Improving Productivity in Consumer Goods Manufacturing

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Summary

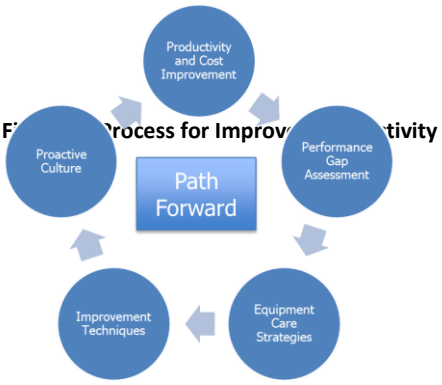
Margins, the difference between manufacturing cost and selling price (what the market will bear), is very "tight" in the Foods and Consumer Goods industry. Competition from different brands, startups, product lines, and changing consumer tastes puts pressure on margins for many manufacturers. This leads to manufacturing cost pressure for manufacturing. Manufacturing has only so many levers to pull such as improving productivity or reducing their cost structure. Many companies look first to reducing the cost of their overall supply chain through reduction in logistics, procurement and operations. The following process involves focusing on improving the productivity of the manufacturing base whether it is one site or a network of sites. The process involves knowing the gap in desired performance, knowing what levers to "pulled", designing the right asset care strategies, deploying various improvement techniques, attaining a proactive culture and finally attaining the needed improvement in productivity, manufacturing cost and attaining supply chain leverage. The experience from deploying this process across several clients has resulted in :

- Improvements in OEE by more than 5%
- Improvements in Equipment Availability by 10%
- Reductions in Operating Cost by 10%
- Reductions in raw material usage
- Meeting customer demands in peak seasons
- Reductions in Logistics and Procurement costs
- Reduction in Maintenance costs by more than 10%
- Reductions in off-site waste disposal by 15%

Purpose

The purpose of this presentation is for the reader to learn how to assess the performance gaps in their facility's productivity through higher level metrics and then understand the "levers" that are available to close performance gaps such as reducing downtime, improving line speeds, reducing variability, designing asset care strategies aligned with business needs, and removing waste from the manufacturing process. Next, to know which improvement techniques can be applied to move those "levers" such as criticality, lean manufacturing, leading and lagging metrics, and performance boards, to name a few. An important drive is that towards proactive cultures that recognizes failure early, minimizes costs to restore function, and drive out variances. The presentation will then describe how to communicate this to management through a strategic plan.

Introduction



The process shown in Figure 1 depicts the process to be described in this presentation. It starts with knowing the gap between higher level metrics the business uses to judge its performance and the performance level of those metrics at each facility. The size of the gap drives improvement. The next step is knowing which "levers" are available to the site in order to close the gap. In other words, the "levers" represent the granularity in each of the metrics. For instance, OEE has several components such as Productivity, Equipment Availability, and Quality. Under Productivity, the user must understand line speeds, variability of operating variables, and observations of individual line performance. Equipment availability is affected by downtime, effectiveness of equipment care strategies, and maintenance execution effectiveness. Equipment strategies need to comprehensive to include Preventative, Predictive, Operations, MRO, and Lubrication components. In many instances some of these elements of care are not developed leaving the site open to equipment failure.

Next, several improvement techniques are available to help drive the improvement. Criticality is an important strategy to deploy to align resources with business needs. Lean manufacturing has many components that remove waste from manufacturing processes. Leading and lagging metrics help people understand what they can improve. Performance boards and floor-level meetings help keep goals and targets in front of line operators. One of the most important cultures to achieve is one that values proactive behaviors like finding failure early, understanding early how daily system variances drive targets, and dealing with the culture of change management. Finally, this process is put together through developing a Path Forward through a strategic plan. This is pathway that management and floor-level personnel buy into the overall improvement process. The plan contains early wins, operating system installations, maintenance execution system implementation, and target identification.

Food Industry in Unique

Most of my experience has been in the Chemical Manufacturing. I dealt with large equipment like pumps. vessels, columns, etc. but the food industry is unique from many perspectives. First of all, Food Safety such as Sanitation, Pasteurization, and GMP offer challenges to equipment care due to aggressive cleaning and designs that can accommodate easy cleaning. The complexity of its Supply Chain and Product Lines for both Retail and Commercial distribution channels is much broader than most Chemical supply chains. The diversity of its processing equipment from food preparation, mixing, cooking, pasteurizing, packaging and palletizing requires a broader variety of care strategies. Its variety of packaging types also broadens the equipment variety utilized. Finally, the utility demands from cooking (Hot Water, Gas) to Refrigeration (Ammonia) introduces an element of Process Safety Management but is smaller than most Chemical manufacturing operations. All these perspectives require food manufacturers to build extensive care strategies and broaden participation level of those involved in both operating and maintaining these assets.

Performance Gap Assessment – Metrics

The first step in our process is to understand the gap between current performance and not only company targets but also benchmarks for the industry. The following table shows a list of some metrics used at a strategic level to understand performance. Order fulfillment metrics like On Time in Full should be greater than 95%. If current performance is 90%, the next question is determining why the difference exists through more granular measures like those in logistics. Operations plays a role through Production schedule compliance. The metric to focus on is OEE (Overall Equipment Effectiveness). It is composed of Equipment Availability, Productivity and Quality measures. Most facilities should exceed 80% OEE but most are well below in the 60% range.

Let's take Equipment Availability as point of granularity to investigate. The difference could be explained through high equipment breakdowns, poor scheduling, too many grade changes, slow changeovers, too many PM's, and excessive downtime. Once a root cause is known the site can then establish improvement plans to improve these leading metrics which result in higher OEE. In closing, no matter the metrics a site uses, a gap analysis is needed to explain the difference between current and desired performance for each one.

Metric
OTIF (On Time In Full)
Units (SKU's) Shipped
OEE
Inventory Levels
$/CWT
$ Labor / Day
$ Maintenance / Replacement Asset Value

Performance Gap Assessment - Levers

Once the difference is identified and reasons for the gap are known, a consumer goods manufacturer needs to understand which "levers" can be adjusted to move performance back to targets. There are many levers available to the site. These include line speed analysis, observations, variability analysis, downtime analysis, lean manufacturing waste analysis and equipment failure analysis. Each of these offers "clues" as to why performance is no where near targets. Let's describe a few further.

Line speeds are subject to variability based on how resources are arranged. Line speeds should be known by counting production at the end of the line. The rate should be compared against maximum demonstrated production rates. Observations can compliment this analysis by understanding how resources are arranged on the line, managing any constraints, and recognizing where operations do not meet the demand of the line like supplying raw materials or where automation can benefit the line speed. Understanding the "pattern" of variables that control output is important to look for trends or the effect of daily decision that influence line performance. Downtime analysis is the most insightful "lever" since its categorization can provide granularity into why line speeds and other processing operations are not performing. Operations as changeover are a typical culprit to slowing down performance for lack of standards, wasteful tasks, and poorly designed campaigns. Lean manufacturing techniques through a knowledge of the magnitude of the seven wastes provide multiple "levers" to be adjusted like waste of motion, waste of oversupply, etc.

Knowing the mean time between failure for the assets is also a "lever" than can be adjusted to improve performance. Rotating assets should have at least a 4-6 year MTBF for any consumer goods manufacturer. However, most do not use the functionality of their Maintenance system to determine that number. Failures in excess of this MTBF level cause higher downtime, higher maintenance costs, and can lead to unsafe conditions.

Knowing your “levers” to adjust to improve performance allows a site to selected improvement techniques aimed at moving these “levers” in the right direction. The remainder of this paper will delve into these techniques.

Equipment Care Strategies

One major class of “levers” to be changed are equipment strategies. However, many site’s equipment strategies (how assets are cared for) can be compared to how a horse is treated in a race. First, blinders are put on the horse so he or she can only see the track. That is the same for equipment strategies in consumer goods manufacture. In their case asset care in basically PM’s. In fact, too many PM’s and probably not very effective PM’s. Most of their care plans are “blinded” to other aspects of care and do not consider other important elements shown in Table 2.

Table 2. Improve Productivity : Asset Care Plan

Preventative	Time-Based Activity
Predictive	Condition-Based Activity
Operator Care	During Operating time
Lubrication	Practices for different components
Startup / Shutdown	Pre and Post Inspection
Cleanliness	Housekeeping issues
Spare Parts	Critical, Consumables

Comprehensive care includes condition-based, operator, and lubrication practices, etc. At a minimum, critical assets should have a full set of care assigned as shown in this table. However, most sites do not even know their critical assets which will be explained further.

In the introduction, we talked about the diversity of equipment used in the consumer goods industry. The list could include Palletizers and De-Palletizers, Cartoners, Fillers – Liquid, Solids, Rollers, Conveyers, Spirals, Box Makers, Labelers, Hydraulic Systems, Mixers, Pumps, Agitators, Case Packers, Robotic Case Makers, Glue Machines, Wrappers, Ventilation, and Refrigeration machines. Each of these assets has a unique set of care tasks that PM’s only cover a portion of the requirement. PM’s are mostly poorly written and applied and cause more problems that they are worth but that is the topic of another paper. Most PM’s need to be reviewed for their effectiveness and the quality of their content.

Let’s take as an example a case packer that is used in various consumer goods industries. Of course, PM’s lead the list but only to replace wear out components. More importantly, condition-based care should include motor checks for high temperature and vibration checks for bearing issues, etc. The operators should be checking the suction cups that pick up carton for tears, making sure the match marks are lined-up, photoeyes and reflectors are aimed at each other, machine is clean, and the belts are tracking right. Maintenance should ensure lubrication is adequate. The right spare parts should be in Stores. All of these elements spare part of an asset care plan for this machine. If any are missing, failures will occur which lower its productivity and increase its maintenance cost. This type of analysis should be done for all critical assets first in the facility.

Improve Productivity : Asset Care Plan	
Preventative	Replace components
Predictive	Temperature motor, bearing Vibration analysis
Operator Care	Check suction cups Check match marks Check conveyers, motors, bearings Check photo eyes, reflectors Check air pressure, vacuum Belt and Hose conditions
Lubrication	Bearings, Conveyer and Drive motor, Moving parts
Startup / Shutdown	Cardboard properly placed Match marks
Cleanliness	Remove containers, cardboard
Spare Parts	Suction Cups, Belt, Hoses

How does a site correct its care and be more comprehensive? First, become more proactive which be discussed later through converting PM's to line checks that are performed while the equipment is running. Second, review the work orders for each piece of equipment and determine what care is needed to eliminate the failure modes identified. Do not use vendor manuals! They only want to sell you parts! After your review of failures, develop your care plans using other tasks such as improved operator monitoring, standardizing operating procedures, better lubrication practices, expanded use of infrared, vibration, and oil analysis. Always start with your critical assets first.

Improvement Techniques

Now that you know how big the gap is and what levers you pull to close those gaps, the question is how you move those levers to improve your plant's productivity. There are many improvement techniques that will move those levers such as Criticality, Time Cycle Management (Controls, Changes, Campaigns, Production Wheel), Visual Factory (Field Controls), Lean Manufacturing (Staging / Kanban), Match Line Management, Dashboards (Leading and Lagging Metrics), Performance and Field Issue Boards and Floor-Level meetings. It will take combinations of these techniques to move those levers of line speed, control variability, equipment mean time between failure, and downtime. Let's discuss a few of these techniques.

Criticality is important to determine for all your assets. Generally, 20% of your assets are critical to the business. Determining criticality and aligning your asset care plans, maintenance resources, parts, and supplies with the top tier equipment will improve equipment availability. Criticality maybe different for your business so consult the best practice within your industry group for determining criticality.

Time cycle management reduces downtime. It can be done through standardizing time cycles for mixing operations. Changeovers between products is a major culprit in wasting time. Changeovers should be "choreographed" so as to determine the most expeditious way to execute them. Production scheduling can also provide opportunities to maximize the time equipment is making product. The objective is to create a schedule that minimizes changeovers. Campaigns are a great way to minimize changeovers. Production wheels also allow for the minimization of cleaning and cross contamination.

Visual factory allows the communication of important information to floor-level workers. This information can be shown on machines so as to communicate key operating variables or how to watch out for variances during equipment operation like match marks that start to drift.

We could write a book on Lean Manufacturing. Lean manufacturing eliminates the seven wastes in manufacturing. The use of Kanban allows for signals to indicate the need for raw materials and other supplies. Constraint management ensures that improvements made in productivity are actually seen at the end of the line. The use of 5S minimizes the time people look for "things" they need in order to reduce downtime. We could write volumes on this subject, but I urge you to study more on Lean Manufacturing techniques.

Many machines in the consumer goods manufacturing environment rely on match marks for proper timing. These are physical marks on the machine that must align for proper operation. This alignment must be established at startup and can be different from one product (box) to the next. They must be watched during Operation to ensure they don't drift.

Most individuals do not understand how their activities impact performance metrics. The reason why is that we manage their work through lagging metrics that only measure results! We need to manage them with leading metrics which measure process performance. For instance, in safety, the number of injuries is a lagging metric while the number of safety observations, near miss reports, and root cause

investigations are leading metrics. In manufacturing, maintenance cost is a lagging metrics but schedule compliance, work order completion and the number of proactive work orders are leading metrics. Lagging metrics are for management while leading metrics are for floor-level people.

Performance boards and floor-level meetings enable the communication of important information. They do contribute to move levers by giving the floor-level person the knowledge of what is important to the business. Visibility of metrics drives improvement.

Proactive Culture

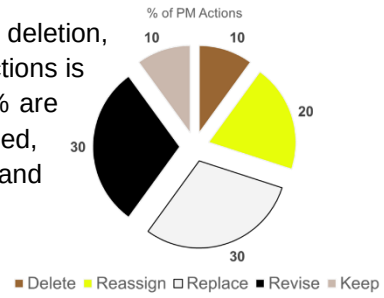
Identifying failure early is vital to both reducing repair costs and improving uptime. We know from the Bathtub curves that the majority of failure occurs randomly. Most failures start to indicate their progression towards total failure through vibration, noise, temperature, smells, and other detectable indications. Continuous monitoring of machines allows for the identification of these early signs. PM's are both intrusive and introduce higher probability of failure if not done properly, so they are not the answer to asset care to satisfy business needs.

A proactive culture means to get ahead of failure and identify failure before it become corrective maintenance. One route is through PM Optimization and the creation of Line Checks. Most sites have 30% more PM's than they need, and the effectiveness of many PM's are questionable.

A PM Optimization exercise is a practical approach to determine which PM's are effective and which can be transferred to Proactive Line checks. PM's are reviewed for critical assts first through a set of questions. These questions can include:

1. Does the PM find the onset of failure?
2. How often does the PM discover failure:
3. Can these tasks be transferred to Operations?
4. etc.

After these questions are answered, actions generated to allow the deletion, modification, or redesign of the PM's reviewed. Generally, the distribution of actions is shown in the attached diagram. Approximately 30% of PM's are revised, 10% are deleted, 20% reassigned, and 30% are placed. Those that are reassigned, deleted, and replaced can be part of proactive line checks by maintenance and operations that do not take the line down but look for the early signs of failure.



Line checks can be arranged so entire production lines are reviewed as they operate several times per day looking for the early signs of failure. They contain for each piece of equipment the operating windows for each operating parameter to be checked. This includes a description or value and what to do if the parameter checked is outside of its operating window. For instance, in the following example first the environment around the unit is checked for lighting, doors and sanitation. Next each piece of equipment is checked for key operating parameters and physical conditions while the machine is operating.

Line 6 Pre-Cook East Shift Inspection **Procedure Code - 101** **Version 1.0 November 1, 2017**

Area: Pre-Cook, Lenox, IA = Lockout/Tagout Required ① = See Notes

PPE: Bump cap, safety glasses, steel toes shoes, hearing protection, hairnet

Tools: Flashlight, Screwdrivers, Wrenches, and Utility Knife

SHIFT PROACTIVE MAINTENANCE ROUTE **Start Time _____ Stop Time _____**

TIMING = START OF SHIFT AND COMPLETED BY 9AM / 6 PM / 1 AM EACH SHIFT

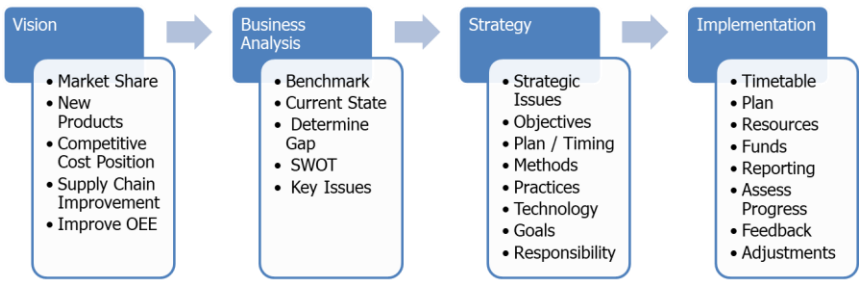
NOTIFY SUPERVISOR/LEAD IF NOT ON TRACK

LOCATION #: EQUIPMENT	WHAT TO CHECK	DESIRED CONDITION	Condition Found	Action Take WO # (if needed)
#1: ENVIRONMENT	LIGHTING	NO BURNED OUT LIGHT		
	EMERGENCY LIGHTS AND SIGNS	ALL LIGHTS IN STANDBY WITH INDICATOR ON AND SIGNS LIT		
	DOORS	ALL DOORS CLOSED		
	SANITIZER	SPRAYING AT DESIRED FREQUENCY AND SUPPLIES ARE NOT EMPTY		
#2: LINE 6 FEED	CHECK PRODUCT FEED PRESSURE	EXPECTED: 10 PSIG	PRESSURE _____ PSIG	
	CHECK AIR PRESSURE	PRESSURE 65 PSIG, NO AIR LEAKS	PRESSURE _____ PSIG	
	CHECK FEED PUMP (SEALS, BEARINGS, COUPLING, MOTOR) FOR PROPER CONDITION	NO LEAKS, HIGH TEMPERATURE, NOISES, SMELLS, OR EXCESSIVE VIBRATION		
	CHECK FEED TANK FOR INTEGRITY	NO LEAKS		
	CHECK MIXER	NO UNUSUAL NOISES OR VIBRATIONS, NO GEARBOX LEAKS		
#3: LINE 6 OVEN INLET	CHECK DEPOSITOR PUMPS	BOOTS HAVE NO RIPS OR TEARS, CONSISTENT PRODUCT DEPOSIT PATTERN		
		SOLENOIDS ARE NOT LEAKING		
		AIR LINES ARE NOT LEAKING		
	CHECK TEFLON SCRAPPER	GOOD CONDITION NO DAMAGE		
	CHECK FEED LINES AND HOSES	NO LEAKS OR DAMAGE		
	CHECK CONVEYER BELT	CENTERED, TENSIONED, AND IN GOOD CONDITION, NO WIRES BROKEN	CHECK CONVEYER BELT	
	CHECK CONVEYER MOTOR	RUNNING SMOOTHLY, NO NOISE OR EXCESSIVE VIBRATION, NOT RUNNING HOT	CHECK CONVEYER MOTOR	
	CHECK GEARBOX	NO LEAKS, NOT RUNNING HOT	CHECK GEARBOX	
	CHECK CHAIN	TENSIONED PROPERLY, NO EXCESSIVE WEAR	CHECK CHAIN	
	CHECK GEAR WHEEL	GREASED	CHECK GEAR WHEEL	
	CHECK RACK SPINDLE	GREASED	CHECK RACK SPINDLE	
#4: LINE 6 OVEN OUTLET	CHECK CONVEYER BELT	CENTERED AND IN GOOD CONDITION, NO WIRES BROKEN	CHECK CONVEYER BELT	
	CHECK CONVEYER MOTOR	RUNNING SMOOTHLY, NO NOISE OR EXCESSIVE VIBRATION, NOT RUNNING HOT	CHECK CONVEYER MOTOR	

These line checks can be created for each production line, utility, facility, roof equipment and maintenance shops. They act as a driver for proactive cultures. These cultures look for the early signs of failure and then work to eliminate their reoccurrence.

Path Forward

Creating a strategic plan is the key to success. It starts with a business analysis to understand the gap in performance and to quantify that gap in dollars for management. Through the use of understanding which levers needs to be adjusted through a SWOT analysis



which are then identified as strategic issues. Improvement techniques become part of the implementation plan which then then turn into practices for the business. This is all put together in a timetable along with a cost benefit analysis for buy-in from company leadership. No improvement in productivity should be started with out a creation of a strategic plan.

Conclusions

The process described above has been used in multiple engagements by the author. Unfortunately, specific improvement statistics are not permitted to published by his clients. However, in general, the following has been achieved:

- Improvements in OEE by more than 5%
- Improvements in Equipment Availability by 10%
- Reductions in Operating Cost by 10%
- Reductions in raw material usage
- Meeting customer demands in peak seasons
- Reductions in Logistics and Procurement costs
- Reduction in Maintenance costs by more than 10%
- Reductions in off-site waste disposal by 15%

Biography

David Rosenthal, CMRP, PE has over 38 years of manufacturing experience covering chemicals, consumer goods, pharmaceuticals, food, beverage, paper, and oil and gas industries. He has held numerous positions in operations, maintenance, and engineering with Rohm and Haas Company and others. He has a bachelor's degree in chemical engineering from Drexel University and a master's degree in chemical engineering from the University of Texas at Austin. He is board member of SMRPCO.

Keywords

Productivity, Improvement, Care Strategies, Strategic Plan, Lean Manufacturing, Performance Gap