Asset Performance Networks

LEADING INDICATORS OF TURNAROUND PERFORMANCE OUTCOMES

By

Bobby Vichich
(Vice President Turnaround Professional Services (2006))

Houston Office
18333 Egret Bay Blvd., Suite 640
Houston, TX 77058
Tel: +1 (281) 554-8181
Fax: +1 (281) 554-8585

Executive Summary

Turnaround outcomes are impacted by numerous factors of varying degree of controllability. Based on quantitative data collected from recent turnarounds, this paper examines and presents the drivers ("Leading Indicators") of turnaround performance and quantifies their effect on turnaround outcomes. The paper introduces turnaround risk and readiness indices ("TRI") and their relationship to turnaround outcomes, and the concept of a standardized turnaround scope index. Finally, benchmarks of best turnaround practices are shared.

Introduction

Turnaround data indicate that turnaround safety, cost, schedule, and operability problems are not random. Rather, these problems are predictable months prior to any particular turnaround. Leading indicators - such as turnaround characteristics and the level of definition and planning - have a quantifiable effect on turnaround outcomes. There are varying degrees, however, to which these leading indicators are controllable. This paper examines these controllable and uncontrollable factors and their effect on turnaround outcomes with specific focus on turnaround cost predictability and competitiveness.

Although the turnaround organization does not have control over many turnaround characteristics – such as qualified labor availability, material condition of the plant, equipment congestion, etc. – the examination and understanding of these characteristics enable the quantification of their effect on turnaround outcomes. And, therefore, provide a gauge of the likelihood of meeting turnaround targets. As importantly, effective risk management practices could lessen the effect of these characteristics on turnaround outcomes; and, hence, the negative impact that a protracted or costly turnaround may have on the manufacturing business.

Scope definition and planning practices, are not only within the control of the turnaround organization, but are also leading indicators of turnaround success. The best turnaround systems effectively use a gated and phased approach to turnaround definition, planning and execution. The best-of-the-best achieve integration and organizational alignment around their objectives, scope, plans, and execution strategies through the effective use of their gated and phased turnaround work process and its alignment with their project development process.

Industry Dataset

This study is based on an industry dataset of recent (past four years) turnarounds from industry. The dataset contains more than 400 refining and chemical turnarounds. A subset (135 units) of the refining portion of the dataset contains detailed turnaround scope data. Figure 1 provides a breakdown of the turnaround database.

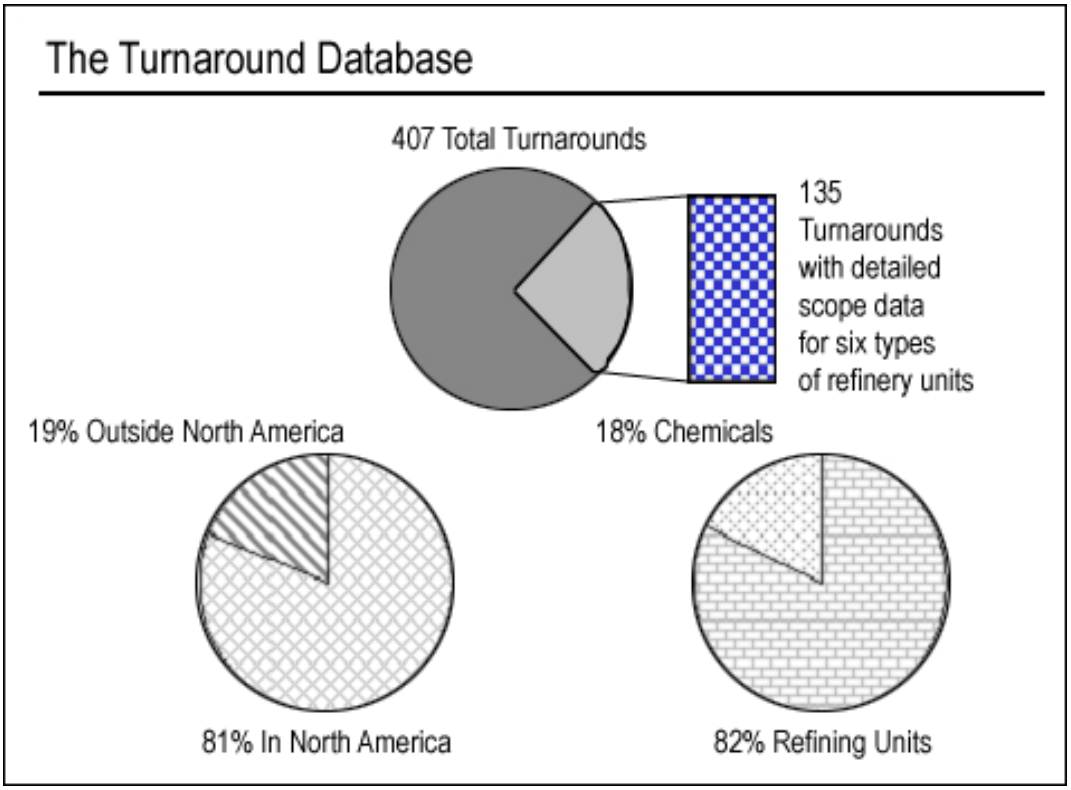

Figure 1

Quantitative Characterization of Turnaround Complexity

The data indicate that there are three turnaround characteristics that have the most influence on turnaround predictability: 1) the size of the turnaround measured in direct field labor hours; 2) the amount of capital work; and 3) the turnaround interval. The first and the second factors obviously measure size and difficulty, while the later factor is perhaps a proxy for the degree to which the material condition of the unit is known, as well as the experience of the team with the unit. The Turnaround Complexity Calculator© , as developed by Asset Performance Networks combines these three factors together to produce a single factor known as Turnaround Complexity™ which is a single indicator of turnaround predictability. The data shown in Figure 2 reveals the significance of Turnaround Complexity (High, Medium, and Low).

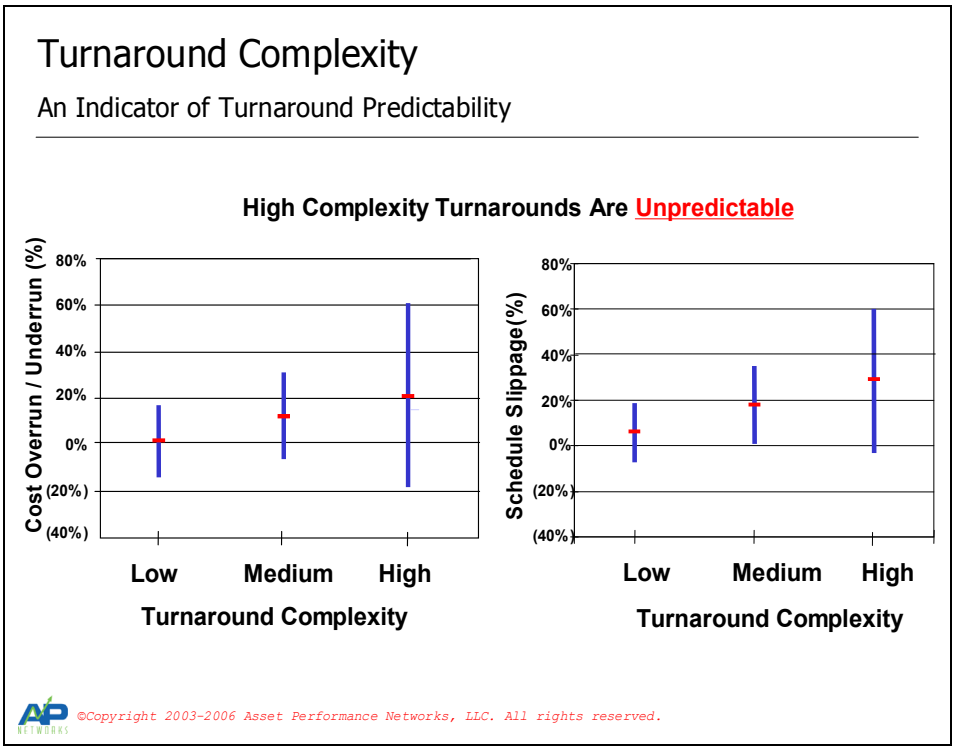

Figure 2

Controllable and Uncontrollable Factors driving Turnaround Outcomes

In addition to the indications offered by Turnaround Complexity, two larger categories of leading indicators work together to drive turnaround predictability, as outlined in Figure 3:

1. Inherent plant and turnaround characteristics that pose significant challenges and difficulties which are uncontrollable by the turnaround team.
2. Level of scope definition, planning, preparation and readiness to execute the turnaround, all of which are well within the control of the turnaround team.

Uncontrollable Leading Indicators

There are over 20 characteristics that influence turnaround safety, schedule, cost, and operability outcomes. The following are just a few examples of these characteristics:

- Turnaround complexity

- Availability of skilled labor
- Amount of piping work
- Amount of I&E work
- Changes to decontamination method and procedures
- Equipment congestion

The level of control that the turnaround organization has over these characteristics is very limited - for example, the outcomes of turnarounds with highly dense work areas are less desirable than those performed on less congested units. Turnaround organizations have no control over the plot plan or the equipment layout within the various operating units; and, hence, unit congestion is a given. Nevertheless, it has an impact on turnaround outcomes.

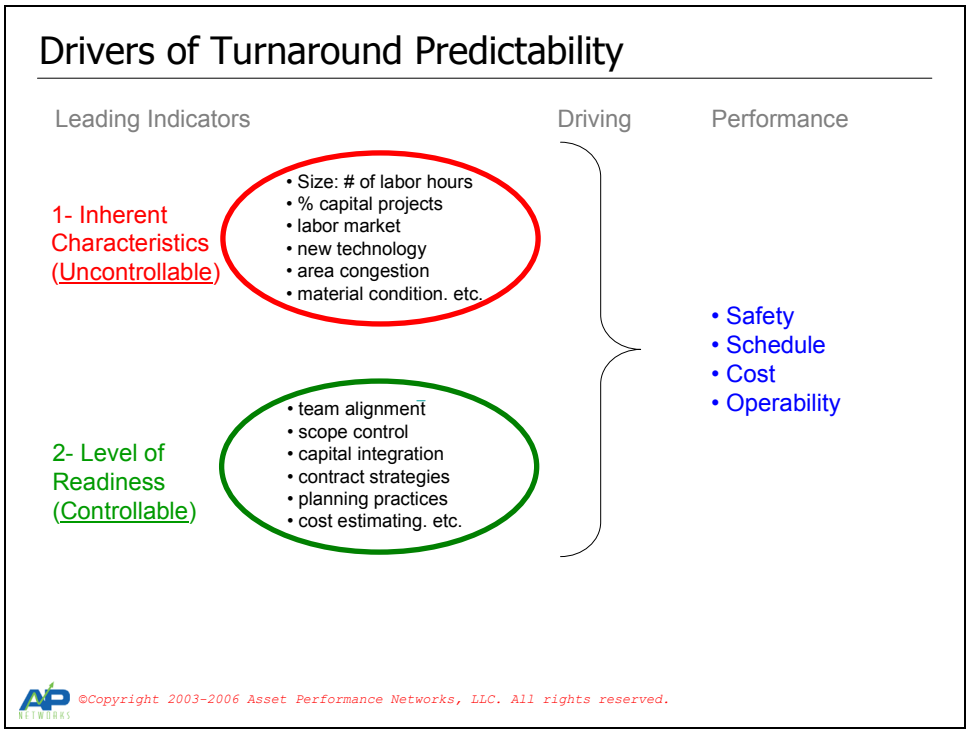

Figure 3

Figure 4 reveals the cost outcomes of a subset of turnarounds in our database. It shows that those with high inherent risks overrun their cost estimate by an average of 33%, while those with medium and low risks overrun by an average of 19% and 9%, respectively. It is important to emphasize that, although Turnaround Complexity is a significant factor in the Risk Calculation, the reference here to “high”, “average”, and “low” risks are different than the complexity categorization. The Risk Calculation accounts for more than 20 inherent factors, while complexity only reflects the most dominant three. For

brevity, Figure 4 shows only the cost variability, however, these inherent risks have a similar gradual impact (different percentages) on schedule outcomes.

Controllable Leading Indicators

Although each turnaround is characterized by a set of inherent, or uncontrollable, factors that affect its outcome, the turnaround team regularly deals with a myriad of factors that are controllable; and actually have a more profound impact on turnaround predictability. At a high level, these are: team alignment, scope definition and control, comprehensive planning, schedule integration, and level of preparedness - collectively "readiness". In the next section, we describe the Readiness measurement methodology, and examine its impact on the uncontrollable inherent risks described above.

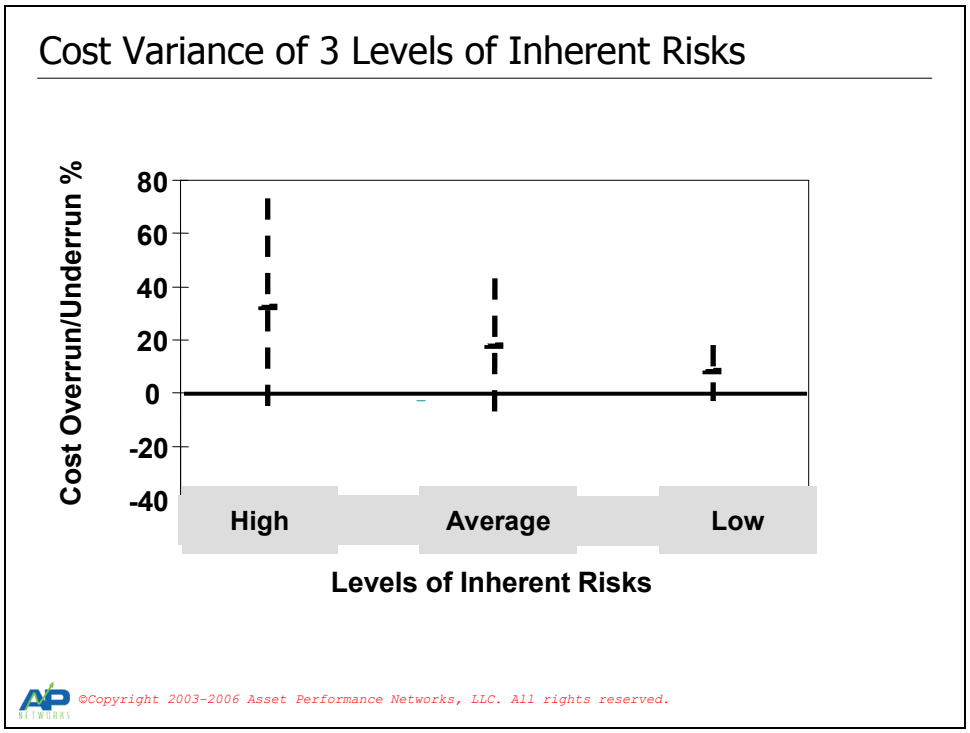

Figure 4

Turnaround Readiness Pyramid©

Asset Performance Networks has developed a Turnaround Readiness Pyramid© tool to measure the level of Readiness of a turnaround of any complexity at any point in time during the definition phase (i.e. the tool adjusts for 3 levels of turnaround complexities and for the time phases prior to the start of the turnaround). The Pyramid© is a web-based tool that involves each turnaround team member independently evaluating the teams' status in the 21 components of the turnaround preparation process. The results are collectively input into statistical algorithms and the status of each of the 21 elements is

displayed in a “traffic light” fashion (red, yellow, and green). Additionally, the Pyramid© calculates the level of alignment around the status of each of the 21 pyramid elements.

In the spirit of sharing with the industry-at-large, Figure 5 shows the Readiness Pyramid© for the average industry turnaround of medium Complexity in 2005. This pyramid shows the red, yellow and green light status for each of the 21 pyramid elements. A similar Pyramid© (not shown) is produced detailing the team alignment for each of the 21 Pyramid elements. The detail produced by the status and alignment pyramids are then used by the turnaround team to identify the more critical gaps, and ultimately prioritize resources.

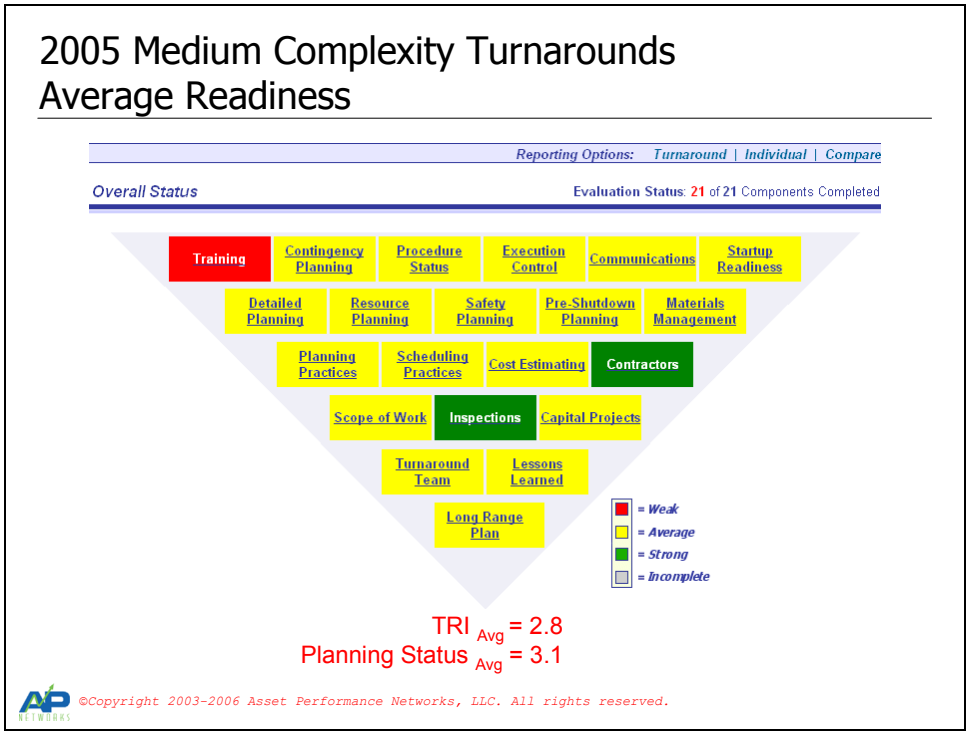

Figure 5

Surprising to most, team alignment is often a more influential driver of turnaround outcomes than is status, especially on high Complexity turnarounds. The most significant misalignment is usually contained within the Capital Projects component. For turnarounds with a high percentage of capital work, the engineering representatives consistently rate the status of this element as close to best practical (“engineering packages have been reviewed and are being produced in a timely fashion”); while the turnaround team members consistently rate it as having significant gaps from Best Practices (“engineering packages are behind schedule”). Misalignment indicates an opportunity for improved communications, and possibly more.

Turnaround Readiness Index

The Turnaround Readiness Index ('TRI") is produced when the Status and Alignment Pyramids are combined. TRI is used to indicate the ultimate level of readiness of a turnaround at any point in time in the preparation phase. TRI ranges between 1 (poorest) and 5 (strongest), with the optimal range between 3.8 and 4. The best turnarounds are not only well-planned, but the team is also well aligned. This is especially true for high Complexity turnarounds.

Figure 6 simply breaks down the Figure 4 data into three levels of Readiness - Poor, Average, and Strong (shown as Red, Yellow, and Green, respectively). The chart shows that Readiness improvement correlates not only to reduced variability, but also to lower average cost overruns. Readiness, or "TRI", is an extremely reliable indicator of cost predictability and, similarly, schedule variation and average performance.

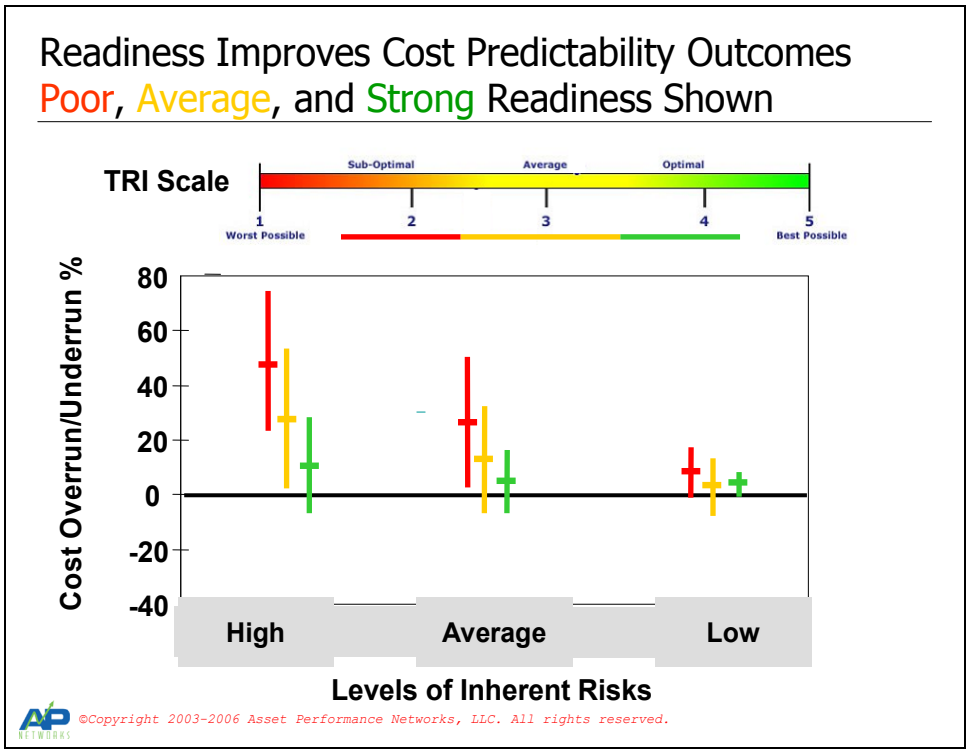

Figure 6

One additional "Semi-controllable" Factor also Drives Performance

As we continue to examine the controllable and uncontrollable factors driving turnaround performance, it is evident that Inherent factors and Readiness provide a very convincing indication around turnaround outcomes. And although both of these factors impact turnaround competitiveness; there is one additional and much more significant factor behind turnaround competitiveness – i.e. answering the following question: "Although my FCC turnaround overran its budget by 18 percent, how come its cost is still 20 percent under another FCC within my company which is of similar technology, size, and vintage and runs a similar product slate?" After adjusting for Inherent Risks and Readiness, the short answer is the amount of work scope. Hence, a Scope Index for each type of unit is required to be able to compare the amount of work scope for turnarounds on like units.

Figure 7 shows the total picture of how inherent characteristics, turnaround readiness and the amount of scope can work together to deliver turnarounds that are predictable and competitive. And, when these fundamentals are complimented with the right benchmarks, competitive targets can be set and ultimately achieved.

It is important to emphasize that scope comparisons should be done on an "apples-to-apples" basis. In the past two years, we have extended our database to include detailed planned and actual scope data on six types of refinery units. Our scope database currently numbers 135 units; and there is always room for more data and benchmark participants. We are in the process of developing a Turnaround Scope Index ("TSI"), which will be the third Leading Indicator of turnaround performance with a strong impact on cost and schedule competitiveness.

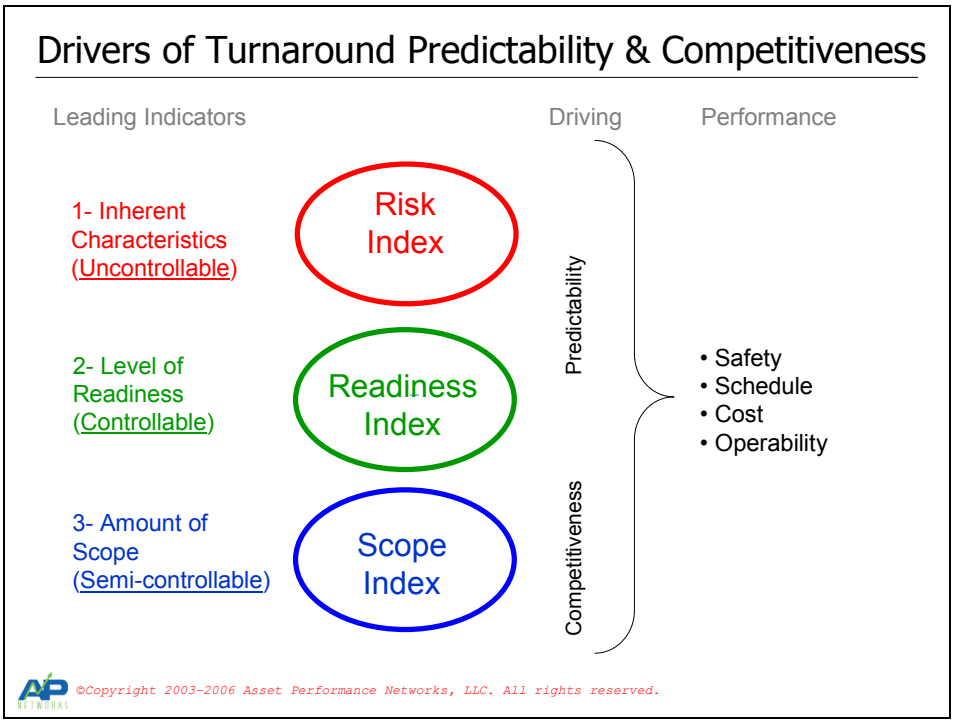

Figure 7

Conclusion

Not all turnaround disasters can be avoided. However, through strong team integration, thorough scope definition, risk identification and mitigation, robust planning and scheduling practices, and diagnostics and monitoring tools risks can be significantly minimized. As a result, the best turnaround teams plan and execute the right turnaround right by following their phased and gated turnaround work process. This means starting with strategic decisions that lead to well defined tactical planning, which, ultimately, end up as a series of comprehensive integrated execution plans. Identifying, defining and freezing scope; completing planning early; managing risks; achieving team alignment and all along measuring Readiness relative to world-class performers are the fundamental building blocks to achieve turnaround competitiveness and overall success.

About the Author

Bobby Vichich is Vice President of Turnaround Professional Services at AP Networks - a project and turnaround solutions implementation firm based in Bethesda, Maryland, USA. Bobby joined AP Networks' executive management team after 16 years in the petrochemical industry with ExxonMobil and Lyondell Equistar Chemical. Throughout his career, Bobby's focus has been work process design and measurement and optimization of turnarounds. He has

served in various planning, scheduling, controls and execution management roles of major turnarounds on many of ExxonMobil Chemicals' business lines. He also led a corporate benchmarking study chartered to define the next generation turnaround breakthrough performance metrics. Bobby has earned a recognized standing in the turnaround industry and has participated and chaired industry conferences on turnarounds. Bobby holds a Bachelor degree in Engineering from Virginia Tech.

About Asset Performance Networks, LLC

Asset Performance Networks, LLC (also known in the industry as AP Networks or APN) is a consulting and solutions development company with offices in Bethesda, MD, Houston, TX and the Netherlands. Our mission is to develop and implement innovative tools and solutions to enable breakthrough performance in plant turnarounds and capital projects in the oils, energy and chemicals industries. Browse the following portals for company information: ap-networks.com & turnaroundnetwork.com.

Appendix 1:

Brief Description of the 21 Readiness Components

Long Range Plan Long range planning is the process for establishing Turnarounds based on Reliability Issues, Capital Planning, and Economic Decision Models. Effective Long Range Planning permits sound management of Capital Projects together with Operational and Reliability Issues and permits an organization to better allocate its Human and financial resources.
Turnaround Team The Management of a Turnaround from conceptual stage to completion is a team effort. Team members must clearly understand their Roles and Responsibilities and work in an effective manner. Key practices include the organization, the leadership or steering team, and the team building process.
Lessons Learned A systematic study of critiques of previous Turnarounds and large capital projects is an important element in the preparation for a successful Turnaround. Key part of this process is to understand previously encountered issues with improvement action items assigned to individuals with deadline dates for completion.
Scope of Work The scope of work for the turnaround refers to all the activities that need to be planned and executed during the shutdown, execution, and startup phases. The scope includes all types of activities, including maintenance, inspections, and capital projects. Key practices include scope development, growth control, and analysis, prioritization, and evaluation.
Inspection The Inspection findings from previous Turnarounds and any in-process inspections must be accommodated in the work scope. During the Turnaround a key reliability process to assure mechanical integrity is an inspection plan to find any issues, and Risked Based Inspection techniques is being increasingly used by many organizations to effectively focus the Inspection effort.
Capital Projects Capital Projects are typically performed during the Turnaround of a Process Plant. Key elements include the project team, the engineering packages status, and integration of the activities. Another key practices is the coordination of the capital effort during the period immediately before and during the Turnaround window.
Planning Practices Planning is the process of analyzing the work scope to determine how it most effectively could be performed in the field. The Planning Process considers logistical issues to optimize the work and to assure that all advanced preparations are complete. In addition, plant shutdown and startup sequencing is often performed in this preparatory phase of the Turnaround.
Scheduling Practices The Process to sequence the work in the most effective manner is part of the scheduling phase of the work process. During this phase the critical path and the manpower resources required to perform the work are typically determined. The schedule must be able to be progressed in the field to establish proper control of the workflow. For a large Turnaround the scheduling is typically performed with a computerized Scheduling Program that allows " What If " type analysis.
Cost Estimating The cost estimating process is performed sequentially with more definitive estimates available as the detail planning progresses. Typically the cost is categorized into direct, indirect and overhead costs, each of these cost is tracked as part of the overall cost control effort. A good estimating method permits cost tracking and control during execution.
Contractors Contractors play a critical role in the planning and execution of a Turnaround, and this component relates to the owner's contracting strategy and process for selecting contractors.
Detailed Planning During this phase of the Planning Process the work scope is broken down into job packages which provide all the information to perform the work in the field including trade allocation, drawings, procedures tools, equipment and materials. Job walk downs with contractors are also performed during this phase of the planning process.
Resource Planning Resource Planning involves the determination of skilled craft requirements and the staffing needs of the Turnaround management organization. Logistical issues and shift schedules are also addressed during this phase of the process.

Safety Planning Planning is an essential tool to obtain excellent safety performance in the Turnaround. This involves the development of site wide safety guidelines and training requirements and training packages for the workers to be brought on site. During this phase job level safety analysis is performed to establish appropriate safety procedures such as Lock- Out / Tag- Out and Personal Protective Equipment are determined.
Pre-Shutdown Planning All work scope opportunities that can be performed before the Turnaround are planned and scheduled. Appropriate manpower planning is completed and used as an opportunity to mobilize and train the turnaround work force.
Materials Management During this Phase Materials are ordered and / or allocated and usually by equipment or project number with the computerized maintenance system. At this phase the plan to control and distribute and stage the material is established. Contracts with all execution contractors and shops for component overhaul area also completed.
Training A Training Plan for all necessary training including how and who will perform the Training is established. This involves site specific safely training for all the workers as they are mobilized on site. Operational and Maintenance training for new equipment or processes is also completed during this phase of the preparation process.
Contingency Planning During this phase all potential risks that threaten the turnaround execution goals are assessed on a basis of Likelihood and Consequence of Occurrence. For all high risk items contingency plans to appropriately deal with the risk should be established.
Procedure Status Comprehensive review and revision of all procedures used during the Turnaround is performed. This phase also includes the establishment of training packages for any new or revised procedures, which are identified.
Execution Control This phase of the planning process is related to the methods for controlling cost, schedule, and percent work completion during the turnaround execution. In addition, such issues as the handling of mischarges and monitoring fieldwork progress are also identified.
Communications The appropriate communication of turnaround goals and progress to achieving these goals is essential to the success of Turnaround. Daily and weekly meetings to establish priorities and resolve issues must be well planned and disciplined to be effective. Communication between shifts and units that must be worked together are also important.
Startup Readiness Startup plans refer to the specific pre-commissioning, commissioning, and start-up plans and procedures for each of these stages as part of the transfer from the turnaround team to operations. The handover and acceptance process is also included as part of this topic.