Asset Performance Networks

Why Traditional Risk Management Fails in the Oil and Gas Sector:

Empirical Front-Line Evidence and Effective Solutions

By

Brett R. Schroeder
(Managing Director (2007))

Jan A. Jackson
(Senior Consultant (2007))

Corporate Office
3 Bethesda Metro Center
Suite 925
Bethesda, MD 20814
Tel: +1 (240) 683-1001
Fax: +1 (240) 683-1009

I. Abstract

High levels of complexity for capital projects and turnarounds in the oil and gas industries have historically led to some of the highest project losses. The application of traditional risk-models and management principles has proven insufficient to prevent a high rate failure in this sector. Diminishing returns in the upstream exploration of new resources is shifting focus to the optimization of effective risk management. Empirical evidence collected for various oil and gas related projects and plant turnarounds suggests risk categories, which, if left insufficiently managed, can lead to severely negative project impacts. This paper will present the most significant risks identified by project and turnaround teams in the oil and gas sector and present tools and techniques to improve the effectiveness of risk management.

II. Introduction

Project risk management has considerably matured over the last decade, a trend that had been prominently accelerated by highly publicized stories of corporate misconduct, globalization, new contractual risk shifting vehicles, and last but not least, recently enacted regulatory requirements such as the 2002 Sarbanes-Oxley Act. Rather than considering risk as simply one focus area among others, all elements of project management, such as cost, time, or human resources are increasingly being analyzed from a *risk perspective*. Energy projects, especially in the upstream sector are faced with magnitudes, combinations, and sometimes even types of risks commonly not experienced, at least not to the same degree, in more traditional project concepts. Given such unique challenges, common risk categories and traditional approaches to risk mitigation are insufficient for the Oil and Gas sector. Any risk model or tool must be able to address specific categories, based on certain risk areas. Despite major advances in risk planning and mitigation tools, new capital projects and plant turnarounds (shutdowns) in the oil and gas sector continue to experience a high rate of failure. Based on initial data reviews, interviews, and case studies, the specific causes for failure on these projects point can be traced to the risk management process during the planning phases.

III. Defining Risk Management

The Essence of Risk

The nature of risk is *uncertainty*. Desired outcomes are inherently under threat of failure or non-compliance due to events that may occur during the project-, program-, or asset life-cycles. Such events may vary in their degree of probabilistic occurrence, magnitude of impact (severity), and manageability. Kerzner defines risk itself as "*[a] measure of the probability and consequence of not achieving a defined project goal*" [2]. Consequently, Risk Management utilizes such variables as probability and severity (impact) to typify risk and risk events for further action (risk response) or other considerations. Nonetheless, the specific shortcomings of the traditional approach are rooted in its 'linear' and sequential process thinking in regard to risk management. But even more sophisticated risk systems don't seem to deliver the desired results and frequently fail in their application for large and complex upstream projects. On its most basic level risk may be described by various functional elements, utilizing the variables or terms just introduced:

(1) Risk = f (probability, impact) = exposure
(2) Risk = f (hazard, safeguard), or alternatively, f(exposure, manageability) [1].

A risk is therefore defined as any uncertainty that if it occurs would affect one or more project objectives. But inherent to any economic endeavor, there are two kinds of risk:

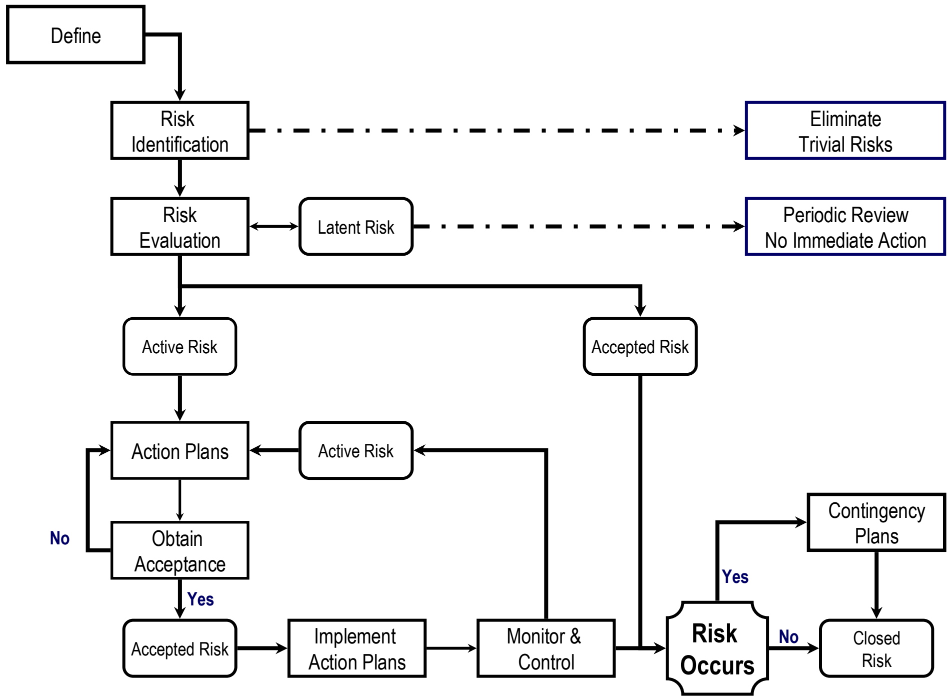
Threats: Any uncertainty that if it occurs would affect one or more objectives negatively.
Opportunity: Any uncertainty that if it occurs would affect one or more objectives positively.

Teams often view all risks as negative events and the potential for positive impacts are often under-estimated or not adequately considered in the risk management process. This very process is the methodology of identifying, listing, assessing, prioritizing, registering, and controlling risks, throughout the project life cycle, by eliminating or reducing the probability of occurrence and the potential impact caused by the threat[i].

The following Figure (1) shows the life cycle of a risk. Once a risk is identified and included in the register it should undergo the following process:

1. Assess the probability of the risk occurring and the potential impact on project or turnaround
2. Determine whether the risk is "Active" and therefore requires further work.
3. Develop action plans for active risks to reduce the probability of occurrence or reduce its potential impact if the risk were to occur.
4. Gain acceptance from other team members on the action plans.
5. Implement action plans and monitor the risk.

Figure (1) – Risk Management Process

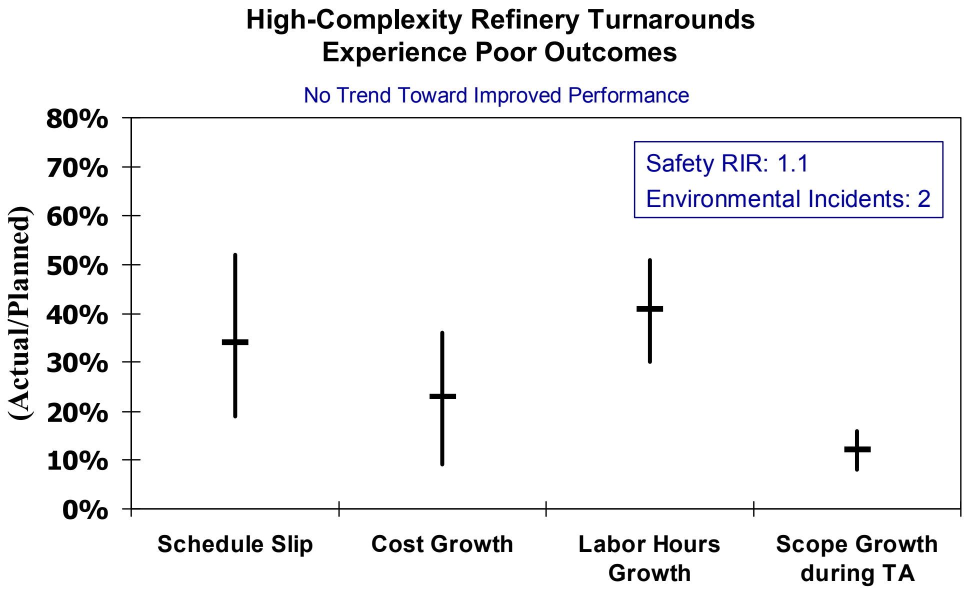


IV. The Nature of Risk for Oil and Gas Projects

The oil and gas industry is the world's most capital-intensive industry and invests hundreds of billions annually in new projects and maintenance of existing facilities. The industry has been using risk management techniques for several decades now but there has not been any systematic measure on how effective these techniques have been in improving project or plant turnaround performance. Based on our work with several large petroleum operators, we estimate that the rate of major project failure measured in terms of significant cost overruns (>20 percent), major schedule delay (>20 percent), or poor plant operability after startup is over 30 percent. The need to find and develop new fields is pushing the upstream sector to the extremes in terms of both environment and technology. For the major western petroleum companies, there are few opportunities to extract oil and gas with minimal risk any longer. This is compounded by an industry-wide skilled labour shortage.

This shortage of skilled labor appears to be having a particularly adverse impact on turnarounds (shutdowns) in the refinery sector. Plant turnarounds are the periodic and planned shutdown of facilities to perform maintenance and/or install new equipment. Figure 1 shows the performance of 36 recent high-complexity refinery turnarounds. The average schedule delay is more than 35% and the average cost overrun is 25 percent. Perhaps more importantly, there is a large degree of variability in the performance as indicated by the bars which measure plus one and minus standard deviation. This means that the turnarounds are highly unpredictable.

Figure (2) – Turnaround Performance Data



Source: AP-Networks Closeout Data from Jan 2005 through June 3rd 2005 on 36 plants

As these trends gather momentum, risks to project execution will only increase. The use and implementation of risk management systems varies widely across the oil and gas industry. Techniques range from simple spreadsheet based systems to more sophisticated enterprise-wide software systems. For the most part, project teams are identifying and tracking risks. However, effective quantification and implementation of response plans is lacking.

Highest Rated Risks in Oil and Gas Sector

Based on a database of risk registers we have identified what type of risks both project and turnaround teams are consistently rating as the most severe prior to the execution stage. In total, more than 25 risk registers of differing magnitude and granularity have been evaluated and sorted to reveal the dominant sources of perceived project risks in these sectors. For the most part, these teams used similar methodologies and tools to categorize projects within a common Risk Breakdown Structure (RBS) as well as an applicable

Work Breakdown Structures (WBS). Individual project teams tend to slightly differ on their interpretation of risk categories and to which element within the RBS the risk should be allocated. To overcome such deficiency, several basic and overarching categories have been introduced to capture all risks in a comparable manner.

Capital Projects

This analysis is based on nine major oil and gas projects. The combined number of risks identified within the reviewed risk registers amounted to one-hundred-eleven (111) after eliminating entries that are too high-level, unspecific, or may not qualify within the framework of this study. Subsequently, nine basic categories, such as Market/Commercial, Technology, and Organizational have been created to sort all qualified risks. Pursuant to the sorting, all categories have been counted to determine the rank-order, or priority of each category within the projects risk framework. Technology clearly topped the list, followed by Planning/Schedule and then Organizational. Project teams are consistently focused on ensuring that technical definition and design issues are well-defined prior to the execution stage and tend to view these issues as the ones with the both highest probability of occurrence and highest impact. The primary concern of these teams is to ensure that there is sufficient time to in the project definition phases to minimize the chances of late design changes during detailed design or construction.

Table (1) – Project Risk Rating
Rated in order of Risk Severity

RISK CATEGORY	SUB-CATEGORIES
1. Technology	- Ensuring adequate technical definition prior to detailed engineering - Use of new or unproven technology - Design flaws
2. Planning/Schedule	- Permitting takes longer than anticipated - Long-lead times for major equipment
3. Organizational	-- Adequate staffing, -- Effective team Integration and interface management - Partner alignment
4. Market/Commercial (Economic)	-- Ensuring robust economic case (ROI) -- Cost escalation and budget constraints
5. Scope Definition	-- Tie-ins with existing facilities (Brownfield modifications) - Adequate understanding of OSBL (Outside Battery Limits) interfaces

6. Procurement & Materials	-- Availability of staff and supporting equipment
7. Commissioning & Startup (Operational)	-- Interference with on-going operations
8. Health, Safety, and Environment	-- Safety Incident

Turnarounds

This analysis based on 15 large-scale refinery turnarounds. The combined number of risks form these registers total over 300. The highest rated risk categories deal with obtaining adequate resources in a timely manner. The top rated category is Technical Support followed closely by Contracting and Labor. Both categories are a reflection of the challenges being faced by large-scale refinery turnarounds in attracting enough skilled labor. In addition, turnaround teams are having increasing difficulty obtaining adequate internal technical support from other disciplines during the turnaround to deal with problems and trouble-shoot issues, particularly during the critical startup period.

Table (2) – Turnaround Risk Rating
Rated in order of Risk Severity

RBS Category	SUB-CATEGORIES
1. Technical Support	-Insufficient training and lack of both in house and contractor resources for startup and trouble-shooting
2. Contracting and Labor	-Limited availability of skilled craftsman and low quality labor
3. Planning, Scheduling, and Cost	- Inadequate process/systems to manage discovery work
4. Scope Definition	- Late engineering packages
5. Procurement and Materials	- On time arrival of materials and procedures to handle and distribute materials
6. Startup & Operations	- Insufficient number of operators available for startup
7. Shutdown and Chemical Cleaning	- Cleaning and handover of units takes longer than anticipated
8. Organization and Communications	- Poor understanding and communication of roles and responsibilities
9. Capital Projects & Integration	- Late capital scope and/or incomplete, poorly defined engineering packages

10. Field Execution & Logistics	Congestion, traffic, and offsite personnel
11. Health, Safety, & Environment	Changes in safety procedures, inadequate understanding of new regulations and inexperienced workforce

These data only represent a small slice of recent industry experience and the findings should be viewed as indicative rather than definitive.

Oil and Gas Case Studies

In the last year there have been striking examples of the sometimes-catastrophic risks faced in the industry:

- Sakhalin II is new offshore platform under construction on Russia's Pacific coast and is the largest integrated oil and gas project in the world, with total resources of some 4 billion barrels oil equivalent.

  Last year it was announced that the forecasted project costs would more than double from $10 billion to $22 billion due to high raw material costs and contractor overruns. Additional factors that have been cited as sources of the large overrun include unrealistically low contingency in the cost estimates, lack of hedging for foreign currency losses, and the difficulty of operating in such a remote location. The project has also been characterized by disputes with the Russian government over potential environmental violations. In December 2006, Shell the operator and leading shareholder in the development, sold most of their stake in the project to Gazprom after pressure from the government.

- A client of ours recently executed a refinery-wide turnaround estimated to be more than 500,000 man-hours with a planned duration of 40 days. The duration more than doubled to 81 days and the costs increased by 30%. Moreover the project was characterized by a below average safety performance and had a recordable rate of 0.93. The turnaround had developed a risk register but never effectively followed up by assigning risk owners and developing response plans. This turnaround also included a large portion of capital work. The risks of effectively integrating the capital work were identified early by senior team members, but these risks were never adequately understood or addressed by site management.

  Both the Sakhalin II project and the refinery turnaround had implemented risk management processes and systems. Still, they experienced a series of unexpected events that caught their management teams by surprise resulting in major failures. Our experience in working with and reviewing hundreds of the capital projects and turnarounds indicate that there are systematic flaws in how most teams are implementing risk management processes in practice. The net effect is that the risk management within these teams is lacking rigor and is not central to the daily management of the project. Typically, managing the risk register is delegated to a junior staff person without the authority or relationships to ensure that risks are being effectively evaluated and managed. This paper will suggest a series of steps that we believe will help improve the effectiveness and hopefully help reduce the rate of major failures in the Oil and Gas Sector.

To summarize, the oil and gas industry is unique and is particularly complex due to the following:

- Management of numerous internal and external interfaces
- Magnitude and scale
- Regional constraints
- Technology stretch
- Sensitivity to market conditions

V. Effective Risk Management – Tools and Techniques

1. Establish a Common Risk Categories or RBS

Table 3 provides Risk Breakdown Structures (RBS) for both Capital Projects and Turnarounds in the Oil and Gas Sector. These categories provide a logical method to group risks. The consistent structure can also help teams analyze risks across a portfolio and facilitate the sharing of risks across different functional areas. Reviewing previous Risk Breakdown Structure allows teams to learn from experience and better understand the systematic threats that need to be addressed during the risk identification stage. Moreover, teams should be able to identify what action plans were implemented and their level of effectiveness.

Table (3) – Risk Breakdown Structure

RBS Level 1: Capital Projects	RBS Level 1: Turnarounds
A. Scope and Definition	A. Scope Definition
B. Technical	B. Capital Projects & Integration
C. Contracting	C. Shutdown and Chemical

	Cleaning
D. Project Location	D. Technical & Tech. Support
E. Health, Environment, and Safety	E. Planning, Scheduling, & Cost Control
F. Execution Complexity	F. Field Execution and Logistics
G. Commissioning and Startup	G. Contracting and Labor
H. Operational	H. Procurement and Materials
I. Market and Commercial	I. Startup and Operations
J. Interfaces (JVs, NGOs, etc.)	J. Organization and Communications
K. Drilling and Completions *(Upstream Only)*	K. Health, Environment, and Safety
L. Subsurface *(Upstream Only)*	

2. Hold Cross-Functional Risk Identification Events

Risk identification and assessment workshops have proven to be one of the single most important steps within the risk management process for the Oil and Gas sector. In planning for such workshops specific attention is given to the attendee list, which should reflect the broad spectrum of all project or turnaround stakeholders. These workshops provide a unique opportunity for team members to not only identify potentially adverse issues arising from their area of responsibility, but also allow these team members to develop and crystallize essential interdependencies among various threats. Insomuch, risk workshops will add to the *connectivity* of the individual disciplines and reveal possible misalignment among team members on certain risk expectations. It is recommended, that several team workshops are held prior to the execution phase. These team workshops may have at times various *foci* other than risk depending on area or discipline under discussion (e.g. planning status, team alignment, etc.) but should at a minimum feature a review or discussion of the current status of risk assessments and risk-related action plans.

It has proven helpful to conduct post-execution assessments of specific risk actions taken in preparation for and during the project. The results of such feedback measures ensures effective 'lessons learned' application for future use. The cause and effect intelligence gathered in such a format will prove invaluable in planning for the next major project.

3. **Quantify Impact Values and Probabilities – Rather than Resorting to Ranges**

Team members should express probabilities and impacts as single number (eg. $10 MM, 5 months, etc.), or as a distribution (eg. min=$5, likely= $10 MM, max=$20 MM). Using quantitative numbers to express impact creates better alignment and consistency in how risks are rated among team members. Teams need to avoid qualitative assessments that are not linked to values since this will erode the quality of the risk rating and precludes further analysis and quantification of project risks. Importantly, the quantification of risks enables team members to perform some cost-benefit analysis. That is, what response plans, if effective, will have potentially the largest benefits on mitigating threats to project value?

4. **Avoid Over-Reliance on Simple Spreadsheet and Adopt Systems that Allow for Detailed Real Time Tracking and Visualization**

Most project and turnaround teams in the oil and gas sector have adopted spreadsheets to maintain risk registers. There is nothing inherently wrong with the use of spreadsheets, but their use tends to concentrate the risk management process to a single individual and preclude the cross-functional dialogue that should be a key part of the risk process. The use of specialized risk management software systems should make this process easier since the register can be accessed and reviewed by various team members.

5. **Develop Response Plans and Clearly Communicate High Impact – Low Probability Risks that do Not Have Mitigation Plans**

Many teams do a good job at identifying and quantifying risks and capturing them in a risk register. However, in our experience many teams fail to complete the risk management cycle by developing the appropriate response plans. For large registers the task may appear overwhelming to develop response plans for each risk. If this is the case, the team needs to prioritize on the high-impact and high-probability risks and ensure that at a minimum these are addressed. The team also needs to communicate the low probability risks that have high impact on project objectives. These are the threats that often result in catastrophic failure.

6. **Review the Risk Register as Part of Regular Team Meetings**

Make the review of the risk register a regular part of the weekly or monthly team meetings. This ensures that the risk process remains central to the management and communication processes.

7. Minimize Risks Through Improved Project Definition

The fundamental cause of most failure is poor planning and front-end loading. Risks can be minimized through excellent definition. This should be the aim of every project and turnaround team.

8. Re-Evaluate Risks Periodically

Teams need to hold-periodic cross-functional risk events to update the register with new threats and opportunities and re-assess existing risks.

References

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