and effect" relationship.
- Complete elimination of a risk is not necessarily an optimal approach in managing assets. There needs to be an optimized approach to addressing each threat type, assuring that funding is prioritized based on the most significant risks.
- Current practices and tools around damage prevention, leak mitigation, and tests/inspections are important inputs to the Risk Management solution. However, they do not, in and of themselves, lead the gas pipeline operators to the highest priority risks, nor lead to an optimum investment portfolio of mitigation actions.
- There are proven practices and solutions available to support risk-based solutions around pipeline safety.

About the Authors

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