PROACTIVE MAINTENANCE as a STRATEGIC BUSINESS ADVANTAGE

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Keynote Presentation

Greater Chicago Plant Maintenance Show and Conference

Sponsored by Plant Services Magazine, a Putman Publication

September 11, 1997

For maintenance to make its proper contribution to profits, productivity, and quality, it must be recognized as an integral part of the plant production strategy -- an integral component of the overall plan by which the plant provides the product to the customer at the quality he wants at the price he wants to pay.

Production, of course, is charged with the responsibility of meeting production targets for which they must utilize equipment and facilities. Often production targets are demanding (and sometimes unrealistic). The pressure to meet production targets often causes production to defer crucial maintenance activity preferring to continue operations when, in fact, maintenance may be necessary to avoid deterioration of the equipment assets, or to minimize adverse impact in other others (quality, life-cycle cost, overall utilization of the equipment, or overall production efficiency) over the long term. If this situation prevails long, it is only a matter of time before the costs of not doing the required maintenance begin to show up.

Production has priority; that's as it should be--after all, producing product is what it's all about. So maintenance is a clear loser in the first round. But production loses in the second round because the neglected equipment produces more downtime when repaired under adverse (perhaps emergency) conditions. The end result is poorly maintained equipment which is less reliable. Such equipment has greater total downtime, not less; and, because no product is produced when equipment is down, plant profitability is reduced.

Not only that; more than money is lost when maintenance doesn't get to do its job: product quality suffers (waste and rework increases), overall productivity of the plant is degraded ("value-added" time is reduced), personnel have little time to do anything other than fix problems (reactive, firefighting mode), and product is delayed to the customer (time is becoming a key competitive factor) --

--- not exactly the formula for "World Class" status!

Indeed, recent competitive trends have been pushing manufacturing executives to reconsider the impact and importance of increasing equipment availability and utilization (decreasing downtime; higher production efficiencies), increasing maintenance productivity and resource utilization, and increasing quality and responsiveness of maintenance services in meeting overall goals to achieve World Class status.

Virtually every key business function--manufacturing, procurement, distribution, marketing, product and process development, maintenance--is being challenged to develop strategies for improvement.

...But improvement involves more than simply rethinking current practice--trying to do what we're already doing better--that won't work. That more like "working harder" not "smarter".

> [Someone has said that the essence of insanity is "doing what you've always done the way you've always done it, and expecting a different result!"]

The ability of a company to achieve "World Class" status depends on how well it can get the various functions to work together to accomplish its business objectives. Indeed, this is almost the definition of a world class organization.

This is nowhere more true than between production and maintenance. Maintenance must be recognized as an integral part of the plant production strategy by which the product is delivered to the customer at the quality he wants at the price he's willing to pay.

...But maintenance can't do it alone.

For maintenance to do its job properly, to accomplish the maintenance mission, requires the cooperation of, and the collaboration with, virtually every department (production, procurement, engineering, accounting, human resources, etc.) in the plant--***but especially with production!***

Not only must we in maintenance know what *our* objectives (roles and missions) are, but know how they are related to (and in fact a derivative of) the larger sets of roles, missions, and strategic objectives of the overall organization.

Now.... it's relatively easy to encourage maintenance improvement within maintenance organizational lines; that has been the traditional approach. What is more difficult is to get "beyond the boundaries"; to get other departments to adjust, to work out new, more productive arrangements that sometime cross traditional boundaries, or shift 'territories' or responsibilities, and get different departments or

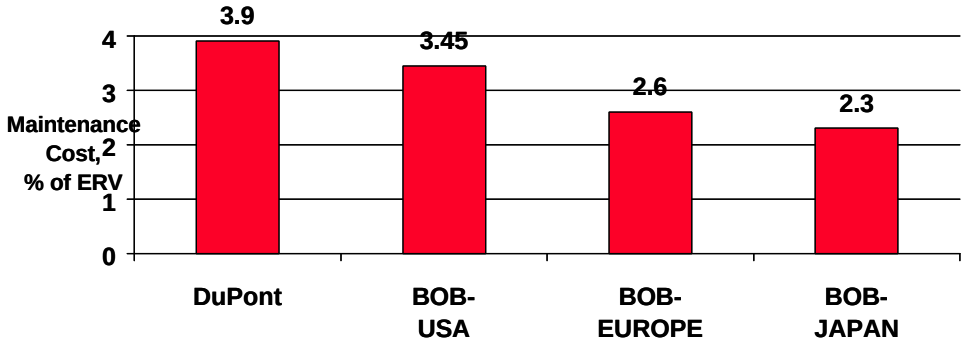
functional groups to even accept each other's ideas--but these things are absolutely ***crucial*** for "world-class" organizations.

We believe both production and maintenance share a number of basic responsibilities that each must exercise diligently in concert with each other to get what they all want. The challenge is to gain recognition, at all levels, in all departments, that maintenance is a strategic tool ...just as JIC, CIM, TQM, or any of the other "world class" methods and techniques being implemented...for improving a company's competitive edge, playing a ***major*** role in reducing quality defects, increasing production capacity and throughput, and improving overall plant productivity and profitability. Not as an "also ran", but as a ***primary contributor.***

In the late 1980s DuPont commissioned ATKearney to benchmark their performance against companies in the US, Europe, and Japan. The findings of that initial study and subsequent efforts since then have come to be known as the BEST of the BEST Maintenance Benchmarking Study. [It has become the 'mother' of all maintenance benchmarking studies...and now forms the basis for an annual award known as the **North American Maintenance Excellence Award**, a collaboration between ATKearny and Plant Engineering magazine.]

DuPont was surprised--and not just a little disappointed--to find they did not measure up as well as they has assumed they would. [They thought the study would show how *good* they were; they thought they had achieved functional excellence in maintenance. The data did not support that position.]

DuPont Benchmark Data
vs.
Best-of-the-Best (BOB)
Maintenance Performance (1986)



In fact, they found DuPont was at least 12% ***higher*** than the Best of Best (BOB) in the US--and even worse when compared to Europe and Japan!

BOB EUROPE vs. USA — Used more people; less materials (40%); better skills; less waste

BOB JAPAN vs. USA — Attacked all 5 areas of defects;

TPM...

- Cross-functional teams *for defect elimination* (Engrg; Mtce; Ops)
- Cleaning *for inspection* (300-400 defects in single piece of equipment)
- Operator Involvement in maintenance; early detection and removal (not repair)

Evidence seemed to be that systematic removal of defects could typically produce 90-985 reduction in failures

They had a lot of numbers on a lot of plants, and as you might imagine, there was a lot of scatter in the data. Winston P. Ledet and his colleagues at DuPont did statistical analysis on the benchmark numbers-and found they could account for almost all the variation in the data with about 11 variables. *But they were all cost variables!* Yet, they knew from the benchmarking interviews that the Best of the Best performers did <u>not</u> push cost, did not focus on cost very much at all.

But if it wasn't ***<u>costs,</u>*** what was it?

They had a suspicion that these improved cost factors were the result of good maintenance practices--not the other way around. In other words, low cost maintenance is a consequence of good maintenance practices--

Cost is the measure of success, not the knob you turn.

So Ledet turned to Systems Dynamics Modeling techniques to sort out the variables. Systems Dynamics is discipline that came out of MIT in the 1960s. It's been made popular by a book that, by now, almost everyone is familiar with (even if they haven't read it): **The Fifth Discipline** by Peter Senge (1990), and later its companion volume, **The Fifth Discipline Fieldbook** by Senge and others.

System Dynamic modeling has had a major influence on the practice of management by introducing the concepts of *systems* and *learning organizations*.

One of the most profound "learnings" of this century has been that human endeavors influence, and are influenced by, the *systems* of which they are a part. Rummler and Brache, in their book **Improving Organizational Performance, Managing the White Space on the Organizational Chart** point out convincingly that our performance is more a function of the system of which we are a part than any particular attributes we may bring to the job....that we are always acting in a system, whether we are managing it as a system or not...that given a good performer and bad system, the system will win, every time.

All business endeavors are systems. They are bound by invisible fabrics of interrelated actions and events, separated by time and space, which may take years to fully play out against each other in ways that are not obvious--often hidden completely from view.

Complicated situations or systems are not always easy to study--in the real world consequences of our mistakes are slow in developing and may occur far from where we took action. After a long delay or at a great distance, we may not even recognize the results of our behavior. ...and everyone knows about the "law of unintended" effects.

So DuPont did some Systems Dynamics modeling,. and that was considerably more enlightening.

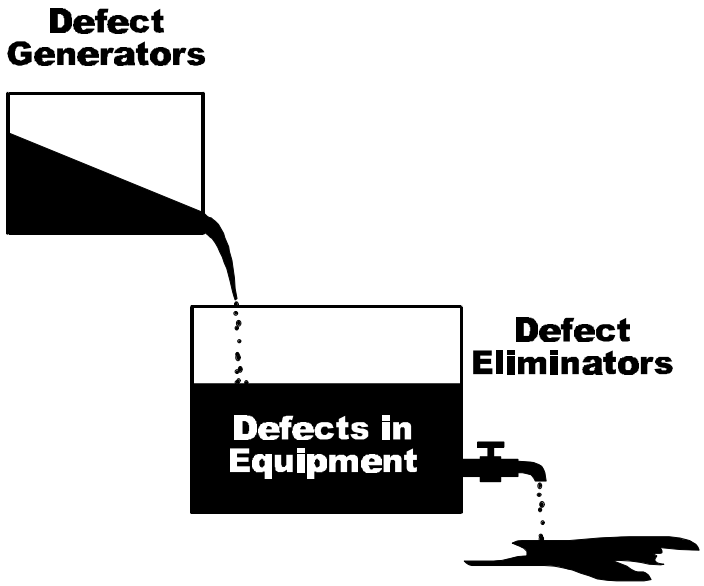
Perhaps the best way to illustrate the difference between statistical analysis (which showed cost to be a key variable] and Systems Dynamics modeling (which showed that certain maintenance practices and consequences, including cost, could be modeled as a *systemic* process) is to talk about milk production in the United States.

To put it briefly, in the US there is a very good correlation between milk production and a number of econometric variables such as GNP, interest rates, etc. The correlation using these variables is very accurate--you can put these variables into the model and get a very accurate indication of milk production (especially the past).

But if you want to do something about milk production, you have to model it in terms of "cows" and "milk per cow" and the variables that affects *those* things.

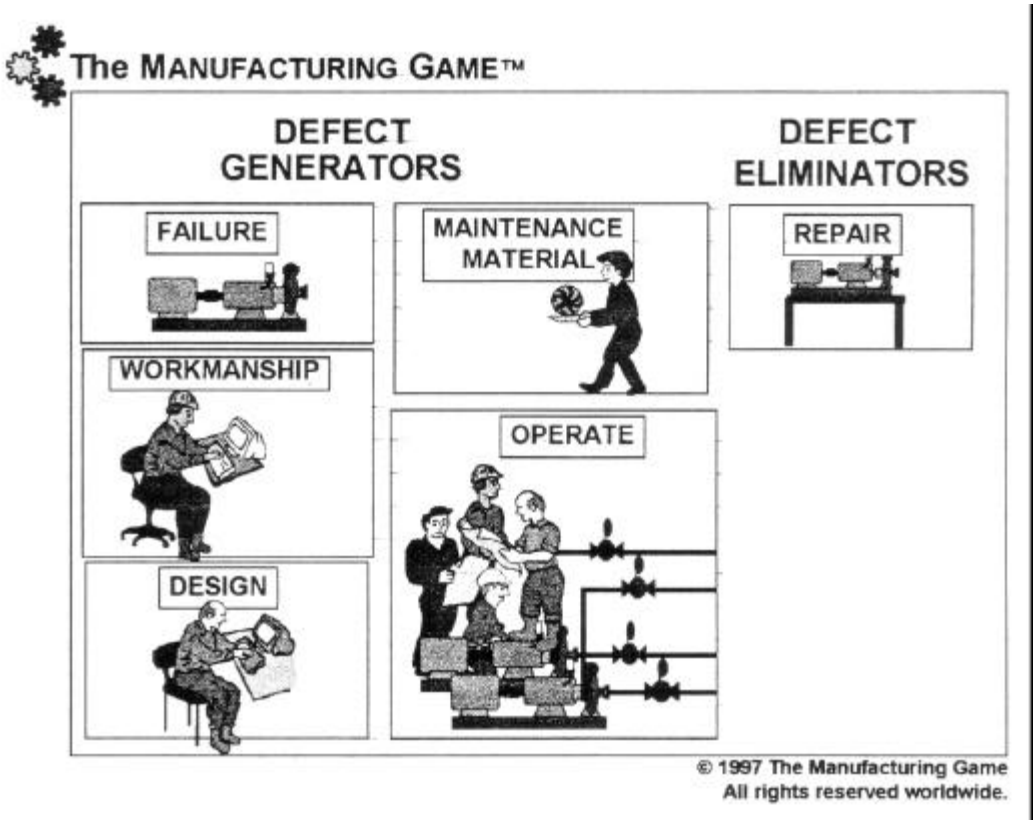
That's what System Dynamic modeling does for you; it focuses on discovering and articulating the underlying structure of a system and then looks for key leverage points through which to *change the system*

Maintenance as a Process of Defect Management



The DuPont study revealed maintenance could be modeled as a process of Defect Management (where a "defect is defined as anything short of perfection).

There are defect generators. The equipment accumulates the defects until it breaks down. The repair process is the defect eliminator. The level of defects in the equipment determines the breakdown rate.



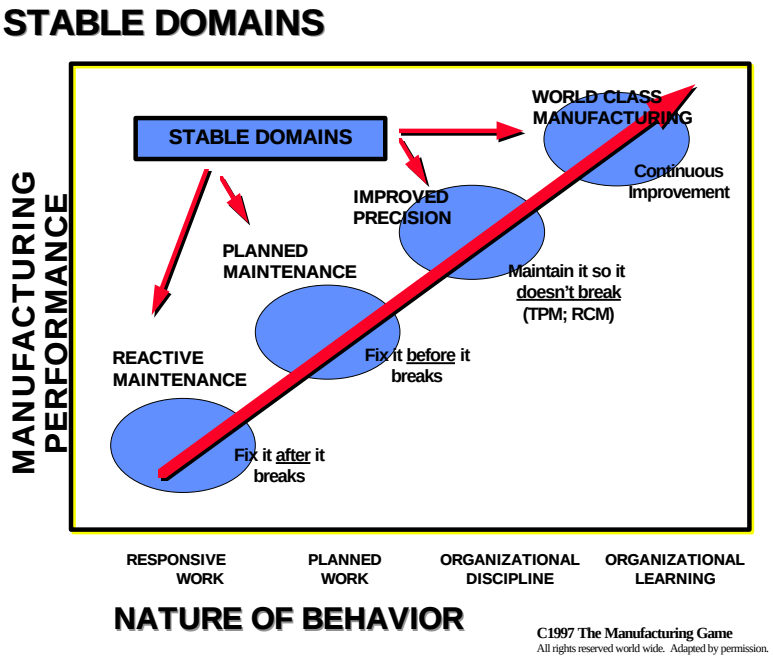
There are 5 major sources of defects identified in the model:

FAILURE	"Collateral" damage (bearing seizure damages shaft)
WORKMANSHIP	What they do; not what they *could* do. Not just skill and motivation...the *system*, as well. (being so reactive and time-pressed so as to fail to align the pump before bringing it on line)
DESIGN	Design not fitting *current* use; could be poor initial design, but usually result of changes in the application or current *conditions* of use.
MATERIALS	Defects in mfg., storage, handling, and sourcing. DuPont found that one in three spare parts had a defect of some sort *before* it got to the equipment.

OPERATIONS Normal wear and tear; operational practices (cavitating a pump; ignoring vibration, etc.; good example: teenage driver)

STABLE DOMAINS of PERFORMANCE

First of all, the model was able to explain how and why companies in the benchmarking study fell in place along a continuum of performance... from "Reactive" to "World Class".



The model showed manufacturing performance and behavior of the benchmark companies were clustered into "stable domains". In other words, manufacturing performance would tend to stabilize in certain regions and at certain levels as a function of behavior, or maintenance practices.

Admittedly, reactive maintenance organizations are on the low end of the manufacturing performance scale, but it is a stable environment, and some companies are *good at it.* It can serve you well for a long time, and become the *paradigm* of good maintenance performance. In other words many production people think *fast service* (from standby mechanics) is *good maintenance;* it's actually lousy maintenance; just *fast service.*

It works until competition heats up, at which time an organization may need to move up the performance curve, which can be done, but only by breaking the paradigm of reactive maintenance. Those who move to a planned domain can have a competitive advantage by systematizing their resource management through planning/scheduling of work, better parts and inventory material control, and establish good work order control systems (among others).

In the planned domain, we haven't eliminated the defects so much as we are able to deal with them more efficiently, with more productive use of our labor, material, and capital resources. Perhaps the premier example of the planned domain is Alumax Aluminum Company of South Carolina where they have created an environment in which 90% of all work is planned at least one week in advance; only 2% of their maintenance activity goes to breakdown, crisis work. No surprises at Alumax!

And this works, too, until competitive pressures require even higher manufacturing performance, forcing us to break the paradigm of planned maintenance and move to what we call the "improved precision domain". This is a stable domain in which defects are not just dealt with better, rather defects are eliminated, so as not to have to deal with them at all.

Think TPM (Total Productive Maintenance) or RCM (Reliability-Centered Maintenance) as typical methodologies applied at this stage. The motto of TPM is "Zero Defect Maintenance" or sometimes referred to as "Zero Breakdown Maintenance". RCM is similar in focus; it emphasizes if not the elimination of the failure, then at least the elimination of the consequences of failure with ruthless attention to elimination of root causes.

The final domain is one we've called World Class Manufacturing. We've allowed for the fact that TPM and/or RCM are not the final frontier and that even better performance is yet to come through continuous improvement.. The behavior required for World Class performance domain is believed to be "Organizational Learning". (This goes back to Senge again). It's better to look at these improvement concepts and progressions as a journey, not a destination. The biggest obstacle in getting from one domain to another may be success in the current domain. (e.g., those in reactive domain often don't see how they can get better, those good at planning and scheduling at the level of an Alumax may have difficulty in seeing better because they are so good at what they are doing now.) Don't let any domain become the "goal".

SO WHAT IS PROACTIVE MANUFACTURING?

It should be clear to us all by now that adopting a continuous improvement model in moving to an "improved precision" and/or a "world class" domain, the involvement of people and integration of cross-functional groups becomes important because all groups contribute to the creation of defects, and to be successful, they must contribute to their elimination.

Major Paradigm Shifts are needed ....
.... from reactive to proactive

Reactive domain (Respond to Events)	**Fix it after it breaks** Firefight with each new crisis; spend whatever is necessary
Planned domain (Pre=plan all work)	**Fix it before it breaks** Predict, Plan and Schedule all work
Proactive domain (Organizational discipline)	**Don't just fix it, improve it** Eliminate defects from all sources; Maximize equipment uptime
Strategic domain (Organizational learning)	**Differentiate** **Maximize Integrated value**

Source: Monus, Sr Project Engineer, BP Oil Refinery

The rub is that we must shift paradigms and practice new behaviors at every step. Why do we fail?

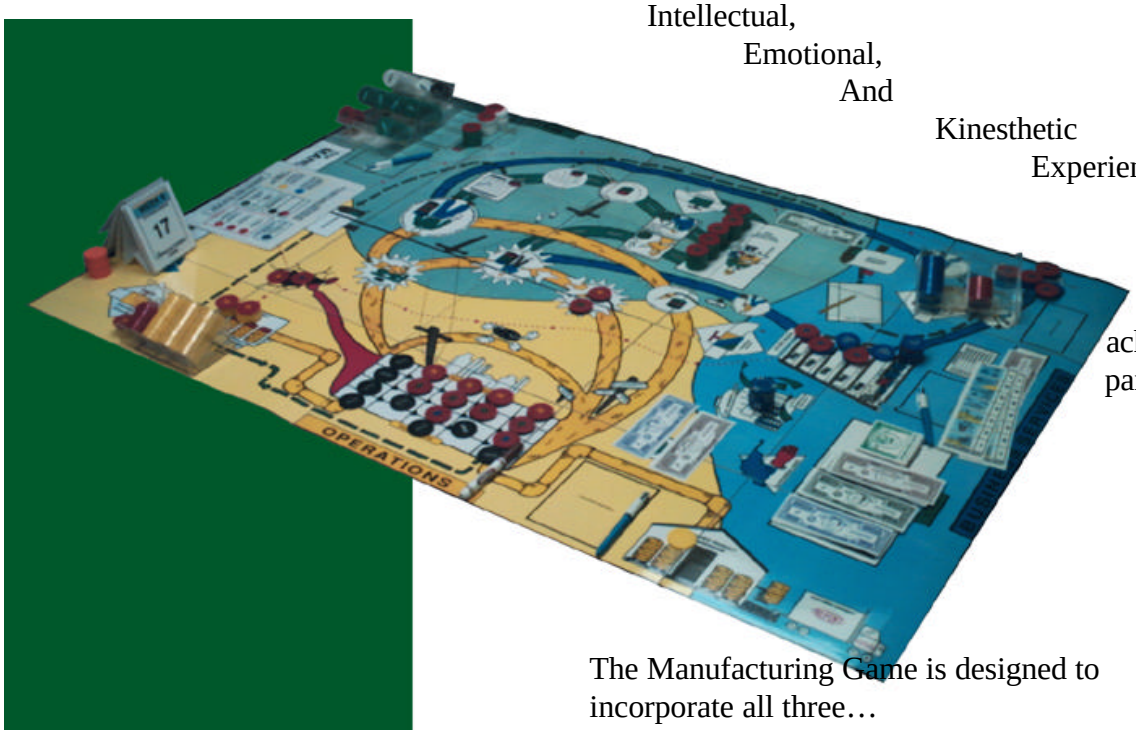
- Can't learn the new paradigm; can't make the shift.
- Changes we make aren't significant or substantial enough to sustain the effort.
- People don't learn and practice the required new behaviors.

To create the kind of culture change in an organization to be successful, you have to find a way to express the need for the change, the value of the change in ways that are meaningful to them; to build passion in people, to get everyone focused on the right ideas, and practical action steps they can "get their arms around".

DuPont created a game simulation and workshop that we now use with our manufacturing and process company clients that effectively engages all levels and functions of an organization toward a proactive vision and implementation of best maintenance and manufacturing practices leading to world class cost performance.

THE MANUFACTURING GAME

Accelerated Learning Technology says you need
Intellectual,
Emotional,
And
Kinesthetic
Experience...



…to achieve a paradigm shift.

The Manufacturing Game is designed to incorporate all three…

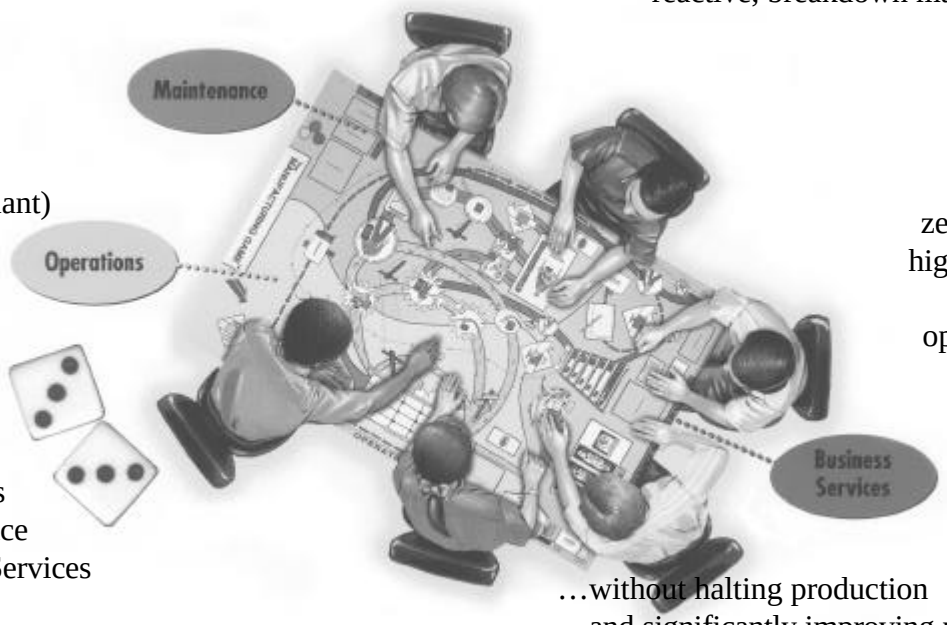
The centerpiece of this workshop is The Manufacturing Game™, an interactive simulation of a plant that: allows participants to self discover the value of changing, creates a common vision of the "right" ideas, generates a lot of grass roots passion to improve things, followed by a workshop that launches the actions required to get the improvements started.

THE MANUFACTURING GAME

Board Game Simulation
-- no computers --

Teams work together to lead their mediocre manufacturing facility from a reactive, breakdown maintenance mode…

Cross-Functional teams (3-6 per plant)



…to a proactive, zero-failure, high-volume, low-cost operation…

3 Roles:
Operations
Maintenance
Business Services

…without halting production
…and significantly improving profit!

The game is a very interactive experience of people in three functions trying to meet all the demands of running a business. People often comment that the game is just like the plant. They feel all the same pressures to remain reactive and just keep some level of survival going.

In the game, however, all the dynamics and results are sitting right there on the gameboard in front of you. People are able to look across the table and see the consequences of their strategies and tactics in a short amount of time.

Because of this system view of the whole business, people start to feel the need to do things that are right for the benefit of the whole business instead of just for their function. To help this process, we ask people to take opposite roles in the game from the one they play in the real world. Therefore, they feel the frustrations created by lack of coordinated and integrated strategies from the other functions perspective. This alone seems to translate into some empathy back at the plant for the needs of the other functions.

The participants also see the real business needs for cash and profit as a means of continuing to be viable. They recognize that some strategies create a large strain on the financial well being of the corporation (i.e., as good as some strategies might seem from a single functional perspective, they can be disastrous for the system as a whole—and ***that*** is a crucial learning!).

There are several roles to be played on the simulation. Operations people make the product using the facilities currently operational. Maintenance repairs the equipment which is broken and can use planned maintenance to improve the efficiency of the defect removal process (repair). The Business Services people take care of the logistics of selling product to the market and buying the necessary spare parts and raw materials. They also interact with the bank and handle the finances for the business. Customer service is provided by always shipping the quantity needed, even buying competitor's product at a premium, if required to meet demand.

The play of the game progresses from week to week with an opportunity to reflect and change strategies every 5 weeks cycle of the simulation. The process takes a full day to experience and each game board can accommodate 6 people.

Usually four to six teams play simultaneously to allow for a benchmarking experience between the teams which helps establish a team learning atmosphere.

The game allows people to experience in a day what would normally take over a year to experience in the real world and gives them opportunity to take risks they would not normally take. The game starts out with typical reactive performance and the team attempts to make the journey to proactive and profitable operations.

We <u>do not</u> mention anything about being a team. We let people discover that for themselves. What they find in the game is the same as in the real world: they cannot succeed without the cooperation of all functions.

This causes them to come together as a team around the work that needs to be done.

But mostly, what people get out of the game is some hope that a proactive way of working together is possible, and that this proactive approach can yield substantially better results. Participants typically leave with a strong desire to experience that proactivity in their everyday work life.

Action is the second key element of The Manufacturing Game workshops. The second day of the workshop is primarily focused on translating the ideas and passion developed in the game to the real world through action teams. The concept of action teams comes from Robert Schaffer's book, **The Breakthrough Strategy** (1988). He promotes the idea of an action team coming together to work on a specific issue with a very clear goal for a short fixed period of time. In our case the issue is defect elimination. The best teams are small (5-7 people) and cross-functional; they have operators, mechanics, engineers, and procurement people from a given area. The team identifies defects in their equipment and processes and creates an action plan to eliminate one of them. They have goal of eliminating that defect within 90 days. A typical workshop will launch 4-6 action teams. Action teams are the vehicle to both begin the process of eliminating defects and continue the change in culture.

A lot of companies balk at the idea of action teams. A common objection is, "We just want to train the managers. Our operators and mechanics don't have time for this." Unfortunately in a reactive mode, the front-line people will never have the time. More importantly, our experience has been that only the front-line personnel know where the majority of the defects are. Management can typically point to a few defects that production bottlenecks, but they cannot identify the hundreds or thousands of little things that eat up time, process efficiency, and quality. Another big barrier to launching action teams is management's perceived loss of control. To make a big change quickly in reliability, you cannot have a few highly managed and facilitated teams. You need to get 80-90% of your site personnel out there eliminating defects to get the impact. If every improvement and change has to come through one or a few people, the process will move very slowly and there will be little passion from the front-line.

The Manufacturing Game has been used inside of DuPont for the last six year and outside of DuPont for the last four.

Several large manufacturers and producers have used this approach with a large portion of their front line-workers and managers to "jump-

start" the change in culture required to achieve the best-of-the-best in reliability and manufacturing performance. By engaging the whole organization, we have found that improvements in operations can begin within 90 days and bottom line, measurable improvements *are possible within the first year*, versus the 3-5 years often quoted for more traditional approaches.

Here's a example of a good roll out of the game:

Example of a Good Roll Out

Followup to failed re-engingeering which created a terrible rift between union and management

Piloted first three workshops in six months

Roll out over next 6 months

Ran 2 workshops per month for 36 people each

Covered 80% of plant employees

Created 24 action teams in the process

Maintenance costs increased 30% above budget for first 6 months but ended year 30% below budget for entire year!

Achieved $12 million reduction in operating losses

Increased capacity by 7.4%

While this example is certainly impressive, it's actually quite typical of several such stories that could be told. This plant has succeeded in turning a very nasty climate around and are making improvements at a very strong pace. This site is a place where they have a few fifth generation union members... so you can imagine how strongly entrenched and ingrained some of the mental models of how a plant should be run could be! The Manufacturing Game has helped change the attitudes of the people who work there. They have been able to work together in spite of their long history of labor problems. People are feeling more in control of their fate now that they concentrate on trying to get the equipment to run and product out the door. The long history of adversarial relationships between union and management in by no means gone, but it is interfering less with getting the job done.

Three Steps to World Class Maintenance

The task of any business, any business is to make resources -- labor, material, capital -- productive. The most significant deficiency associated with the maintenance process in many plants is a 'systemic' one; that is, there are insufficient administrative principles, practices, and procedures currently in place for adequate control of maintenance resources.

Getting Your Act Together *Reactive to Planned*

Maintenance improvement must start with good management processes. To make maintenance resources more productive requires the implementation of appropriate planning methods, organizational structures, and measurement and control techniques so as to optimally manage and control the maintenance process in terms of its direction, its quality, its quantity, its standards of performance, and its economy and efficiency.

Getting Beyond the Boundaries *Planned to Proactive*

The ability of a company to achieve 'world class' status depends on how well it can get the various functions to work together to accomplish its business objectives. This is nowhere more true than between production and maintenance. Maintenance must be recognized as an integral part of the plant production strategy by which the product is delivered to the customer at the quality he wants, at the price he's willing to pay. ***But, maintenance can't do it alone***. For maintenance to do its job properly, to accomplish the maintenance mission, requires the cooperation of, and association with, virtually every department (production, procurement, engineering, accounting, human resources, etc.) in the plant -- ***but especially with production!*** Not only must we in maintenance know what our objectives (roles and missions) are, but know how they are related to (and are in fact a derivative of) the larger sets of roles, missions, and strategic objectives of the overall organization.

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Fix the Process, Not Just the Problem *Proactive to World Class*

We believe both production and maintenance share a number of basic responsibilities that each must exercise diligently in concert with each other to get what both want. The challenge is to gain recognition, at all levels, in all departments, that ***maintenance is a strategic tool (just as JIC, CIM, TQC, or any of the other "world class" methods and techniques being implemented) for improving a company's competitive edge***, playing a major role in reducing quality defects, increasing production capacity and throughput, and improving overall plant productivity and profitability. It's continuous improvement with a new twist.

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