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Total Productive Maintenance: *Determining Right Strategy for the Plant and Changing its Culture for Successful Execution*

Company Background – Corporate Overview

International Manufacturing Corporation (IMC), a manufacturer of axles for the automotive market, was created in the mid 1990's as a spin-off from one of the "Big 3" domestic automotive manufacturers. The company was formed by a group of private investors who had seized the opportunity to make a successful company from a failing division of one of the Original Equipment Manufacturers (OEMs). The company was privately held initially by an investment group until it went public in late 1990s. Company Leadership was primarily comprised of the "old guard" from different automotive companies that had extensive experience from being part of bankruptcy turnarounds of the 1980s.[1](Hamper 1991) IMC started with four unionized locations in the United States (U.S.) with its headquarters situated in Detroit, Michigan. Because the company had been created from an OEM there was initially only one customer, although very large, that promised long-term single source contracts.

The Management culture of the new organization was very aggressive, a mirror image of the "old school" OEMs[2]. Leadership vision was driven by a goal of rapid profitability and the organizational culture was old school style "command and control". After successfully abating the ubiquitous ineffective manufacturing operational methods, the next critical objective was to garner new business from non-OEM companies both domestically and globally. This meant first addressing some very inefficient processes, stogy management and supervisory protocols, and the OEM stigma of poor quality products associated with the strong union setting.[2] To correct this, IMC leadership focused on going back to the management basics that had been slowly dissolved and neglected by the OEM during the years of high profitability, little competition, strong union contracts, and poor future vision. The issues considered basic were worker start and stop times; the employee is paid for 8 hours of work and is expected to work 8 hours; Overall Equipment Effectiveness (OEE) and housekeeping. The IMC Leadership team was very "hands on" and started to involve the hourly workforce in plant productivity issues. While this helped gain credibility with some plant floor unionized personnel, the changes needed to be at warp speed, not every three years

[1] The Book "Rivethead: tales from the assembly line" Provides a vivid picture of the cultural issues that have been deep rooted in the Automotive industry since the 1970's. Hamper, B. (1991). Rivethead: Tales from the Assembly Line New York, NY, Warner Books.

[2] In the book Passion for Manufacturing, Richard E. Dauch explains some of the techniques that helped the companies Volkswagen and Chrysler become successful organizations. Richard E. Dauch has demonstrated the extraordinary ability to unify organizations and makes positive impact by focusing on the fundamentals. Dauch, R. E. and J. Troyanivich (2005). Passion for Manufacturing. Detroit, Society of Manufacturing Engineers.

Kenneth J. Gembel II prepared this case under the supervision of Dr. Ratna Babu Chinnam (list your major advisors) for the Global Executive PhD Track in Industrial Engineering at Wayne State University. Wayne State University GET cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective engineering / management.

when the local union contract was renegotiated. This is the tipping point where the recently installed collaborative culture would tend to revert to the old school management versus union motif[3](Lutz 1998) . As goals or tasks were not accomplished on time, typical adversarial positions would be taken, with face-to-face confrontations and belittling of the supervisors and managers by the union. As expected, this created a hellish plant floor setting for both management and the union workforce, taking a toll on teamwork, camaraderie, and for sometime the product. Additionally, the mental and physical stress led many from both sides to use illegal drugs, heavy alcohol intake, and take sick leaves from work. Although IMC achieved the needed results through the initial decade of the company's existence, it also created a work environment where individual managers and now the pseudo collaborative teams were leery of making operational decisions without first getting permission from senior management. In this organization there are two pillars which drive the company, product manufacturing and design/build engineering. With the majority of the senior leadership experience in manufacturing, the organization spent $250 million dollars early on addressing housekeeping and image of the facilities. Because manufacturing generally is considered a dirty, grimy and nasty process, with continuous equipment coolant leaks and metal chip debris contaminating the process environment, it was considered important to create a worker friendly job site.

Having its operational soul created in a command/control environment with military veterans after the various wars, manufacturing operations mirrored a battlefield with the enemy being the union. Additionally, the new leadership didn't trust inherited team members, although why would they when the inherited group was a part of the problem that caused the downfall of the old company. It was almost as if the cultural issues that were inherited were solely created by the mid-level managers that were forced to stay with the new organization. For total oversight purposes, the senior management team created an operational protocol which would monitor daily performance. The form known internally as the "Production Control Report" was mailed out daily to all senior management within the organization. It reviews the primary production metrics and is completed for all facilities, and at each point where product is shippable to the final customer. This report covers the basic metrics such as monthly Production Days, Planned Daily Build, Actual Daily Build, Daily Build Attainment and Weekly Build Attainment. It also breaks-down the daily build detail by vehicle platforms[4]. The build quantities include the diverse product offerings for each of these OEM vehicle platforms. This report is reviewed by all levels of the organization on a daily basis and is an efficiency measure that depicts if the customer is getting the required production units on time. While this tool gives a rough outline of production benchmarks, it tends to elicit poor operational practices. If the daily output "Number" is not met, then it receives higher scrutiny from the CEO and Vice Presidents within the organization. This tended to drive unnecessary overtime, over building or banking of parts in quantities that are not required and should not be in the inventory, reducing profitability.

Opportunity as a Plant Manager

[3] The automotive book GUTS written by Robert Lutz is about the steadfast business principles that help guide massive organizations make the necessary changes to become thriving business. Lutz, R. A. (1998). GUTS: The seven Laws of Business That Made Chrysler the World's Hottest Car Company, John Wiley & Sons.

[4] Vehicle platform refers to the sharing of technology, engineering, components and processes to produce different products by using some common items between the different automobile models to reduce overall cost. Simpson, T. W., Z. Siddique, et al. (2006). Product Platform and Product Family Design, Spring Science.

On March 1, 2009, a new Plant Manager was given the opportunity to have full control over manufacturing and assembly facilities. This was an excellent opportunity for the manager because it would be the first time he could control the profit and loss statement for a business unit. It would also be the first time he was in full control of an operation with very little oversight/micro-management other than weekly and monthly reports of P & L. The only formal external metric that was given with explicit direction was to make sure the facility is in the black and not losing money. Internally, the plant had a number of different metrics to insure continuous improvement.

The following departments would be reporting to the Plant Manager and are factored into the business unit is P&L: Manufacturing, Quality, Engineering, Maintenance, Materials (which includes purchasing), Finance and Human Resources. In essence, the Plant Manager has full control of all the resources that support and control operational performance and their allocation. In this role there isn't any responsibility for obtaining new business. From a new plant manager's point of view, understanding the current systems from each of these areas and how they supported the operations would be the focus of enhancing the P & L. Many of the costs associated with the support groups such as Engineering, Quality and Materials do not have as much impact on the financial performance from a labor side. These groups while extremely valuable to an organization are support for operation and indirect costs. Where their impact is significantly felt is in driving stability into the manufacturing systems and processes they support. The key salaried personnel at IMC supporting the PM are discussed in Appendix G.

Plant Performance: Current State

When in control of all plant operations it is very important to fully understand the "systems" that guide the operations. One of the most critical parts of being the person in charge is the development of trusting relationships with all people in the organization, "the team". In this case the focus is primarily on two functional groups, manufacturing and maintenance. These groups have the most impact on plant performance. When given the responsibility to run this plant, the manager had never worked with a group of individuals harboring such a negative, untrusting attitude as those that composed the Heavy Duty Axle Plant; there was significant, positive, interpersonal ground work that needed to take place. As seen in Appendixes A, B, C and D the plant had negative performance financially. Noted in the breakdown of the facility costs are numerous alarming items. Many of the cost controllable items such as Direct labor, Indirect Labor, Maintenance Labor, Sundry Labor, **D**irect **L**abor **O**ver**t**ime **P**remium (**D/L OTP**) and **I**ndirect **L**abor **O**ver**t**ime **P**remium (**I/L OTP**) are not meeting the budget requirements. These costs, discussed in Appendix H, are based on the operational performance.

The groups are divided out like this to separate and capture the individual cost, as each of these functional groups have a different cost structure based on the skill needed to perform the job. It also highlights where there are deficiencies in performance. Just a brief review of each of these areas highlights some major concerns. The main item of concern surrounds trying to gain an understanding of why the operations are not performing to the required budgeted levels.

Key Metrics that Drive Measurable

There are two significant metrics that can help a team focus in on opportunities for making improvement to the plants performance, labor efficiency and Overall Equipment Effectiveness (OEE).

Operational Efficiency

The first metric is operational efficiency which is an internal calculation used to make sure the plant is making money with the allocated labor. It is a standard generated by the finance group that takes into account all the costs that impact product manufacturing such as shipping, the metal market, outside manufacturing, direct and indirect labor, Sales, General & Administrative Expenses (**SG&A**), past plant performance and expected performance for the next calendar year. The efficiency is based on the manpower hours allocated to groups combined in the throughput of the product. It's a tool that is used to help the production supervisors understand if he/she is making money with the manpower on a daily basis.

Overall Equipment Effectiveness (OEE)

The second metric is Overall Equipment Effectiveness (OEE). The efficiency of an operation or process can be calculated by the following Formula:

- **OEE=Availability * Performance * Quality**
- **Availability** = Operating Time / Planned Production time
- **Performance** = (Total Pieces / Operating Time) / Ideal Run Rate
- **Quality** = Good Pieces / Total Pieces produced

The plant is composed of six manufacturing and assembly departments. These departments are major drivers of cost in the P&L statements. Chart #2 shows the OEE performance of each group and the dollar value of improvement for each of these groups. The internal standards for OEE at IMC are 92% for assembly lines and 85% for manufacturing groups.

	Cost of 1% OEE Per Year	BASE	JANUARY		FEBRUARY	
DM Heavy Duty Axle Plant		2008	Actual	Target	Actual	Target
A - 12"Case Machining	$4,545	80.6%	56.0%	80.6%	55.6%	80.7%
B - 12" & 14" Hub & Disc Assembly	$27,797	83.3%	72.0%	83.4%	77.3%	83.5%
C - 12" & 11" Axle Assembly	$121,673	73.8%	72.6%	73.9%	72.5%	74.1%
D - 12" & 14" Axle Shaft Manufacturing	$48,654	73.1%	71.6%	73.2%	78.5%	73.3%
E - 12'/11" 3rd Member Assembly	$58,231	61.4%	60.6%	61.6%	64.1%	62.1%
F - 11" Case Manufacturing	$22,669	79.7%	79.6%	79.8%	68.2%	80.0%
G - 11" Shaft Manufacturing	$18,666	43.4%	43.8%	69.1%	39.6%	69.3%
H - 12"/14" Hub & Disc Manufacturing	$11,799	71.8%	76.7%	71.9%	68.2%	72.0%
Average	$314,034	70.9%	66.6%	74.2%	65.5%	74.4%

Table 2. OEE expectations and recent performance by department.

Analyzing the current performance

Immediately a Current State Value Stream Map was constructed as can be seen in Appendix A. This highlighted some significant issues with stability in the operation. The customer demand at this time was 830 axles per day and the TAKT time [5] was 35 seconds. When the manager started evaluating the systems with the impact OEE he were alarmed to find that some of the groups were not capable of meeting the TAKT time of the customer. This is done by taking the ideal process cycle time and dividing by the groups OEE (see **table 3)**.

[5] TAKT time refers to the frequency the customer is requesting the product or service. It is used to synchronize the pace of production with the pace of sales. Rother, M. and J. Shook (2003). Leaning to See: Value-Stream Mapping to Create Value and Eliminate Muda, The Lean Enterprise Institute.

DM Heavy Duty Axle Plant	# Shifts	Daily Requirements	Takt (sec/pc)	Ideal Cycle time (sec/pc)	OEE	Actual time (sec/pc)
A - 12"Case Machining	1	100	288	157	55.6%	282
B - 12" & 14" Hub & Disc Assembly	2	2950	20	11.2	77.3%	14
C - 12" & 11" Axle Assembly	1	830	35	25.5	72.5%	35
D - 12" & 14" Axle Shaft Manufacturing	3	2700	32	23.3	78.5%	30
E - 12'/11" 3rd Member Assembly	1	830	35	28.8	64.1%	45
F - 11" Case Manufacturing	2	1000	58	46.8	68.2%	69
G - 11" Shaft Manufacturing	2	600	96	69	39.6%	174
H - 12"/14" Hub & Disc Manufacturing	3	2950	29	20	68.2%	29

Table 3. TAKT time analysis by department.

The majority of the issues creating the problem of poor OEE performance are related to excessive machine downtime. In the facility there are eight total departments, two departments that only perform assembly operations and six others that are strictly machining departments. The assembly groups in general have more manpower than the machining groups as seen in **table 4.** The current operating practice and top priority is for equipment maintenance and production throughput, which are focused on the assembly groups that build the axles and the third member assemblies which are another component of the vehicle drive train.

DM Heavy Duty Axle Plant Manning	1st Shifts	2nd Shifts	3rd Shifts
A - 12"Case Machining	4	0	0
B - 12"/14" Hub & Disc Assy	6	6	0
C - 12"/11" Axle Assy	40	1	0
D - 12" & 14" Shaft Machining	7	7	7
E - 12'/11" 3rd Member Assy	15	1	0
F - 11" Case Machining/Assy	4	4	0
G - 11" Shaft Machining/Assy	4	4	0
H - 12"/14" Hub Insourcing	4	4	4
	84	27	11

Table 4. Direct Labor Manpower by Department.

Recent Lean Transformation and Lessons Learnt

Transition to a lean manufacturing process has been a struggle for production operations since the modern industrial revolution of the past few centuries. With the slow elimination of craft work and the evolution of mass production, controlling these complex manufacturing systems has emerged as a key management initiative. The emergence of Frederick Taylor and 'Scientific Management' in 1911, attempted to capture the wasted and non-efficient movements of the workers and the systems. On March 24, 1917, Overman Act was passed by the United States Council of National Defense, to curtail non-essential industries and eliminate non-essential uses of labor, capital, and equipment in all industries. Since that time, automotive leaders such as Henry Ford and Alfred Sloan, Jr., have captured the manufacturing moment with a more efficient and effective production process and revolutionized management's control. With the call by customers for more diverse and cheaper products, manufacturers have been tasked with establishing the best production methods meeting the desired needs. As such, it was the new manager's responsibility to grasp and understand the initial scheduling process which was very cumbersome and complicated, and transform it into a lean, cost competitive system. The outgoing manager would spend the first hour of the day scheduling the production for each of the 8 groups in the plant. This was a standard push system. Watching the previous plant manager try to use multiple spread sheets of product **W**ork-**I**n-**P**rocess

(WIP) numbers to verify whether there was available the correct parts to build to the customer requirements was stressful due to its complexity and ineffectiveness. Because the scheduling system was not visual, all levels of management had to verify and take different WIP counts throughout the day to be assured the appropriate material to meet the customer requirements was available. Most of the Plant Manager's team was not working on making the process better but working on just trying the run the right components for the daily schedule, this left very little time for the supervisors and general supervisors to make improvements. In the first few of days of running the operations, the manager witnessed multiple instances where manufacturing did not have the right components for the assembly lines. Because of the influence of the Production Control Report, the plant would typically over build on axles not immediately needed. This challenging daily scheduling routine was a source of massive waste and inappropriate use of resources. Because of this, process simplification was needed, and the lean transformation process started.

To implement the lean manufacturing protocols the first task was instituting a lean steering committee for the plant that engaged the plant floor personnel and hourly employees. Instituting and disseminating the lean protocols required training and rapid floor application.

The first item that the Plant Manager wanted the team to tackle was "level scheduling"[6] for the final assembly line and then "pull systems"[7] implementation for the departments that supply products to the main assembly line. Essentially, the manager wanted the team to work backwards. Pull systems had been implemented many times before and had limited, if any, success. Instead of jumping into a plan of pull system implementation and scheduling systems implementation, the manager had the team focus on 5s (**S**orted, **S**et in Order, **S**hined, **S**tandardized and **S**ustained). The mindset was that if a culture to follow the system rules for 5s could not be established then it would not be possible to follow pull system rules, follow standardize work instructions or even follow gage instructions to build in quality. To make this fundamental change take root, the team performed daily audits in various groups to monitor progress and assign action items for the improvements. The actions were expected to be addressed within a 24 hour period. To make sure this happened, the group revisited the previous day's action items and closed them out before starting the new 5s walk. At first these were pretty cumbersome meetings, but after about 2 weeks everyone began to understand and increase their expectations and the improvement started to stream very quickly. This was a very important tool to implement because it was easy to engage hourly employees and be the conduit for good communication as well as a forum for teaching lean concepts to the masses. These really help spread the vision and set the tone for how rapidly we need to progress.

Lean implementation had been attempted many times earlier in the plant but conflicted with practices of senior managers. Past implementation attempts failed partially due to senior managers not fully understanding the core lean concepts. Because of this, the Plant Manager involved the leadership in deploying the 5s; pull systems, and level scheduling process. The lean steering committee had a monthly meeting where many of the company's senior leaders (vice-president level) attended and would be part of transformation process. This would also work as a training tool for the senior leaders who also did not understand these systems. The real "meat and potatoes" of the lean implementation happened at the

[6] Level scheduling refers a lean manufacturing technique that creates smooth flow of production over a period by minimizing changes in demand levels by matching the product family schedules with product-by-product schedules. Liker, J. and D. Meier (2006). The Toyota Way Fieldbook: A Practical Guide for Implementing Toyota's 4Ps, McGraw-Hill.

[7] Pull system is a material systems where the customers demand (pull) of material dictates that more product be produced or shipped. Ibid.

weekly meeting where the team discussed performance gaps and put plans in place to make improvements to the system. This internal plant meeting was cross-functional and comprised of all levels of plant management from every department including the hourly workforce. When considered from a dollars and cents perspective, this is money well spent for both system implementation and team building. At this meeting the team determined the plant direction and how it needed to prepare for the monthly management meetings. One of the key items insuring system success was how religiously the systems were audited to monitor performance and if the system was being adhered to. Seen in **Appendix F** is an example of an auditing tool used to monitor the 5s performance. All the audits take place in the departments and thus accomplish rapid results due to the floor personnel totally understanding the problem and resolution.

Current Maintenance Strategy

The current IMC maintenance department operates with traditional organizational type structure in terms of job responsibility and functionality, which it has been since it was configured at the OEM. The organization like any company strives to generate profit. So when determining the appropriate manpower to support the operation, it is very difficult to hold extra associates to perform preventative maintenance work. The structure is aimed more as a reactive system where the trades are staffed to handle daily equipment breakdowns that occur, and when they are waiting for a reactive call, they attempt to complete Preventative Maintenance (PM) items. The hourly maintenance is divided by job classifications that are negotiated between the United Automobile Workers (UAW) and the senior management of the organization. These classifications were aimed to create experts in specific fields to make repairs and planned maintenance more fluid. This hasn't necessarily been the case in all areas and a good portion of the operational issues are due to not managing these specified resources effectively. The classifications that are used to support production functions are explained in Appendix I:

Skilled Trades Group	1st shift	2nd shift	3rd shift
Electricians	3	2	1
Machine Repairman	4	2	1
Millwrights	2	1	0
Pipefitters	2	2	1
Welders	1	1	0
Machinist	1	0	0
Carpenters	1	0	0
Hydraulics	2	2	1
Power tool	1	1	0
Building Repair Group	1	1	0
Total/shift	**18**	**12**	**4**

Table 5: Skilled trades' headcount by shift.

All of the skill trades are centrally located inside the plant. The manpower is set up to work in a reactive manor. The trades basically sit at their work station waiting for a call from the production group to fix a problem. When issues develop, it is first recorded in a computer database system called Maximo and then sent to the dispatch area where all the trades reside. The required trade's person takes the work order and then goes to the job to assess the situation and perform the repair. The typical union tradesperson maintain the perception that if they can sit at their workstation, things are running good. The way the plant is staffed is such that it mirrors production operational levels. If production line rate is slow, maintenance personnel are minimized. With the current UAW contract, many of the maintenance jobs or breakdowns, even simple repairs, require multiple trades. And as is expected a union brother/sister will not crossover and do another trades work unless they are in full utilization mode, even if it is a critical production line breakdown or emergency.

Planned Maintenance

As can be seen from the OEE chart #2, there is great amount opportunity to reduce the amount of break downs. The ultimate goal would be to have a system that eliminates break downs. With the Maximo system, it is very easy to set up planned maintenance (**PM**) tasks and was designed to help orchestrate planned maintenance activities. Initially, the history of how PMs were set up within the plants was based on joint collaboration with the machine suppliers/builders, and manufacturing engineers that certified the equipment. Because a significant portion of the systems equipment is custom built, trying to estimate machine failure modes and downtime potential is fairly speculative. It is very difficult to simulate equipment failure rates when long-term operational hours, system and building ambient temperatures are uncertain, machine component metal fatigue verification, and thorough system maintenance is intermittent. Additionally, with no equipment failure rate history to support a breakdown probability matrix, a SWAG is the typical planning method. The second method for PM determination is through catastrophic machine breakdowns or unexpected failures. This started to create another issue because many of the components would fail for different machine cycling modes and these modes could take years to manifest a failure. When the group would set the PM, they would be directed by higher authorities to make the frequency of the PM daily or weekly. This plant has over 150 pieces of different assembly and manufacturing equipment, so, it becomes unfeasible to do all the PMs. Another critical issue is that due to first shift being manned the heaviest with production workers, stopping the line for PM is very costly, relative to output and labor. It’s not practical to shut the equipment down when you have so much direct labor standing around idle. What was thought of as the most ideal time was on the off shift, but the issue is that the equipment in the groups that runs on second and third shift have low OEE as can be seen in **table 2**. So, the trades that the team would like to use preventative maintenance are busy doing reactive, plant breakdown type maintenance.

How to restructure the maintenance system?

In the initial phases of taking over the facility, the Plant Manager made significant changes relative to system functionality. He saturated the facility with 5s and pull system visual management tools which allowed the management staff to perform more value added activities other that scheduling. The OEE needs to be the primary focus in order to make the facility profitable. The only way to do this is to make significant changes to the maintenance systems structure. How should the system be structured to make maintenance more value added and improve the OEE of the facility? What is the right maintenance strategy for this plant? How should the plant determine this strategy and how should they go about changing the ingrained, by the contract, adversarial culture for successful execution of this strategy?

Appendix A

INTERNATIONAL MANUFACTURING CORPERATION

WEEK ENDING 3/8/2009

TOTAL LABOR EFFICIENCY *WEEKLY* 94.1%

WEEK TO DATE PERFORMANCE								Time	Total		
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Adjust.	Actual	Budget	Variance
DIRECT	$ 22,236.11	$ 23,723.95	$ 26,809.01	$ 22,256.53	$ 26,415.00	$ 7,178.46	$ 719.08	$ 248.27	$ 129,586.41	$ 119,678.05	$ (9,908.36)
INDIRECT	$ 5,819.79	$ 6,386.31	$ 6,249.28	$ 6,551.96	$ 5,203.06	$ 2,021.11	$ -	$ (79.40)	$ 32,152.11	$ 33,535.61	$ 1,383.50
TOOL LABOR	$ 1,043.11	$ 1,401.21	$ 1,245.75	$ 950.19	$ 1,218.26	$ 430.05	$ 22.38	$ 81.01	$ 6,391.96	$ 6,437.14	$ 45.18
MAINT LABOR	$ 6,279.67	$ 7,242.20	$ 8,221.20	$ 7,701.03	$ 7,816.83	$ 4,958.84	$ 11.16	$ 1,519.83	$ 43,780.76	$ 46,596.28	$ 2,815.52
SUNDRY LABOR	$ 190.72	$ 1,400.35	$ 243.34	$ 334.70	$ 286.40	$ -	$ -	$ (464.88)	$ 1,990.63	$ -	$ (1,990.63)
D/L OTP	$ 1,857.29	$ 2,114.71	$ 2,388.41	$ 1,185.86	$ 2,214.84	$ 4,127.34	$ 606.45	$ 394.83	$ 14,889.73	$ 7,737.58	$ (7,152.15)
I/L OTP	$ 528.51	$ 1,126.09	$ 822.20	$ 818.77	$ 610.39	$ 3,437.65	$ 6.33	$ 422.82	$ 7,772.76	$ 6,228.38	$ (1,544.38)
COLA	$ 5,323.38	$ 5,971.15	$ 6,385.44	$ 5,666.47	$ 6,110.61	$ 2,132.83	$ 112.73	$ 129.75	$ 31,832.36	$ 32,214.55	$ 382.19
TOTAL LABOR	**$ 43,278.58**	**$ 49,365.97**	**$ 52,364.63**	**$ 45,465.51**	**$ 49,905.39**	**$ 24,286.28**	**$ 1,478.13**	**$ 2,252.23**	**$ 268,396.72**	**$ 252,427.61**	$ (15,969.11)
SCRAP	$ 2,001.82	$ 2,474.62	$ 6,458.38	$ 3,385.46	$ 4,744.53	$ -	$ -	$ -	$ 19,064.81	$ 18,816.50	$ (248.31)
TOTAL LABOR & SCRAP	**$ 45,280.40**	**$ 51,840.59**	**$ 58,823.01**	**$ 48,850.97**	**$ 54,649.92**	**$ 24,286.28**	**$ 1,478.13**	**$ 2,252.23**	**$ 287,461.53**	**$ 271,244.10**	$ (16,217.43)

Appendix B

Internation Manufacturing Corporation

WEEK ENDING: 3/15/2009

TOTAL LABOR EFFICIENCY *WEEKLY* 94.3%

WEEK TO DATE PERFORMANCE											
									Total		
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Adjust.	Actual	Budget	Variance
Labor											
DIRECT	$ 21,521.59	$ 30,885.18	$ 24,140.11	$ 25,050.72	$ 25,517.79	$ 16,526.77	$ 952.52	$ 380.68	$ 144,975.36	$ 139,961.97	$ (5,013.39)
INDIRECT	$ 4,759.99	$ 7,637.10	$ 6,849.67	$ 5,949.69	$ 5,792.68	$ 2,999.30	$ 369.33	$ 2,256.93	$ 36,614.69	$ 37,521.98	$ 907.29
TOOL LABOR	$ 772.99	$ 1,711.22	$ 1,300.86	$ 1,316.84	$ 1,283.30	$ 1,249.16	$ 85.62	$ 178.97	$ 7,898.96	$ 7,687.52	$ (211.44)
MAINT LABOR	$ 7,585.32	$ 9,026.44	$ 8,332.22	$ 7,916.24	$ 7,826.74	$ 6,705.21	$ 1,034.43	$ 463.03	$ 48,889.63	$ 51,013.88	$ 2,124.25
SUNDRY LABOR	$ 246.90	$ 310.49	$ 190.72	$ 190.72	$ 214.56	$ -	$ -	$ (457.73)	$ 695.66	$ -	$ (695.66)
D/L OTP	$ 2,029.04	$ 2,678.75	$ 2,003.82	$ 2,404.01	$ 2,492.69	$ 9,446.47	$ 1,094.38	$ 284.61	$ 22,433.77	$ 9,052.55	$ (13,381.22)
I/L OTP	$ 562.86	$ 982.31	$ 798.04	$ 591.62	$ 725.33	$ 5,577.09	$ 1,533.11	$ 902.13	$ 11,672.49	$ 7,194.07	$ (4,478.42)
COLA	$ 5,232.23	$ 7,374.01	$ 6,066.89	$ 4,960.98	$ 5,787.42	$ 3,830.40	$ 332.51	$ 543.04	$ 34,127.48	$ 37,457.41	$ 3,329.93
TOTAL LABOR	**$ 42,710.92**	**$ 60,605.50**	**$ 49,682.33**	**$ 48,380.82**	**$ 49,640.51**	**$ 46,334.40**	**$ 5,401.90**	**$ 4,551.66**	**$ 307,308.04**	**$ 289,889.38**	$ (17,418.66)
SCRAP	$ 4,265.25	$ 2,777.37	$ 2,494.45	$ 5.408.98	$ 4,436.44	$ -	$ -	$ 0.00	$ 19382.49	$ 22,633.73	$ 3,251.24
TOTAL LABOR & SCRAP	**$ 46,976.17**	**$ 63,382.87**	**$ 52,176.78**	**$ 53,789.80**	**$ 54,076.95**	**$ 46,334.40**	**$ 5,401.90**	**$ 4,551.66**	**$ 326,690.53**	**$ 312,523.11**	$ (14,167.42)

Appendix C

International Manufacturing Corporation

WEEK ENDING: 3/22/2009

TOTAL LABOR EFFICIENCY ***WEEKLY*** **89.1%**

WEEK TO DATE PERFORMANCE										
								Total		
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**	**Adjust.**	**Actual**	**Budget**	**Variance**
DIRECT	$ 25,295	$ 26,044	$ 24,141	$ 26,981	$ 24,331	$ 7,110	$ 107	$ 2,069	$ 136,078	122,053	$ (14,025)
INDIRECT	6.065	6,516	6,160	6,707	6,776	1,321	-	983	34,528	34,002	(526)
TOOL LABOR	1,915	1,315	1,226	1,511	1,218	316	19	174	7,694	6,739	(956)
MAINT LABOR	8,751	8.527	8,489	9,380	7,817	5,259	223	765	49,212	47,114	(2,098)
SUNDRY LABOR	226	191	718	12	1,678	-	-	-	2,825	-	(2,825)
D/L OTP	2.224	2,541	2,296	2,526	2.302	3,817	62	742	16,509	8,080	(8,429)
I/L OTP	970	836	874	1,039	778	3,482	126	646	8,749	6,341	(2,407)
NSP	1,915	1.315	1,226	1,511	1,218	316	19	174	7,694	6,739	(956)
COLA	5,929	6.078	5,800	6,328	5,982	1.962	45	763	32,887	32,827	(60)
TOTAL LABOR	**$ 51,375**	**$ 52.048**	**$ 49,703**	**$ 54,484**	**$ 50,882**	**$ 23,267**	**$ 582**	**$ 6.141**	**$ 288,482**	**$ 257.156**	$ (31,326)
SCRAP	4,023	6.793	1,883	3,359	3,056	-	-	(0)	19,114	20,608	1,495
TOTAL LABOR & SCRAP	**$ 55,397**	**$ 58,841**	**$ 51,587**	**$ 57.843**	**$ 53,937**	**$ 23,267**	**$ 582**	**$ 6,141**	**$ 307.596**	**$ 277,765**	$ (29,831)

Appendix D

International Manufacturing Corperation

WEEK ENDING: 3/29/2009

TOTAL LABOR EFFICIENCY *WEEKLY* 85.7%

WEEK TO DATE PERFORMANCE										
								Total		
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Adjust.	Actual	Budget	Variance
DIRECT	$ 24,357	$ 28,134	$ 26,491	$ 29,180	$ 26,807	$ 19,579	$ 2,007	$ 2,920	$ 159,476	137,329	$ (22,147)
INDIRECT	5,937	5,601	6,232	7,474	4,455	4,414	379	495	34,986	37,004	2,018
TOOL LABOR	1,332	1,451	1,645	2,204	1,231	1,283	99	196	9,441	7,614	(1,827)
MAINT LABOR	8,926	8,386	7,616	9,608	7,311	7,804	751	(51)	50,352	50,440	89
SUNDRY LABOR	948	789	(1,338)	95	95	-	-	-	589	-	(589)
D/L OTP	2,080	2,987	3,353	3,234	2,615	11,176	2,175	1,661	29,282	8,974	(20,308)
I/L OTP	807	807	843	1,325	355	6,871	1,119	476	12,603	7,069	(5,534)
COLA	5,906	6,339	5,780	6,827	5,736	4,706	456	241	35,991	36,769	778
TOTAL LABOR	**$ 50,291**	**$ 54,495**	**$ 50,621**	**$ 59,948**	**$ 48,606**	**$ 55,834**	**$ 6,986**	**$ 5,938**	**$ 332,718**	**$ 285,199**	$ (47,519)
SCRAP	4,812	4,605	2,038	5,502	8,752	-	-	(0)	25,709	22,091	(3,617)
TOTAL LABOR & SCRAP	**$ 55,103**	**$ 59,100**	**$ 52,659**	**$ 65,450**	**$ 57,357**	**$ 55,834**	**$ 6,986**	**$ 5,938**	**$ 358,427**	**$ 307,290**	$ (51,137)

Appendix E

Appendix F

5S AUDIT CHECKLIST

AREA:	Work Area	DATE:	10-Jul-06

	SORT	SET IN ORDER	SHINE	STANDARDIZE	SUSTAIN	TOTAL
Total Score	11	9	7	1	5	33
# of Questions	6	11	8	4	5	34
Average Score	**1.8**	**0.8**	**0.9**	**0.3**	**1.0**	**1.0**

SCORING GUIDELINES

0	1	2	3	3.5 (4)	4.5 (5)
ZERO EFFORT	SLIGHT EFFORT	MODERATE EFFORT	MINIMUM ACCEPTABLE LEVEL	ABOVE AVERAGE RESULTS (3 AUDITS)	OUTSTANDING RESULTS (6 AUDITS)

SORT ACTIVITY DESCRIPTIONS	SCORE
1) Only the required **spare parts, materials, WIP, etc.** are present at the workstation. Items not required to make the current product are removed from the workplace.	**2**
2) Only the required **tools** are present at the workstation. Items not required to make the current product are removed from the workplace.	**1**
3) Only the required **paperwork** is present at the workstation. Out-dated or otherwise unnecessary posters, memos, announcements, reports, etc. are removed from the workplace.	**4**
4) Only the required **equipment** is present at the workstation. All obsolete, broken or unnecessary equipment, shelves, lockers, workbenches, etc. not required to make the current product is removed from the workplace.	**2**
5) Only the required **furniture** is present at the workstation. All broken or unnecessary chairs, shelves, lockers, workbenches, etc. not required to make the current product is removed from the workplace.	**1**
6) **Tripping dangers** such as electrical cables, etc. are removed from standing/walking areas.	**1**
SET IN ORDER ACTIVITY DESCRIPTIONS	**SCORE**
7) Locations for **containers, boxes, bins, WIP, materials, etc.** is clearly defined by painted lines and properly labeled (part number, quantity, etc.).	**1**
8) **Tools** have a designated storage location that is within reach of the operator. The location is properly labeled and tools can easily be identified if absent.	**1**
9) **Paperwork** is properly labeled and has a clearly defined and labeled location that is visible to the operators and away from work surfaces.	**0**
10) **Equipment** is clearly identified (numbered, named, color coded, etc.) and placed in a properly identified location. Critical maintenance points are clearly marked.	**2**
11) **Furniture** is clearly identified (numbered, named, color coded, etc.) and placed in a properly identified location.	**0**
12) Work areas requiring **personal protective equipment** are clearly labeled.	**0**
13) **Stop switches and breakers** are highly visible and located for easy access in case of emergency.	**0**
14) **Fire hoses, fire extinguishers** and other emergency equipment are prominently displayed and are unobstructed.	**0**
15) Working conditions are **ergonomically friendly**. Tools are stored at appropriate heights, lift assist devices are provided where necessary, etc.	**1**
16) The **workplace layout** accomodates easy exit in case of emergency.	**2**
17) **Walkways** and vehicle paths are clearly identified and unobstructed. Exits are clearly labeled and unobstructed.	**2**

(Limited 2006)

Appendix F-continues

5S AUDIT CHECKLIST

SCORING GUIDELINES

0	1	2	3	3.5 (4)	4.5 (5)
ZERO EFFORT	SLIGHT EFFORT	MODERATE EFFORT	MINIMUM ACCEPTABLE LEVEL	ABOVE AVERAGE RESULTS (3 AUDITS)	OUTSTANDING RESULTS (6 AUDITS)

SHINE ACTIVITY DESCRIPTIONS	SCORE
18) **Containers, boxes, bins, etc.** are clean and not cracked, torn, or otherwise damaged. They are neatly stacked.	1
19) **Tools** are kept clean and in good working order. Where possible, tools are stored in a manner to keep them clean and free from risk of damage.	2
20) **Paperwork** is not torn, kept clean and protected from dirt.	N/A
21) **Work surfaces** (machines, workbenches, dies, and other equipment including electrical boxes) are clean and painted.	N/A
22) **Floors** are free from dirt, debris, oil, parts, hardware, empty boxes, packaging material, etc. Drains (if required) are properly located and unclogged.	0
23) **Walls, partitions, railings, etc.** are painted and kept clean.	1
24) There is a **schedule** showing times, frequency and responsibilities to clean areas of the workplace such as windows, corners, walls, doors, top of cabinets, etc.	0
25) All **cleaning equipment** is neatly stored and is readily available when needed.	0
26) All **personal protective equipment** is maintained in sanitary and reliable condition and is properly stored in a easily accessible and labeled location when not in use.	2
27) **Equipment safety** concerns are clearly identified. Safety guards are painted, in good working condition and provide adequate protection.	1
STANDARDIZE ACTIVITY DESCRIPTIONS	**SCORE**
28) **Tools, equipment, paperwork, furniture, etc.** are stored neatly in designated areas and are returned immediately after each use.	1
29) **Documents** are labeled clearly as to contents and responsibility for control and revision. The date and revision number are clearly visible.	N/A
30) Equipment **maintenance records** are visible and clearly state when maintenance last occurred and when next maintenance is scheduled.	N/A
31) **Product waste** (e.g. shavings, containers, liquids, wrappers, etc.) is consistently and often cleaned up and removed from the workplace.	0
32) **Preventive measures** have been implemented to ensure the workplace meets 5S guidelines (e.g. systems that do not allow waste to accumulate such as containers to collect product debris from machines).	0
33) The **results of the previous audit** are posted and clearly visible to the entire team.	N/A
34) **Areas for improvement** identified during the previous audit have been completed.	N/A
35) The **work environment** satisfies the requirements of the work being performed. Lighting (brightness and color), air quality, temperature, etc.	0
SUSTAIN ACTIVITY DESCRIPTIONS	**SCORE**
36) A member of **Management** has participated in a 5S activity such as an audit or other activity within the past 3 audit periods.	1
37) **Recognition** is given to teams who get involved in 5S activities.	1
38) **Time and resources** are allocated to 5S activities (e.g. designated daily/weekly clean-up time, 5S team leader, etc.)	1
39) All operators, team leaders, supervisors, etc. are assigned **5S activities** to be completed at least once/week.	0
40) The team took the **initiative** to make improvements to the workplace that were ***not*** identified during the last 5S audit.	2

(Limited 2006)

Appendix F-continues

5S Scoring Guidelines

SCORE	CATEGORY	DESCRIPTION
0	Zero Effort	There has been no 5S activity in this work area related to this criteria.
1	Slight Effort	Any 5S effort is probably the work of 1-2 people. There is no organized effort and plenty of opportunity for improvement.
2	Moderate Effort	Some attempts have been made to implement 5S, but efforts are temporary and/or superficial.
3	Minimum Acceptable Level	The entire team is working on improving their 5S implementation. Previous improvements are becoming standardized.
3.5	Above Average Results	The level of 5S in the work area is excellent. Although there is still room for improvement, the workplace is becoming world-class.
4	Sustained Above Average Results (3 audits)	After 3 consecutive scores of 3.5, a score of 4 may be awarded.
4.5	Outstanding Results	The level of 5S in the work area is world-class, a showcase for the industry. 5S is fully institutionalized in the workplace.
5	Sustained Outstanding Results (6 audits)	After 6 consecutive scores of 4.5, a score of 5 may be awarded.

AREAS FOR IMPROVEMENT	DATE

(Limited 2006)

Appendix G

Key Salaried Personnel

The chain of command in the plant manufacturing system starts with the Production Supervisors, the most important personnel on the management team. They are responsible for leading the hourly workforce and are critical to productive success. They take direction from senior management and disseminate that vision and mission to the hourly workforce. These people generally oversee approximately 30-40 hourly production employees each. The supervisors are totally responsible for all issues productive and non-productive in their departments.

The next management person under the manufacturing umbrella is the General Supervisor (GS). They are responsible for leading the supervisor and are generally seasoned veterans who have demonstrated extraordinary leadership at the supervisor position. The “generals” typically train the supervisors making sure they are upholding the production standards and plant operational shop rules. This job becomes a little more administrative, when they have numerous supervisors reporting to them. The GS will prioritize critical areas and help determine where the correct resources are needed to handle daily scheduling of the production groups and working with support groups to allocate the appropriate resources to support operations. The lead GS reviews daily output data to improve such metrics as Scrap, First Time Quality (FTQ), Overall Equipment Effectiveness (OEE), and Department Efficiency. This position reports to the Plant Manager. To cover the current operating plans, the Plant Manager is staffed with two general supervisors for the first shift and one each for second and third shifts. This team was fairly seasoned and carried a range of experience from 6 to 40 years of manufacturing and supervision experience.

Productivity Manager is the person that is typically second in command of the plant. While the Productivity Manager doesn’t have any direct reports, he/she is looks at the longer range planning for the facility and works very close with the Plant Manger to develop the business forecast for the facility, and analyzes the long-term schedules to set up the manpower for all departments. The Productivity Manager also functions as a Value Stream Manager. This is a critical role because the person that typically does this owns the Value Stream Map (both current and future state) which gives vital product flow information of how the plant is currently functioning and what is needed to drive continuous improvement, reduce lead time, and eliminate waste in the process. This person doesn’t solely create the ideas for the whole facility but they control the productivity map and help the Plant Manager have the most relevant information pertaining to the top issues that need to be focused on by the team.

The maintenance department is structured very similar to manufacturing / production groups. The maintenance team’s highest ranking person is the Maintenance Manager and reports directly to the Plant Manager. This person has full control of the maintenance department and tends to focus on the long-term issues such as staffing and maintenance budget items. This is the person that the plant manager communicates with relative to direction and cultural issues within the department. The maintenance department also has Maintenance Supervisors that report to the Maintenance Manager. The role of maintenance is to support the manufacturing operations by using the maintenance resources to address equipment breakdowns (corrective maintenance) and also handle preventative maintenance. The maintenance supervisors directly interact with the skill trades workers that actually carry out the maintenance activity.

Appendix H

Direct labor refers to all the manpower hours and costs used to operate the manufacturing and assembly equipment.

Indirect labor is all the manpower hours and costs used to support the operations such as quality inspectors, fork truck drivers, supermarket (parts storage) attendants and janitors.

Maintenance labor is all the skill trades hours and costs that are needed to support the manufacturing plan.

D/L OTP is the overtime premium used for the direct labor. Per union contract, the OTP is 1.5 times the hourly rate after 8 hours and twice the hourly rate on Sundays and holidays.

I/D OTP are the overtime premium used for the indirect labor and include maintenance. OTP is once again 1.5 times the hourly rate after 8 hours and twice the hourly rate on Sundays and holidays.

COLA (**C**ost **O**f **L**iving **A**djustment) expense will move proportional with all the other controllable cost because COLA is an adjustment paid on each hour worked. So when plants are underperforming and the hourly workforce is working overtime beyond what was budgeted significant costs are added to plant operational costs.

Appendix I

Electricians are the trades that handle the electrical wiring of the equipment used to manufacture the products as well as support the actual electrical wiring for the facility. This trade is certified or developed through an apprentice program which helps give the fundamentals and training to become proficient in this field. The group primary function in this environment is highly versed in trouble shooting of the electrical components that make up the assembly and manufacturing equipment. They will replace the computer controllers for the equipment but not repair them. They also complete simple electrical work such as the replacement of proximity switches and Radio Frequency Identification (RFID) tags on conveyors and machinery.

Machine Repairmen are skilled trades that handle mechanical repairs to equipment. They are responsible for all spindle repair, alignment and/or replacement, axis slide repair in lathes, mills and drills. They would also perform belt replacement for motors and drive systems.

Millwrights are skilled trades that the handle conveyor repairs or anything that conveys product. They are specialist in the rigging and moving of heavy equipment and objects.

Pipefitter's skilled trades are often confused with plumbers, but this trade has the responsibility for maintenance and repairs industrial piping systems. These skills are generally gained through an apprentice program or trade school to gain proficiency. These industrial systems are operated at much higher pressure levels than residential systems. This trade would do some fabrication and design, but mostly fasting systems together. The only joining that they perform in this organization would be the sweating of copper tubing.

Welders are responsible all the welding in the facility and are limited to that as well.

Carpenters are responsible for anything needs to fabricate from wood.

Painters have the responsibility for painting, scrolling the floor materials storage, painting the aisle ways lines, equipment, and parking lot spaces.

Machinist use the basic tools of grinders, lathes and mills to fabricate replacement tooling. These trades will take drawing created by manufacturing engineers and make the part to the print specifications. An example of what work these tradesmen perform would be machining of robot grippers, chuck jaws for part clamping in production lathes

Hydraulic trades group was responsible for all hydraulics systems on the production equipment. The do emergency repair when hydraulic systems fail. They repair hydraulic lines various types of systems that are controlled.

Power tool Trade specifically for repairing pneumatic, electric and computer controlled torque and fasting tools.

Building Repair Group (BRG) is responsible for items related to maintaining the facility. There typical job responsibilities function cleaning the sidewalks, empting chip gondolas, cleaning and flushing chip troughs, empting trash and general housekeeping outside of the facility.

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