Chapter 3

Islands of Pain

Executive Summary: To change behavior, first understand the problem. Historically, sub-optimal supply chain practices within organizations have created "islands of pain." These islands evolve as individual departments implement isolated EAM and supply chain management programs. Like a balloon squeezed at several different points, an organization feels the effects as these localized and isolated management tactics ripple through the organization, most often in terms of added cost and inefficiencies. This chapter classifies the most common islands of pain and outlines alternative practices—the building blocks for a cohesive Strategic MRO solution.

Paul's presentation to his Executive Forum had gone well. Forum members had been intrigued with his classification of Strategic MRO channel players as: asset owners, asset makers, and asset service providers.

While most of the forum members were asset owners, there were a few asset makers. These asset makers quickly realized they too were asset owners —they owned plants, equipment, and other assets used to make the assets that were their primary products. All of the forum members readily identified asset service providers as those firms that supplied them products and services that kept their assets, plants, and equipment running.

The forum members also were quite interested in the revenue created per dollar of asset investment statistics Paul talked about. Over the past week, Paul had

received several telephone calls from forum members who had calculated their own company's revenue per dollar of asset investment. The calls seemed to have a common theme: What are the problems within companies that lead directly to below-average revenue generation per dollar of asset investment? This was the same question Paul was contemplating.

Future Perfect Revisited

The phone calls from his fellow forum members directed Paul's thinking toward the next forum topic. He knew the goal was future perfect. In his mind this meant:

- Only produce exactly what is consumed in the market.
- Only invest in the assets necessary to produce exactly what is consumed in the market.
- Only invest in assets that never fail over their useful life.
- Achieve zero Total Cost of Ownership (TCO) for all assets.
- Only invest in resources that enable the first four future perfect objectives.

What Paul didn't know was what was in the minds of his company's top executives. He called a staff meeting to discuss future perfect. He began by redrawing his future perfect continuum and explained its meaning (see Figure 3.1)

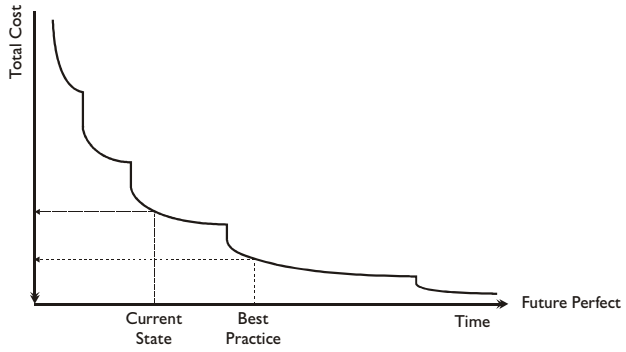

Figure 3.1 - Future Perfect Continuum

The vertical axis represents total costs for the organization, he explained. The future perfect target is zero total costs. The horizontal axis represents the passage of time. Careful analysis and changes in organizational practices involving people, processes, and technology over time should result in lower costs. Thus the graph moves downward (lower cost) as it moves to the right (time passes). Another way to say this is that costs are lower this year compared to last year because we improved our processes. Costs do not go down just because time passes. The graph generally goes down with the passage of time because people take actions that result in improved business processes.

Paul asked the group to look at the left side of the graph. This represents a point in time many years ago when our industry was relatively unsophisticated. Notice that costs are high compared to where we are today, which is labeled Current State on the graph. In the early days of our industry, there were large cost reduction opportunities because practices were unsophisticated. Thus, at the extreme left of the graph, costs declined dramatically with little passage of time as the industry improved its practices. But, when the early, easy improvements have been made, further reductions in cost are more difficult to attain. That is why the cost curve's rate of decline tends to flatten out over time.

The vertical drops in total costs (step changes) are a direct result of deployment of new technology. For example, the change from manual machining operations to computer controlled machining operations represents a change in technology that reduces costs dramatically. The declining curves between the step changes brought on by new technology represent incremental cost reductions due to fine-tuning day-to-day use of the technology, processes, and people currently in place.

Finally, the point labeled Best Practices represents the cost position we will enjoy when we have implemented all of the best practices known today both within and outside of our industry. Points to the right of Best Practices depict cost reductions that may be attainable in the future due to not-yet-envisioned new technology and business practices.

The extreme right portion of the graph represents the use of future perfect business practices and technology that result in costs much lower than today's costs.

Leadership's Vision of Future Perfect

Now that his staff members understood his future perfect vision, Paul asked each person to describe future perfect in their world.

His CFO wanted to be able to produce products without owning any assets or paying for materials until the company was paid for the products they sold. In fact, the CFO really wanted to delay payments to their suppliers until 45 days after they were paid for the products the materials went into.

Paul realized that owning no assets was probably not possible. He was gratified, however, that his CFO understood that future-perfect visions should not be constrained by what you think is possible but, rather, directed toward what would be the perfect case. The example Paul had used to illustrate the folly of thinking something is impossible was a simple one. In 1869 how many Americans would have thought it possible for a man to walk on the moon? Yet a mere 100 years later the moon walk was reality.

Paul's COO wanted to have the lowest cost operation possible that only produced what the customer needed, right the first time, at the time the customer needed it. Though these were great aspirations Paul wondered if true future perfect for operations might include more than this.

Future perfect for the maintenance manager was more people and materials to deal with the unpredictable nature of the machines. Paul wondered if future perfect in the area of maintenance should be that every failure is predictable. If that was the case, then he could minimize the number of resources needed to react to failures and simply take steps to prevent the failures to begin with.

The supply chain manager wanted suppliers that delivered just what was needed, when it was needed, at the lowest total cost of ownership. What a perfect situation.

Paul thought it remarkable that, so far, no one contemplated a future perfect model that consisted of a totally vertically integrated company. He sat back in his chair, stared at the ceiling, and said: "What if we had a design where all supply resources were under one roof, under one command, and under one system, sort of the Henry Ford idea at the River Rouge facility?"

After a long silence, a free-for-all conversation began. Ideas about dedicated or shared capacity, owned capacity versus bought or leased capacity, and owned or supplied designs had always created much debate. The notion of outsourcing non-core competencies that support core competencies of the organization was another fundamental point of disagreement. The discussion, although thought provoking, quickly diverged. Paul steered the team back to their visions of future perfect.

The engineering staff believed future perfect consisted of product and service designs that required no assets at all to produce. The breakthrough! Now we are getting it, Paul thought. His engineering staff wanted to design products and processes that enabled the company to create revenue at the desired profit levels with no production costs. They knew assets were cost drivers. Their goal was to eliminate them.

Paul knew his assets represented a potentially huge liability in employee safety, health, and welfare. Environmental contamination such as emissions and spills represented threats to his employees and to the community. His legal chief agreed that future perfect for them meant zero legal liabilities for contract performance, health, safety, and environmental practices.

His CIO wanted the lowest cost technology that met the information requirements necessary to support sales, engineering, operational, financial, and legal objectives. The CIO defined the role of information technology as a process enabling, compliance assuring, data driven system that facilitated management direction, communications, and continuous improvement efforts. Not to be outdone by engineering, the CIO indicated his goal was zero DRIP (Data Rich Information Poor) processing. In essence, all data collected was to be converted into useful information, at zero cost and zero maintenance, enabling the organization to achieve its future perfect objectives.

At the end of the meeting, Paul compared his future perfect objectives to ones generated by his staff. Certainly his staff was more focused in their application of future perfect. He had to find a way to align his vision with the vision of his executive staff. Misalignments seemed to create joy for some and pains for others. Procurement got the lowest price but operations paid for it in increased failures

and maintenance costs. Engineering designed the most reliable equipment in the world, except some of these highly engineered items had 16-week lead times. It seemed as if his staff had local rather than global visions. Visions focused on their own areas sometimes created islands of pain for other areas within the company. Paul wondered how he could get people to think in a company-wide or more global way.

Paul reviewed his future perfect continuum and doodled on it. How do I make sure our decisions move us collectively toward future perfect at the lowest total cost?

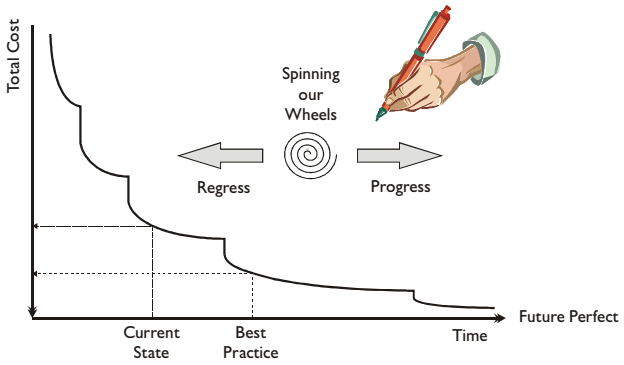

Figure 3.2 - Future Perfect Progress

Paul wondered how he could focus the Strategic MRO initiative while motivating his staff, which seemed—with the possible exception of his CFO—focused on their own individual islands of pain instead of future perfect. The more he thought about it, the more he realized these islands of pain would make a great topic for his Executive Forum. As he began jotting down his thoughts, Paul realized that behavior could not change if people didn't see or understand the impact of their misdirected behavior. The misdirected behaviors were, in part, what kept companies from moving toward future perfect.

Paul decided to focus on understanding the essence of each island of pain. He also vowed to never forget the bigger picture, the overriding future perfect. His intuition told him the notion of future perfect would help his staff see their short-term pain in the context of the perfect but (for now) unattainable future they had to move toward.

Classifying the Islands of Pain

Behaviors in the industrial market are driven by the desire to satisfy local needs and create local profits. Local decisions are often made for local expediency in a particular business environment and/or geography, lacking a broader viewpoint that considers more far-reaching issues. For example, a distributor may make inventory investments in excess of what is actually needed by local customers. That

distributor may lack knowledge of what local customers actually consume, may want to receive price breaks from suppliers for buying in quantity, or fear that if they cannot immediately meet the needs of a customer they will lose a sale.

Expanding the local view of industrial market behavior to a more global view reveals that various inefficiencies are introduced into the components of enterprise asset management and the MRO supply chain by these apparently optimal local behaviors. For example, quantity discounts often drive inventory reorder quantities. To get a piece price reduction, distributors buy in excess of what is needed to support the actual consumption of their customers; subsequent overproduction by manufacturers results.

Overproduction results because the manufacturer of the product that the distributor has stocked in excess mistakenly views product movement to the distributor as consumption by the end user. The manufacturer then schedules to produce more of the material. Thus, excess inventory is introduced into the supply chain. This excess inventory carries with it costs related to storage, obsolescence, taxes, loss of opportunity, and many others. This is but one example of a business practice at the local level that creates waste in the supply chain.

We call actions that are seemingly optimal at the local level but sub-optimal in the total supply chain view "pathological behaviors." These behaviors introduce huge inefficiencies resulting in unnecessary costs and seriously hamper overall value stream performance. Those that persist in engaging in such behaviors will not be rewarded with competitive advantage. Those that identify these pathological behaviors and set out to change them will set themselves apart in their respective industries.

Our goal in this chapter is to identify sub-optimal practices or islands of pain. Of course, our view is a more global one. Individual businesses, with their understandably local view, will have to define their own place and practices within this global view. We have loosely classified the islands of pain within each of the five future perfect objectives described at the beginning of this chapter.

Islands of pain associated with the future perfect objective: Only produce exactly what is consumed in the market.

A company today must participate in a complex supply chain to deliver its "unit of value" in the form of products and services to the market. Too much or too little production results in waste or lost opportunities. Finding perfection in volume, timing, and delivery is a constant challenge. The various islands of pain make it evident that both strategic and tactical Strategic MRO initiatives are required to be successful in today's market.

Pain #1: Strategic MRO is not considered an executive imperative.

Rarely do mundane topics such as enterprise asset management, maintenance management, storeroom management, MRO supply chain management, equipment standardization, condition based monitoring, reliability-centered mainte-

nance, total productive maintenance, and other operational issues make it to executive staff meetings.

Operational costs are summarized, reported, and compared to the budget. But what is really important to the executive?

- Our stock value today?
- How are sales figures looking?
- How are our margins?
- What is our backlog?
- Are there any potential accounts on the sales horizon?

To slight Strategic MRO issues in favor of the above concerns represents a lack of focus in our opinion. Strategic MRO initiatives can and do result in operational cost reductions. For a company earning 5% profit on sales, $50,000 in operational savings equals the same increase in profit as $1 million in additional sales revenue. Understandably the top line is important. Increased sales revenue is a tried and true path to a larger bottom line. Another path to the bottom line is through successful deployment and management of assets. However, this path is often ignored at the executive management level.

Pain #2: Outsourcing your way to the lowest total cost.

As companies pursue various supply chain strategies such as contract manufacturing, outsourcing core competencies, and supply partnerships, the assumption is that the organizations performing the outsourced activities are more cost effective than funding the activities in-house.

Too often we have observed outsourcing viewed as a bid-and-buy activity. A short-term perspective leads to choice of the low bidder to perform the outsourced activities. The low bidder might have bid at very slim margins to get the job. When this is the case, there may be no way for the bidder to afford to implement the appropriate enterprise asset management and Strategic MRO initiatives needed to assure cost improvement over time. Outsourced cost improvement should be expected in the same sense that internal functions are expected to become more efficient over time.

In the worst case, the low bidder may be counting on a price increase next year to offset the slim margins in the year the bid was originally won. The bidder's thinking may be that in year two it is harder for a company to internalize a set of activities that were outsourced the year before. That bidder may be right.

A contract manufacturer may have no vision for the life of the product being made for a third party. The primary vision may be to maximize profit. Reality suggests that most products must be made in an ever more efficient manner to remain competitively priced in the market.

Contract manufacturers may receive tools and machines from contracting companies. This can create lack of standardization in the contractor's plant. It can

hamper efforts toward efficient enterprise asset management and development of low-cost MRO supply chains.

The issues above can diminish the ability of the supply chain to produce a combined "unit of value" that meets the four economic utilities of form, time, place, and possession. One weak link puts the entire chain at risk. Shifting of asset responsibilities does not shift the risk of the value stream.

Pain #3: Ignoring the impact of geographical location on Strategic MRO initiatives.

Imagine your operation attached to both its customer and supply base with a series of rubber bands. What happens when you move operations to a low-cost labor country? Is the infrastructure adequate to handle your operations? What new or different government regulations apply to the operations and maintenance of your assets? What about the MRO supply chain? As companies go global, so must the assets. The value stream is only as productive as its assets.

Islands of pain associated with the future perfect objective: Only invest in the assets necessary to produce exactly what is consumed in the market.

Companies must invest in two types of assets to fulfill its market obligations: revenue producing and non-revenue producing assets. We will discuss this distinction in more detail later. However, for now, we will say that over and under investment in both types of assets has associated costs and penalties. Ideally asset investment equals the market requirements for value creation, no more, no less. The following islands of pain focus on the importance of aligning asset requirements to market demands.

Pain #4: The asset lifecycle is the least of our worries.

Companies focus on meeting sales objectives until it is time to expand, sell, or shut down operations. Then what becomes of the assets?

In practice every company that produces a "unit of value" must manage a product lifecycle. In general, it begins at product concept and ends at obsolescence. The asset lifecycle must be perfectly matched to the product lifecycle to achieve the lowest total cost. Rarely does industry synchronize product and asset planning. The asset planning should encompass design, development, and production as well as obsolescence to achieve the lowest total cost. Which assets will be upgradeable, expandable, repairable, disposable, resalable, or recyclable?

Lifecycle decisions relating to revenue-producing assets impact the profit contribution of the products they produce. Non-revenue producing assets must be managed to improve workplace performance without ballooning operational costs. The asset lifecycle is as important as the product lifecycle if the organization intends to create value as a going concern.

Pain #5: Disconnect between EPCs, product lifecycles, and O&M.

As asset-owning companies outsource their asset design, build, and installation activities to professional asset service providers, managers need to maintain a keen awareness to ensure that Strategic MRO remains an internal core competency. Engineering, Procurement, and Construction (EPC) companies build plants to a specification put out to bid. These specifications may not align the product lifecycle with the asset lifecycle.

The EPCs do not run the plant, so their limited knowledge of product and market requirements must come from the customer. When these requirements are not effectively contained in the plant specifications, the outcome is inevitable—a mismatch between asset design, build, and startup and product performance objectives. This is the first disconnect between the EPC and the product lifecycle.

EPC bid awards are typically based on the lowest acquisition cost, not necessarily the lowest Total Cost of Ownership (TCO). Too often, parts of the plant and equipment are specified using the words "…or equivalent." This equivalency phrase in the specification creates latitude designed to allow the EPC to shop for the best price. This is well and good, except that it leads to an outcome that creates lack of standardization in components and equipment. This in turn creates a high-cost operating environment for the operations and maintenance (O&M) function that eventually has to maintain the plant; it drives the "operational" cost of assets up. Thus plants are built in a manner designed to reduce the initial construction cost without thought to the years of high MRO spend and high investment in MRO inventories that will result. This is what we describe as a disconnect between EPCs and O&Ms.

As a result of these disconnects, the early maintenance activities often include equipment resizing and changing out of serviceable components to achieve standardization objectives. Changeout may also occur as maintenance installs components for which there is a ready and dependable source of supply. This higher than normal MRO spend in the early years of a plant should be accounted for as a capital project overrun in the plant construction budget, but this rarely happens. Collaboration between the firms constructing the plant and those that will eventually operate and maintain the plant will result in lower MRO spend throughout the planned years of equipment operation.

Pain #6: Operating as if all assets are exactly the same.

This behavior manifests itself in a number of future perfect objectives. However, this island of pain originates when companies make their initial investments in assets. There must be a clear distinction between revenue-producing assets and non-revenue-producing assets. If a choice has to be made between a marble entryway to the corporate office or a more reliable production asset, what do you think the priority should be? If the marble entryway wins because we need to

show customers that we are a professional organization then the price we will eventually pay is greater equipment downtime.

Clearly, assets that create the "unit of value" must be given first priority. First priority must also be given to the best engineering talent, the best maintenance resources, the best supply chain specialists, and the best operators. Simply put, all non-revenue-producing assets may represent unrecoverable costs if revenue-producing assets are not doing their jobs as efficiently as possible.

Islands of pain associated with the future perfect objective:
Only invest in assets that never fail over their useful life.

If the asset never fails, it never needs servicing or replacement. This is future perfect. However, the second law of thermodynamics stands in the way of achieving our future perfect. The second law of thermodynamics states that all unattended, irreversible systems requiring mechanical energy will eventually stop, due to wasted energy, friction, wear, and failures. This is the nature of the assets we use to create value. Our future perfect driver is to mitigate the asset's performance deterioration over its intended useful life. What are the more frequently occurring islands of pain that stand boldly in the way of future perfect?

Pain #7: Lowest acquisition cost wins out over the lowest TCO.

Acquisition cost is often narrowly defined as the purchase price of an asset. The goal of some is to get the lowest price, period. We affectionately call these people price buyers. All sales people loathe them because they hate having to justify the higher price to them. Their single-mindedness is often rewarded with bonuses and the world is their negotiation stage. Our contention is that any untrained person can select the lowest price. Caveman tactics have been around since the beginning of humankind. What's new?

A better approach is where an asset-owning company says "Time out on outdated practices! What do we need from the asset and what is that worth to us?" This is the essence of Total Cost of Ownership decision-making. What are the "all-in" costs of owning an asset? Price is only one component of TCO calculations. Acquisition includes all costs of design, sourcing, freight, and installation of an asset.

TCO goes considerably farther than this. TCO also considers cost of ownership components such as insurance, maintenance costs, operating costs, MRO supply costs, the cost of downtime, cost of first-time-through quality and other factors. The final component of TCO is the cost of disposal. Alignment of the asset lifecycle with the product lifecycle is key to minimizing the impact of assets outliving or failing prior to the end of product life in the market.

In practical applications, engineering goals to ensure performance requirements and to minimize liability often result in asset over-design situations. Requiring engineered components or high-end products where commodity components would suffice may unnecessarily drive acquisition costs up. Likewise,

purchasing's need to drive down initial acquisition costs by choosing the cheaper alternative without consideration of component failure rates and plant standards may drive operational costs up.

The battle lines are now drawn between engineering and purchasing—lowest operational costs versus lowest purchase price. These battles then move into operations. Construction is pressured by the organization's need to speed up the build, install, and startup process to accelerate revenue creation. This may leave little time or money to consider the longer-term asset maintenance and performance requirements.

In some cases, it could be argued that engineering is looking out for the maintenance impact by designing assets that have the highest reliability and availability. Reality often suggests otherwise. Listen in on most maintenance planning and problem-solving sessions; the first question is invariably, "Who designed this piece of junk to begin with?" Does pain know no boundaries?

Pain #8: All asset failures are the same.

In an ideal world, do all assets and components fail in a similar way? Our contention is that the company loses if engineering designs assets expecting all component failures to be predictable and thus preventable. Why? All failures are not predictable. Reliability and failure studies consistently identify several distinct and common failure patterns. Each failure pattern, like infant mortality where parts fail shortly after being put into operation, requires a different maintenance plan. This infant mortality maintenance plan would be very different than the plan for a component that has long life under planned load.

Earlier we said that all assets should not be treated the same. We said, "that first priority should be given to revenue-producing assets." We now suggest that all failures are not the same. Therefore Total Cost of Ownership decisions must be based on some reasonable knowledge of failure patterns of the owned asset.

A failure impacts a function. All functions of revenue-producing assets do not necessarily impact the production of the "unit of value." Using this logic, key functions, often described as key control characteristics (linked to key product characteristics), take first precedence for understanding potential failure patterns. Within this priority scheme the organization begins to develop the lowest total cost plan to respond to failures before, during, and after failures occur. Subsequently, this plan becomes the essence of demand planning for labor, materials, and equipment to maintain assets.

Pain #9: Thinking that OEMs know their equipment failure rates and thus your spare parts need.

We notice spares inventories that have never been used in plants . Upon investigation we often find spares for equipment that no longer exists. We have observed this often enough during our routine analysis of MRO inventories that we

felt compelled to understand why investment is routinely made in items that are never used.

The answer is surprising but believable. A package of spare parts is available for newly purchased equipment. Many buyers of equipment purchase this spares package reasoning that, "who could better know better what fails and needs replacement than the original equipment manufacturer?" The lesson here is that those who design assets do not always use them. Likewise, those who design and build plants (EPCs) may not have experience operating and maintaining them.

This is not to suggest that all original equipment manufacturers are clueless as to what should be in spares packages, only that some know better than others. The key is to understand how the manufacturers of equipment used in your plants determine failure rates. Buying spares from the OEMs is one of the warranty conditions. However, OEMs seldom agree to buy back unused parts.

Do OEMs perform failure mode and effects analysis? Do they track component failure rates as reported from the field? Do they request failure rate estimates from their component manufacturers? Know the answers to these questions before investing in OEM recommended spares.

Pain #10: Two assets are better than one.

"Don't worry if it fails, we've got a back-up." Why do we need 110 buses when 100 will do? You never know when one will go down? Extra assets are sometimes used to compensate for poor operational and maintenance practices. Engineers should design assets with a reasonable assumption of proper use and maintenance. Planning for and supporting redundant systems is costly.

Continuing the logic of our previous islands of pain, the first priority is given to revenue-producing assets. Focus first on functional failures that impact the "unit of value" itself. Redundant systems play a significant role in mitigating critical failures that are unacceptable and have a reasonable chance of occurrence. What is a critical failure? Is it related to the cost of the lost asset? What is reasonable? Should it be a 50 % chance that failure will occur during hours of planned operations where the cost of unpreventable downtime is equal or greater than the TCO of the redundant asset?

Pain #11: Who needs standards? All commodity MRO products perform the same.

Some argue that process engineering should actually be called configuration management. They argue that most asset designs are merely a combination of commodity components fashioned in such a way as to perform desired functions. Because we are dealing with commodity components, market channels exist for the parts to repair the asset.

With the exception of highly engineered assets, this is not a farfetched description of the world we operate in. Just because three bearing manufacturers exist and each has an equivalent bearing, does it make sense to have all three bearings in use

in a plant? Our price buyer says yes, because it provides the ability to pit competitors against each other to obtain the lowest price. The maintenance person may say it's no big deal. The products look alike and do the same thing. The storeroom clerk smiles as, once again, poor thinking increases his job security. The operations manager wonders why MRO inventory costs are so high. And engineering wonders why maintenance keeps installing brand X that seems to fail twice as much as brand Y.

For simple asset components, standardization has little effect on skill required to install and maintain. For more complex components this is not the case, especially if the device requires both hardware and software knowledge. Lack of standardization leads to the proliferation of MRO inventories and increased need for skilled resources to service differing brands of equipment. Design standards—based on failure rates, ease of installation, source of supply, and other cost factors—lower TCO.

Pain #12: Condition-based monitoring is too expensive.

Rather than using condition-based monitoring (CBM) systems, some companies rely on maintaining extra maintenance staff and stocking all possible repair parts. This often is the unintended consequence of running all equipment to failure or replacing items before they even hint at failure. These policies dramatically increase MRO inventory investments and contribute to excessive levels of unplanned plant downtime.

Failure patterns can vary significantly. Each failure pattern drives different maintenance strategies. A primary goal should be to prevent failures that impact the critical functions of a revenue-producing asset. To accomplish this, companies try to determine if an asset or its components can alert us to an impending failure. Early warning systems and CBM systems have been designed for this purpose.

Condition-based monitoring is an automated way to trigger the work order for repair activities. These systems can trigger the demand for purchase of what otherwise would be expensive repair parts that might sit idle in an MRO inventory. Condition-based monitoring systems have become reliable and affordable in the past few years. Still, CBM systems are viewed as too expensive by many companies because of a short-term view that focuses on the initial cost of the system. When used properly CBM can alleviate the need for unnecessary preventive maintenance activities, lower MRO stock inventory, and provide a signal to schedule needed maintenance thus avoiding unplanned plant downtime.

Condition-based monitoring systems are no less prone to failure than any other well-designed system in a plant. They can be sabotaged or circumvented by unhooking or wiring around sensors. Circumvention is often an indicator of a lack of understanding of what the system is supposed to do or the desire to put off needed maintenance. Used properly, CBM systems operate in real time and sense conditions to trigger the scheduling of component replacement, adjustment, or additional testing and inspection.

Islands of Pain associated with the future perfect objective: Achieve zero Total Cost of Ownership (TCO) for all assets.

For those still unconvinced that Strategic MRO is a strategic imperative, consider the following islands of pain. Achieving zero TCO is a future objective that drives organizations to eliminate all wasteful asset management activities and thus reduce cost of operations. These wasteful activities number in the thousands. We will simply point out the ones we see most often. These wastes begin with design, then are accentuated by how an organization manages the supply response to asset demands. Supply consists of labor, materials, and equipment necessary to satisfy asset demand created through use.

Pain #13: Lack of basic understanding of costs and realization of cost savings.

Costs come in two flavors: hard costs and soft costs. Hard costs savings are savings that result from money not being spent. Soft costs savings are savings in time and in a few cases, space. Savings in time are interesting, but not as interesting as not spending hard currency. "Show me the money!"

Hard currency not spent reveals itself as increased cash in bank accounts and larger net profit. Soft cost savings may not result in any change in hard costs and thus may never have a measurable impact on expense budgets and the bottom line.

As an example of a hard cost savings, consider cutting tools used in a plant. Suppose the tooling vendor sells the plant on using a kind of cutter that costs twice as much as the currently used cutter but lasts four times as long. So, for example, the expenditures for these cutters might be reduced from $40,000 per year to $20,000 per year. The $20,000 not spent is a hard cost savings. That $20,000 remains in the cash account and does not appear as an expense; net profit is $20,000 higher.

Now consider, as an example of soft cost savings, a technology that can reduce the time needed to process purchase orders by 30 %. Those trying to sell such technology will calculate cost savings by multiplying 30 percent of the time required to process a purchase order by the number of purchase orders processed and then multiply that by the wage rate of the person processing POs. This calculation will result in an estimated dollar cost savings based on reduction in processing time.

But suppose there is only one person processing purchase orders. Due to adoption of our example technology, the person processing purchase orders will now have 30 % fewer of their daily hours occupied. Since the time savings is less than one person equivalent of total time, it is likely that no real cost savings will ever occur because it is difficult to reduce the work force by 30 % of a person. Time savings are a soft cost savings that can only be considered a hard cost savings when they accumulate to the point where a person can and is removed from that department's payroll.

Sometimes actual savings in processing time never result in decreases in payroll expenditures. The time required to perform the work required can be expanded to exactly fit the time available. People may do this to avoid having to learn new skills or because they fear loss of their job.

Let's review another example. Companies often are frustrated in their efforts to understand the true nature of cost savings from reducing maverick purchases. To reduce maverick purchases a company may consider new technology designed to link purchasing and the maintenance function directly to suppliers in real time. Organizational goals include improving purchasing procedures, increasing responsiveness and eliminating off-contract purchases. Of course, the technology has a cost, so a cost justification that looks at future cost savings must take place.

The new technology will prevent purchases from unauthorized suppliers and will easily and automatically direct purchase of specific items to the supplier who has the contract for that item. These are all positive outcomes. The cost savings mistake comes when a figure of 40 % of the yearly dollar value in past maverick purchases is recorded as the cost savings attributable to the new purchasing procedures and technology.

Sure, the new system will help people procure materials from the right source at the negotiated price in the future. Our point: the material will still be needed and bought in the future. The cost savings is not the value of the maverick purchases prevented. It is the difference in price between what was paid in the past and what will be paid in the future when bought on contract from the correct suppliers. You can also estimate the savings in time; just keep in mind that this is a soft cost unless the savings total up to a person equivalent and that person is removed from the payroll.

One more example. Procurement cards (p-cards) are another area where we see mistakes made relative to cost savings. Someone calculates that every purchase order processed costs the company $250. (Where that number comes from is often suspect but, for our example, let's assume it is at least close to correct.) The solution appears to be to issue fewer POs and the procurement card is the mechanism that will allow needed materials to continue flowing into the plant. But to actually reduce costs through processing fewer POs, head count usually must be reduced. This may or may not happen.

With the new p-card strategy comes loss of control in several areas. First, it is difficult to tie demand back to the asset creating the demand when the purchased items are bought using p-cards. Preferred suppliers may not be used. Much time may be wasted driving to suppliers that have the perceived lowest purchase price on selected items. Finally, reconciliation of p-card statements may be the responsibility of the maintenance department. This effectively shifts a relatively unskilled clerical job responsibility to a relatively skilled person in the maintenance department. Did we save money with the p-card strategy?

Finally, in the area of mistakes relative to cost comes the area of inventory investment. MRO inventories create much higher internal cost than many com-

panies realize. Most companies think that inventory investment carries a cost equal to the cost of short-term borrowing. In reality, the cost of MRO inventory investment is much higher than this. At best, the cost should be considered equal to the return on assets expected by the company's equity holders. Even this is probably on the low side. If we take into consideration the cost of insurance, storage, pilferage, obsolescence, asset recovery, and disposal as well as the cost of money, the cost of inventory ownership is 20 % of the value of owned inventory per year at a minimum. Most companies would be better off buying MRO inventories as needed even at a slightly higher unit price compared to maintaining large investments in inventory.

To clarify, we endorse endeavors to lower soft costs whether based in technology, process improvement, or both. Even if time savings never impact the bottom line directly, they are important for at least two reasons. First, reductions in cycle time usually result in better customer service. Second, freeing up time allows a company to process additional transactions in the future—brought on by growth, for example—without having to expand head count.

So continue to look at technology and process improvements that will save time. At the same time, understand what will affect the bottom line directly so your assessments of cost savings made to justify technology and other activities today will be close to the reality observed in the future.

Pain #14: 80 % of MRO costs are designed and redesigned in.

Most MRO improvement efforts are focused on improving processes and equipment currently in use. This is a natural focus; the equipment and processes in place are what people have to work with when called on to reduce costs. However, 80 % of the cost of operating equipment and processes is locked in by the initial design of the equipment and processes. This means the most effective after-design improvement endeavors can only hope to reduce costs by 20 % unless redesign occurs.

Because we know assets wear or fail through use, it is reasonable to assume these assets will have to be maintained. Some key questions:

- Does the design lend itself to ease in serviceability? This implies the asset design has been optimized to reduce the time, effort, and expense of changing components and performing routine servicing. Design considerations may include modular design, allowing quick change of component subassemblies.
- Does the design require component standardization across a number of sizes of machines to reduce the number of spare parts required in an MRO inventory? Component standardization further reduces the number of maintenance specialists required.
- Is the asset designed with the MRO supply chain in mind? Or does a special, engineered item drive up replacement lead times, machine downtime, and the cost of critical spares and specialized labor?

- Do we repeat these same oversights during redesign activities? Do we understand the impact of uncontrolled modifications to equipment on TCO?

Pain #15: Our problems would be solved if we only had more maintenance resources.

A recent assessment of a manufacturing facility revealed the need for more electricians. The reason given: "If you only knew how many controllers we have, how much programming we must do, how many power substations we must support.... A more detailed study revealed legacy (old) control systems dating back to the early 1980s, six different brands of PLC's (programmable logic controllers), and nearly 600 PLC configurations. When asked about the impact of having one brand, the same PLC model year and sizing standardization on the number of electricians, the response was simple. We would need less, not more resources. Why then would a company continue to pay the labor, material, and downtime premium to operate this way? Our experience is they haven't calculated the total-cost impact of their decisions.

Here is a simple test of the above logic. What if your company operated using DOS, Win 3.1, Win NT, Win 2000, Unix, 12 different database engines, four accounting systems, and 12 different PC brands? What do you think your IT (Information Technology) staff would look like and how much would it cost to support this wide variety of systems? Are you doing the same thing to your maintenance staff?

Our next question is even more straightforward. Have you established a hierarchy of asset criticality, with an associated demand criticality classification so that maintenance resources can be scheduled to respond accordingly? The answer for most companies: All assets are treated the same. We have already addressed this island of pain. Studies indicate that the presence of a formal demand response strategies can reduce wasteful labor efforts a full 25 %.

Our assessment of the plant used in our example above revealed that less than 25 % of a maintenance person's time was actually spent performing tasks to restore an asset to its desired performance level. Because maintenance personnel were spending more than 80 % of their time responding to non-critical functions and non-revenue-generating assets, they were not readily available to perform the critical tasks that impacted the company's revenue creation. It's no wonder many plants see maintenance costs going up and think they need more people.

Pain #16: No time for planned maintenance or downtime when we are building to stock anyway.

Two quite different production philosophies exist. One is make-to-order and the other is make-to-stock. Companies that pursue a make-to-stock production strategy should always build planned downtime for planned and preventive main-

tenance into their schedule. Unfortunately, too often we see companies building stock to a forecast and putting off maintenance. Why? Because the forecast demands it.

In fact, the forecast is nothing more than an educated guess as to what future consumption will be. Why put off planned and preventive maintenance when we are building inventories? No customers suffer as a result of selling off inventories during maintenance. Base production on consumption in the market. This reduces finished goods inventories and leaves time for planned maintenance.

Pain #17: Internally supplied functions have no cost to us.

Incremental cost analysis is a pathological behavior in many companies. We define incremental cost analysis as the general practice of observing that performing one additional activity adds no cost because we own the function that performs the activity. Examples of this behavior abound. It is often said that the cost of taking one more order is nil because we already have the order entry person working an eight-hour day.

Maintenance is another example. Rather than investing in condition-monitoring equipment and utilizing real-time predictive maintenance, companies rely on a run-to-failure strategy because "we already have a maintenance workforce and the labor cost of one more repair is near zero." The same holds true with material handling. Rather than redesign production facilities and warehouses to drastically reduce material movement, companies use existing forklifts and operators to move materials in circuitous paths.

Inventory cost analysis is another area where incremental cost analysis leads to sub-optimal decisions. Warehouse people and space occupied are not deemed to be a part of the cost of ownership of MRO inventory "because we already have the space and the people." Acknowledging these costs means a much higher (and more accurate) inventory carrying cost. This in turn would increase efforts to reduce inventory investments.

Incremental cost analysis is not inherently wrong. It is simply not well understood and often misapplied. In many areas, costs change as a step function rather than in a linear way as activities increase. That is to say, adding activities may not change costs until the point is reached where another person must be added to the workforce. Then total costs go up by the amount of that person's salary plus benefits. At that time activity costs increase dramatically because the additional person initially is underutilized.

Internally supplied functions have a cost that, averaged over time, should remain fairly constant on an activity-performed basis. The notion that total cost does not change as activities are increased is purely a short-term view that leads to poor long-term decision-making.

Pain #18: Managing labor utilization instead of TCO.

Some think that human resources must be fully utilized to justify their existence on the payroll. That mindset can lead to hard dollars spent on non-value-adding activities, such as rushing to repair or replace non-revenue-generating assets.

A maintenance person creates real value by brainstorming how to improve the efficiency of production assets, not by performing activities to fill the day and show high labor utilization. The prime objective must be to improve the availability and reliability of revenue-generating assets. Labor content should be measured relative to total cost reduction and revenue enhancement.

For organizations whose assets are geographically dispersed, travel time can be significant. Work-order reporting may indicate high labor utilization if travel time is counted as a part of the total time to perform maintenance. This is misleading. We would really like to see the effect of all non-value added time so that it can be prevented in the future. Management by TCO aggregates work orders by geographic proximity, thus reducing the cost of non-value-adding activities, such as travel.

Pain #19: Not integrating production and maintenance planning.

Idle resources and inventory increase when production and maintenance planning are not integrated. For example, suppose that a manager of a mechanized deep-level mining operation is given what he perceives as a relatively easy production goal. Imagine his surprise when actual production is only 80 % of that planned for a particular month. Two of eight continuous mining rigs had to be withdrawn from production for a 3000-hour and a 5000-hour time-based maintenance service. Serious under-performance occurred simply because production and maintenance planning was not integrated.

Revenue-generating assets are the first priority and ensuring their availability to planned production schedules is critical to business success. TCO statistics indicate there is no less than 5 % unplanned downtime in virtually every organization. Further, there is no less than 10 % maintenance overtime, no better than an average of 35 % maintenance labor utilization, and no less than 30 % excess MRO inventories (just in case we need them)…need we say more?

Pain #20: Buying office products is the same as buying maintenance products is the same as buying direct materials.

Not all MRO products are equal. This is true from the perspectives of criticality, sourcing complexity, specifications, and many other attributes. It is sheer folly to purchase all MRO items using the same procurement policies and procedures. This is analogous to applying the same maintenance practices to all failure types. This practice can only result in over-specification of some items and under-specification of others. Thus, cost of procurement and use are driven higher.

To adequately address this island of pain, it is necessary to examine the underlying system of financial control used by many companies. All properly managed companies have implemented systems that allow for checks and balances for purchases and cash disbursements. These checks and balances seek to provide for efficient use of purchasing expenditures and prevent outright fraud and theft. These systems include the Purchase Order (PO) system, receiving verification, accounts payable, matching of invoices with receipts and POs, as well as invoice auditing procedures.

In general, financial control systems evolved over time and started their lives as manual systems backed by paper. Almost without exception, these systems were put in place to provide proper accountability and control over relatively large expenditures made to purchase raw or direct materials. Because any one of these expenditures was large, a complex set of checks and balances was needed for accountability and to prevent misuse of funds.

Now consider the typical MRO purchase. It is usually quite small in value compared to the typical raw material purchase. However, that small MRO purchase may well be subject to the same purchasing controls and procedures used to assure proper management of larger direct materials purchases. No wonder we find that the average PO for MRO materials has a transaction cost of $175 to $250. Purchasing procedures should be geared to the type of product being bought and to the engine generating the demand.

The demand engine for direct or raw materials is the Material Requirements Planning (MRP) or Enterprise Requirements Planning (ERP) system. The demand engine for maintenance items is the asset or equipment the items are used to support. The demand engine for office products is the person using the products.

Use the ERP or MRP system with complex financial controls to manage large expenditures for direct materials. Do not subject purchases for MRO materials to the same level of control. The engine responding to demand for MRO materials should be the enterprise asset management system (EAM). The EAM can associate demand with the asset producing the need for MRO material. Likewise the EAM can record and make available differences in MRO component parts and consumable needs that vary when a particular asset is used in different locations within a plant. For example, a pump used in a wastewater application in a plant might have the need for a different impeller than the same pump used in a caustic chemical application. The ERP or MRO system generally cannot capture these differences in maintenance need, based on location.

Procurement of most office supplies, then, should be left to the people using those supplies. Of course, logical enforcement of pricing and purchasing agreements as well as aggregation of demand should be provided for but, in general, the buying of office supplies should be a desktop requisitioning procedure. There is little need for the complexity of even the EAM for office supplies because lack of such supplies will rarely shut down a plant and the level of specification for them is low.

Pain #21: MRO supply consumption/demand confusion.

This island of pain is significant and represents immediate cost savings. The differences between product demand and product consumption are not well understood by participants in industrial supply chains. We define demand as the anticipated need for product at a particular point in the supply channel. Most channel planning is called demand planning. This planning seeks to have the appropriate products and quantities at the points of need at the right time. Perhaps this approach to planning would more appropriately be termed "demand anticipation," because in practice we find that little attention is placed on understanding end-user product consumption except when demand planning has created excess inventories. Then the attention is an after-the-fact focus on why demand planning failed.

Consumption, on the other hand, is the actual use of a product by an end user. The key difference between demand and consumption is that demand is anticipated usage and consumption is actual usage. Ultimately the efficient supply chain must be driven by replenishment of actual consumption—not anticipated demand. This is revolutionary thinking. Past practices have been predicated on lack of actual consumption data availability to participants in the supply chain. Consumption data must be available to all channel participants in the future.

To illustrate why demand planning rather than communicating actual consumption to channel participants creates inefficiency, consider the following scenario and its ripple effect back up through the supply chain. First, a maintenance technician in a plant is dispatched to repair a failed bearing in a pump. The technician requisitions the bearing and two seals. Only one seal is actually required, but the technician fears the second one will be needed if the first is damaged in the installation process. As it turns out, the second seal is not needed but— rather than return it to the storeroom—the technician keeps it in his toolbox as it is a common item.

The requisition of two seals throws the storeroom inventory below its order point. A replenishment economic order quantity (EOQ) is calculated based on average past usage. Suppose this order quantity is eight seals. This seems like a reasonable number because two were used in the current month. Eight seals represents a four-month supply. The storeroom orders eight replacement seals from the local seal distributor.

When the distributor fills the order for eight seals, their seal inventory is depleted; an order for replacement seals is triggered to the seal manufacturer. The distributor's EOQ recognizes demand of eight in the past month and orders a three-month supply, or 24 seals. The manufacturer receives the order and schedules production for a two-month supply, or 48 seals. The production planner rounds the quantity up to 50 because a particular raw material for the seal is packaged in packs of ten.

Conventional demand planning has triggered the production of 50 seals when only one seal was consumed. The demand planning process has actually hidden the

timing of future demand from all participants in the supply chain. The next time a seal is needed in the plant, the maintenance tech uses the one in his toolbox. The distributor wonders why the plant has not ordered any seals recently; They simply delay their next seal order to the manufacturer. The manufacturer has no clue when the distributor will order more seals and, in fact, wonders why their inventory of seals is so high.

Some will say our example above is contrived and misleading. They may say the law of averages applied across many players in the supply chain evens things out. And to a limited degree that's right. Nevertheless, the above scenario plays out every day across many items and channel participants. The result is that inventory turnover in industrial channels is dismally low and inventory obsolescence is surprisingly high.

Planning for production, product positioning, and movement in the supply chain based on actual consumption rather than demand—is revolutionary thinking for industrial products supply chains! It is common practice in other supply chains. Consider the consumer products channels. Fifteen years ago, Wal-Mart and others invested in systems that could report point-of-sale (consumption) information on a daily basis to their suppliers to avoid inefficient inventory deployment in their supply chains.

Whether a channel player sees demand or consumption depends on its position in the channel. Some see a confusing mixture of both. For example, the end user can track actual issues of material from the storeroom. This material may or may not be consumed as shown in our above example. The end users of industrial products project demand for the future based on past consumption. The demand projections are what trigger replenishment orders for storeroom stock in many systems.

For the most part, distributors see only demand because they are filling orders for replenishment that are demand based. The demands they see are almost always larger than actual consumption during the period in which they see the demand. Likewise, periods of time pass when consumption takes place at the end-user facility that the distributor knows nothing about.

As we move further away from the end-user consumer, upstream channel participants see demand at various levels of aggregation. An individual distributor projects demand based on the aggregated past purchases of all of its customers. The manufacturer projects demand based on the aggregated past purchases of all of its distributors. The aggregation of demand at the manufacturer, in theory at least, should approximate consumption by the end user. This is rarely the case due to incentives that induce sporadic large purchases by all participants downstream of the manufacturer. This disguises the timing of actual consumption to the point that the best a manufacturer can do is project future demand based on past purchases by its distributors. As noted earlier, the timing and quantity of these demand projections may be grossly different than actual consumption of material by end users. These differences lead to shortages or excess inventory in the channel.

So consumption is *actual* usage of material by the end user. Demand, on the other hand, is the projection made by suppliers as to what they *think* consumption should be in the current and future periods based on past purchases by the channel players. The supply chain would be better served if the timing of consumption was known to all players. This allows all involved the opportunity to produce and/or stock replacements for what is actually consumed. This is generally not the case for industrial supply chains.

Demand in excess of actual consumption is created in the industrial supply chain by a variety of mechanisms. This excess demand not only creates excess inventory in the channel, but also creates shortages of other materials. When manufacturing capacity is used to create these excesses, it is not available to make other items that are in short supply. Bottom line: the right parts aren't built simply because of the timing mismatch caused by not knowing what is actually being consumed.

There are several contributing factors to the excess demand dilemma. The first mechanism is when various channel players try to reduce procurement transaction costs. Companies buy larger quantities less frequently to reduce the volume of purchase orders, which reduces the frequency of accounts payable activities. Electronic procurement and funds transfer can drastically reduce these costs by making it easier for companies to buy the right quantity based on true need; it essentially removes the administrative overhead factor. To date, companies have been slow to adopt e-commerce technology and business practices to fully leverage procurement transaction cost reductions.

Another mechanism that inflates demand compared to actual consumption is a company's desire to transfer ownership of inventory to one of their channel partners. For example, a manufacturer might want to minimize their finished goods inventory levels and maximize cash flow. They might offer discounts to distributors to encourage larger quantity purchases. The distributor now has an incentive to buy ahead of actual consumption. However, the manufacturer also creates a demand in their product movement history that may be far in excess of actual consumption—the inflated demand cycle is in full swing! Contrast that scenario with a planning system geared toward manufacturing replacements for what is actually consumed at the end-user level.

A simple desire to increase sales in the current period also creates demand in excess of actual consumption. The same incentives to transfer inventory ownership also are used by channel members to influence the timing of sales recorded on their income statements. A company's motivations for increasing sales in the current period are varied: financial performance targets, higher factory utilization rates, as well as bonuses at the individual or department level.

We view most industrial supply chains as push systems. Driven by artificial demand, manufacturers use production planning systems to produce quantities in excess of actual consumption. These products and quantities are pushed down through the channel using various incentives. Viewed from a total supply chain

level, excess inventories and shortages created by these mechanisms translate into higher costs and lower overall service levels.

A pull system must be based on knowledge of consumption as we have defined it in the market. When consumption takes place, a replacement is scheduled for production or "pulled" through the supply chain. Recognition of usage by the end user must be near instantaneous and propagated back up the channel so channel members can restock or schedule a replacement for manufacture. In a pull system driven by recognition of consumption, the only idle inventory will be that in transit and stocks necessary to satisfy customer lead times shorter than manufacturing and transit time.

Pain #22: Lack of transparency of consumption data.

Real-time consumption information is absolutely critical to increase inventory efficiency throughout industrial supply chains. Several business practices hinder information flow through the channel. One is the wide variety of computer systems in use by channel members today. Often, these systems have trouble "talking" to each other automatically. The technology to connect disparate computer systems exists today. But business philosophies tend to hinder consumption information flow. These philosophies relate to ways of doing business that have evolved over time, lack of business process discipline, and perceived advantage by channel players.

End users may fear that timely communication of consumption data may harm their ability to negotiate better piece prices based on volume. Often, these price negotiations are predicated on an end user's estimates of volume that are in excess of actual need. They can become self-fulfilling prophecies as purchasing organizations buy ahead of need to stay within negotiated volume requirements.

End users may want to split purchase volume among several suppliers for a variety of reasons. When this is the case, they may not want suppliers to know their total consumption. A perceived point of leverage, then, results in the choice not to convey exactly the information needed to make the channel more efficient.

Poor business practice discipline contributes to lack of consumption information in the industrial products supply chain. Unlike consumer markets where almost all products have a universal product number, the players in industrial markets commonly use their own product numbers. This leads to a nightmarish cross-referencing endeavor for those who want to communicate product use information electronically. To add to the problem, it is not uncommon for end users to have the same item represented in their business systems multiple times. Thus, consumption information is distributed among multiple part numbers that represent exactly the same item.

Likewise, distributors in industrial markets may see reasons not to communicate actual consumption information back to manufacturers, even if they could get it from end users. They might fear volume pricing negotiations could be ham-

pered by this information. And distributors may want to split volume among several manufacturers.

Distributors have evolved their business practices to gain advantage by participating in favorable "spot" markets that exist periodically due to overproduction by manufacturers. Lack of product consumption data creates these opportunities. These distributors perceive that knowledge of actual consumption by manufacturers would lessen the magnitude and frequency of overproduction. This, in turn, would reduce the need for the manufacturer to offer price discounts to move excess product. Of course, the existence of excess products of one kind often means shortages of other products exist because manufacturing capacity was used to make the wrong products. To a degree, however, the distributor sees these shortages as another kind of opportunity and has learned to live with and even profit from them.

Manufacturers, in general, like to see transparency of product consumption data in their supply chains. This allows them to continuously fine-tune production scheduling to make the replacements for the products actually being consumed. But many manufacturers will have to adjust their business processes to make appropriate use of timely product consumption data. Flexible manufacturing systems that can accommodate smaller batch sizes and quick changeover of machines will have to evolve in many manufacturing organizations.

Many manufacturers currently offer incentives to their customers for buying in bulk. These bulk purchases increase manufacturing lot sizes and decrease the manufacturer's transaction costs associated with order processing, storing, and shipping of finished goods. These incentives disguise the timing of consumption. The manufacturer needs this information to drive a production system that makes the right products at the right time. This seems to imply that incentives for bulk purchases create inefficiency in the supply chain. If this is so, in addition to developing flexible manufacturing systems, many manufacturers will have to implement more efficient small-order processing systems.

The notion of which players in a supply chain might desire transparency of consumption information is not as simple as noting that manufacturers want it while distributors and end users do not. It may be more accurate to say that the sell side of the organization in the supply chain sees great value in consumption data transparency while the buy side of those same organizations can see reasons to hide that information from their suppliers.

For example, an end user of industrial products may maintain a storeroom that "sells" product to maintenance people. They certainly want to know what is consumed and when. They do not want that product use data adulterated by maintenance people requisitioning quantities larger than they actually use. But the purchasing or "buy" side of the end user's organization may not want product consumption data passed on to the their suppliers for the reasons noted above. As

we direct our view of the supply chain upstream we find that the same is true of distributors.

Pain #23: Demand engine is not connected to supply engine.

Assets, not people, create their own demand for repair parts and consumable items. This rate of demand varies depending on such factors as production rate, asset design, and level of preventive maintenance. For companies that use enterprise asset management systems, the EAM is the engine that fulfills demands from the asset. When the asset needs maintenance, a human creates a work order in the EAM.

Too often, the repair parts (MRO) inventory is maintained on the central enterprise resource planning (ERP) computer system. The EAM work order system may not be able to access these inventory records without a manual lookup by a human. Thus, time is lost and labor is employed trying to determine whether or not parts needed for a repair are available. If parts must be ordered, notification that the parts have been received by the ERP system may be a manual process. Further time is lost.

Most ERP systems cannot associate MRO material usage with particular assets. This means material usage can only be tracked at the aggregate level. Tracking consumption at the aggregate level means future demand predictions may include quantities for machines that a plant no longer uses simply because past usage for these parts exists in the historical usage database.

A better solution is to use the equipment assembly structures available in EAM systems to associate material demand to the asset that caused the demand and consumed the material. Then, procurement for MRO materials can be based on an analysis of equipment used today and the rate at which those assets have consumed repair parts and consumables in the past. This represents a tight coupling of MRO supply with MRO demand.

We predicate our reasoning that supply and demand for repair and consumable items should be tightly coupled on an examination of how direct materials procurement systems are designed. These systems tightly couple procurement of the raw materials used in the manufacturing process to the near term production schedule by exploding the bills of material for what is scheduled to be built.

Procurement of MRO materials should consider the demand created in the past for the actual machines in use today adjusted for the rates these machines are scheduled to run in the future. MRO material needs derived in this manner will be quite different from needs determined from an analysis of total past usage if there are differences between assets used in the past and assets to be used in the future.

Pain #24: Thinking that maintenance function is the demand engine rather than the asset.

Assets create demand for repair parts and consumables. That is, the use of the machine causes it to need lubricants, belts, bearings, and other parts. Assets used sporadically create less demand for these parts while assets used continuously create correspondingly higher demand.

Different assets create wear part and consumable demand at different rates. For example, consider two different brands of a machine designed to do the same manufacturing operation. Because of inherent design differences, these two machines doing the same operation can produce different demands for wear parts and consumables even when run at the same production rates! The same notion applies to vehicles, conveyors, and any other kind of equipment and facilities used in organizations of all types.

Organizations think that the maintenance department should predict the demand for specific materials to be purchased. This is a fundamental mistake that has little to do with the individual in the maintenance department.

People intuitively think of historic consumption as a way of estimating future needs. However, people generally do not take failure rates into consideration. For example, it is easy to note that we used a particular item this month. Therefore we need another one. But if the failure rate of the specific equipment is once every two years, items will be bought to sit on the shelf. People also tend to protect themselves by estimating a higher future demand "just in case."

Significant inventory reductions can be achieved without increasing availability risks if organizations realize that the assets are the demand engine. Knowing what materials a specific asset consumed in the past—given a specific production rate—will produce much more accurate demand predictions. Thus, the maintenance person is simply an interpreter of equipment needs (demand). Condition-based monitoring combined with skilled maintenance personnel and operators act as the best interpreters of asset demand, but they do not create the demand. The asset itself creates the demand.

When procuring parts and services to maintain an asset, clearly link these parts or services with the particular asset to create a profile of the asset demand. Rather than focus on MRO spend per maintenance person, we should concentrate on MRO spend per asset. Then we can identify assets that are expensive to run versus those that are less expensive, even given the same production rates. The goal should be to reduce absolute MRO parts and labor spend per unit of production by gravitating to assets that are inherently less expensive to run. This is difficult to do without having first connected demand to each asset.

Pain #25: Thinking that cost should be controlled via better inventory management while ignoring the underlying generation function.

In many enterprises today, more emphasis is placed on cost control via better MRO inventory management than on managing the underlying demand for MRO materials. While better inventory management is a noble quest, larger cost savings come from understanding how and why enterprise assets are creating demand for MRO components and consumables. Remember: the assets themselves create the demand for MRO materials.

Inventory management generally strives to use an investment efficiently and effectively. If the investment is caused to turn over beyond a certain target annually, inventory management is said to be efficient. If low stock-out rates or high fill rates are achieved, the inventory management is deemed to be effective. From an inventory management perspective, both high fill rates and high turnover are desirable and probably reduce the cost of maintaining inventories. Greater cost savings, however, are achieved by altering the demand generation functions of enterprise assets.

Enterprise assets are designed to eat components and consumables through natural and forced deterioration. Natural deterioration occurs when equipment, machinery, or vehicles are deployed, used, and maintained exactly as they should be. They wear and use consumables at a natural rate. Forced deterioration occurs when assets are deployed in harsh environments or are not maintained at optimum intervals. Forced deterioration causes expenditures for wear parts and consumables to be much higher than they otherwise would be. Most enterprises would be better served by understanding and reducing the need for MRO materials caused by forced deterioration rather than just focusing on moving these expenditures efficiently and effectively through an inventory system.

Enterprise assets are what they eat. That is, equipment, machines, and vehicles may experience lower overall maintenance costs when fed a diet of better quality consumable materials. A higher quality bearing costing twice that of a standard bearing may last five times as long. In other cases, overall cost savings can be achieved through feeding an asset more of a consumable. Certainly many vehicles and other types of equipment perform longer at lower cost with more frequent oil changes. These are total cost of ownership issues. Unfortunately, efforts focused on cost savings through better inventory management rarely consider total cost of ownership issues.

Please do not interpret our comments in this area to mean that we are not in favor of better MRO inventory management. We applaud all efforts that result in more efficient and effective use of an inventory investment. That said, we would like to reinforce the idea that the best inventory management efforts may do little to manage the creation of demand by enterprise assets. Reducing the demand for wear parts and consumables typically realizes cost savings far in excess of those realized through better inventory management.

Pain #26: The notion that purchasing controls can reduce the maintenance spend.

MRO purchasing policies and procedures exist for various reasons. Primary among these is the desire to establish financial accountability standards within that part of the organization. Unfortunately, in many cases these standards evolve over time into controls seeking to regulate the amount spent for procurement of MRO materials. This type of control is inappropriate and destined to failure because it is misdirected.

Assets create the demand for MRO materials. The supply side of the organization (purchasing) simply buys the material to satisfy the demand. Controls on the supply side that slow the procurement of material needed to satisfy demand simply delay needed repairs to assets supporting the value stream.

In extreme cases, maintenance people circumvent purchasing and buy the parts they need. When this happens not only does maintenance take longer than it should, the maverick purchases may be made from suppliers outside of existing price contracts. In general maverick purchases are an indicator of malfunctioning supply processes. Maintenance people do not purchase in a maverick manner on a whim. They do so because they need parts to fix malfunctioning assets and they believe they cannot get those parts in a timely way through use of normal procurement procedures.

The designation of preferred suppliers by purchasing is another supply side control that can cause inefficiency and delays in procurement of MRO materials. Purchasing policies and procedures usually establish how suppliers are awarded a preferred status. The preferred designation may or may not take into consideration the ability of those suppliers to directly supply all key materials needed to maintain organizational assets.

When preferred suppliers cannot directly supply the materials needed to properly maintain equipment, one of two things happens. Either the maintenance people buy the needed materials outside the system or purchasing orders the material from a preferred supplier who must then source it from an un-preferred supplier. Both of these cases result in wasted effort and are likely to cause a delay in obtaining needed MRO materials.

We contend that supply side or purchasing controls designed to reduce MRO expenditures are misdirected. Control of MRO expenditures should be directed at the demand side of the system. Assets used to support the company's value stream create demand for replacement parts and consumables. If these expenditures are higher than desired look to replacement of the assets, preventive maintenance programs, condition based monitoring, and any other endeavor designed to reduce the underlying demand for MRO materials.

Pain #27: Inventory expensed directly to a job or department as it is acquired does not show on my books.

Some companies expense any MRO material directly to jobs upon acquisition, whether or not it is consumed or goes into a stockroom. This is a highly misleading

practice—an island of pain. It is true that no inventory investment shows on the balance sheet. Yet inventory exists, but since there is no accounting entry for it, no one is concerned about managing it.

The practice of expensing MRO inventory upon acquisition often leads to a distorted view of which assets are consumed for what and when. The distortion occurs because this association of MRO materials with an asset is not done or not done correctly. Material is purchased and expensed to a particular asset but often ends up being used on another piece of equipment.

Likewise, the timing of material use is skewed. Material is charged against a piece of equipment when bought but not used until much later, if at all. A subsequent analysis of MRO material consumption patterns can be quite misleading. Maintenance may be tempted to requisition more MRO material because it appears that material has been used in the past when, in fact it still exists, unused, in the plant.

In the worst case, MRO material is acquired and expensed to a department. Now we lose track of all association of material with assets. We also lose track of what MRO materials should be available for use. The MRO inventory escapes into the black hole of that department and becomes untraceable. True, there is no inventory shown on the balance sheet and people mistakenly believe that return on assets will be higher in the absence of the balance sheet inventory amount. This, however, is untrue. Expenses are higher due to expensing of inventory at time of purchase. Thus, return on assets is affected whether or not the inventory is treated as a balance sheet item as it should be.

Expensing inventory as it is purchased leads to a lack of accountability. Purchasing controls degenerate into a system of approval limits seeking to indirectly regulate the MRO spend. A much better approach is to buy as needed, associate expenditures with the asset requiring repair or consumable materials, and inventory what is not used so that all can know what materials are available for use. Then, focus on reducing MRO spend by focusing on assets that are over-consuming materials and seek to reduce inventories by focusing on the level and timing of purchases that are inventoried.

Finally, expensing MRO material upon acquisition leads to a lack of focus on material recovery and disposal. Since there is no inventory investment to call attention to dead stock, there is no effort to identify items that are in the plant but unneeded. Thus the opportunity to recover a portion of the value of these items is missed.

Pain #28: Thinking MRO inventory is an asset.

Companies that properly account for MRO inventories are not immune to pain. It is just a different sort of pain than experienced by those who expense all MRO materials upon acquisition. We believe that inventorying MRO items and expensing them on use is the proper way to account for MRO spend. This facili-

tates the association of demand with the asset creating the demand, and creates visibility of the items held in inventory.

Over time, MRO inventories tend to get bloated with investments in excess of what they should be. The actual items associated with the investment cannot be located, are obsolete, or otherwise unusable. These inventories should be purged of these items, salvage attempted to the extent possible, and the remaining investment written off. As a part of this process, assess why the excess investment occurred in the first place. Then put procedures in place to stop investing in items that are either unneeded or become unusable over time.

The pain arrives with the realization that the inventory write-off will create an expense and lower net profit. For a variety of reasons, companies do not want to endure the pain of lowered profits. We have observed that the fortunes of the company do not particularly matter with regard to this aversion to taking a write-off that will harm the bottom line. For example, if the company is having a great year profit-wise, there will be those who say, "we can't take the write-off this year. It will spoil a record profit year." Conversely, if the company is having a poor year they will say, "we can't take the write-off this year because our profits are already way too low."

So, for whatever reason, nobody cleans up the MRO inventories. The cash flow opportunity from salvaging those items with residual value is missed. The inventory continues to occupy space. It has to be maintained, counted, and sometimes taxed.

MRO inventories should be evaluated on a continuous basis. Dispose of obsolete and excess inventory as quickly as possible to maximize salvage value. Constantly evaluate procedures to keep the value of MRO inventories held to an absolute minimum. Most companies are better off crafting a supply chain that can supply MRO materials as needed and buying only what is needed in the near term. This is true even if it means paying a slightly higher piece price for the material.

Pain #29: The notion of "buy bulk and save money."

Many procurement organizations measure success by comparing piece prices on key items to prices a year ago. In times of general price inflation, this is modified to measure whether piece prices rose more slowly than the price inflation rate. This focus on piece price as a procurement performance measure is a pathological behavior; it ignores significant cost factors. A procurement organization wants to know they have bought at a fair price. But this focus on price must be balanced with knowledge of how total costs related to acquisition, receipt, storage, use, and disposal of material are affected by the desire to get the best piece price.

In general, purchasing agents are motivated by pricing and availability. Given availability and the same product specifications, better piece price wins the order. This makes sense under most circumstances. However, a blind focus on better piece price can sometimes dramatically increase total cost.

For high-usage items, buying a larger quantity than actually needed to qualify for the next price break seems to make sense. However, increasing the quantity bought to get a better price can quickly increase the procurement spend while inflating inventories. Purchasing staff members often look at the next price break quantity and routinely increase the quantity ordered. Inventories of slow moving stock build up. A better strategy is to buy what is consumed and nothing more for all but a tiny fraction of MRO items.

Even for items consumed regularly and repetitively, buying more than needed to replace actual consumption for the sake of lower piece prices increases cost. In many cases these cost increases exceed the piece price reduction savings.

Inventories create hidden costs that are not easily measurable. These include storage, taxes, pilferage, obsolescence, and the cost of the people necessary to manage, store, and keep the inventories orderly. It is common to find 25-40 % of the value of an industrial plant's MRO inventory either missing, unusable, or obsolete. This represents millions in MRO spend that is virtually worthless. Much of this accumulated over time due to the mentality of buy "bulk and save." These companies would have been better off to have paid a slightly higher piece price for what they actually needed and not bought the excess materials.

Pain #30: Thinking that reverse auctions drive down total cost.

The popularity of the Internet has enabled the use of reverse auctions for MRO materials. Typically a company will place a list of items and quantities needed on their Website and ask suppliers to respond with pricing. The current low price may be shown for each item with the idea that competitors will bid the price to the lowest possible. Then, presumably, the lowest price supplier by item or item category is awarded the contract to supply those items in the future at that price.

Of course, it is important for a company to pay a fair price for all of the products it needs. However, the concept of a reverse auction fails to consider total cost of ownership in choosing future suppliers. Terms and conditions can and do vary greatly among suppliers. Ostensibly, all suppliers participating in the reverse auction implicitly agree with the terms and conditions set forth by the company for the supply of the MRO materials in question. In reality, the total cost of acquiring, receiving, storing, and using the products supplied by the low bidder can be higher than the total cost of supply from a higher bidder.

The reverse auction extends the three-bid purchasing model into that of many bids. Part of the strategy can be to aggregate the demand of many plants into a corporate demand to try to achieve quantity price breaks. Suppliers are understandably leery of this aggregated demand strategy because they suspect that many companies exaggerate the potential demand. Further, suppliers know they will likely have to ship small orders to many different plants, thus negating much of the savings they might have realized from selling larger quantities.

Reverse auctions tend to neglect the value of long-term relationships with key suppliers. They disregard the services and emergency support these suppliers have provided in the past and will provide in the future. The reverse auction process shifts focus away from the key suppler relationship, which evolved because a plant could count on the supplier for timely help when the plant was down. Instead the focus becomes that of lowest product cost.

Too many plants have found that the supplier of a product at the lowest price is not the supplier that can bring the latest product innovation and problem solving information into the plant on a continuous basis. Technical support often suffers when the absolute lowest prices for products are attained. The result can be additional plant downtime expenses that far exceed the reduction in product price savings.

Corporate sourcing of MRO products may not consider inventory practices and preferences maintenance may have for particular brands of products. These practices and brand preferences exist, for the most part, because they support plant and asset uptime. Thus a corporate procurement endeavor may not be supported at the plant level with the plant citing special needs as the justification for not participating in the corporate program. When this occurs, total cost of MRO materials supply will likely be driven up because plants may have to take measures to hide their lack of participation in the corporate endeavor.

In other cases plants may be required to take possession of larger than desired quantities of MRO materials bought as a result of a reverse auction. See our previous comments on the notion of buying in bulk to save.

Islands of pain associated with the future perfect objective: Only invest in resources that enable the first four future perfect objectives.

If 80 % of the cost of operations is designed in, then 80 % of improvement dollars should be spent on redesign efforts. How can our improvement efforts be guided? Are our efforts driven to obtain future perfect? Let's take a closer look at people, processes, and technology islands of pain that keep companies from advancing as rapidly as they should.

Pain #31: No Strategic MRO strategy is the best strategy.

Our experience is that enterprise asset management and MRO supply chain management initiatives that comprise Strategic MRO have not been guided by an understandable set of principles. Typically, there is no definable strategy or practical path forward to guide people's actions.

Questions that help to develop a Strategic MRO strategy include:

- What is the result of not having a set of guiding principles? Does the existence of more than 30 islands of pain provide a hint?
- Do future perfect objectives exist to guide organizational decision-making?

- Are you buying the best assets for the task at hand?
- Will future assets be managed to achieve availability and reliability expectations?
- Do maintenance strategies such as run-to-failure, preventive, condition-based, and risk-based maintenance exist?
- Is TCO a common metric for driving cost-based decisions?
- Are there metrics that ensure progress is being made towards a future perfect?

Great thinking precedes great doing and ends with great results. Organizational focus on Strategic MRO improves both the top and the bottom line.

Pain #32: Assets perform functions; maintenance repairs things.

Any review of work orders at a typical plant will undoubtedly indicate that many assets were maintained or repaired. Likewise, at plants with efficient maintenance organizations, all maintenance resources will show to be fully employed and MRO inventory investments will probably achieve good turnover. Nowhere in the work orders, however, will there be an indication of what functions were restored to operational status.

Throughout our islands of pain discussions we have intimated that assets can be placed into two basic groups. The asset either contributes directly to revenue creation or it does not. Assets perform functions. Maintenance tasks maintain or restore these functions. Not all functions are critical thus not all maintenance and repair activities are critical. Simply constructing a maintenance strategy to repair things misses the target by more than a mile and more than a few dollars. Maintenance strategy should be organized and managed in a manner that takes asset criticality into consideration.

Pain #33: Thinking that maintenance is a "do and don't think" function.

A huge waste is incurred any time an organization loses any portion of insightful human thought and creativity. This may occur when an organization implicitly or explicitly conveys the message that maintenance is to "do as they are told, not think." Failures happen regardless of the strength and depth of Strategic MRO activities. Because of this, maintenance resources must swiftly diagnose symptoms, analyze the impact of the failure, and treat the root cause. These are the actions of an asset doctor, not a mechanic who merely replaces motors per instructions.

Any improvement initiative relies on the analytical and practical thinking of its resources. Understanding failure patterns, applying appropriate maintenance prevention and response modes, crafting the lowest total-cost-of-ownership solutions, streamlining and improving the effectiveness of work order management, coordination of labor, materials, and equipment to respond to asset demands, and orchestrating a complex MRO supply chain requires more than doers.

Thinking by an asset custodian is paramount to the success of the Strategic MRO initiative. This requires the maintenance and improvement of perhaps the most important asset, the asset custodian.

Pain #34: The goal of OEE is 100 %.

Overall Equipment Effectiveness (OEE) is quickly becoming recognized as the metric of choice for tracking the productivity of equipment. OEE components consist of availability (AV), performance efficiency (PE), and first time through quality (FTT). The mathematical equation is OEE = AV x PE x FTT.

As an example suppose the following:

Availability (AV)	*= 95%*
Performance Efficiency (PE)	*= 90%*
First Time Through Quality (FFT)	*= 99%*

OEE = AV x PE x FFT = .95 x .9 x .99
OEE = .8465 = 84.65%

Most metrics have a goal of 100 % if the measure is of something good like "shipments on time," or 0 % if the measure is errors, for example. The goal of OEE is "it depends." Rarely is the goal for OEE 100 %.

Availability is defined as equipment availability to the schedule. Availability of 100 % may imply that no scheduled downtime or maintenance is considered. No planned maintenance is a short-sighted planning strategy for most equipment.

Performance Efficiency is defined as the ability of the equipment to run at its design speed. Equipment can sometimes be sped up to meet production needs. Certainly, most equipment can be slowed down to meet production schedules or balance its speed with other physical assets or bottlenecks in the production process.

First Time Through Quality is a measure of what percentage of products were produced right the first time. FTT should also take into consideration first piece inspection, quality samples, and rework.

The industry benchmark for OEE is 85 %. OEE's of 45 % aren't necessarily bad. That level of OEE might mean that equipment has been slowed down, extra quality samples were taken or maintenance performed whether routine or overhaul.

Striving to reach high OEE goals just for the sake of showing "great equipment utilization numbers" might make no sense at all. It depends on the circumstances. For example, if a plant is working hard to reduce a backlog of actual customer orders and is not scrimping on maintenance, a quite high OEE is very good. On the other hand, if high OEE is achieved by building to stock resulting in inflated finished goods inventories, this may not be good at all.

Pain #35: Lack of visibility of asset demand behavior.

What did each asset cost your company last year? Did the cost exceed the benefit? What assets should be repaired versus replaced? What decision support processes exist to answer these questions?

The only way to consistently answer these questions is to improve the demand visibility of an asset. When issuing parts and/or performing services to maintain an asset, clearly link these parts or services with that particular asset in order to create a profile of the asset demand. Rather than focus on MRO spend per maintenance person we should concentrate on MRO spend per asset. Then we can identify assets that are expensive to run versus those that are less expensive even given the same production rates.

The goal should be to reduce absolute MRO parts and labor spend per unit of production by gravitating to assets that are inherently less expensive to run. Lack of visibility of asset demand patterns is a quite serious pain that industrial organizations face when challenged with improving performance (availability and reliability) and the Total Cost of Ownership.

Pain #36: Confusing management decisions with technology impact.

Recently, much emphasis has been placed upon the use of technology as a key to decreasing costs. Our notion is that technology in and of itself does nothing to reduce costs. We base this observation on our experiences with too many companies who have spent millions on technology and then additional millions making the new technology work exactly like their previous computerized or manual system worked. They end up with business processes that are marginally improved at best and realize little if any cost reductions from their investment in technology.

Interestingly, we occasionally visit companies that have achieved dramatic cost savings through careful business process analysis and refinement. Some of these companies have spent virtually nothing on additional technology. Technology does not reduce costs—the proper application of technology, and sound business practices, based on rational management decisions can reduce costs.

The truth of the matter is that, most often, a careful redesign of business processes along with technology to automate, reduce search time, provide mobile handheld connectivity, and replace paper documents yields the largest cost savings. The technology is secondary to the decision to improve the underlying business process.

It is not uncommon for us to hear about technology providers that claim to be able to help companies achieve price reductions from their supplier of up to 20 %. Companies that are successful in realizing such price reductions do so through implementing effective strategic sourcing practices. No technology is necessarily required although technology can streamline the process by acting as a gatherer of information and as an instrument to facilitate compliance with strategic sourcing decisions.

The key, then, to more efficient, effective business processes is management vision, the decision to undertake the activities to improve and the tenacity and drive to stick to the improvement initiative. Technology has nothing to do with these. Technology is an enabler, a compliance mechanism and a way to automate and streamline processes. Make sure you apply technology to business processes that have been improved to the highest levels of effectiveness and efficiency. After all, technology that automates poor business processes allows you to make mistakes more rapidly than ever!

The Path Forward

Paul's Executive Forum responded quite favorably to his presentation on islands of pain. In fact, the participants suggested islands of pain he had not thought of or uncovered in his research. What a mess, Paul thought. How does a company get started when faced with a list of problems of this magnitude?

What Paul needed was a path forward that would force his resources to focus on future perfect. He hoped to define his current behavior using this process, best practices, and the technology necessary to achieve the absolute advantage he sought in the market. He felt that his Executive Forum couldn't offer him a succinct roadmap for his issues. Paul had to seek specialized assistance.

One of his Executive Forum colleagues suggested that he investigate the Demand Supply Compression (DSC) methodology applied to Strategic MRO. His colleague related that he had become familiar with the DSC approach at an international Enterprise Asset Management conference in Paris. Why not check it out? So Paul did.