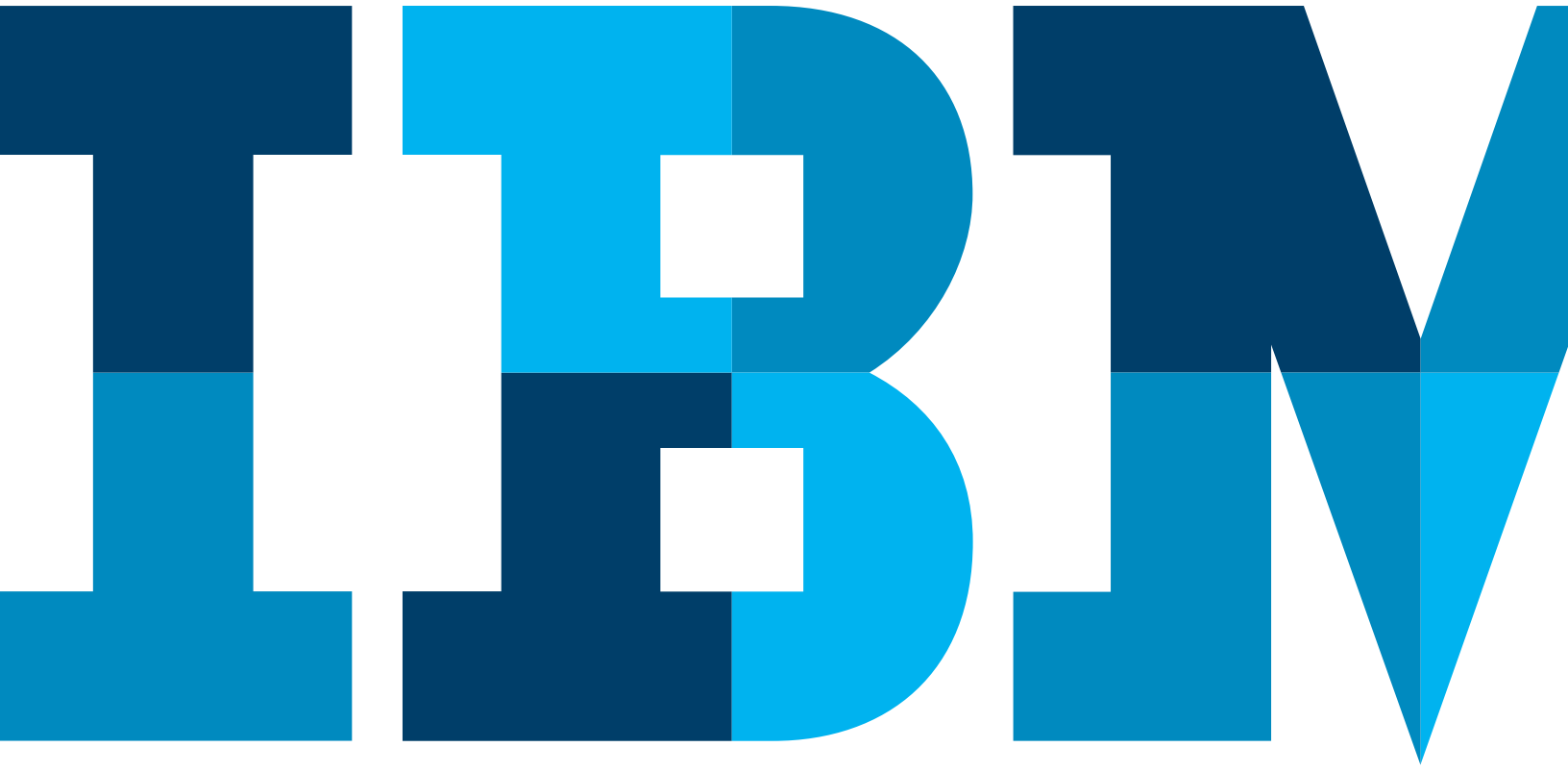
STAR: IBM's Smarter Turnaround Optimization

Maximize asset value through efficient turnaround management



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Introduction

Chemical and petroleum companies regularly have to shut down the production on plants and facilities due to preventive and corrective maintenance activities, modifications of the plants, and tie-in of new equipment. These may be planned or unplanned, be driven by inspection or certification requirements, be vendor-driven overhauls, or capital projects to improve performance. In all cases, turnarounds, often also called TAR, represent a departure from the steady state operations. In addition to being costly in terms of direct cash expense, opportunity cost (lost production) and new investment, they also represent an activity that is not always optimized in terms of process improvement and operational excellence. Only needed on a periodic timescale, the turnaround is a fundamentally different business activity from daily oil or chemical production and requires different skills, different processes, and different tools to get the job done right.

Most chemical and petroleum companies rely on their seasoned experts to make critical turnaround planning and execution decisions. Unfortunately, much of this competency is usually locked away in the intuition and gut feelings of an aging workforce. Turnaround activities may differ from location to location, and the efficacy of the turnaround activity is more often the product of local know-how and heroism than one of formal best practice and technological knowledge. Even though sophisticated planning tools are used to create long term plans for the turnaround, close to the start of execution, planning gets messy with manual workarounds. Lack of proper scheduling solution often leads companies to absorb loss of valuable wrench time during execution.

Making the turnaround more complex is the fact that multiple groups of individual contractors may be assigned to each work package. Offshore turnaround planning is typically constrained by weather conditions, the availability of skilled personnel, transport of spares, personnel and materials, offshore berths, offshore storage capacity, and available workspace. The typical turnarounds are usually planned at least 18 or more months ahead. The decision-making process becomes too large and too complex in today's world for even the most tenured practitioner working on intuition.

Our vision for turnaround optimization

Chemical and petroleum companies would benefit if turnarounds were:

- Optimally balanced—scope and schedule are optimized based on facts and data analysis
- Faster to complete—the downtime was minimized especially during run-down and start-up
- Less costly—the resources and investments needed to execute the work were optimized, with less overrun exposure
- Better coordinated—critical maintenance and other beneficial tasks were conducted during both planned and unplanned turnarounds; tighter scope management for turnaround
- Less risky—few overruns, fewer health, safety & environment (HSE) risks, better asset security
- More opportunistic—improvement and maintenance opportunities were exploited when turnarounds and shutdowns were forced because of dependencies
- Neutral and objective measurement of turnaround efficiency

Achieving these goals requires a new approach and vision for turnaround management. This new mode has several operating characteristics that are different from most typical current state operations, including:

A holistic, enterprise view and visibility: Decision-makers can adopt new views and greater visibility into facilities that may be all linked together in a complex production infrastructure that comprises every stage from wells to market, including views of multiple sites, offshore and onshore locations, interdependencies, and is based on your specific asset environment.

Knowledge and intelligence driven decisions: New fact-based decision-making generated from site and planning data replaces or augments traditional intuition-based decision-making. Knowledge is analytical and technology based, making it consistent and available across decision-makers, workforces, and sites.

Sophisticated longitudinal viewpoints: Turnarounds must be planned over different timescales: for the immediate (execution), the short-term (planning), and long-range (five to 20 years) to provide an optimized turnaround and shutdown strategy. Longer timeframes can create improved longer range equipment management planning and production forecasting strategies. This also makes it possible to evaluate the effect modification and capital expenditure (CAPEX) projects have on future turnarounds.

Risk awareness and proactive risk planning: Decision makers must be aware and ready to deal with risk, such as understanding which assets require maintenance shutdowns, calculating production loss associated with both planned turnarounds and unplanned shutdowns, and understanding HSE and operational risks.

Optimized preparation and execution: When executing turnarounds, teams have information about specific equipment systems, their current condition, associated inspection programs, mean-time to repair and risk profiles, and the duration and cost of the repairs required if a failure occurs. Thus they are able to use sophisticated optimization techniques to manage schedules, assets, resources, and milestones to execute the project optimally. Risks and performance driven by interdependencies is planned and managed.

Evaluation and quantification of a benefit case: Anything that cannot be measured cannot be improved. Throughout scope management, expected quantified benefit of delivering an asset shutdown should be captured. Each item in the Turnaround delivery scope should be analytically evaluated either for risk reduction or for benefit realization measure. Risk reduction value should be measured by estimating the reduced probability of the asset's unexpected failure times and the impact of that failure. Benefits expected should be recorded from the business case of the plant modification driver. Benefit achieved through the cost of turnaround delivery gives a normalized measure of turnaround efficiency. Benchmarking and improvement actions should then be measured against efficiency gain.

It is therefore imperative to have a strong analytical backbone throughout five phases (scope, plan, execute, start-up and evaluate) of turnaround through a process to stich these phases together. This needs integration with corporate systems like work and asset management (WAM), supply chain management (SCM) and a visualization dashboard (for example a corporate reporting solution). It does also need a change in mind set.

IBM STAR or Smarter Turnaround Management Solution: Making optimized turnaround a reality

Turnaround optimization is ambitious and requires new procedures, tools and training to enable the decision-makers and user community. IBM has developed a solution that combines custom analyses, best practices, and powerful technology assets that enable chemical and petroleum companies to transform their turnaround operations. Most aspects of the field are well established and include practices such as linear programming, integer programming and nonlinear programming, derivative, and derivative free methods. Several oil and gas companies are extremely good in managing end-to-end supply chain through integrated application architecture, and others are catching up fast. Many use analytics for the asset management function to understand an asset's future performance and failure probability. IBM's Smarter Turnaround solution leverages enterprise integration framework to optimize turnaround process, brings traceability and transparency and reduces production losses.

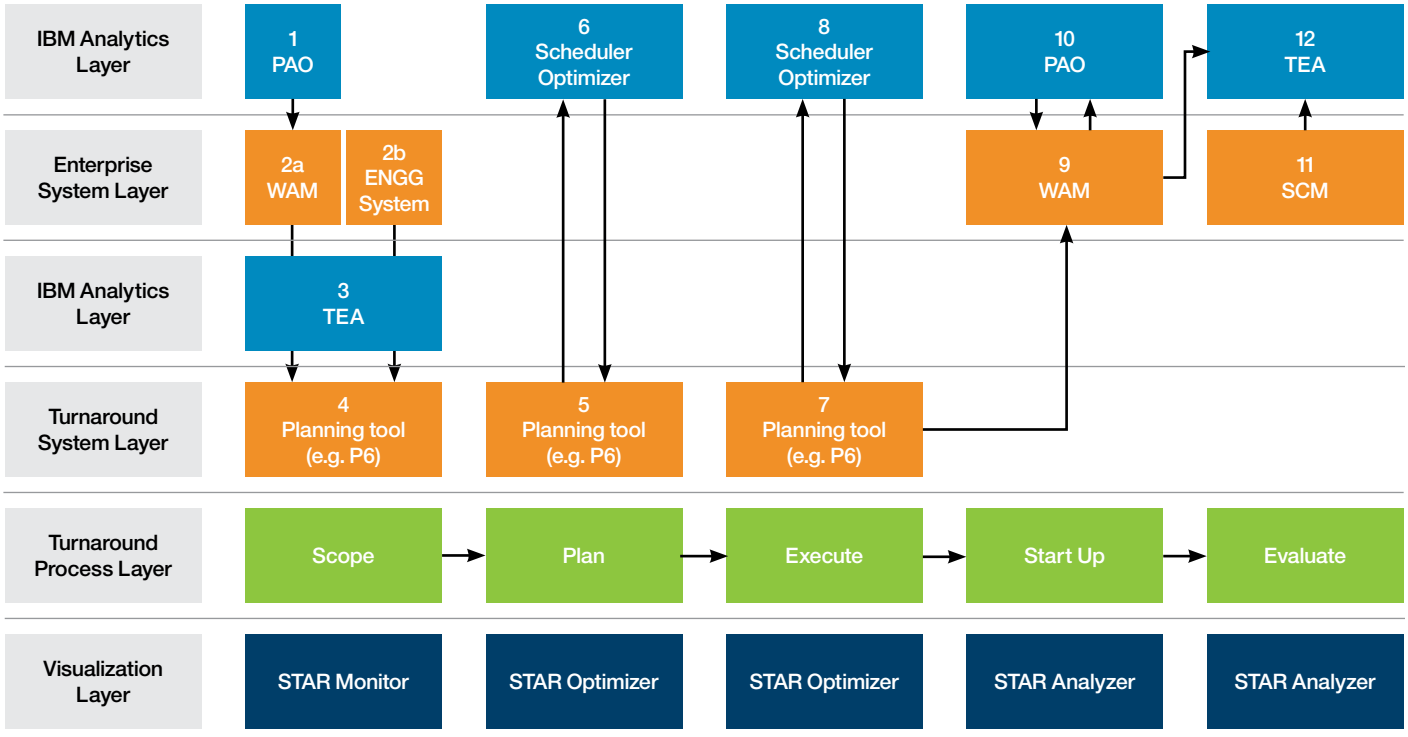


Figure 1: Layers of the Smarter Turnaround Management Solution.

A high-level view of an instrumented, intelligent and interconnected turnaround process looks like Figure 1 where a layer of analytics is enabling traditional turnaround management to become a smarter one, creating the Smarter turnaround or IBM STAR solution.

At the heart of this solution is a new toolset that enables decision-making, risk analysis, and execution planning with an integrated view of the turnaround. More than just technology, this solution requires new competencies, processes, and information strategies that may change many of the traditional activities in planning and executing turnarounds.

The IBM Smarter Turnaround Solution is comprised of three core components:

- STAR Performance Monitor
- STAR Analyzer
- STAR Optimizer

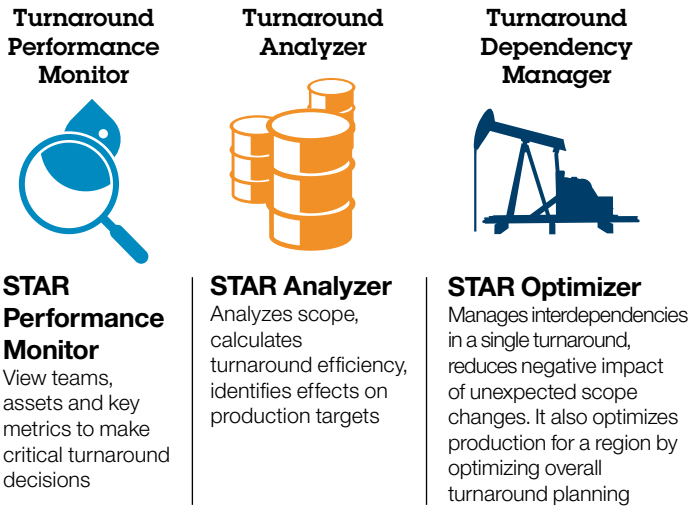


Figure 2: Decision-making intelligence and processes.

The STAR Performance Monitor

The STAR Performance Monitor makes it possible for chemical and petroleum companies to standardize the way they set up, monitor, and benchmark turnarounds across their facilities, to discover and evaluate the effects of possible performance problems prior to turnaround execution, and to compare the performance of their turnaround projects. It enables companies to monitor the progress of ongoing turnarounds, assess shutdown preparedness, identify possible delays, and evaluate the consequences of delays on production efficiency.

The Performance Monitor measures and plans for turnaround preparedness. Turnaround preparedness is evaluated against a set of predefined measurements, such as the number of work orders finished at the various milestones; the time it should take to shut the facility down; and the production lost during the down period. The planned metrics are then benchmarked against actuals during the execution phase. This ultimately enables analysts to understand and estimate the effect of preparedness as well as measure how to utilize unplanned shutdowns opportunistically, such as performing maintenance activities. The STAR Performance Monitor consists of the following modules:

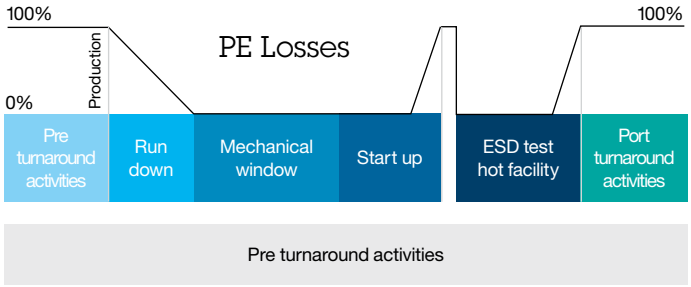
Turnaround Management Assistant—captures data about the turnaround description, project team and manning resources required to execute the turnaround.

Facilities & Infrastructure Database—captures data about the asset, its production profile, logistical information associated with the asset and asset dependencies.

Turnaround Progress Monitor—measures the team's planning preparedness for the turnaround and is time-linked to key milestones leading up to the point of turnaround execution. The milestones cover areas such as work order generation and approval, long lead purchase orders, job safety plan development, and other key factors. At the end of the mechanical execution of turnaround, it tracks activities associated with start-up. It helps track two crucial phases of the execution, Run Down and Start Up, through a planned duration and highlights anomalies for investigations and improvements.

Standard Job Package Descriptor—creates standard packages of work that are carried out in turnarounds (for example, vessel inspection, turbine overhaul, pipe work inspection) and includes risk profile data and resource requirements for the work.

Turnaround Key Performance Indicator (KPI) Dashboard—measures the turnaround execution performance through a series of specific KPIs aligned to the corporation's KPI tree. This module measures loss factors (or availability targets), turnaround duration, scope growth, budget, and HSE performance.



The STAR Analyzer

The STAR Analyzer helps chemical and petroleum companies plan turnaround frequency and duration for a specific facility that gives the lowest production loss, and set realistic production efficiency (regularity) targets for their facilities. For example, a facility might have a production efficiency of 91 percent, but evaluation with the Turnaround Analyzer indicates that a more a realistic target is 92 percent. The Optimizer might indicate changes that would make a 94 percent target possible.

The STAR Analyzer also helps companies identify the key performance drivers within the system, such as which piece of equipment should be replaced, bolstered, or monitored more efficiently for unplanned shutdowns to be avoided. The STAR Analyzer along with the Dependency Manager offers tools for real-time evaluation of various turnaround scenarios and supports selection of the scenario that has the overall lowest production loss, enabling the decision-maker to use more facts and less "gut feeling" in the process.

The modules include:

Risk Profile Database—collects information about specific equipment systems, their current condition, their associated inspection programs and program status, mean-time to repair, and failure profiles. The data used in the database is used to feed directly into the Risk Analyzer module. IBM Predictive Asset Optimization, or PAO, provides a comprehensive capability to provide risk information of all of its corporate assets.

Standard Job Package Analyzer—isolates an equipment system (such as a compressor) and analyzes the inspection and repair program that is defined in the maintenance management 5 or 10 year plan. The analyzer then defines the most optimum timing of turnaround required to carry out inspection or repair activity. This module is designed to optimize the number of turnarounds required over a five to ten year period with the aim of optimizing the number of turnarounds required, thereby increasing plant availability over time and reducing the probability of unplanned plant failures or shutdowns.

Turnaround Efficiency Analyzer (TEA)—calculates turnaround delivery efficiency based on a neutralized and quantified calculation. Turnaround Efficiency Analyzer calculates the turnaround delivery benefit as a ratio between the quantified benefit of a turnaround and cost of delivering that turnaround.

The STAR Optimizer

The STAR Schedule Optimizer optimizes delivery plan and execution schedules for a single turnaround more efficiently than the commonly used planning and scheduling tools. Traditional tools rarely can accommodate multiple business constraints. It is often difficult to accommodate additional work during execution. Replanning is time consuming and often unoptimized. As time is precious during execution, often additional tasks are manually added to the schedule without considering impacts on the overall schedule. Such plans are prone to manual error too.

The STAR Optimizer cannot only improve turnaround delivery plan, but it can also quickly optimize the schedule when any unexpected tasks pop up during execution. It elevates planning and scheduling optimization to a new limit of efficiency by accommodating a large number of uncertainties using a Constraint Programming algorithm. This strong analytics-based planning outweighs the commonly used Critical Path Method.

The STAR Dependency Manager, another part of the STAR Optimizer helps synchronize turnaround plans across assets or fields. This helps chemical and petroleum companies avoid situations where one facility that has recently been shut down for a turnaround is shut down again shortly after due to interconnects with another facility. This is particularly important to companies with dependencies between their fields, such as dependencies due to third party processing, power delivery services, gas processing, transportation, or blending services. The STAR Dependency Manager contains tools for developing test and evaluation scenarios and simulations to help determine the optimal path forward. It then facilitates the definition of work and job packages that support optimal execution of the turnaround. It is driven by trying to minimize the number of days of lost production due to turnaround and shutdowns.

The overall solution has been designed using an integration framework that allows automated collection of key data from enterprise resource planning (ERP), maintenance, and planning systems and to complement existing functionality found in typical ERP packages. The solution may also be extended with asset management functionality and connectivity using enterprise asset management tools such as IBM Maximo.

STAR provides an integrated framework that, along with the dependency manager's analytical layer, can assist handling complex scheduling and execution challenges. The framework allows mobile integration for better coordination during Run-Down and Start-Up phases when several teams engage in a number of interconnected tasks simultaneously. Mobility along with STAR Performance Monitor can significantly improve execution efficiency.

Delivering value—process and people

STAR brings a new perspective to traditionally run turnaround management. The change starts from the integrated process flow, which needs change in human behavior, alongside the technology. STAR brings a new way to work, clear accountability and performance measure. To exploit full benefit of the approach, companies need improved governance processes through which strategic ambitions can be translated into planning parameters, and through which achieved levels of asset performance can in turn be reviewed against strategic intent. It also needs training and adjustments to ways of working that help the turnaround planners make best use of the guidance presented to them.

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- Providing our clients with an integrated approach to business design and execution, turning strategies into actions; these strengths applied to business issues and opportunities give our clients not only the ability to anticipate change, but also take advantage of new possibilities

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Produced in the United States of America
October 2014

GBW03252-USEN-01