The Hidden Plant:
A Collection of Asset Management Articles
published by S. Bradley Peterson

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Developing an Asset Management Stratey

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Abstract

Most large plants have $100's of millions in investment. They were all built with an objective to provide earnings superior to risk-free government bonds. While there are many factors which influence profitability, maximizing output potential is often the single greatest opportunity, especially for low-margin, commodity-type businesses. A typical measure of success of asset deployment is Return on Assets (ROA).

Strategic Asset Management involves managing the capital investment towards a long-term program of increasing the ROA. This is a top-down function of setting a performance specification for each major operating unit, identifying the critical components of performance, and systematically improving the key controllable variables of operation.

Managing assets strategically involves every function in the plant working towards the same goals. Operations and maintenance are rewarded for creating and utilizing the capacity of their units. Purchasing has its main goal as operating reliability, with cost as an important but secondary goal. Engineering is based on total lifecycle value created, including product characteristics, maintainability, operability, and total cost per output unit.
The improvement cycle is based on the *Operational Reliability Maturity Continuum.* This empirical model describes five stages of mastery that create a foundation of improved performance with growth potential continuing over a ten-year period. By describing the role of maintenance, operations, engineering, accounting and management in the improvement cycle, the plant can guide creation of a strategic plan for improvement, tied with bottom-line performance expectations.

Once a business model is developed, each party sets goals and works toward a combined action plan. The initial action plan is usually an improved planned maintenance environment, depending on the benchmark position on the Maturity Continuum. Implementation requires the proper structure, measures, information and commitment. Each major factor of implementation is identified.

Once a proper maintenance process is established, the plant will continue improvement by adopting more proactive maintenance approaches in a staged and measured environment. The key to success is knowing all the factors involved, and institutionalizing change in work and process before proceeding with additional stages of development.

What is Strategic Asset Management?

Strategic Asset Management is a *new model* for extracting value from production assets. It represents a comprehensive, top-down approach to managing plant equipment and people for maximum profitability. It's single most important feature is in its fact-based management of the potential profitability of a plant, based on market conditions and variables within the control of management. The scope of Strategic Asset Management (SAM) begins with sales forecasting, through production planning, includes all facets of manufacturing, and ends with delivery of product to a customer.

We start with a view of the original purpose of the plant. Why did we build or purchase this plant, anyway? To provide employment? Yes, but only as a by-product. To satisfy customers? Yes, but as a means to an end. *We built this plant because we believed we could generate a greater return on capital than investing in a government bond.* By taking the risks associated with manufacturing, we could apply our knowledge, our systems, our proprietary process, and our people for solid profitable returns.

Our goal, then, will always be to manage our resources to gain profits, while safeguarding our people, property, community and environment. This means we need to understand the key levers to unlocking equipment asset potential, by building our capabilities in a systematic way.

The rewards are straightforward. If we can use our total resources better than our competition, we will produce a superior, lower cost product with higher margins, have pricing flexibility to sell all of our product in a saturated market, and survive hard times while our competitors fail.

Differences with Maintenance and Reliability

Our vision and ultimate goal is to have the plant running continuously at full rates, with no downtime and minimal planned outages or turnarounds. Where do maintenance and reliability fit in this picture? Most plants today spend most of their resources responding to emergency repairs. How do we move from a repair culture to asset management?

This starts by aligning the vision of the entire management team. Who affects system reliability and throughput? Engineering? Purchasing? Operators? R&D? Production scheduling? Maintenance? The answer is obvious—everyone affects how well the plant produces. Yet the functions seldom work towards the same goals and rewards systems, leaving us frustrated in our attempts to make progress.

R&D, for instance, often design a process and equipment that don't use industry standard components nor components already stocked by the plant, and don't coordinate with purchasing and engineering. Purchasing often knows little about the effects of their actions, whether the suppliers provide durable, maintainable equipment and parts. Rather they are rewarded most often for cost savings, no matter what the effect on production. Engineers design equipment and processes to meet product specifications. It's rare that they consult with operators or maintainers about the ease of keeping the equipment and processes running. When the new system is operational, they are off to their new project. Production schedules are made to accommodate a fast changing sales forecast, resulting in production run breakages, excess inventory, and stressed equipment. Operators do their best to assure the process is running. But if a breakdown occurs, who you gonna call? The last one on the list—the maintenance guys, who better get it back in production fast! And who are handicapped in getting the equipment on schedule, having the drawings and parts necessary, receiving a poor description of the problem, and working under the gun!

Fixing the maintenance department or starting a reliability function aren't going to create an industry leader. Only through sharing a future vision of plant operations, and multi-year plan of change and continuous improvement, can we make breakthroughs in creating value.

How Does SAM Differ from Traditional Maintenance Improvement Efforts?

Most maintenance improvement initiatives today are *functional* in nature. They compare, among a variety of indicators, how well our company does against a variety of other companies, and endeavor to change the way maintenance is done. What's wrong with that?

First, most of the other companies under comparison are only marginally better than ours. Our conclusion: if we simply change certain practices, we will be as good (or bad) as the rest. There is no emphasis on the financial results we expect to see, no understanding of the core issues at work, no plan for major cultural change, and little senior management involvement and commitment. The issues to be worked are tactical, and seldom result in measurable progress, either in leading or lagging indicators. We don't have a view of the results of change on the financial performance of the plant, and end up spending money to improve maintenance based on *faith* that it's the right thing to do.

The key requirements of successful plant-wide reliability improvement are these:

- An analysis of the potential production available in

the plant based on best demonstrated performance and operating characteristics of best performing plants
- Quantified current operating rates of each units, and goals for improving these rates
- A business case with a three-five year horizon which identifies expectations for costs and production based on improvement efforts.
- A multi-year plan that identifies the types of changes in practices and measurements needed to achieve the goals
- A keen understanding that every function works interdependently to management equipment health
- Accountability for delivering these results, transcending annual budget cycles

A tall order? You bet! This type of sustainable effort is exactly what distinguishes one competitor from another.

A comparison of current practices with Strategic Asset Management practices illustrates the point:

Developing a Strategic Plan for Asset Management

SAM is based on several core principles. These should be well understood before proceeding.

1. The plant exists only for one reason—to produce as much product as possible, to specification and delivery schedules, at the lowest sustainable price
2. To improve will require fundamental changes in discipline and culture, beginning with the management team. Relationships and personal prejudices will be realigned
3. Everyone is the plant is on the same team and must work toward the same goals
    - A shared vision of how the plant will work in the future
    - A multi-year plan for mastering new skills in asset management
    - A business case that continuously creates bottom-line value

<u>Functional Excellence Model</u>

- Operations owns production, maintenance owns equipment
- Maintenance excellence means efficient service (e.g. repairs) to production. A customer service model dominated by operations. Most work is inside planning time horizon
- Repair efficiency is the best measure of maintenance performance. No time to do it right, but hope there is time to do it over
- Production runs at any cost. Don't have time to turn equipment over to maintenance as scheduled.
- Goals are set by functional managers, resulting in contradictory and self-defeating reward/recognition practices. Most measure are lagging indicators, demonstrating past results
- Purchasing excellence means having the lowest cost of items available
- Pressure is on individuals to do better. No gauges or tools of "better" exist

<u>Asset Management Excellence Model</u>

- Operations owns equipment and is responsible for equipment health
- Maintenance is a partnership with operations to identify and work ways to improve equipment health
- Breakdowns represent an unacceptable management system failure, and require failure analysis of equipment and process
- Production insists on and participates in assuring prevention and improvement activities
- Goals are developed top-down in a cascaded fashion. Functions share lagging indicator goals (e.g. monthly production), and have unique leading indictor goals that support activities (e.g. % of PM's performed to schedule)
- Purchasing and inventory management's highest goal is parts service level and MTBF is purchased parts
- Each piece of equipment has an operating performance specification, and gets the attention necessary for it

To achieve a shared vision, we begin by creating a *Strategic Plan for Asset Management.*

Our first step is to identify the potential capacity of the plant, and the profitability available. We look at the overall production map of the plant, and identify both the *theoretical capacity* and the *best demonstrated performance of the unit.* This is the most difficult question management will have to face, because the conclusion is so painful. In some cases the theoretical capacity may be double what we achieve, and even best demonstrated performance identifies a huge gap with where the plant is today.

We can also identify maintenance cost structures and how they must change. When equipment health is excellent, there is less labor and parts required than for a continuous repair operation. Validating maintenance cost reduction potential is an appropriate place to use benchmarking.

The additional production and reduced maintenance costs lead us in two directions. First, we can summarize the business case, with benefits as well as cost, as shown in this illustration.

Capacity Analyis Identifies Potential Bottlenecks and Shortfalls From Potential Production (lbs/hr)

	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
Permit Max		12,905		13,218	12,450	
Theor. Capacity	17,540	13,572	21,842	13,924	13,763	58,422
Best Month	14,986	12,316	11,648	12,585	11,791	26,065
95-96 Avg. Rate	12,338	10,822	9,948	11,063	10,285	20,612
Gain/Loss Factor		-10.0%	+10.5%	-6.2%	-4.5%	
Equiv. Adj. Cap.	14,986	13,855	24,026	12,671	14,087	27,238
Performance	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
Theor-Best Mo.	2,554	1,256	10,194	1,339	1,972	32,357
Theor.-Avg.	5,202	2,750	11,894	2,861	3,478	37,810
Best Mo-Avg.	2,648	1,494	1,700	1,522	1,506	5,453

A Typical Benefits Case Would Cover These Areas

	Year 1	Year 2	Year 3	Total
Cost Reduction ($M)				
Labor	$ 0.75	$ 1.00	$ 0.25	$ 2.00
Contractors	$ 1.00	$ 0.50	$ 0.50	$ 2.00
MRO	($ 0.25)	$ 0.75	$ 0.25	$ 0.75
Total Cost Reduction	*$ 1.50M*	*$ 2.25M*	*$ 1.00M*	*$ 4.75M*
Additional Product				
Unit 1				
KLBS	9,000	14,000	22,000	45,000
Profits ($ 0.20)	$ 1.8M	$ 2.8M	$ 4.4M	$ 9.0M
Unit 2				
KLBS Cap	5,000	8,000	14,500	27,500
Profits ($ 0.60)	$ 3.0M	$ 4.8M	$ 8.7M	$ 16.5M
Total Benefits	$ 6.3M	$ 9.85M	$ 14.1M	$ 30.25M

Second, we can identify operating specifications to achieve our annual improvement targets. Instead of "do better", we identify uptime requirements at the equipment level to achieve total operating goals. Because equipment operates in series, our individual equipment uptime goals must be higher than unit goals. For example, if our unit goal is 75% of maximum capacity, each major piece of equipment must be higher. For five pieces of equipment,

95% x 95% x 95% x 95% x 95% = 77%

We then identify specific goals and work necessary over a multi-year horizon, at the appropriate level of detail.

We document our efforts in an Asset Management Strategic Plan, with the following outline:

- The **Summary** is a concise extract of the important features of the overall plan, intended to give senior management an overview of findings and expectations
- The **Current Assessment** is the status of our plant, including our operating rates versus potential, overall maintenance and reliability statistics compared with world class performance, and a benchmark against the Operational Reliability Maturity Continuum
- **Future Operations Vision** documents how we expect to operate in the future. What will we look like? How will roles and responsibilities evolve? This is based on understanding best practices, and envisioning their implementation in our plant.
- **Initiatives** outline the major components of our improvement process over the next several years. They are described by intent, outcomes and process, rather than as specific plans.
- The **Business Case** outlines the opportunities we intend to capture, both in terms of cost savings and additional production, and the outlays required to get us there.
- **Plans and Resources Required** outline timeframes, deliverables, measures, people's involvement and other resources necessary to achieve the goals.
- **Structure, Accountability and Measures** show how we will execute the individual project components, who is accountable and how we will measure success
- **Next Steps** identify how we will get started and request specific management actions

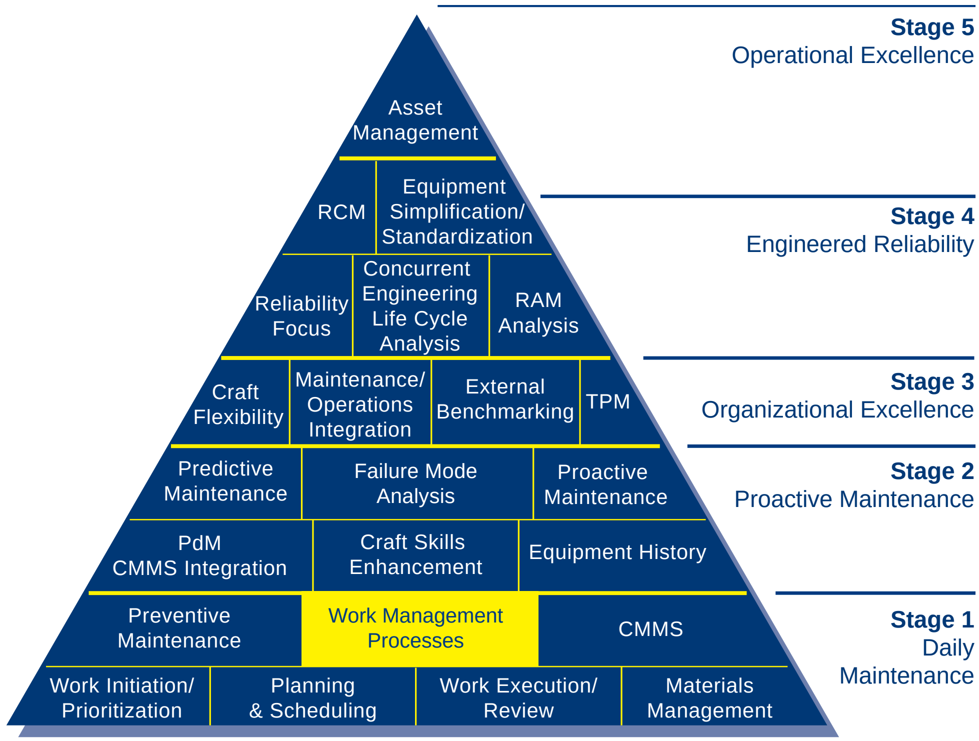
Implementing Strategic Asset Management

We identify major stages of improved asset management, illustrated by the *Operational Reliability Maturity Continuum.* This tool helps us identify the necessary building blocks to improve our operational reliability. The major steps include:

1. Gain control of the work (Stage 1, Daily Maintenance)
2. Gain control of the equipment condition (Stage 2, Proactive Maintenance)
3. Create the environment to maximize the contribution from your people (Stage 3, Organizational Excellence)
4. Systematically eliminate sources of potential system failure (Stage 4, Engineered Reliability)
5. Assure alignment of financial operations, corporate leadership, sales and marketing, and customers (Stage 5, Operational Excellence)

Gaining Control of the Work

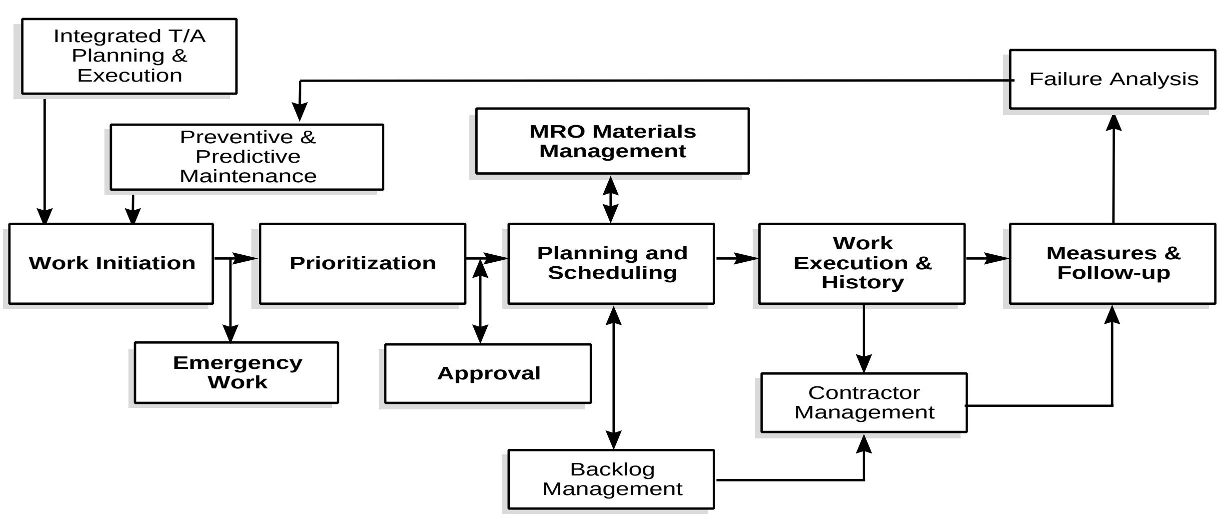
While there are many theories about maintenance best practices, most consultants will advise that planning and scheduling is the necessary starting point. We take a broader perspective, however. Improving Stage 1 is *implementing planned maintenance*. The components of planned maintenance are illustrated below.



The results of implementing planned maintenance are a much better utilization of the workforce, creating capacity to work on proactive maintenance activities.

Each additional stage builds on the successes and capabilities developed in the earlier stage. The most important part to emphasize, however, is that there is a logical and optimum progression to all these pieces to improving asset management practices. In our experience, any other order brings suboptimized results.

The First Step in Gaining Control of the Work is the Discipline of Planned Maintenance



Benefits of Strategic Asset Management

For all of this effort, what kind of payback can we expect? From a non-financial perspective we will have a plant that runs as expected, fulfills customer orders as promised, and where call-outs will be an exception rather than the norm.

As an example of the benefits achievable, we examine the progression through the Operational Reliability Maturity Continuum for a refinery.

Refinery Example of Strategic Asset Management

150,000 nominal bbls/day plant. RAV = $1,000M. Book value - $500M. $3.00 market spread.

Maturity Continuum Stage

	1	2	3	4	5
Maintenance Expense Budget	$40M 4%	$30M 3%	$26M 2.6%	$20M 2%	$16M 1.6%
Annual Volume	30M bbls	35M bbls	40M bbls	45M bbls	50M bbls
Margin/Bbl	$.10	$.50	$1.00	$1.50	$1.80
Annual Operating Profit	$3M	$18M	$40M	$68M	$90M
Return on Invested Capital	.6%	3.6%	8%	13.6%	18%

We choose a refinery example because it is creating a pure commodity. There is little differentiation in raw materials price (sweet vs. sour crude prices generally reflect the costs of refining) nor product price, which are set by international markets. How then does one refinery become dramatically profitable, while the least viable barely break even? The difference is how well the assets are used, and the systems and people involved in the process.

This 150,000 nominal barrels/day refinery has a replacement asset value of $1 billion, the cost of replacing that amount of capacity, and a book value of $500 million. The spread between the cost of crude and the price of gasoline (for example) is $3.00 per barrel. *Thus our maximum profitability is $3.00/barrel. Our job is to capture the greatest portion possible.* Note that the maintenance budget evolves from $40 million to $16 million in traversing from Stage 1 to Stage 5. But more importantly, the volume of product increases with each stage. By lowering the cost (the numerator) and increasing output (the denominator) the refining cost per barrel declines, and our margin increases. The product of increased margins and output in each stage creates a geometric growth in profitability, returning excellent results on our invested assets.

Summary

Improving maintenance alone seldom brings results worth the efforts made. Strategic Asset Management is a comprehensive program, exercised over a strategic planning horizon, that systematically creates value from the plant investment.

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The Central Issue: How to Make Distributed Maintenance Work

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Abstract

During the 90's, many plants have decentralized maintenance to a greater or lesser extent. While these plants have seen many gains from being closer to the consumer of their maintenance services, they also see issues emerging. What are the criteria to choose central vs. decentralized maintenance? Which functions and activities are candidates? Finally, what does this consultant recommend?

Historical Context

Maintenance through the last several decades, until recently, was a relatively monolithic central function. It was usually staffed for peak activities, and often had excess capacity waiting for the breakdown to occur. With the advent of international competition in the 80's, many maintenance staffs were cut dramatically, and over several layoffs became smaller than half their original size. These cuts were often made strictly according to either financial rules (non-union companies laid-off the most senior, expensive workers) or seniority rules (union shops left seniority in place). In neither case were skills and experience the major consideration.

Simultaneous with reducing costs, companies were forced to increase quality, productivity and safety. These efforts focused on the manufacturing unit, looking to reduce variation in product, reduce production bottlenecks, and assure safe work practices. Quality theory told us to define who our customers are and get close to them. Most plants defined operations as the maintenance customer, and in increasing accountability for operating unit managers, gave them more control of the resources.

The initial result was a surge in machine operability, as operations managers directed resources towards equipment problems that had been chronic problems. The craftsmen dedicated to the units felt needed and like they were making a more direct contribution than before as part of a pool. They learned their unit's equipment intimately, and became more proficient and committed to unit performance.

What could possibly be wrong with that scenario?

Emerging Concerns and Limitations

In speaking with maintenance and operating leaders in dozens of plants in this past year, we have heard a number of repeated concerns:

- There is no consistency to how units are performing maintenance.
- In most cases the dedicated crews are working on schedule breakers because of the ease of deploying them. If there is a plantwide priority system, it has no application to these crews. Rather, work is done to the same urgency as the production schedule.
- Planners dedicated to units do very little routine planning. Instead they are expediters, on-call supervisors, and when they do plan, it is for outages.
- Maintenance craft skills are deteriorating. No one in the organization is assuring the continuing development of craft skills
- The CMMS data quality is highly compromised. Some units may use the CMMS, and others don't.

- The remaining central force feels alienated from the unit-based maintenance crew.
- The Reliability Engineering Team (usually those who perform the PdM function) are frustrated that their success is limited to those units whose managers understand their value.
- Important measures of planned maintenance, such as *% planned work*, *schedule conformance* and *%PPM* are declining or very stubborn at improving. Operating units have no standard definitions of these measures, and may or may not even measure and record them.

The first question to ask is, “So what?” If the production schedule is being met, is there any cause for concern?

There is, of course, in any industry where cost is a concern. How do you stay ahead of your competition in most businesses? Produce to a quality standard for less than everyone else. No one we’ve spoken with considers the current practices to be efficient, even if they are seen as effective.

Is there a better way? If so, what is it?

Option 1
Require operating unit managers to be better managers of the maintenance function and process

Option 2
Recentralize maintenance

Option 3
Develop an organization that optimizes **efficiency** *and* **effectiveness**

We can rule out Option 1. Operating unit managers seldom have strong maintenance backgrounds, and would be required to make balanced decisions. Possible, but unlikely. Option 2 would bring back the bureaucracy, and would not benefit the overall organization. It may temporarily improve the control of the work (efficiency), at the expense of production (effectiveness).

A Model for Organizing Maintenance

The answer we suggest is based, in general, on ***centralizing*** *functions that create* ***efficiency*** *and* ***control*** *of work, and* ***decentralizing*** *functions of work* ***effectiveness***.

Functions of efficiency and control in maintenance include:

- Work prioritization for global resources
- Work planning
- Work scheduling for global resources
- Analysis of work done
- Preventive and predictive processes
- Maintenance of information tools
- Compliance with standards
- Central reporting
- Skills assurance

Functions of work effectiveness in maintenance include:

- Response to immediate needs
- Recognition and alleviation of equipment chronic problems within the operating context
- Prioritizing and scheduling area resources

Based on this criteria, we see the following organization meeting both criteria:

Work Identification. Only the area can be expected to identify the totality of the work. Problems not recognized do not get attention.

Work Prioritization. Prioritization is a shared function. The unit places a relative prioritization on the work. A global system of prioritization must be maintained that works across all units, however, or there is no assurance that resources will be working on the “right stuff”.

Work Planning. The planning function is done primarily to improve efficiency. Planned work is typically measured as requiring 1/3 of the labor time as unplanned work. The best model we have seen is to have planners centrally located, centrally managed, but dedicated to a unit(s). The planner is less likely to be diverted to other responsibilities, and more likely to have the time for careful analysis. There are other benefits. During times such as vacation, there are backups available to plan.

Planning is a discipline that is difficult to achieve and difficult to maintain. It needs to be nurtured and developed carefully. This is the greatest issue to maintenance improvement in most plants.

Work Scheduling. Work scheduling is a shared function between the the dedicated planner, the pool resource manager (usually the manager of central maintenance) and the unit leader/supervisor. The supervisor is free to schedule his own dedicated resources against the planned work (allowing for unplanned work), and will receive additional resources for work that is identified as global priority.

Work Documentation. A key to developing a valuable history is complete documentation of the actual work performed. This is done by the craftsman at the end of each job (to avoid the quit early syndrome), and reviewed by the planner for the area. The planner must be the coach to assure that work is documented according to plant standards.

Work Analysis. Planners are the only staff in position to understand and review the work. Part of work analysis is done by simply reviewing the work documentation. Standard job plans may be updated, chronic problems flagged, materials and parts issues noted, and future RCM, FMEA or Root-Cause analysis needs identified. In addition, planners become very familiar with the analysis and reporting tools available through the CMMS, and can most readily scan history for recurring equipment problems.

Preventive and Predictive Work. To assure that PPM work gets done consistently, we have seen the Reliability Team most effectively used reporting to a central leader. As in planning, these people must become specialists, and learning and helping each other is a key to success. This function would report centrally.

Information Tools, Reporting and Compliance/ Performance Audits. Providing information tools, such as maintaining the CMMS, reliability tools, making the reports for reliability and Key Performance Indicators, performing analysis and audits are all functions that would have central oversight or performed centrally.

Area Maintenance

One of our clients calls the craftsmen reporting directly to the area "Min. Crews", short for minimum crews. The concept is that they are able to handle the minimum average workload of the unit. One method to identify the appropriate staffing level would be to examine the amount of work done in the units during the 10 weeks during the year in which the least hours are recorded by the unit and staff to that level. The objective is to keep as many available to the central group as possible for outage work, etc., and to staff just enough to keep the units operating at an optimal level.

This group becomes identified with the unit where they work. Their goals have less to do with typical maintenance KPI's, but directly with the production goals of the unit. As such, the often act as the SWAT team to handle immediate work. They also work on the annoying problems of the unit that would never hit the high priority list of the central priority system.

Their interaction with operators is mutually beneficial. Operators more readily participate in "maintenance" tasks when the crafts performing the work are "their guys". The craftsmen learn the intimate details and idiosyncrasies of the unit's equipment, and become expert in restoration of function. In the best cases, they routinely remove the sources of work (chronic problems) from the units.

The downside of this union is twofold. First, the craftsmen are not maintaining their skills because their work is "Jack of all trades". Second, there becomes a schism between the area and central groups. We have seen this problem resolved through a periodic rotation of staff through the area.

Scheduling of work is a primary responsibility of the area. This is typically handled in a weekly planning meeting between the unit-dedicated planner, the assigned maintenance coordinator, and the unit production supervisor. The planner has issued a list of planned work available for work to the parties ahead of time. They come to the meeting with prioritized work lists that they reconcile, creating the work list and schedule for the following week.

Conclusions

Area maintenance has contributed a great deal to the effectiveness of manufacturing among our clients in North America. In many cases, however, these plants have dismantled the central organization. Reestablishing the efficiency and control functions under a central organization can help the plant improve the total amount of value-added work contributed by the maintenance staff.

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Defining Asset Management

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Asset management is a term that has been getting a lot of press recently. The term implies many things to many people, and there is no industry standard for application. Implied in the term, however, are some basic concepts:

- Business goals drive decisions regarding the use and care of equipment assets
- Asset strategy is determined by operational considerations
- Maintenance and reliability are means to a defined goal, not an end in themselves
- The intent is to optimize the application of all resources, not just maintenance

We have seen attempts to define *asset management* as life-cycle cost management; it has been used in the phrase "asset management reliability", which seems to be redundant or confusing; we have seen the term substituted for maintenance or reliability practices. **We define *asset management* as a global management process through which we consistently make and execute the highest value decisions about the use and care of our assets.**

Our approach is based on the *Operational Reliability*

Maturity Continuum. This empirical model describes five stages of mastery that create a foundation of improved performance with growth potential continuing over a strategic horizon. This model was described in some detail in the September 1997 issue of *Maintenance Technology* magazine entitled Developing an Asset Management Strategy.

Background

Mobil has identified reliability as a primary competitive opportunity. Prior to working with SAMI, they had developed the concept of "Business-Driven Reliability", or employing reliability improvement where business value is created. The opportunity lay in developing an overall business process where the business plan would be achieved by statistically assuring the underlying reliability of people, processes and equipment necessary to achieve the goals. And this would be assured at the lowest cost. While the goals may seem no different than other plants, the difference comes in the process, specifications and decisions necessary for implementation, and ultimately the new behaviors exhibited by the workforce.

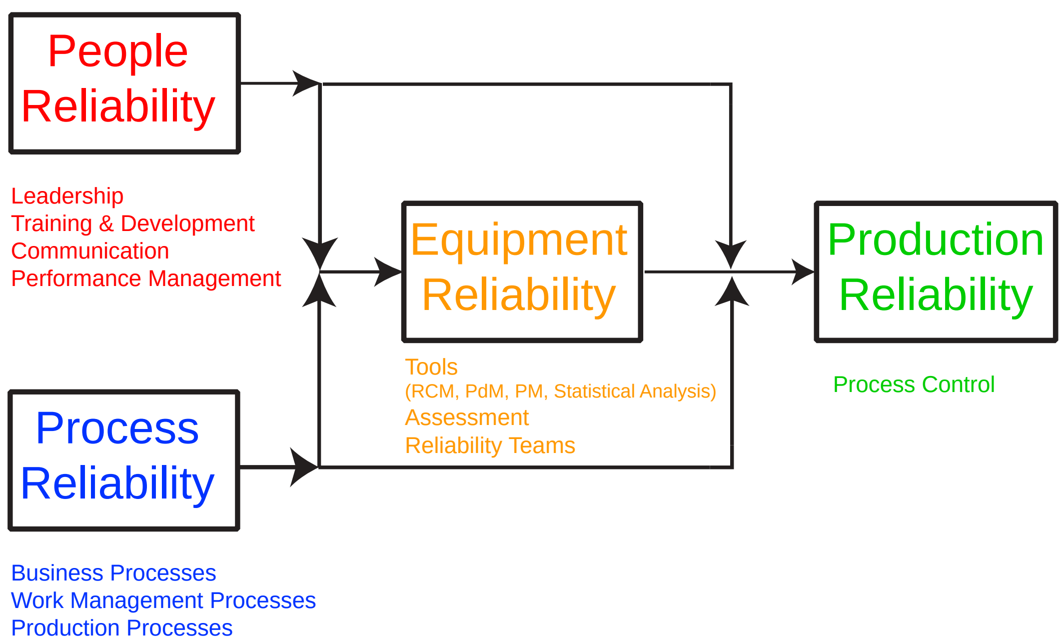
The Asset Management Model

In addition to the *asset management* concepts identified in the first paragraph, we identify several more:

- TEAM™ must completely align the business plan with plant realities, identifying specific equipment condition and performance gaps to overcome to achieve the plan
- All of the work starts with an asset performance specification, based on supporting the business plan; we perform the necessary work to sustain the performance specification, neither more nor less
- All measures, from a corporate ROIC (Return On Invested Capital), to plant contribution, to unit production rates, to specific equipment health requirements, to the supporting maintenance strategy, all cascade in alignment
- The central focus of TEAM™ is the operator. He/she understands the manufacturing process and goals, understands and manages equipment health to meet requirements, and gathers the resources necessary to achieve production goals

Implementing *asset management* is a process. It contains in it the following elements, and the decision models to determine when to use them:

- Empowered Workforce
- Reliability Centered Maintenance
- Work Management Processes
- Predictive and Preventive Maintenance
- Self-managed Work Teams
- Measures of Leading and Lagging KPI's



- Reliability Leadership and Planning
- Safety, Health and Environment
- Continuous Improvement
- Reliability Modeling and Equipment Risk Assessment
- Cost of Unreliability Tracking
- Root Cause Failure Analysis
- Capacity/Business Objectives Modeling
- Lifecycle Costing/Engineering
- Activity-based Management

The TEAM™ Process Model

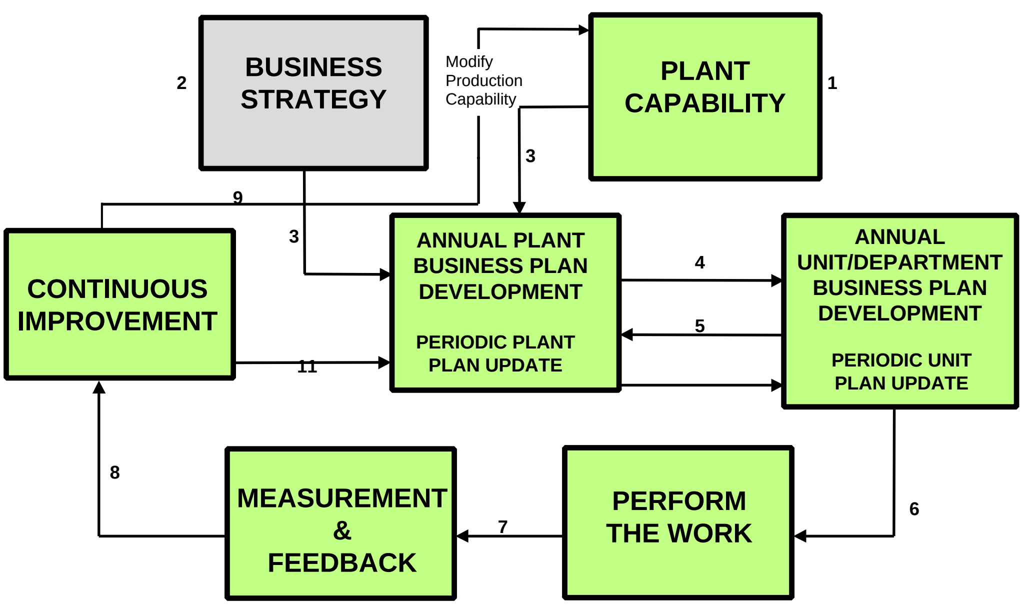
The TEAM™ process model is illustrated here. The flow is generally as follows, and explained in greater detail below:

1. We identify equipment criticality, condition, FMEA's, maintenance requirements
2. This information is taken into the annual planning process. Plant-wide goals are set and passed to the production units for validation
3. The production units prepare their production and expense plans, identifying what resources are required to meet the plant goals. They also identify improvement opportunities and resources. This information is passed back to the plant-level plan for review and consolidation
4. When budgets (activity-based now, not historical) are set, the units create an annual plan for all work in the unit (not just maintenance, but operations and engineering)
5. The work is done to the schedule
6. Results are measured
7. Corrective actions are identified and prioritized with the currently identified work
8. Any changes to the plant are modeled for impact on reliability, and new configurations are incorporated into Plant Capability

Plant Capability

In the **Plant Capability** segment we do "front-end RCM" on a processing unit. That is, we identify system and component hierarchy, we classify process and component criticality, we identify system failure modes and effects analysis, determine critical equipment condition, and assign a maintenance strategy for each system or component based on criticality and value. This positions us to prepare activity-based maintenance budgets, begins to identify equipment condition gaps,

TEAM™ Flow Model



and provides the basic data to prepare a reliability model for the unit.

The operators and their supervision do all this work, after significant training. Initial training includes participating in The Manufacturing Game, which serves as a highly leveraged orientation and change management tool. It also initiates Action Teams, which model the type of team behaviors that will be necessary to operate the units in the future.

We have simplified the equipment condition assessment by equipment class type to be in a yes/no question checklist format that provides the basis for operator daily care practices. The maintenance strategy is assigned via a simple matrix based on component value and criticality.

Plant Capability, as shown by the diagram, is done initially and provides input to the annual business planning cycle.

Annual Plant Business Plan Development

Typical annual plans begin with Corporate setting a financial target for the plant, followed by efforts of the plant to justify a lower target, or deciding how to live with the goal. Most often this follows the "I wish" principle of goal-setting: in spite of not having made plan last year, we look for an increase of, for instance, 8% production this year, while decreasing the operating budget by 5%. Since the plant leadership team are "tough guys", they are left to figure out what to do differently. In most plants, decreasing budgets leads to less equipment attention, decreased equipment health, and declining production.

The process for capital investment is often even less structured; plant management finds out the capital plan is due in corporate by Friday, and meets all day Thursday to determine which projects will be proposed, based significantly on emotional commitment to specific projects. This lack of structure is not seen as important, however, since this only allocates a "bucket of money", and projects will be decided in earnest during the course of the year.

Unit goals are often specified by numbers for which there is little accountability during the year. Rather, we look for record shift goals, or running wide open, not knowing the consequences on equipment, safety or cost.

Under TEAM™ this process changes dramatically. The first step is to determine the effects of increased demand on the units for throughput. What is the probability of achieving the increased throughput goal? The chart below gives a viewpoint for production probability:

Depending on the unit's production volume requirement, we can select the appropriate maintenance strategy with to meet the probability of production required. If the unit at its healthiest equipment condition is unable to

Maintenance Is Assigned According To This Matrix

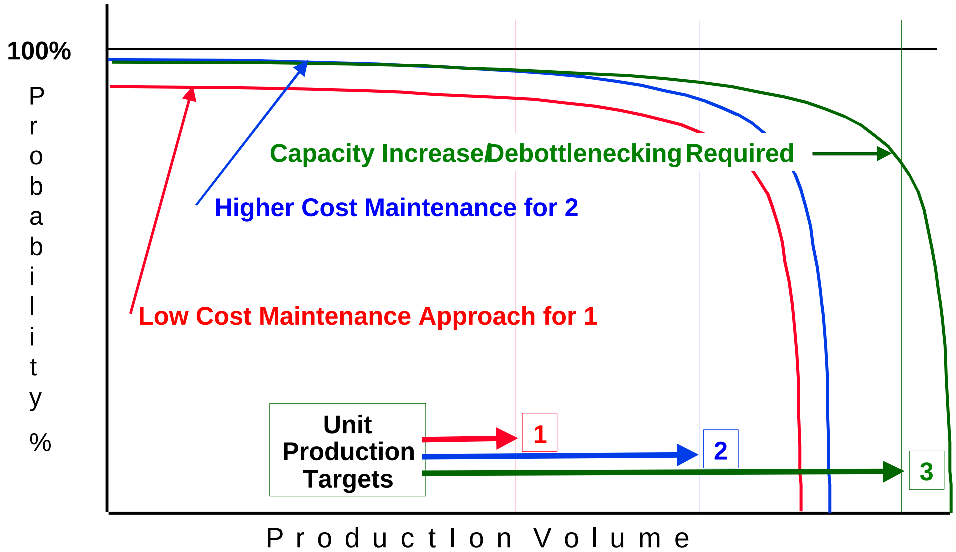
Criticality	*Proactive* Maintenance Activities		
High-1 High-2 Medium-1	Time Based Useful Life, Schedule & Replace before Failure (1)	Time Based Useful Life, Inspect, PM & Condition Monitoring (2)	RCM, Continuous Monitoring, Predictive Maintenance, PM & Root Cause Analysis (3)
Medium-2 Low-1 Low-2	Inspect, Run to Failure (4)	Inspect, Preventive Maintenance (5)	Predictive Maintenance Root Cause Analysis (6)
High-3 Medium-3 Low-3	Run to Failure (7)	Operational Maintenance (8)	Preventive Maintenance (9)
Component Value	0 - $5,000	$5,000 - $50,000	Greater than $50,000

High Criticality- A process in which a service interruption would result in a CoUR event.

Medium Criticality- A process in which loss of service for less than 8 hours and would not cause a CoUR event.

Low Criticality- A process, which operates intermittently and service interruptions, will not result in a CoUR violation

Maintenance and Capital Spending are Matched to Meet the Production Volume Requirement



produce at that required rate, we design the capital project, along with the cost/benefit calculation. This is fed back into the planning process, to determine whether the cost of maintenance or capital project is justified to meet the rate requirement.

Thus we are able to iterate the goal setting process, based on facts and probabilities of achieving the goals. For instance, an 80% likelihood of achieving production targets would probably not be considered adequate assurance, and engineering steps would be taken in increase the probability to acceptable limits.

We will have a list of capital projects, each having a specific return on investment, from which the management team will choose. The guessing game is eliminated; it is actually likely that more capital will be approved since the justifications are so clear, and the plant debottlenecking efforts will be based on maximum utilization of existing assets, rather than substituting a capital project for good asset health practices.
For each capital project we will review RAM, MOR and MOC (reliability, availability, maintainability, management of reliability, and management of change). The Management of Reliability will assure that the probability of performing at specified production volumes for the unit is not negatively affected by the project work.

Annual Unit/Department Business Plan Development

The unit will set objectives based on the overall plant objectives, coming out of the initial pass of Prepare/ Update Annual Business Objectives.

At this point the unit will determine the likelihood and barriers to achieving the production goal, as well as the maintenance budget. They will model in detail the unit's capabilities, creating performance specification for each system and subsystem, all the way to identifying the required MTBF for components. Where there exists a gap, we identify equipment upgrades, capital projects, and any changes in the maintenance program necessary to meet the goal. We will create an activity-based maintenance and operating budget, since we know the specific maintenance and operating strategies for each system and component in the unit.

The unit then signals the plant leadership what the costs and barriers may be to achieve the goals, and decisions are made regarding the variations. The important aspect here is the *precision* with which decisions are made. We know our capacity and probability of operation; we have a rationale strategy and associated cost with every maintenance activity, and will report on those activities and specific variances.

Given this level of specificity by the units, a planner will have most of the information necessary to begin his work, and can prepare most work packages ahead of time.

Continuously Manage Work

In the *Continuously Manage Work* segment, we introduce some new concepts. First of all the Work Management System, in addition to holding the maintenance work and resources, plans and schedules operations and engineering work and resources. For instance, if an RCM study is planned for a piece of equipment for this year, resources will be loaded against that as a task. The operators' daily rounds are identified as routine tasks, and reported as they are completed. Engineers in most plants are critical path resources, yet we don't schedule their time; in the TEAM™ process their tasks and priorities would be managed like the work of the craftsmen.

Another opportunity we grasp is scheduling all the work; this includes routine maintenance, responsive maintenance; operator performed maintenance; major maintenance, outages and shutdowns; engineering work. Fundamentally we need to plan everyone's work, and by doing so, we are making judgements about the priority and value of each task, start and stop times/dates, and performance expectations, measures and reviews.

At this time the reader may ask, "Isn't this terribly structured and data driven?" "Where is there room for spontaneity and interest?" Our primary intent in manufacturing is to set a standard that meets customers' needs, and to manage work and product to minimize variation. That can only be done with data and planning. The fun comes in through the feeling of control and contribution by the hourly workforce, but being able to complete a planned task before starting several more, and by being consistently successful. More people than have participated in the past require creativity and better decision-making. Reducing variation in the manufacturing process is everyone's job, not just the managers and superintendents.

Because there are clear specifications for equipment health and work management, measurement becomes much easier. It is performed by the hourly staff, who are motivated to improve, as performance is directly related to rewards and recognition. We will need to make meeting performance targets pay well for the hourly ranks, just as management is measured and rewarded.

Measurement and Feedback

Review of results is an ongoing task. Variances are treated as opportunities to understand more about the equipment and the process. Because we have a direct knowledge of cause and effort in our equipment, we will identify necessary changes in our equipment, our knowledge, and our processes. Most failures will be seen as caused by the management system, rather the individuals who willfully fail to perform.

Continuous Improvement

Based on the analysis of the variance, we may find that our maintenance routines are under- or over-maintaining equipment, that we are not eliminating systemic failure modes and effects, that engineering projects are more or less robust that anticipated. Any changes we make need to be reflected back in the Plant Capability database. We may also make changes that affect our Annual Profit Plan, which will be updated.

We also recognize that many failures are effects of lacking of understanding of equipment function, so we take action to reduce our staff's actions as a source of variation.

Plan Updates

Control may be seen as desirable, but impossible, in our ever-changing world. Even a Stage 5 company has unplanned downtime. Customers' needs change. External forces buffet the plant, especially reactive responses to events. The question is not whether we will respond to change, but how to do so most productively.

Our approach suggests that keeping to a monthly plan is highly desirable. We can say in tune with the entire plant, and make changes in a planned fashion. One of the greatest causes of variation in production and equipment come when changes are made with little communication, with little planning, and little consideration for other effects. For instance, we often hear that driving a process beyond prior limits without safeguards caused an equipment outage. Or that one part of the plant made a change without informing the rest of the plant, and led to unexpected results.

The TEAM™ model calls for changes to be reflected in both the annual plan and the unit production plan. If we have a product that is currently selling at a high margin, and we want to adjust production levels, great! But let's make the change in a planned fashion. We revamp our annual plan to reflect volume changes; the units have a chance to respond to the efforts of the change, and to prepare for them. If we have been through this particular change before, we can safely make the production adjustments based on prior history. If our equipment configuration has changed, or our workforce has turned over, proceeding deliberately will maximize the likelihood of achieving the desired goals, and minimizing unintended consequences.

Specifically, in addition to changing our annual plan and the unit plan, we will work to understand the system stresses that will result from the change. We will run the appropriate models of RAM, MOR and MOC, as well as our unit reliability models to try to foresee and accommodate effects of the change.

Results Expectations

Mobil has made some very good gains, even though we are very early in the implementation process. From a financial perspective, teams have identified more than $1 million is benefits, and the Cost of UnReliability has a reduction trend in 1999 to yield $8-10 million. As telling, though, is the enthusiasm and dedication of the hourly workforce. Their leadership recognize the benefits of greater contribution, control and satisfaction that comes to the workforce with this process.

The unit teams receive more training than ever before, and they are applying the training immediately. Because this process leads to fundamental changes in managing activities, there are changes in virtually every job and core process in the plant. It is not a path for the timid or those unwilling to change. Some of the results of the process include:

- Corporate is using this project as part of the model for all manufacturing facilities
- The Operations manager has said, "This is the best return on any money I could have spent!"
- Union Official: "We want our employees to share in the profits, because they will be taking much more responsibility"
- Operator: "For the first time I feel like I am not asked to check my brain at the door."

Summary

Aligning plant resources to continuously maximize value and minimize variation has been an industry goal for decades. Technology and human factors have finally provided the tools necessary to close in on this achievement.

Advanced and sophisticated plants, able to successfully change and which have excellent leadership, are candidates for the process we call *asset management*, or *TEAM™*. We suggest that companies complete a minimum of *Stage 3* performance before they embark on this program.

Recognizing that the concepts of *asset management* will grow and mature over time, we offer TEAM™ as a stake in the ground that provides a basis for discussion. We welcome reader's input to continue to better define this process.

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Designing the Best Maintenance Organization

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Background

We find a lot of uncertainty about optimizing plant organization among maintenance and plant leadership. This is manifest by frequent change in the organization design, typically swinging from centralized maintenance to decentralized maintenance, and back again.

The result of this frequent change is the uncertainty of leadership, responsibility channels and direction (other than the familiar and maligned reactive maintenance) of the new organization's accomplishments versus the accomplishments of the former structure.

Improvement initiatives usually lose momentum as people get acquainted with the change of relationship, and look for new cues for how to act. If there has been no communication plan executed as part of the change, the craftsman has time to adjust to the new role, and finds no reason to initiate anything new. Reactive maintenance maintains its tenacious grip.

Is there an objective method we can use to design the organization? What are the major factors that influence the design? We present a model in this article that uses organizational competencies and improvement strategy as the driving considerations behind organization design.

Current Criteria for Organizational Change

We find many organizations designed to fix a perceived problem, that in many cases raise more issues that they solve. Rather than having a clear rationale, the design is made reactively. The intent of the design is more important, actually, than the structure. (consider re-phrasing: The intent of the design actually become more important that the actual structure.)

Among the reasons we see for specific design are:

1. We see a lot of dissatisfaction with maintenance by the plant manager or production. Results: Distributing of decentralizing resources. "Give me the crafts", says Mr. Production Manager. "I'll show you how maintenance should be done".

2. In a desire for increased accountability, many plants have gone to an autonomous unit-based structure, and divide all resources among the units to eliminate excuses. Results: Decentralized resources. It now becomes virtually impossible to move resources between units.

3. In order to minimize costs, maintenance resources are moved to report to a production supervisor, eliminating the (perceived) need for the maintenance supervisor. Results: Distributing or decentralizing resources. Usually the production supervisor had a full-time job, and no maintenance experience, leaving crafts on their own to find work to do. Over a period of time, craft skills deteriorate and incidents outside the unit increase (e.g. utilities).

4. Many plant managers are frustrated that maintenance seems monolithic, slow paced, every job requires excessive time to get done. Maintenance people fail to understand the business of manufacturing, and don't seem part of the team. Results: Decentralize or distribute resources. Maintenance

becomes more responsive to unit or department needs. They learn the equipment, work to eliminate chronic failures (because they are so tiresome), and now feel a part of the core business.

5. Maintenance costs seem to rise each quarter. More and more contractors are brought in for larger jobs that used to get done in-house. Expediting parts becomes more common, and planners don't seem to find time to plan.
   Results: Resources are centralized, perhaps to the chagrin of the craftsmen, who often feel more part of the business out in the unit or department.

Criteria to Judge Organizational Effectiveness

Rather than designing the organization to solve a specific problem, we need a set of criteria to identify an effective organization. We propose the following as a starting point:

1. You Have Control Of The Work

- Work is accurately and completely identified
- When work is written up, there is confidence it will be done in a reasonable timeframe
- Activity is performed according to the priority of operational criticality and safety
- Work scheduled is consistently work done
- Work is executed efficiently. Little waste during the course of the craftsman's day
- Results of the work are properly recorded and periodically analyzed for opportunities to improve the system, or an individual's performance

2. Defects Are Routinely Being Eliminated

- Prevention is the bias of the maintenance department (PM, PdM)
- Operations takes responsibility for equipment, including routine surveillance, proper operating procedures (to minimize breakage), raw materials are appropriate for the equipment application
- Equipment health in maintained (lubricants applied, alignment checked, tensions maintained, critical operating performance levels are charted)
- Materials management assures appropriate service levels are maintained and lifecycle cost, rather than purchase price, is the primary consideration
- Failures events are evaluated, prioritized, analyzed and failure modes eliminated

3. Maintenance Costs Are Minimized

- Jobs and skills are matched in the scheduling process
- Jobs are planned (estimated, parts & tools reserved, drawing available) & materials available prior to scheduling
- Equipment is prepared prior to crafts arrival to job:
  - a Cleaned, isolated mechanically & electrically
  - b Safety procedures observed
  - c Proper shutdown and start-up procedures observed
  - d Operators perform tasks according to their ability and the level of sophistication of the facility (see *Developing an Asset Management Strategy*, Maintenance Technology, September 1997, for a description of these stages.)
  - e Stage 1: Prepare equipment, identify work, learn equipment function, act as craftsman's helper
  - f Stage 2: Perform Operational Maintenance (Surveillance, Lubrication, Adjustments, Cleaning)
  - g Stage 3: Perform simple maintenance (e.g. packing valves), troubleshooting, participates in repair
  - h Stage 4: Work with defect elimination, participating in RCFA's, RCM's, etc.

Basic Types of Organizational Models

What are our options, then, to consistently provide the capabilities listed above? Simply put, there are three types of organization design.

- Central Maintenance. All crafts and related maintenance functions report to a central maintenance manager.
- Decentralized. All crafts and maintenance craft support staff report to operations
- Distributed. A combination of the above. Typically centralized maintenance leadership function, with maintenance and reliability staff functions reporting here. Crafts are in some

proportion allocated to production units and to a central maintenance function.

Models for Decision-Makers

All quality theory suggests one study the value chain, that is, where is value created in the organization. What value does maintenance (and its counterpart, the reliability team) create? And what organization enables that value?

VALUE	MEASURE	BEST ORG. STRUCTURE
1. Repairs Equipment	Mean time to repair Maintenance Rework	Distributed Distributed
2. Trouble-shoots	Mean time to repair Maintenance Rework	Distributed Distributed
3. Improves Operability	Throughput	Distributed
4. Improves Maintainability	Mean Time to Repair	Distributed
5. .Monitors Equipment Condition	Throughput Mean time between Failures Maintenance Cost	Centralized
6. Overhauls, Capital Projects	Efficiency, Schedule Compliance	Centralized
7. Controls Cost	Maintenance Cost	Centralized
8. Manages Materials	Availability, Cost	Centralized
9. Increases Reliability	Throughput Mean time between Failure Maintenance Cost	Centralized/Distributed

While this list may not be comprehensive, it does indicate that neither a centralized nor decentralized organization is ideal to accomplish all the value-added requirements of maintenance and reliability functions.

The Reliability Maturity Continuum

Stage I, Planned Maintenance, has as its primary goals to gain control of the work and to minimize maintenance cost. Often referred to as planning and scheduling, it attempts to maximize the effective use of the craftsman's time. This is done by assuring a complete work package, tools, parts and permits are ready before work is started. Also, by careful scheduling, we may perform several jobs on a piece of equipment when it is down, instead of just one. Defect elimination is a by-product as well. By prioritizing jobs, and assuring the right parts and tools are available, we spend our time doing the most important things right the first time, rather than patching a patch.

Stage I Optimal Organization. Establishing and enforcing a common system across all units in a plant requires strong central authority. Important new skills must be learned and continuously reinforced. Planners must be dedicated to their jobs, and while assigned by area or unit, their concentration cannot be scattered by a variety of extra assignments. So until this new system is firmly in place as a way of doing business, the best organization, we believe, is **centralized.**

Stage 2, Proactive Maintenance, is aimed at defect elimination, which of course reduces costs. It also increases control of the work, because schedule breakers decline as failure modes are eliminated. The goal of proactive maintenance is to eliminate common failure modes and effects across the entire facility. We have seen concerted efforts on rotating equipment, for example, increase mean time between failure of pumps from six months to four years, or one-eighth as many jobs to perform. Consider this stage operating under the 80/20 rule: 80% of the failures come from 20% of the failure modes.

Stage 2 Optimal Organization. Since we are looking for failure modes across the entire plant, and not in only one area, the reliability teams continue to be organized **centrally.** New skills must be acquired for crafts and engineers. Costs for acquisition of condition monitoring equipment need to be carefully evaluated for best application and value. These decisions are best made cross-functionally, and executed centrally.

Stage 3, Organizational Excellence, now engages the rest of the operation in Asset Health Care activities. In Stage I, operators prepared equipment for maintenance; in Stage 2, operators helped to identify and diagnose chronic problems. Now in Stage 3, we ask operators to begin to take ownership for equipment condition. Part of this ownership is to perform Basic Care activities, including lubrication, adjustments, obervation and recording of operating parameters, and other tasks we might label *operational maintenance.*

In addition, we now move a portion of the maintenance crews to work under production. Why can we do this? We are in control. Our work management process clearly identifies, plans, schedules and assures proper execution of the work, and our proactive maintenance has eliminated most of the common failures in the plant. We are now set to focus on cross training, craftsmen learning the equipment from operators, and operators learning equipment care from craftsmen. We still maintain, at least for some time, the maintenance supervisor, but the role changes to that of facilitator and coach.

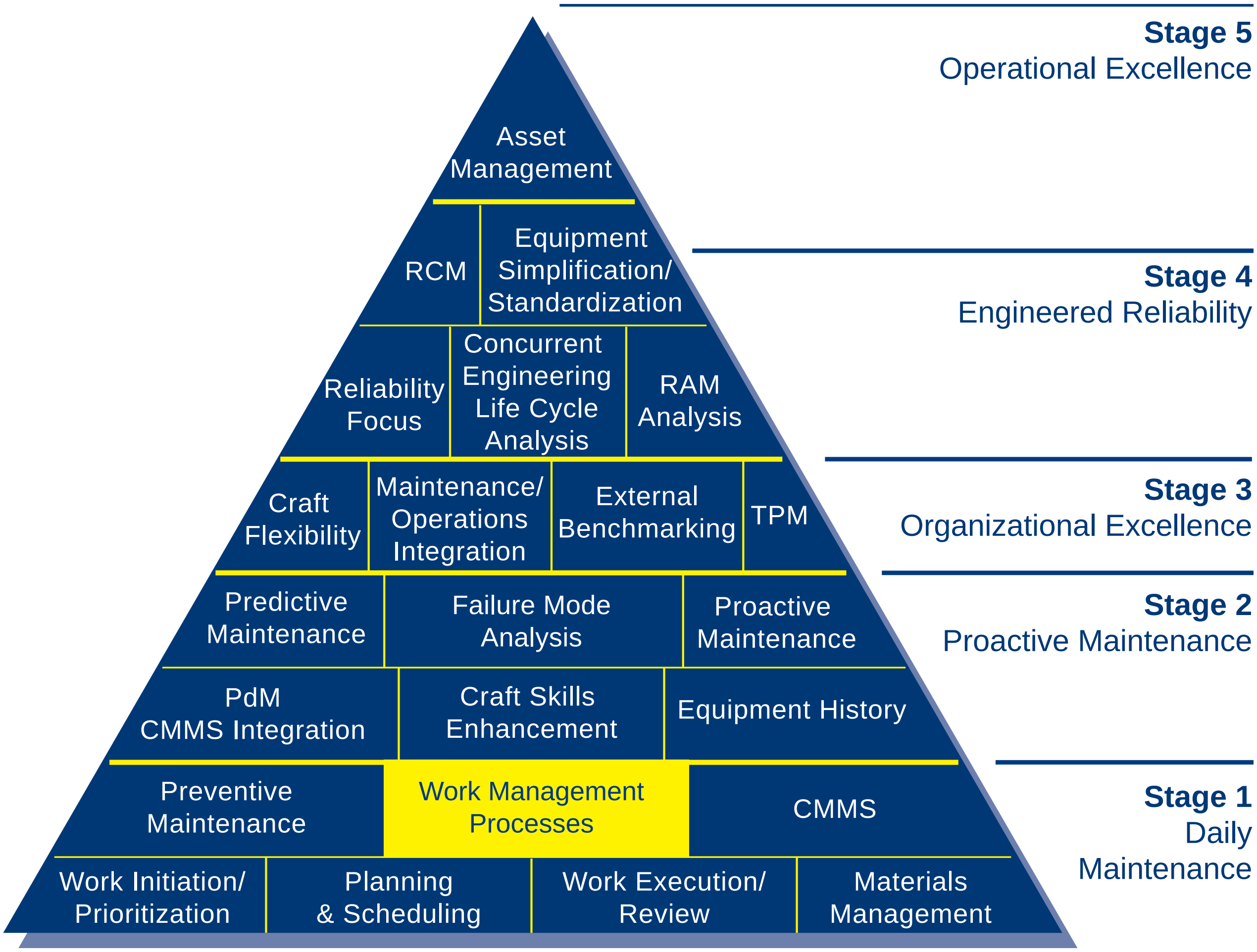
Stage 3 Optimal Organization. While we have moved a portion of the craftsmen to the areas, we continue to maintain a central group for overhauls, turnarounds, shops, and common services. Planning and engineering continue to report centrally, but get increasingly specialized as to their equipment responsibility. This is possible because there are fewer fires (schedule breakers) to put out. This organization is best described as **distributed.**

Stage 4, Engineered Reliability, is primarily unit-based, working on defect elimination on specific systems, rather than common failure modes. As much of this work is equipment unique, it further requires unit-based collaboration. At this point process engineers and planners may report in to the units, depending on complexity of the equipment, and the amount of work to be done.

Stage 4 Optimal Organization. While we have distributed more resources to the unit or department, we continue to have a central maintenance manager who oversees *systems*. Examples of these systems may be craft training systems, the CMMS, a reliability reporting system, a maintenance cost system, etc. At this point, the size of shops or turnaround teams may diminish, and it is a good time to review outsourcing certain functions. This organization is best described as **distributed.**

Stage 5, Operational Excellence, adds a dimension of business goals driving and determining all maintenance and reliability efforts. We are now truly trying to *optimize the plant*, and the role of the shift-based teams increases. They now have primary charge of monitoring and maintaining asset health, as well as optimizing production and yields. By this point, there are few unanticipated equipment breakdowns, work management is a way of life as is continuous improvement. Responsibilities are clear, but work practice is very fluid, calling upon resources flexibly, but in a completely planned manner.

Stage 5 Optimal Organization. The ownership of resources is now a minor issue. Since nearly all maintenance is preplanned, as much as a year in advance, resources are assigned by priority of the work



needing to be accomplished. Much work will continue to be unit based, but the opportunity to share across units is available, since the planning horizon is long, as the discipline to make value-based resourcing assignments is in place. We think the best way to characterize this organization is actually decentralized or **matrixed,** but the level of self-management, discipline and planning is so high, that organization charts are replaced by a work management process that accounts for all the resources in the facility.

Summary

In summary then, the organization needs to account for the *intent* of the managers. If a systems orientation for control and cost are an issue, or if the solutions we are looking for transverse the entire facility, we believe the successful strategy will be centralized. If the issue is unit-based, then distributed is the highest value strategy. Finally, we believe that only a very mature, high-performing organization can be optimized with a decentralized structure.

Most of our readers will not have the luxury of making immediate organization changes to reflect this philosophy. Nor do we think they should, as the application of these rules must be done in the context of the capabilities, attitudes and history of the plant. We do think, however, that setting out a list of objectives before any organization change, and identifying how these will be accomplished in a revised organization, is the key to any success.

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Creating An Asset Healthcare Program

How to Assure Your PM Program is Effective

by S. Bradley Peterson
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Abstract

A key question in operating any plant is this: Are we doing the right amount of maintenance? Are we doing the right type of maintenance?

How do you know? Most plants we visit have developed preventive maintenance programs over the years for a hodge-podge of reasons. In some cases equipment PM's have been based on OEM recommendations. In some cases, PM's have been developed in response to major failures. But we almost never find that a systematic approach, based on manufacturing value, has been deployed to develop the care program for the asset.

This article gives a step-by-step method to systematically develop an asset healthcare program, resulting in the necessary reliability to meet your business plan, at the lowest cost. It discusses the concepts of asset healthcare, gives an overall closed-loop process to develop your program, and identifies how to measure success and make required adjustments

.

Traditional Difficulties

For many years as I have given public and industry presentations I have asked the question: "How many of you (the audience) believe you have a good or excellent Preventive Maintenance program?" Without exception there are no hands raised in the audience.

What makes developing such a program so difficult? Other difficult things are accomplished in maintenance improvement: sometimes planning and scheduling are implemented plant-wide with good results. Frequently a storeroom offers good service, while minimizing total inventory cost. So why is preventive maintenance so difficult?

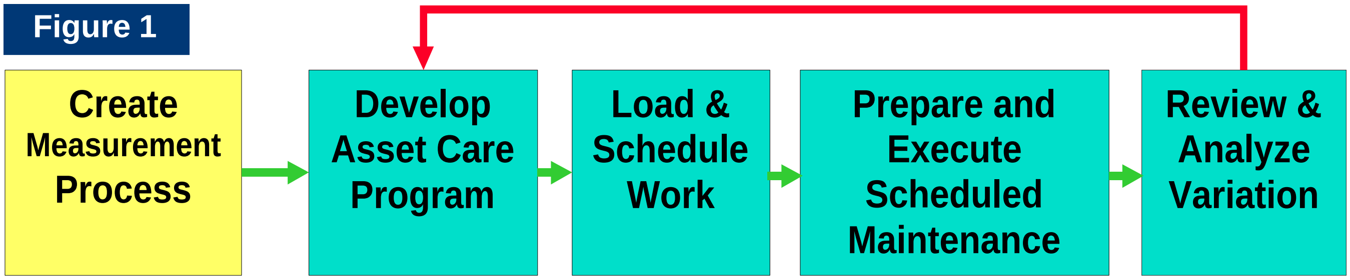
The elements of PM's are well known. You need a set of tasks performed at a certain frequency, and these tasks are scheduled and performed thoroughly by qualified craftsmen or operators. Some of the problem, of course, is simply trying to implement prevention in a reactive environment. Work isn't planned, parts aren't available, or the equipment isn't made available due to missing production schedules. That isn't the problem, though, where good planning and scheduling exist. *So the issue comes down to identifying the right tasks, and the proper frequencies.*

Reliability Centered Maintenance (RCM) is often selected as the tool of choice for plants advanced enough to understand that the prevention tasks must be aimed at correcting specific defects or failure causes. This fails, too, because there is no plant in my experience that has the resources or fortitude to perform RCM studies on every piece of equipment or aspect of the facility. *Risk-based RCM* comes closer to the mark as a tool, but still tends to look at specific equipment. It is not used to *develop the plant-wide prevention plan.*

Replacing "Preventive Maintenance" with "Asset Healthcare" as the Operative Concept

We think the first part of the issue is semantics or definitional: the term *preventive maintenance*, or even the more encompassing "preventive-predictive" maintenance fails as a *concept*. It connotes for most people, *activities* more than *intent*. For that reason we prefer the term *Asset Healthcare.*

Figure 1



When we examine the concept of healthcare as it applies to people, we understand it to mean *maintaining function, or the condition of the body to perform certain activities.* Likewise, we understand that our objective in maintenance is to *assure the likelihood (probability) that equipment can perform a certain function when required.* We understand, too, that reactive maintenance cannot assure that probability, but only minimize the impact of failure. For these reasons, we encourage a new concept (not of our invention, but not commonly used) of *equipment or asset healthcare.* Our preference is to use the word "asset" because it applies to the facility as well as the production equipment. In most cases, failure of the facility degrades our production capability in a similar manner to equipment problems. Thus we encourage clients to start with the concept of *assuring asset healthcare.*

Introducing "Probability" as a Necessary Concept in Developing the Asset Healthcare Program

Another concept we need to introduce is that of probability. We know that decreasing the *frequency* of a failure mode increases the *probability* of performing the intended function.
However, without an intimate understanding of molecular strength of every aspect of every component, and the forces to which it will be subjected, we are left with uncertainty about the timing of a given failure mode. Thus our goal is to manage the *probability of equipment performing its intended function.*

Why is this distinction important? Because as we approach the ultimate (100% assured availability) costs for maintenance go up exponentially. Our goal is being able to answer the important question: *"What is the appropriate type and amount of maintenance necessary to assure a specified level of performance for the asset?"*

All of our asset healthcare tasks (preventive maintenance) need to answer this question, or we will never know if we have succeeded in our goals.

The Asset Healthcare Closed-Loop Process

In this figure we see a five-step process that describes a self-improving method for Asset Healthcare development and exection. Steps 3 and 4, *Load and Schedule Work* and *Prepare and Execute Scheduled Maintenance* are typical processes in the Planned Maintenance Cycle, and won't get separate attention here. Steps 1 and 5, *Create Measurement Process* and *Review and Analyze Variation*, are also typical of any closed-loop process, but we will be identifying some new concepts here, so they will be covered, though not in great detail. Obviously the step that will get the most attention is number 2, *Develop the Asset Care Program.*

Developing the Asset Healthcare Measurement Process

We know we can't permanently improve what we don't measure. But in the plant environment the plethora of indicators that can be measured are overwhelming. There is a compelling need to simply the measurement process, to make this manageable in an era of downsized workforces.

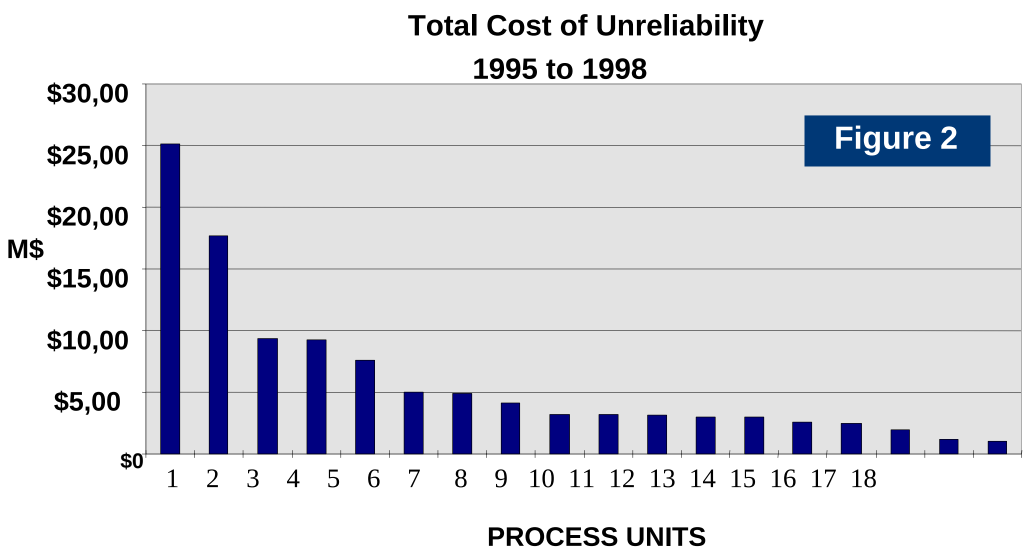
There are, of course, leading or process measures that are required. These include PM (Asset Healthcare task—or **AHT**) compliance, % AHT to total work hours, etc. We need a measure of results as well.

We won't dispute the value of those who measure "Uptime", or "Overall Equipment Effectiveness". These are excellent measures and give an overview to any plant that deploys them. Where they may have shortfalls is in identifying the *cause* of a problem. They don't do much to identify the "delta" which needs work.

We have seen only a single plant that has maintained a plant-wide measure of "Mean Time Between Failure". This requires a lot of data and continuous effort for reporting. It fails, however, to guide one from a business perspective: Where do we place our efforts and emphasis?

Instead of the above measures, we'd like to introduce a concept we learned from one of our clients: **Cost of UnReliability (CoUR).** This is an extension of the Cost of Quality concept used to measure deviations in quality theory. Figure 2 shows a graph of four years of tracking CoUR in a major facility with many operating units. One can quickly grasp, with clear evidence, where to place attention!

The advantage to CoUR is in the planning process. Practically, what has cost us money? Are there patterns? Where do we focus our efforts? It becomes a practical scorecard overall, to see if our CoUR is declining, while also directing our work towards specific failure causes. It records history in a way this is impractical for a CMMS, without the limitation of a huge data collection workload.



Fundamentally, CoUR measure the production value of the downtime for a department or a unit, and adds in the cost of repair, both labor and materials. We record and maintain a database for those CoUR events greater than X dollars. X, of course, depends on the production value of your plant, and your visibility and dedication to recording incidents.

Key data elements include:

1. Date and time of incident
2. Location (Department, equipment center or unit) and specific equipment number that failed
3. Downtime and valuation of downtime
4. Repair costs (usually the work orders that apply)
5. Failure reason code
6. Failure description

Using the power of the database, all failures can be sorted by location, size, reason code, etc. Also, for this client, when the cost of the failure hit a threshold (e.g. $100,000), a Root Cause Failure Analysis is required.

So, on to the task of creating the Asset Healthcare tasks appropriate for a plant or facility.

Typical Asset Healthcare Task Development and Rationale

We might spend a moment considering two questions. First, in the history of this plant, when were asset healthcare tasks created? And second, by what methods were they created?

We seldom find that greenfield plants develop their prevention program before the plant starts operations. Usually this simply hasn't been part of the start-up plan. When it is, there isn't sufficient time or money given to its development. And where in isolated cases AHT's were created for specific equipment, it was usually done according to the vendor's specifications, without the benefit of experience within the operational context.

The next time we might see PM's developed is when there are significant failures that gain lots of attention. Sometimes these are one-time events, but reaction requires we dwvelop a PM, and it gets generated every month, forever. We may also put a team together to develop PM's. These are done as well as possible, with best guesses as to appropriate tasks and frequencies. These are usually the most valuable of the PM collection that gets printed out each period and distributed to the craftsmen

We want to change these methods forever. What we seek is *an effective, simple, measurable system that enables us to create a proactive maintenance strategy for every piece of equipment in the plant.* Currently RCM, in its many flavors, is identified as the method to accomplish this task. In most applications, however, it is too cumbersome to apply to all the equipment in the plant. We propose a hybrid method that meets these characteristics:

- Covers the entire equipment spectrum
- Applies easy to understand rules that can be modified with experience
- Adds value during it's development, not just in the future state
- Minimizes data reentry
- Can be implemented by the hourly workforce with minimal guidance beyond training

The Seven Steps to Developing Asset Healthcare Tasks

Our Asset Healthcare System used employs these steps:

- Select and Install the Software Tool (Asset Healthcare System, or AHS)
- Develop Hierarchy
- Develop Criticality
- Develop Equipment Condition
- Establish Strategies for Component Care
- Develop Failure Modes and Effects
- Develop Maintenance Activities

Working with one unit or department at a time, these steps develop the system of proactive Asset Healthcare. We discuss each one in overview.

1. **Acquire, Install and Train in AHS Software.** After working in many situations without a fully functional software tool, we have found that there is a better way. Find a good tool and use it to its maximum capability! We searched for and reviewed over 200 "RCM" software tools, and found a handful that met our requirements:

Figure 3

- Easy to use.
- Easy to learn.
- Complete training and documentation.
- RCM Cost/Benefit capabilities.
- Documents component and system criticality.
- Quick to implement plant-wide.
- Upgrades to the software.
- Links to CMMS
- Migrate CMMS info into RCM tool.
- Meet/comply with Corporate IS standards & requirements.
- Applicable libraries of failures/tasks (specific to the industry).
- Allows as much or little FMEA (Failure Modes and Effects Analysis) detail as needed (not all plants need the same level of detail).
- Uses Pareto analysis tool.
- Ability to conveniently group PA's (maintenance tasks that can be completed at the same time).
- Monitors effectiveness of RCM with key performance indicators.
- Convenient software support.

We use this tool for all purposes in the following steps.

2. **Develop the Equipment Hierarchy.** In many instances an equipment hierarchy exists in electronic form somewhere in the plant, and usually is embedded in the CMMS. We suggest going as many as four to five levels in describing the equipment hierarchy, depending on how far down it is necessary to go to get to a maintainable component. This may be a pump, motor, gearbox, or electrical panel. This initial identification of the equipment gives us the basis to develop a proactive maintenance strategy for every component.

   One of the benefits of this step is the equipment owners, the operators and the maintainers, perform this task. In doing so, they educate themselves about the equipment, going over drawings, listings, and manuals. We hear many positive comments by the team during this task, which takes several days: "I didn't know that was how it worked!", or "Is there really a filter there? We've never cleaned it!" Another opportunity is to identify to engineering where the drawings are out-of-date, where changes haven't been documented.

3. **Develop Criticality.** In order to determine the level of maintenance a component should receive, we need to understand its value in the operating context. To keep it simple, we ask “How critical is the process to which this is a part? Our answer set would be: a) Must be running all the time, b) Must run most of the time and on demand, or c) Must run occasionally. One can also use CoUR as a gauge of process criticality: for instance, using the value of any hour of downtime as the range of criteria.

Figure 4

If, in any mode...	Then:
Shutdown of any duration causes a CoUR event of $100K per day	• Assign the sub-system a criticality code of "H"
Shutdown causes a CoUR event of $10K to $100K per day.	• Assign the sub-system a criticality code of "M"
Any incident $1K to $10K per day	• Assign the sub-system a criticality code of "L"
Any incident below $1K per day	• Assign the sub-system a criticality code of N

Once the *process* has been classified on criticality, we classify the *component*. In this case, we use a number instead of a letter.

Figure 5

If	Then
Failure of the component will cause personnel injury or a reportable environmental release	• Assign the component a criticality code of "1"
The component’s failure will result in a failure event of $100K or greater per day	• Assign the component a criticality code of "2"
The component’s failure will result in a CoUR event between $10K and $100K per day	• Assign the component a criticality code of "3"
The component’s failure will result in a loss of between $1K and $10K per day.	• Assign the component a criticality code of "4"
The component s failure will results in a loss of less than $1K per day	• Assign the component a criticality code of 5

The result will be a table of equipment with associated criticalities, all entered into the Asset Healthcare System, as shown in Figure 6.

Component	Description	Type	System Criticality	Component Criticalit
81LV00	Level Control Valves for C-8105 hydrocarbon	Control	H	5
81FC01	Flow control valve to C-	Control	H	5
81LV00	Control valves Sour water to injection	Control	H	5
E-	Trim	Exchange	H	3
E-	Overhead	Fin-Fan	H	1
E-	Overhead	Fin-Fan	H	1
E-	Overhead	Fin-Fan	H	1
81TC00	Overhead temperature	Instrumentatio	H	5
Overhead Recvr	Process instrumentation for C-	Instrumentatio	H	5
GM810	Motor for coker reflux/gasoline	Motor	H	4
GM810	Motor for coker reflux/gasoline	Motor	H	4

Figure 6

4. **Develop Equipment Condition.** For several reasons we now take time to evaluate the condition of the highest segment of critical equipment, at a minimum, all H-1's and H-2's. Our reasons to do this:

- We can get an immediate impact on plant performance and safety where we can eliminate defects on this highly critical equipment.
- In some cases we will identify conditions that require a longer term solution, e.g. a motor that is run beyond its limits. This gives time to plan and schedule intervention before the equipment fails.
- Evaluating the equipment, by the operations staff, creates the basis of ownership, and developing operator's inspections "rounds".
- This information is part of the annual planning process, to help determine the material and labor costs and schedule required to meet plan for the next year.

Once again we take a simplified approach. For each class of equipment, we create a template for evaluating component condition. Using a simple yes/no evaluation for each category we can evaluate the overall condition of the equipment. An example is shown in Figure 7. Any equipment whose composite health falls below a threshold, say 70%, is written up for attention with a work request.

Figure 7

Component Condition Worksheet

Asset Area	Region 5	***Classification***	**Pressure Vessel (Spheres, bullets, separators, filters, reactors, fractionators)**
Operating Unit	Coker 2	*Criticality*	H1
System	Fractionater	*Manufacturer*	Electro Welding Co Inc.
Sub-System	Frac Overhead	*Serial Number*	Natl Bd # 1046
Equipment Number	C8105 Overhead Rcvr		
Done By	Steven Kuckley	*Date*	6/30/99

Operating Function/Standard/Range

To collect condensed liquids and gases from the frac overhead cond coolers and provide Adequate NPSH for reflux and sw pumps.

Comments/Observations

Evaluation Criteria

#	Criteria	Yes	No	Method/Measurement
1	Does the component s care appear to meet plant standards?		X	• Visual inspection • Check cleanliness & overall condition, valves, gauges, etc.
2	Has it been worked less than once within the past turnaround cycle?	X		• Tabware/SAP/Work Order history
3	Are the relief valves set at the proper pressure release?	X		• Are they pulled off and tested/inspected as scheduled • Visual inspection
4	Is the equipment free of process leaks including man-ways?	X		• Visual inspection
5	Are there test records available for tested pressure vessels?	X		• Check at engineering
6	Is corrosion under insulation not a problem?	X		• Check records of previous inspections and work with inspection personnel
7	Is the pressure vessel grounded and protected from lightening?	X		• Visual inspection
8	Are the studs free of corrosion?	X		• Visual inspection
9	Is the existing insulation in tact?		X	• Visual inspection
10	Is the foundation and supports in good condition?		X	• Visual inspection

Condition	70%

5. **Develop Strategies for Component Care.** At this point we have created the equipment list for the unit down to the maintainable component; we have classified the component's criticality, and we know its condition and operating requirements. We are now in a position to classify the type of care (maintenance) it should receive.

Types of maintenance include:

- Run-To-Failure
- Inspect
- Preventive
- Predictive based on Time or History
- Condition Monitoring
- Predictive base on Condition Projections
- Continuous Monitoring
- Requires FMEA or Tap-Root Analysis

We identify which type of maintenance to perform based on a simple matrix, once again applied by the unit team. Figure 8 show a model that uses CoUR as a basis to make the maintenance strategy.

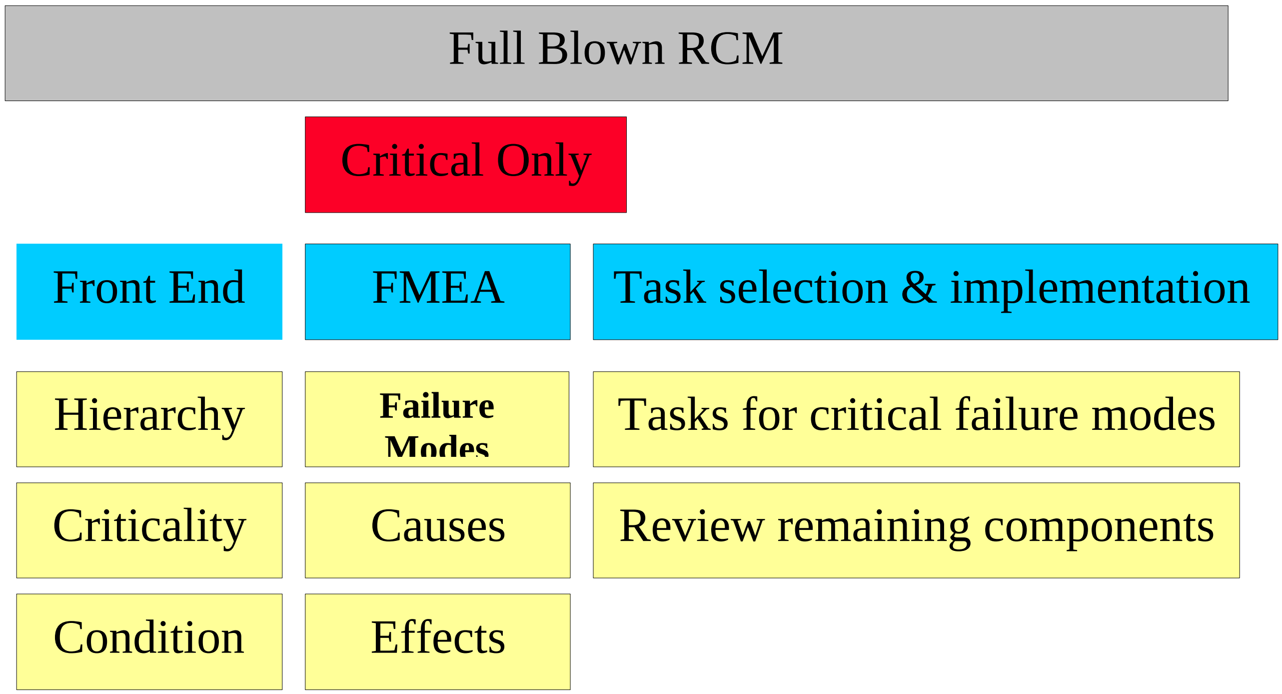
6. **Develop Failure Modes and Effects.** For equipment whose criticality is high, we catalog the ways in which it has failed in the past, based on experience of the team, and identify the cause and effects of those failures. Where there is high criticality, we need to specially design our maintenance activities based on the failure modes and causes.

FMEA is a significant part of performing an RCM study, which we identified as being a large and often tedious effort. The methods we are presenting here don't change the nature of the task; they do, however, create a structure where only those items that require the analysis get the effort. In addition, every other component in the system has a clearly considered maintenance strategy at the same time. The Asset Healthcare System we are using does simplify the task of performing RCM analyses, however, and gives us an audit trail that identifies how we made our decisions.

Figure 8

Criticality	*Proactive* Maintenance Activities		
High-1 High-2 Med-1	Time Based Useful Life Schedule & Replace B/4 Failure	Time Based Useful Life Inspect, PM & Cond. Monitoring	RCM, FMEA, Cont. Monitoring, PdM, PM & Root Cause Analysis
Med-2 Low-1 Low-2	Inspect, Run to Failure	Inspect, Preventive Maintenance	PM, PdM, & Root Cause Analysis
High-3 Med-3 Low-3	Run to Failure	Operational Maintenance	Preventive Maintenance
Component Value	0 - $5,000	$5,000 - $50,000	$50,000 ++

Figure 9

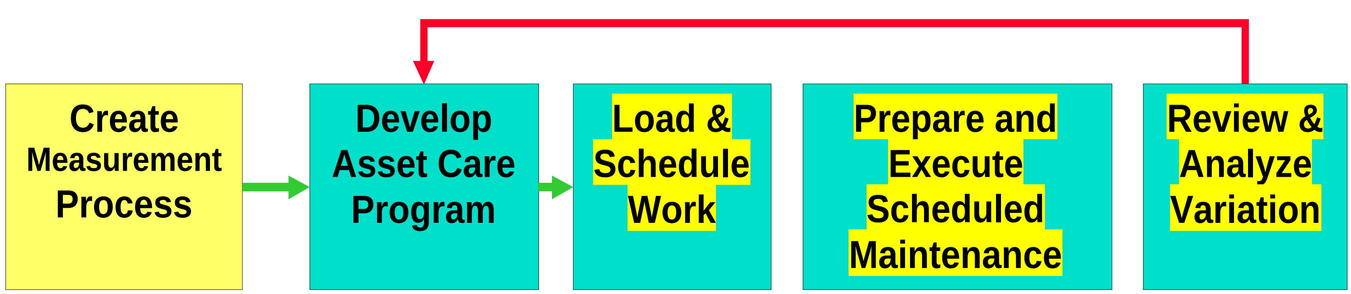


7. **Develop (Asset Healthcare) Maintenance Activities.** We now have identified the appropriate *strategy* for every component in the equipment system. We proceed to design the healthcare task according to the strategy. This makes *run-to-failure* a legitimate proactive AHT, because it is the best identified action for the business need.

Each strategy implies a set of activities that will optimize its use within the unit. Thus for each component, we proceed to design its specific care needs, and if we have performed a Failure Modes/Effects Analysis we designed specifically to mitigate the failure cause.

It would be the subject of another article to cover in sufficient detail the specific design process for asset healthcare tasks. However, our software tool, if appropriately chosen, has industry-specific equipment healthcare tasks that serve as templates in this design. In many cases the existing preventive and predictive tasks, if they have been found to be the best strategy, can be used as a starting point as well.

Figure 10



Completing our Closed-Loop Process

Load and Schedule Work is the next activity after we have completed the development of the Asset Healthcare Program. In this activity we:

- Finalize jobs, with tasks, parts, skills, tools ,etc.
- Load into CMMS
- Set and optimize schedules as identified

To *Prepare and Execute Scheduled Maintenance* we:

- Develop the Weekly Schedule
- Identify that jobs have parts available
- Assure that the labor and equipment will be available
- Perform the scheduled asset care tasks and record the results (e.g. Conditions found, corrective maintenance required)

To *Review and Analyze Variation* we:

- Prepare Performance Indicator Reports (e.g. PM compliance, downtime)
- Review trends
- Review completed work orders for issues and opportunities
- Adjust frequencies as appropriate
- Flag failure modes for investigation & identify required changes in maintenance

Benefits We Have Seen

Operators and maintainers who apply this method to their production areas gain a much greater understanding of the equipment and production process, including:

- Equipment Function
- Component Criticality
- Proper maintenance activities and division of responsibilities
- Current condition of components

An other benefit is immediate improvements in operating procedures, equipment condition (through SWAT Teams), and levels of productivity. Improved cooperation between maintenance and production lead to significant gains in many areas. Finally, increased precision of maintenance or performing the right prevention for problems results in increases efficiency and decreased downtime.

Figure 11

Results from a recent engagement

Equipment database (1,948 pieces of equipment) has been "cleaned up" by removing 351 components (18%) that no longer exist

P&IDs have been completely revised and reconciled with equipment database

Total risk for credible failure modes for each critical component have been assessed

Relative criticality have been documented for each system and component

Documented technical basis for each component's care strategy

3 design change recommendations were proposed to mitigate risk of failure

209 PM maintenance tasks were validated, deleted, or created for critical equipment

460 condition-based operator rounds and console operator type tasks were validated, deleted, or created for critical equipment

Also, other care tasks for non-critical equipment required by regulatory commitments were validated or created to satisfy these commitments

This proposed strategy involves no marked increase relative to current workloads, but large improvements in effectiveness by applying the proper care tasks for all equipment

Financial results *include:*

- Action Teams documented $1.5 million in benefits, more than enough to cover all the outside services
- A single large unit is producing at an increased rate valued at $15,000,000 in annual product
- Another refinery customized the process with our help, and identified $30,000,000 opportunity achievable with this process. Once we trained them, they are implementing successfully without SAMI's help

Summary

A new language can help us break the paradigm of *predictive and preventive maintenance* as suitable for all types of risks and conditions. The *Asset Healthcare framework* will simplify the effort to create a comprehensive maintenance program for equipment, and match the effort and type of intervention specifically to the criticality of the system and the component.

Our results include proactive maintenance for all components, an ability to create an activity-based maintenance budget, gaining control of the work schedule, improved equipment health and lower costs.

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Creating a Successful Corporate Maintenance Council

by S. Bradley Peterson, President

Most large, multi-plant companies have launched corporate "Maintenance Councils" in the past decade. While some have achieved a significant success, most are still floundering for direction and concrete results. What are the differences that make some successful and some status quo?

Types of Maintenance Councils

There are a number of models we have observed that work successfully to add value to a multi-plant company. These include:

- Networking & Competency Development
- Coaching for Change
- Agents of Change

The Networking Model

What is it?
The council s primary purpose is education; learning from each other, creating specialist teams, problem-solving, sharing practices, etc.

Model s Strengths	Model s Weaknesses
Low Cost	Slow to Build Value
Builds Organizational Knowledge	Strengths may not exist in company
Increases Technical Skills	May not influence operations/eng.
Leads to Functional Improvements	Knowledge may not be implemented
Can be done on a part-time basis	

Successful Examples: Mobil Oil (Walter Jones, Beaumont); Lyondell-Equistar (Joe Fluder); International Paper (Ken Collins)

The Coaching Model

What is it?
The council sets up a direct assistance organization, leading member plants in assessing their gaps, and coaching for change

Model s Strengths	Model s Weaknesses
Can lead to significant value creation	Where to acquire & maintain skills?
Cost billed to plants that want help	Change may be quite slow or nil
Creates examples of success	Too limited assistance to drive change
Raises visibility of maintenance in company	May not get high priority in plants
	Maintaining organizational visibility

Successful Examples: Alcoa (Bill Mathews); DuPont (Ralph Tewksbery); Weyerhaeuser (Rick Nelson, Pat DiGiuseppe)

The Consulting Model

What is it?
The council s primary purpose is developing a corporate plan and structure for change and significant value creation

Model s Strengths	Model s Weaknesses
Highest Value to Company	High Cost
Works best with large number of plants to support on-going organization	High Leadership and Ownership Requirements
Significant change agency for company	High Skill Requirements
Replaces need for external consulting	May lose staff to outside interests

Successful Examples: Rohm & Haas (Dick Pettigrew), DuPont (in the early 90 s)

Development Lifecycle for the Corporate Maintenance Council

Whichever model applies to you, there are three phases in the lifecycle of the Corporate Maintenance Council: Initiation, Growth and Maturity. Successful completion of each is a requirement to move to the next. We explore each phase, including the objectives, success factors, what to do, and what to measure.

Figure 1

The Lifecycle of the Corporate Maintenance Council

Initiation

Objective: Set-up for Success

CSF: Leadership, orientation, structure, philosophy

Activities:
- Create Excitement
- Recruit Sponsor and leaders
- Develop Charter
- Create Structure
- Assure Visibility
- Identify Business Value
- Initiate, educate members

Measures:
- Level of Sponsorship
- Value of Business Case

Growth

Objective: Early Successes

CSF: Leadership, methods, value creation, visibility

Activities:
- Identify Initial plant site
- Assess plant status
- Develop Business Case
- Plan Implementation
- Implement changes
- Measure success
- Market Success

Measures:
- Quantitative Results
- Qualitative results and support generated

Maturity

Objective: Repeat Success

CSF: Leadership, flexibility, marketing, financial integration

Activities:
- Create Permanent Team
- Routinize assessment & Implementation methods
- Develop & execute internal/external mkt plan
- Increase scope of value delivery
- Integrate results with leadership rewards

Measures:
- Total value created
- Increasing responsibility

Initiation Phase.

Our objective in initiating the Council is to structure it for long-term success. The consequences of failing here are a council that is not respected, has no cooperation from the rest of the manufacturing community, and fades away into that sunset of committees unable to create value. So all efforts here should be directed towards a successful launch.

What is critical in this early stage?

- Top **leadership must endorse** the need, the goals and the methods of the Council
- A **champion** of sufficient stature needs to make a priority of establishing the Council
- The **Council leader must be respected** as a doer, probably the person who is too busy for this job. Experience shows that other things being equal, it is better if the leader comes from production rather than maintenance
- The structure of the group needs to support ongoing scrutiny and visibility, and willingness to **be accountable for its actions**
- The Council **must represent production** in a significant manner, if necessary to the exclusion of maintenance staff. If possible get more than one representative per facility, as people change jobs often and lose continuity. Get involvement by a balanced group (including maintenance, production, engineering, staff), and don't be afraid of having hourly involvement. It may take more time at this point to achieve union or hourly ownership, but it will pay-off in implementation
- The Council must be seen as **action- and goal-oriented**, and can't spend its start-up capital (goodwill in the formation of anything new) by having meetings that don't seem to get anything done
- Certain **methods and deliverables** will yield success. These include developing a charter, developing an estimate of value to be captured, and developing a communications plan
- Identifying how group **funding** will work, both for the time and travel expense, as well as any outside services

Delivering Value

Three successful internal maintenance consulting organizations we have known or been involved with (Rohm & Haas, Dupont and Alcoa) have greatly simplified the identification of value. Each uses a single measure for maintenance cost and product throughput. While each uses a slight variation of definition, they come down to this concept:

Cost is measured as *Maintenance Expense as a Ratio of Replacement Asset Value*.

In some industries this is routinely benchmarked, especially in Refining, where the Soloman Study is a standard measure that a majority of companies use to gauge their performance. In others there may be no standard of performance and even measuring Replacement Asset Value (RAV) is difficult to determine. So the Council needs accounting involved to assure a consistent measure of maintenance expense among all plants exists, and secondly that there is a consistent means of valuing RAV. This is sometime taken from the Maximum Probable Loss calculation of the property and casualty insurer if no better measure exists.

Throughput, or capacity utilization, or uptime or OEE measures how well the plant is making use of the inherent utility of the equipment assets under management. Each of these measures can be tied to a financial amount.

A concern on this point is that sometimes only a small amount of downtime is *mechanical or unplanned*. The Council needs to decide if all sources of downtime are going to be reviewed, or only those directly affected by maintenance. For instance, sometimes a plant in not sold out, or is sold out seasonally; whatever result the team and plant come up with needs to be justifiable, and owned by the plant leadership.

Typically, for a company whose overall maintenance costs might be $100 million, we have seen that 15-25% savings is available by meeting a reasonable expectation of performance by every plant. Capacity utilization can usually be improved by 10-20% as well, although we have been seeing steady improvements in many industries, especially those that routinely benchmark performance such as chemicals and refining.

Summary of Initiation Phase
Getting started in a way that creates enthusiasm, support and expectations of good things to come will make or break the overall effectiveness of the Corporate Maintenance Council. We would suggest that from the first meeting of the Council, no more than 12 months pass before beginning work at a plant site.

Growth Phase.
Having successfully gained the attention of leadership, recruited movers and shakers to the Council, and created the structure for success; it's now time to begin meeting expectations. That means successful change at a plant location.

It will be clear early on that there are three types of plant managers the Council will deal with. First, and most apropos to this section, are the leaders who welcome improvement, seeking out methods and sources of continuously making their plants more effective. Second is the plant manager who is in trouble and knows he needs to do something (anything?) to improve, because his money or his job is on the line. Finally, there is the plant manager who wants no part of this program. His reasons may be several: we have too much on our plate already; timing isn't good because of construction or a turnaround; we are already very good and don't want or need corporate interference; or we don't want to expose ourselves to measurement and comparison because we won't look very good.

Where do we start? The Golden Rule in corporate life: first impressions will last forever! That means there is only one chance to do this right, to make a positive difference, and for the work to be viewed positively (these are not quite synonymous!) So we begin by looking for a site champion with these characteristics:

- He is considered successful already; his patina of success will rub off to the Council's activities
- He knows how to run projects, how to take the personal interest necessary to make things successful
- There is a defined business opportunity whose scope is neither too small to matter, or too big to be an unqualified success.
- This project is personally and professionally important to the plant manager

Next the Council needs to have a method to proceed. One very important deliverable from the Initiation Phase is an assessment method and an implementation method. Rohm and Haas used an outside maintenance consulting firm to help them create an assessment methodology and an implementation approach(es). Dupont embarked on a global maintenance cost benchmarking study with a consulting firm. So this is a proven way to get started.

Getting plant ownership goes beyond the plant manager's support; before starting, the entire leadership team will need to understand the outcomes, the resources required and any out-of-pocket costs associated with the project. There needs to be a workplan, sample documentation, and delineation of responsibilities.

Figure 2 Summarizes the Implementation Phase.

- During this process we set **goals** for changes to our leading indicators (such as changing schedule compliance from 25% to 80%), as well as changes in results (lagging indicators) such as % overtime, or the availability of a unit.
- We employ **change management** techniques to assure that people are ready to proceed. Two methods we like include employing The Manufacturing Game™ and beginning implementation with a redesign activity, to develop a complete work management process. In this activity we use plant participants from every function and every level, all working together, resulting in great ownership.
- The first result we seek is **efficiency**; getting more work done with our staff, and taking over work currently done by contractors. The method to accomplish this is better work management processes, as shown in Figure 3
- Efficiency creates work capacity, which in turn can be invested in other activities. **Optimization** will look at inventory levels, PPM frequencies, etc. Optimization reduces (usually) costs, and further increases effectiveness.
- We also invest the work capacity we create into **reducing defects**. Most frequently reducing defects in Stage 1 is simply to assure that the PPM's you have are getting scheduled and properly executed. This further reduces work, and as we catch up on our backlog of preventive work, we increase availability of equipment. We can also plan and optimize stores better because there are fewer emergencies.

Figure 2

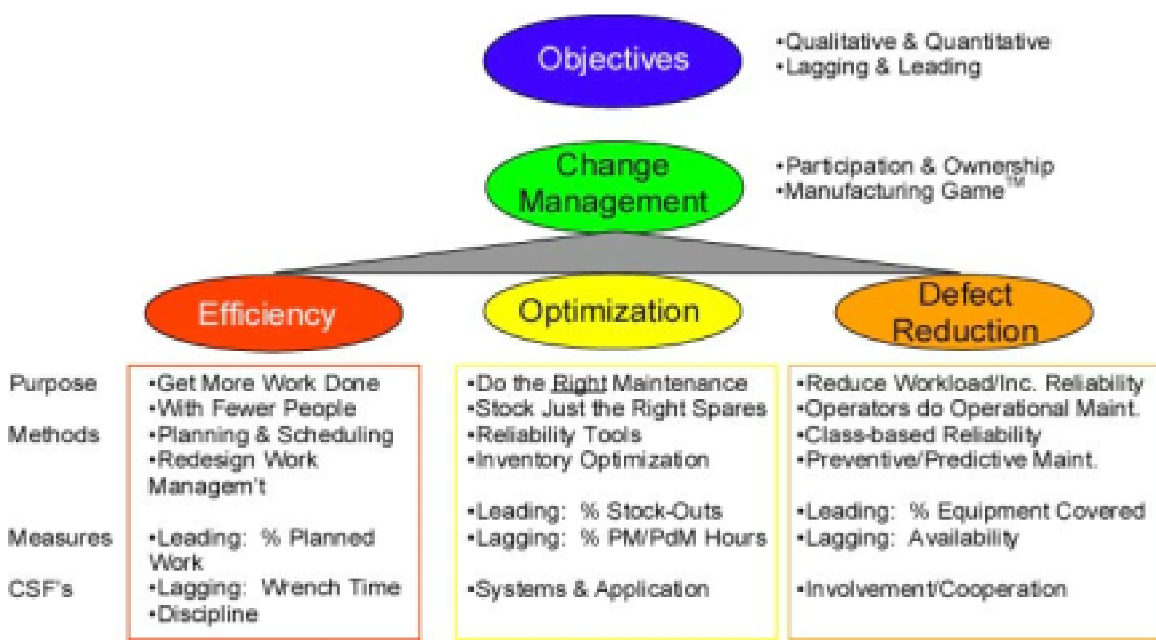

Figure 3

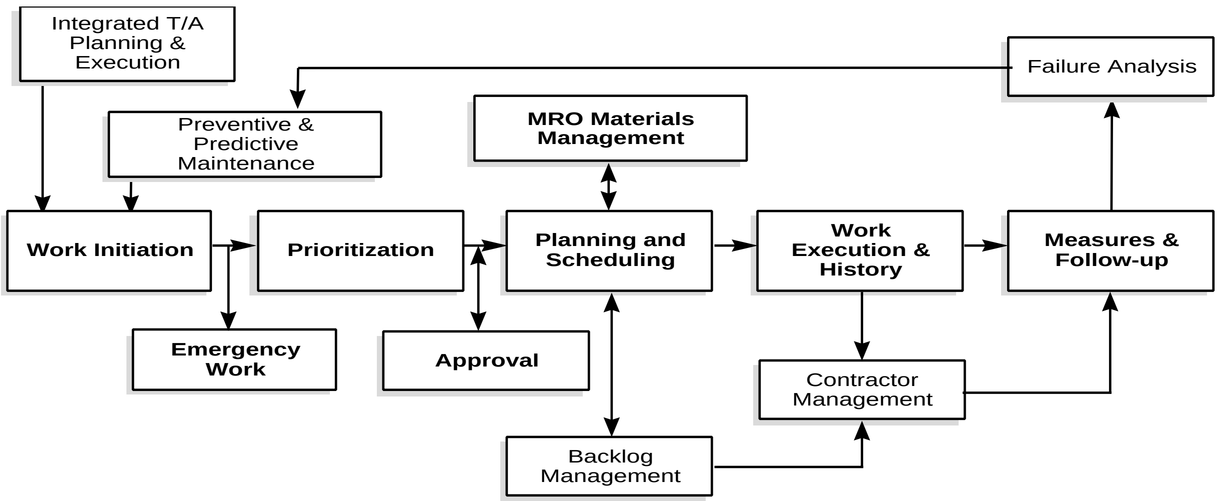

Figure 3—Elements of Planned Maintenance, Stage 1

Typical results of implementation in Stage 1 activities are cutting overtime in half or more; reducing contractors to only specialty work; and improving availability of specific equipment centers by as much as 10%. It is true that getting to these levels may require 6-12 months of continuous support, but without such results the Maintenance Council is seen as little more than a group who meets and accomplishes very little.

Most Plant Managers would give their first-born child for these results! A plant manager who has made the made the efforts and gained the results is an exceptionally strong advocate among his peers to invest in similar efforts. The role of the Committee is now to assure that the success is presented far and wide within the company, preferably by people from the successful plant itself. This sets the stage for the next Phase, **Maturity.**

Maturity Phase.

Sometimes the greatest predictor of failure is success. A great deal of time and attention went into the initial effort to make the Pilot Plant have great results. There is a tendency to forget the lessons that got us here to start with and to relax.

The Pilot Plant was chosen because of the strong leadership, and bias for measuring results and holding people accountable. Less able plants will now come forward looking for similar results but without a full understanding of what it takes to change that was demonstrated by the Pilot.

How does the Council overcome this barrier?

The answer has several parts. First is documenting the methods and lessons employed to get the results the first time. The path has been developed, and it can be improved each time the group goes to another site to work. The second success factor is to continue to work with volunteers who have demonstrated successful ability to change. In other words keep stacking the deck to the extent you are able.

We have observed a third factor that appears to be vital in *institutionalizing change*; that is the creation of an internal consulting organization, dedicated to guiding change at the plant level. Essentially the group becomes semi-professional, with:

- marketing strategies to develop and execute,
- methods to develop and refine,
- relationships to create among the field managers,
- recruiting within the company for those unique individuals who can lead change
- ability to attract a permanent funding method by reselling their services
- creative ability to work on new problems and situations throughout the plant

Both DuPont and Rohm & Haas developed an internal consulting capacity to meet maintenance and reliability opportunities head-on. In doing so, they created a new language and awareness within the Senior Management Community of their company. As the understanding of the value to be created grew, management compensation programs were changed to reflect progress on maintenance expense and "Uptime".

Rohm & Haas—An Example of the Best We've Seen

Dick Pettigrew led the formation of Rohm & Haas' Maintenance Council. While with another consulting firm I participated in their initial formative efforts. Most of the steps we have discussed here were steps Dick led. He had a Champion, Tom Archibald, who is a manufacturing executive, and a strong supporter of the programs.

Dick learned by doing, experimenting, and tirelessly promoting their efforts both inside and outside of their company. He used consultants, engineering specialists, SMRP and other professional associations to educate his internal team. As time went on, Dick relied less on outside experts and more on his own cadre of internal experts.

As their successes grew, so did their influence in the company. Getting additional funding for more positions wasn't easy, but by demonstrating and marketing results, they have become an integral part of their leadership's toolkit for change. More recently, the internal consulting group has been asked to take on other challenges of lean manufacturing, in addition to their work on Reliability and Maintenance.

Conclusions

With careful attention to methods and communication, Maintenance Councils can be vehicles for change within your company. The results will easily be worth the extra effort, because so often today we observe few results from a lot of hard work.