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Executive Summary

This report examines five job operations at the Saginaw Malleable Iron Plant, a division of General Motors Powertrain Group. It focuses on manpower utilization for four operations in the annealing department (Department 15) and one operation in the finishing department (Department 16):

- The Utilityman (Department 15)
- The Kiln Operator (Department 15)
- The Tipover Operator (Department 15)
- The Brinell Operator (Department 15)
- The Pangborn/Draw Furnace Truck Driver (Department 16)

Time studies conducted by industrial engineering were examined, as were departmental procedures for each operation.

Based on the analyses, the following recommendations are made:

- Reassign the responsibilities of the Utilityman for increased utilization.
- Combine the Kiln Operator and Tipover Operator responsibilities.
- Combine the Brinell Operator and Pangborn/Draw Furnace Truck Driver responsibilities.

Introduction

This report examines the utilization of five job operations at the Saginaw Malleable Iron Plant, a division of General Motors Powertrain Group. The purpose of this report is to provide the management team with the information necessary for assessing the efficiency of the job classifications in the annealing department. Recommendations are given for management's consideration in planning for further utilization and/or redeployment of these job classifications.

Our History Dictates our Future

Since becoming part of the Saginaw Products Division of General Motors in 1919, the Saginaw Malleable Iron Foundry (SMI) has been a leader in its field. Starting as a one-at-a-time floor molding and batch melting operation, the plant has continuously innovated. It was one of the first foundries to transport iron from a cupola to an electric arc furnace, metallurgically control, and then hold until needed by the molding lines. The invention of pearlitic malleable iron (trade named Armasteel) by SMI in 1936 demonstrated the plant's leadership in the foundry industry.[1]

The leadership continued when SMI started the electric melt revolution in 1962 with the installation of a 9-ton coreless induction furnace. Continuing its innovation, the plant developed and installed the first rotary mechanical fully-automatic iron pouring machines in the 1970's. The early 1990's saw SMI's perfection of the counter-gravity casting line, which uses a vacuum to draw molten iron up into a mold.[2]

Indeed the plant stood atop the entire foundry industry, producing 1300 tons of castings per day. The 1950's, however, brought about the powdered metal and ductile iron processes. Malleable iron proved vulnerable to these other materials, which could be produced more cheaply. The plant slowly declined from its 1300 tons of castings per day in the 1960's to 1080 tons per day in 1979. Further declines brought production to 600 tons per day in 1995. Currently the foundry produces around 250 tons of castings per day.[3]

With the decrease in demand for malleable iron castings, SMI began a massive re-engineering effort in 1995. For example, the consolidation of the three cope-and-drag green sand lines into one operation resulted in substantial cost savings. The elimination of the pan conveyors in favor of the new slipstick conveyor technology marked another area of substantial savings.

SMI continues to make improvements in both quality and cost. The plant remains true to the SMI Vision Statement:

> *The vision of SMI is to challenge all of our people to work as a team committed to excel in everything we do, to position ourselves as a viable plant, to positively contribute to the Future of General Motors and our Community.*[4]

Focus of This Study

It is in the spirit of this vision that the ideas for this paper were born. Only by continually improving our processes can we position ourselves as a viable plant.

This study focused on manpower utilization for four operations in the annealing department (Department 15) and one operation in the finishing department (Department 16):

- The Utilityman (Department 15)
- The Kiln Operator (Department 15)
- The Tipover Operator (Department 15)
- The Brinell Operator (Department 15)
- The Pangborn/Draw Furnace Truck Driver (Department 16)

Time studies conducted by industrial engineering were examined, as were departmental procedures for each operation:

- Responsibilities and utilization of the Utilityman.
- Kiln Operator and Tipover Operator responsibilities.
- The Brinell Operator and Pangborn/Draw Furnace Truck Driver responsibilities.

The report presents ways to improve efficiency at this facility. With such a proud past to look back on, the employees (both hourly and salaried) need to look to the future and continue to strive for excellence. Adrian Wilkinson, in a 1991 study, summed it up best:

> Successful companies reveal a propensity to act innovatively and creatively, pursuing continuous improvement through experiment and persistence.[5]

The Annealing Process

Four operators in the annealing department were studied. Annealing is the most important step in the production process. Malleable iron cannot be formed in the molten state; it must be heat-treated. SMI pours all castings as “white” iron, a high carbide and brittle material. White iron produced by the foundry line is transferred to Department 53, where it is sorted and boxed.

The annealing processors take the boxes (gons) of castings to the “charge” end of the kilns, where the castings are dumped into various feeders for processing. The castings are then transferred from the feeders into baskets of high alloy steel which rest on a "skateboard-like" dolly called a shoe. These baskets and shoes, known collectively as trays, are brought from the "discharge" end of the kilns by way of a conveyor referred to as a trayline. Traylines run along the side of each kiln. When the trays reach the "charge" end (front) of the kiln, they are placed onto another conveyor that positions them horizontally in front of the kiln, where they are filled with castings.

Once filled with castings, the trays are placed in horizontal groups of three, known as a "push." When needed, they are loaded onto a charge elevator that raises them inside the kilns, which are mounted approximately 12 feet off the ground. When the "push" is placed inside, the kiln is cycled.[a] Each kiln is approximately 100 feet long and about 15 feet in width. A kiln holds 46 "pushes" of trays and is cycled a total of 102 times a day or 34 times a shift. The cycle time is once every eleven minutes, with a 30-minute break every 90 minutes. Inside the kiln, the castings are heated to around 1700° F, where they will "soak" for eleven hours before being removed. The high temperatures melt the carbides and allow carbon to migrate throughout the casting, creating malleable iron. As trays from the charge elevator are pushed into the kiln, all the trays (pushes) are advanced forward. The last "push" is then run onto the discharge elevator where it can be removed.

Because the plant produces armasteel, a form of pearlitic malleable, the castings must be further processed. This is accomplished through a quench phase. When the castings are pushed onto the discharge elevator, they are lowered and then loaded into a dump on a tipover, an electrically powered trolley mounted on two rails. The tipover travels from a kiln to one of three oil pits, where the castings are dumped into a basket that is submerged in the oil pit. The tipover must take the castings from the discharge elevator and into the oil in less than one minute or else the castings must be put back through the kiln. They are quenched in the oil for three minutes, at a temperature between 145° and 165°. Taking the castings from an atmosphere of 1730° to the low temperature of the oil in under a minute causes rapid cooling, which produces a carbon-iron configuration

[a] A kiln has three rams that push the trays off the charge elevator and into the actual kiln. This is why the three trays are known as a push; they are literally pushed into the kiln.

known as pearlitic malleable or armasteel. After dumping the castings, the tipover takes the trays to the trayline where they are unloaded and sent back to the charge side for reloading.

After quenching, the castings are fed onto a conveyor that runs through a draw furnace where the castings slowly “draw” for five hours; this makes them slightly softer for further processing. When the castings exit the draw furnace, they are checked for hardness and then shipped to the finishing and shipping departments.

The annealing process which follows takes place in a department composed of 17 kilns and four draw furnaces. Currently three kilns and three draw furnaces are in operation; the remainder are idled. As of fall 2002, the kilns that are operating are #5, #7, and #8. Maintenance is in the process of rebuilding one kiln. A layout of the annealing department is found in Appendix A. The ideas proposed in this paper are based on the knowledge that as of winter 2003, the department will be operating kilns #1, #5, and #7. All proposals are based on this information.

<u>The Utilityman</u>

To determine the efficiency of the annealing department, the first time study was conducted to observe and document the job of the utilityman, and determine utilization of this classification.

According to procedure ANN042, the utilityman main duties include the following:

- Check the kiln instruments on the operating kilns
- Audit kiln temperature charts a minimum of once per hour
- Every second hour after the start of the shift, complete audit form 30-15-57B
- Make any temperature adjustments
- Replace burner fuses that are blown
- Light any kilns that go out during the shift
- Pull wrecks from kilns
- Change burner tips per procedure #ANN43
- Clean and maintain a set of screens for back flash tanks on kiln
- Check and repair all fire checks
- Change kiln filters per procedure #ANN74

The time study, conducted on July 24th and 25th, 2002, covered the three shifts. Navin Khubchandani observed and documented the job in reference to the operating procedures. The results showed a utilization of 59.4%. The study is cited in appendix B. Based on these results, the time study recommended the elimination of the utilityman. Thus industrial engineering submitted the following recommendations:

- Supervisors should resume responsibility for checking kiln instruments.
- Kiln operators should assist millwrights and electricians for wrecks and downtime issues.
- Burner tip replacement responsibility should be given to the millwrights.

However, the elimination of the utilityman is not in the best interest of the department. The kilns have the potential for explosion if not properly monitored. This fact rules out the possibility of transferring utility duties to the area supervisor and millwrights. Because various millwrights are assigned to the department on weekends and during vacations; too many skilled tradesmen would have to be trained to perform these assignments. Should the responsibility of inspecting kiln instruments be placed on the area supervisor, a number of unnecessary union issues would be raised.

With the possibility of job elimination ruled out, other measures need to be taken to increase utilization. This can be accomplished by combining the utilityman classification with other department 15 classifications that are currently vacant and not needed on a full-time basis. The following classifications are currently assigned to other worker classifications or overtime workers as needed:

- Procedure ANN028: Kiln, Draw & Oil Quench Cleaning Person
- Procedure ANN036: Annealing Truck Driver
- Procedure ANN037: Tipover Monorail Blow off
- Procedure ANN081: Annealing Re-Sort Operator
- Procedure ANN088: Sweeper
- Removal/Replacement of Alloy Form Tray lines

With the exception of procedure ANN036, no full time employee is currently committed to doing these jobs. The kiln operator on #5 kiln and the feeder operator on #7 kiln are currently performing truck driving. These jobs can be assigned to the utilityman to increase utilization. Splitting the assignments into two groups can do the following:

- Full Production: Utilityman is also assigned truck-driving responsibilities

- Weekend Hold: Utilityman is assigned responsibilities from the other areas as needed.

Table 1 shows the average time needed for a truck driver to load a casting feeder (See Figure 1) for two cycles through the kilns. Each shift operating three kilns will run 102 "pushes." One box of castings equals roughly 1.5 "pushes."

Table 1: Loading to Casting Feeder

No.	Task	Time (sec)	Time (min)
1	Walk to Truck	35	0.58
2	Load Casting Feeder @ 45 sec per box x 2 boxes per cycle	90	1.50
3	Truck to empty storage @ 31 sec per box x 2 boxes per cycle	62	1.03
4	Unload empty box @ 10 sec per box x 2 boxes per cycle	20	0.33
5	Truck to full storage @ 10 sec per box x 2 boxes per cycle	20	0.33
6	Pick up box @ 10 sec per box x 2 boxes per cycle	20	0.33
7	Return to full storage @ 23 sec per box x 2 boxes per cycle	46	0.77
		Total	4.88

By loading two boxes into each feeder (one cycle), the utilityman would be able to supply the kilns with iron as well as perform regular duties. The utilityman would have to complete approximately 35 cycles per shift.

Figure 1: Casting Feeder

Table 2 illustrates the layout of the cycles in relation to the three kilns.

Table 2: Staging Cycles per Kiln

Kiln	Number of Boxes	Total Pushes	Total Cycles
1	23	34	11.5
5	23	34	11.5
7	23	34	11.5
Total	69	102	34.5

The shift, minus two 23-minute breaks and a 30-minute lunch, is 434 minutes long; 35 cycles require 165.92 minutes. When combined with the 240 minutes of regular duties, the utilization is increased to 405.92 minutes or 93.5%. An increase of over 40% justifies such a combination.

In order to implement such a change, the department will need to focus on the following areas:

- Reorganize the utility work area.
- Update the utilityman safe operating procedure.
- Train utilitymen.

To ensure the best performance, the study recommends that the utility work area be moved. Relocating the area to underneath #4 kiln is practical (see Figure 2).

Figure 2: Proposed Relocation Site For Utility Work Station

Recently an opportunity charging station has been installed in front of this kiln. The utilityman can walk only a few feet from his work area and then climb into the truck. When he is done filling the feeder, he simply drives back to the charging station and reconnects the truck to the charger to insure a constantly charged battery. If the work area were not moved, then the utilitymen would park the truck near the current work area and there would be problems with the truck not getting charged. The utilityman procedure will have to be updated to reflect this change. The truck driving responsibilities can be added as an eleventh duty in the procedure and referenced as procedure ANN36.

To help prevent any potential problems, the utilitymen should be trained for driving the truck and filling the feeders. While every regular and back-up utility man knows how to drive truck and has filled feeders at one time or another, giving them refresher training is advisable. This will bring to light any problems before the transition is made.

By adding the truck driving responsibilities, utilityman utilization is significantly improved. The problem, however, is that the utility position is a seven-day job, whereas normal production operates only five days a week. The weekends are still not utilized to the fullest. This is a time when the utilitymen should be working the most, as they are receiving substantial pay for those two days. The utilityman should also be in charge of the following areas on the weekend:

- Removal and replacement of trays and baskets from the tray lines.
- Sorting mixed iron.
- Blowing off the tipover monorail.
- Department clean up.

Each of the three utilitymen is in charge of one kiln. They can also be responsible for the removal of damaged alloy on the tray line that supplies their kiln. The replacement of damaged alloy is critical to our operation.

Another area that is deficient is the resort belt. There is no full-time sorting person, so currently we wait until there is a large quantity of mixed castings and then schedule overtime to sort. Since the utilityman is available on weekends, he should be able to help alleviate this problem.

Once per month, two annealing processors, on overtime, blow dust from the electric monorail. This helps prevent insulators on the tipover from burning out. This job can only be performed when production has shut down. The utilitymen can perform this job one weekend a month, with each shift alternating. This way each utility man performs this duty only once every three months.

Each utilityman can be placed in charge of an area for cleaning on a regular basis. Currently each shift is required to clean certain areas in the department. They can be assigned to the same areas as their shift.

The procedures under consideration will need to be referenced in the Utilityman procedures.[6] The proposed changes to this utility classification are necessary to justify the expense the job requires. With the continued focus on improvements at this facility, every department must do everything possible to help eliminate unnecessary cost and ensure maximum utilization from all of the employees.

The Kiln Operator

The most obvious question to ask after consideration of the proposed combination of utility and truck driving is benefits. It does not make sense to take the responsibility of truck driving away from the kiln operator in order to improve the utilization of the utility man if the kiln operator will then be left with extra time. However, this extra time will allow the department to change the kiln operator duties.

Figure 3: Armasteel Kiln

Navin Khuchandani conducted two more time studies to determine the utilization of the #1 kiln and #5 kiln operators. The study for #5 kiln (see Figure 3) was conducted on August 6th, 2002, on first shift. Like the utility study, Navin observed and documented the job in reference to the operating procedures. Table 3 lists the results.

Table 3: #5 Kiln Time Study

Utilization with truck based on cycle Time (10.5min/push)	94.7%
Utilization without truck based on cycle time (10.5min/push)	44.9%
Utilization based on total available minutes (434min)	50%

The second study was developed for one kiln by referencing the data from the #5 kiln study. Table 4 shows the results of three simulated trials.

Table 4: One Kiln Time Study

	Trial 1	Trial 2	Trial 3
Utilization with truck based on cycle Time (10.5min/push)	91.4%	97.2%	91.5%
Utilization without truck based on Cycle time (10.5min/push)	44.9%	44.9%	44.9%
Utilization based on total available Minutes (434min)	51%	51%	49%

Another study on #7 kiln showed a utilization of 66.4% with trucking and 47.3% without.The study of utilization based on total available minutes was disregarded, since metallurgical guidelines require a minimum cycle time of 10.5 minutes. The three studies are cited in appendix C.

By eliminating the truck driving responsibilities, the three kiln operators are left with less than 50% utilization. This gives them the necessary time to assume the duty of discharging their own kiln and taking the castings to the oil pits and draw furnaces. Currently the tipover operator does this job (see Figures 4&5).

Figure 4: Tipover

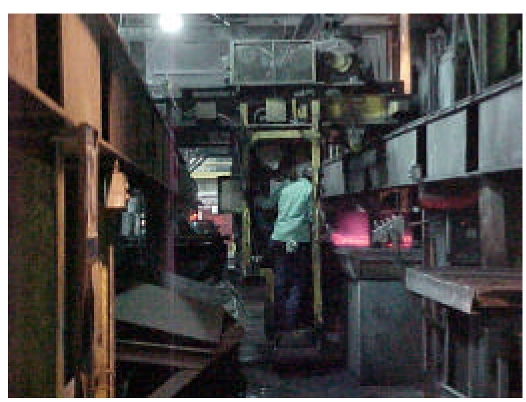

Figure 5: Tipover Operator Discharging Kiln

One cycle on the tipover is 7.9 minutes in length. This cycle includes:

- The discharge of each kiln
- The drive time to oil pits
- Returning trays back to the tray lines

This cycle does not include the time when the tipover operator must complete a job change. This requires the operator to complete six tasks:

- Empty draw furnace feeder
- Turn off feeder
- Close feeder gate
- Restart feeder after change time has elapsed
- Open feeder gate
- Turn feeder on

Since there is no specific time for the job changes to occur (they are determined based on customer schedules), the time spent on job changes must be estimated. The current utilization for the tipover operator is 75%.

By eliminating truck driving from the kiln operator responsibilities, operators will have time to assume one third of the tipover duties. Table 5 shows the projected cycle time of the kiln operator with the tipover operations.

Table 5: Kiln & Tipover Cycle Time

	Time (min.)	Time (min.) @ 34 pushes
Load and cycle kiln.	3.95	134.30
Walk to Tipover	0.75	25.5
Operate Tipover	2.70	91.8
Walk to kiln	0.75	25.5
	Total	277.10

This will add 142.8 minutes to the kiln operator utilization and eliminate the tipover operator completely. This projection is based on kilns #1 and #5; #7 kiln will need to be investigated, but it should likewise be feasible.

The department will have to focus on these areas in order to implement this combination:

- Return #1 and #3 tipover to service, resulting in a tipover for each kiln.
- Designate tipover-parking points.

- Update the kiln operator safe operating procedure.
- Train kiln operators.

In order to avoid a situation where more than one operator needs a tipover, this report recommends that #1 tipover and #3 tipover be brought back into service. This would allow the kiln operators to run tipover concurrently. An alternative would be to bring #1 tipover back into service and operate two tipovers.

The monorail will have to be marked with a parking point when the tipovers are not operating. Because the discharge end of #5 kiln is in close proximity to #3 oil pit, leaving the tipover there would prevent the operator on #7 kiln from traveling to the pit. By selecting parking areas for each tipover, the operators will be ensured of a clear path when discharging the kilns.

The procedures will have to be updated. Procedure ANN30 (Tipover Operator) can be combined with ANN32 (Kiln Operator) into one procedure.[7] The kiln operators will then have to be trained on the tipover. Like the utilitymen, the kiln operators are familiar with tipover procedures. Combining tipover operation with kiln procedures is beneficial to the department. It will result in the elimination of one position, a significant cost reduction.

The Brinell Operator

The final studies to be evaluated in this report cover the brinell operator and the pangborn/draw furnace truck driver. These two classifications work at the discharge end of the draw furnaces. The brinell operator (See Figure 6) tests for proper casting hardness while the pangborn/draw furnace truck driver removes castings from the cooling conveyor.

On May 23rd, 2002, industrial engineering conducted a time study to calculate the utilization of the brinell man, who must take hardness samples twice an hour. The elimination of equipment that resulted in fewer hardness tests for the operator to perform. The results of the study indicate a utilization of 15.9 minutes every half hour or 53%. Table six shows the breakdown of this utilization.

Figure 6: Brinell Operator

Table 6: Brinell Operations

Description	Time	Frequency
1. Brinell Sample (3 Draws, 3 Castings/draw)		
A. Get castings from each draw, return brinelled castings	6.0 min.	1/.5 hr
B. Cool castings, grind and position onto table for brinelling	3.0 min.	1/.5 hr
C. Brinell on castings, read diameter, record measurements	3.0 min.	1/.5 hr
Total Normal Tasks:	12.0min	Per .5 hr
2. Miscellaneous Jobs		
A. Clean drip pan on #1 draw at startup each day	1.4 min	1/.5 hr
B.Clean screens as iron accumulates, taking full gons to sort area	0.2 min	1/.5 hr
C. Perform histograms on 16 samples of suspect iron	0.3 min	1/.5 hr
D. Pull off specials, storing in Brinell area	1.7 min	1/.5 hr
E. Truck histogram iron to dept. 16 upon approval	0.3 min	1/.5 hr
Total Miscellaneous Jobs:	3.9 min	Per .5 hr.

Navin Khuchandani conducted a study on the pangborn/draw furnace truck drivers on September 5th & 6th, 2002, on 1st, 2nd, and 3rd shifts. Again the purpose of the study was to determine utilization. The results showed a significant underutilization of this classification for each shift:

- Utilization on 1st shift: 40%
- Utilization on 2nd shift: 40%
- Utilization on 3rd shift: 36%

As the two studies show, there is a need to further utilize these two jobs. Khuchandani recommended the pangborn/draw furnace truck drivers stage boxes the last half hour of the shift. The Brinell study did not offer any recommendations for improvement, but acknowledged the challenge of finding a task that would allow for 15.9 minutes every half hour for testing. The studies are cited in appendix D.

Like the kiln operator and tipover operator classifications, it is in the best interest of the plant to combine the brinell operations with the pangborn/draw furnace truck driver; having the brinell operator clear gons from the cooling conveyor (see Figure 7).

Figure 7: Cooling Conveyor

Such a combination will be a special challenge as it would involve two departments. The brinell operator, an employee of department 15, will be required to cross lines of demarcation in order to perform the duties of the truck driver. Management will have the task of convincing the union of the need for such a change.

One draw furnace fills an average of 19 boxes per shift; during normal production, a total of 57 are thus generated. The average time per box is 2.7 minutes; the average time needed per shift is 167 minutes. When this time is combined with the 254.4 minutes needed for brinell applications, a total of 421.4 minutes are required to perform both duties. This yields a utilization of 97%. Table seven shows the combination of operations and the needed time.

Table 7: Brinell & Trucking Duties

No.	Task	Boxes	Avg. Min/Box	Total Minutes
1	Remove/Load Box at #1 Draw Furnace	16	4	63.0
2	Remove/Load Box at #2 Draw Furnace	19	2	41.0
3	Remove/Load Box at #3 Draw Furnace	16	2	37.4
4	Brinell Duties			254.40
5	Miscellaneous			25.6
			Total	421.40
			Utilization	97%

The results are a utilization almost doubled for the brinell operator, as well as the elimination of one truck driver per shift, again a significant cost reduction in the annealing department.

The following changes will need to be completed:

- Eliminate the mixed iron sorting responsibilities.
- Relocate the iron change board.
- Update the brinell operator procedures.
- Train the brinell operators.

In order to help increase the brinell's utilization, they were given the responsibility of sorting mixed iron. The combination of duties will prevent them from being able to work on the sort belt. As recommended previously, these responsibilities can be given to the utilityman.

The dry erase board used by the truck drivers to display iron change times will need to be relocated to the brinell testing area. Even though the brinell operators are able to see the change before it exits the draw, the board will prove useful to them.

In addition, the following problem exists with the current operations. If the truck driver does not change the boxes on the conveyors, they overfill and castings spill onto the floor. This lack of attention by the truck driver also allows different castings to get mixed together, requiring them to be sorted. The brinell operator is responsible for both the clean-up of spilled castings and sorting of mixed castings. Since the truck drivers are not in charge of these duties, there is no incentive for them to minimize ocurences.

By combining the brinell operator with the pangborn/draw furnace operator, it is possible to eliminate three employees from the operation. The problems with mixed and spilled iron will be minimized, because the clean-up is the responsibility of department 15. The brinell procedure (30-15-6) should be changed to reference procedure ANN1.[8] This procedure covers the removal of iron from the cooling conveyor.

Opposition to Proposed Changes

Management must be prepared for resistance that will surface should these ideas be implemented. Because the job combinations cross over various classifications, there will be strong union opposition. The biggest obstacle facing management will be to get the support of the union. The best way to accomplish this is through employee empowerment. Giving the workers involved some input as to how the changes will be implemented will lessen resistance and may even encourage change to a degree; since the union will support the wishes of the employees.

In their 1993 study, "The resurrection of Taylorism: TQM's hidden agenda," David Boje and Robert Winsor claim that "by eliminating the perceived power of management to impose control from above and by deluding workers into thinking that this power emanates from their own actions" management can "succeed in eliminating the resistance that has characterized management/labour relations."[9] By soliciting input from the affected workers, management can gain valuable insight as well as give the employees a sense of empowerment. A labor point of view will show the hurdles that must be overcome in order to successfully implement the change.

The most prominent reason that such a change will meet with resistance is because of poor morale among the remaining workers. A Right Associates survey found that only 31 percent of remaining workers agreed that they still trusted their organization after downsizing.[10] "Survivors" of downsizing reduce their commitment if they perceive that the company's downsizing process is unfair.[11]

Conclusion

This report examined the utilization of five job operations at the Saginaw Malleable Iron Plant, a division of General Motors Powertrain Group. The purpose of this report was to provide the management team with the information necessary for assessing the efficiency of the job classifications in the annealing department. Recommendations were given for management's consideration in planning for further utilization and/or redeployment of these job classifications:

- Expand responsibilities for the Utilityman to increase utilization.
- Combine Kiln Operator and Tipover Operator responsibilities to increase productivity.
- Combine Brinell Operator and Pangborn/Draw Furnace Truck Driver responsibilities to improve operations.

The ideas presented are suggestions of what can be done to improve efficiency at this facility. With such a proud past to look back on, the employees (both hourly and salaried) need to look to the future and continue to strive for excellence.

The Vision of Saginaw Malleable Iron stated at the outset is the best guide for the continuation of operations:

> *The vision of SMI is to challenge all of our people to work as a team committed to excel in everything we do, to position ourselves as a viable plant, to positively contribute to the Future of General Motors and our Community.*[12]

Notes

[1] Alfred Spada. "Saginaw Malleable Iron: Re-Engineered for Efficiency." Modern Casting. January, 2001.

[2] Alfred Spada.

[3] Alfred Spada.

[4] Saginaw Malleable Iron, Supervisors Handbook-General Motors Powertrain-Saginaw Malleable Iron Plant. (Saginaw, Mi. August, 2002.) Page 2.

[5] Wilkinson, Adrian, P. Allen, and Edward Snape, "TQM and The Management of Labour." Employee Relations 13/no.1 (1991):24-31

[6] General Motors Powertrain. Saginaw Malleable Iron Safe Operating Procedures. ANN28, ANN36, ANN37, ANN42

[7] General Motors Powertrain. Saginaw Malleable Iron Safe Operating Procedures. ANN30, ANN32

[8] General Motors Powertrain. Saginaw Malleable Iron Safe Operating Procedures. 30-15-6, ANN1

[9] Boje, David M., and Robert D. Winsor. "The Resurrection of Taylorism: TQM's Hidden Agenda." Journal of Organizational Change Management. 6/no.4 (1993):57-70

[10] "HR Paints a Bleak Portrait of Downsizing Survivors." HR Focus. 70:24. May 1993.

[11] Brockner, J., M. Konovsky, R. Cooper-Schneider, R. Folger, C. Martin, and R.J. Bies. "Interactive Effects of Procedural Justice and Outcome Negativity on Victims and Survivors of Job Loss." Academy of Management Journal. 37:397-409. April, 1994.

[12] Saginaw Malleable Iron, Supervisors Handbook-General Motors Powertrain-Saginaw Malleable Iron Plant. (Saginaw, Mi. August, 2002.) Page 2.

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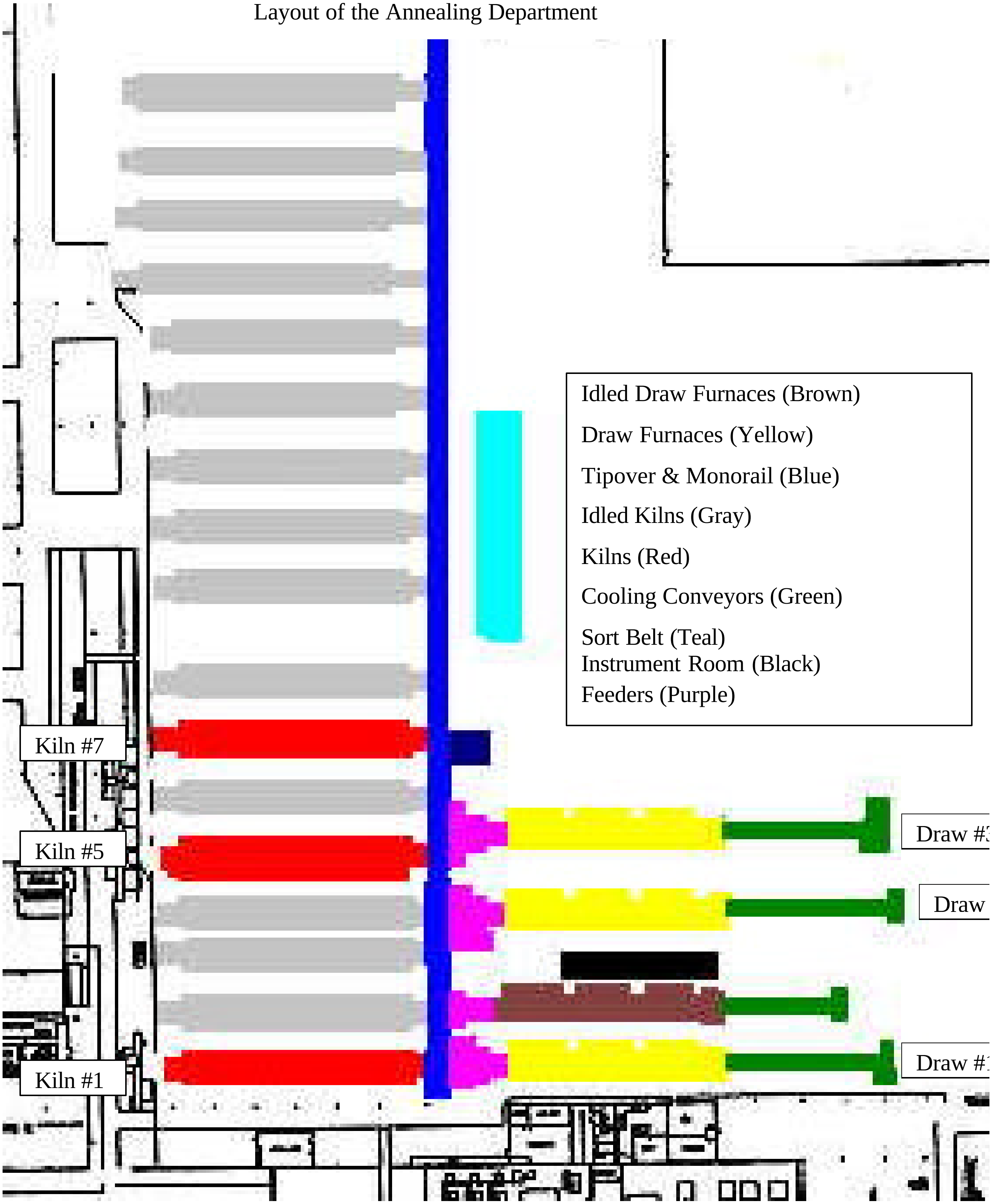
APPENDIX A

Layout of the Annealing Department



APPENDIX B

TIME STUDY

Annealing-Utilityman

Person Conducting Study: Navin Khubchandani

Date of Study: 24 and 25 July 2002 on 1st, 2nd, 3rd shift

Study: Observing and documenting the job of the utilityman in the annealing department.

Reason: To determine utilization of the utilityman

How: Observed and documented, over three complete shifts, the job of the utilityman. Referenced operating procedures.

Results: Utilization = 59.4%

Recommendations:

1. Supervisors should assume responsibility for checking temperatures, gas and monoxide readings.
2. Kiln operators should assist millwrights and electricians for wrecks and downtime issues.
3. Burner tip replacement responsibility should be given to the millwrights.

Observations:

1. Utilityman checked burners twice per shift. Procedure indicates burners to be checked at a minimum of once every two weeks.
2. Procedure ANN42 states that the utilityman is to check draw furnaces twice per shift for burners lit and combustion blowers running. Was told that the area supervisors are doing this.
3. Procedure ANN42 states that the electricians will change thermocouples. The utilityman is performing this job.
4. Reference to procedure no. 30-15-75 as explained in procedure ANN42, attachment 30-15-75C, which is the annealing kiln temperature audit sheet (malleable), needs to be removed from the procedure.

No	Main Responsibility	Frequency	Time Taken (min)	Total Time Taken
1	Check temperatures	1x/hr per kiln	02.0 min/kiln	48
2	Check burners	2x/shift per kiln	15.0 min/kiln	90
3	Change burner tips	2x/per shift	20.0 min/change	40
4	Check gas readings	2x/shift per kiln	2.0 min/kiln	12
5	Take monoxide readings	2x/per shift	2.0 min/reading	4
6	Wrecks/downtime issues			
7	Breaks	2 per shift	23.0 min/break	46
			Totals	240
			Utilization	50.0%

APPENDIX C

TIME STUDY
Annealing-#1 Kiln Operator

Done By: Navin Khubchandi

Date of Study: 16th of August 2002 on 1st shift.

Study: Observing and documenting the job of kiln #1 operator in annealing department.

Reason: To determine utilization of the kiln #1 operator. Job was recently modified with new feeder set up.

How: By referencing the data on the study done on kiln #5 operator.

Results:

	Trial 1	Trial 2	Trial 3
Utilization with truck based on cycle time (10.5 min/push)	91.4%	97.2%	91.5%
Utilization without truck based on cycle time (10.5 min/push)	44.9%	44.9%	44.9%
Utilization based on total available minute (434 min)	51.0%	51.0%	51.0%

Recommendations:

1. Increase speed of kiln equipment during non-trucking cycles.

2. First ½ hr and last ½ hr of shift not pushing kilns. Opportunity exists to stage iron.

TIME STUDY
Annealing-#5 Kiln Operator

Done By: Navin Khubchandani

Date of study: 6th of August 2002 on 1st shift.

Study: Observing and documenting the job of the Kiln #5 operator. Referenced operating procedures.

Results:

	Trial 1
Utilization with truck based on cycle time (10.5 min/push)	94.7%
Utilization without truck based on cycle time (10.5 min/push)	44.9%
Utilization based on total available minute (434 min)	50.0%

Recommendations:

1. Increase speed of kiln #5 equipment during non-trucking cycles.

2. First ½ hr and last ½ hr of shift not pushing kilns. Opportunity exists to stage iron.

TIME STUDY
ANNEALING-#7Kiln Operator

Without trucking		Utilization Cycle
Push & pack	4.97 min/cycle @ 10.5 min/cycle	47.3%
With trucking		
Push & pack	4.97 min/cycle @ 10.5 min/cycle	47.3%
Truck time	2.00 min/box @ 17 box per shift	19.0%
Totals for shift		
Push & pack	4.97 min/cycle @ 10.5 min/cycle	168.98 min/cycle
Truck time	2.00 min/box @ 17 box per shift	34.0 min/cycle
Other duties		10.0 min/cycle
Miscellaneous		30.0 min/cycle
	Total Minutes	243.0 minutes
	Utilization	56.0%

APPENDIX D
TIME STUDY
ANNEALING-BRINELL OPERATOR

Purpose

The purpose of this study was to determine the utilization of the brinell operator. This is due to the following changes that have occurred in the Annealing department since the last study (1998):

- Elimination of malleable iron
- Reduction in the number of kilns being used
- Reductions in the number of draw furnaces being used

Method

The Industrial Engineering department (Burk) spent several days studying the 1st shift brinell operator during the week of May 20, 2002. First, the standard operating procedure for this job was obtained and read. Next, time was spent talking to the operator and his supervisor in order to get an accurate listing of the operator's responsibilities. Finally, time was spent observing, documenting and timing the tasks performed by the operator.

Observations

The times taken to perform the "main" job functions are listed on the next page for review. It must be noted that there was no successful attempt at observing a complete 3-draw test because #2 draw had been stopped for repair during each of the observation periods; thus, each observation included performing brinell tests on two of the three possible kilns/draws.

Several other jobs were listed in interviews both with supervision and employee, consisting of:

- Cleaning drip pan on #1 draw at startup each day.
- Cleaning screens as iron accumulates, taking full gons to sort area.
- Pulling specials off before they leave the department, storing in brinell area.
- Performing histograms on 16 samples of suspect iron.
- Trucking histogram iron to dept. 16 upon approval.

These jobs all were listed as "fill-in" work when spare time permits and will be factored for time on the "Calculated Utilization" page. None of these jobs were observed in several observations by the Industrial Engineering department during the week of May 20.

Results

The brinell operator is 50% utilized with 3 kilns and 3 draws running. The challenge is that the task this employee performs requires that the employee be available every half hour. Therefore, additional tasks that may be assigned to this person would have to be located near the brinell area, and must allow the brinell employee to perform this task for about 15 minutes each half hour.

Description	Time	Frequency
1. Brinell Sample (3 Draws, 3 Castings/draw)		
A. Get castings from each draw, return brinelled castings	6.0 min.	1/.5 hr
B. Cool castings, grind and position onto table for brinelling	3.0 min.	1/.5 hr
C. Brinell castings, read diameter, record measurements	3.0 min.	1/.5 hr
Total Normal Tasks	12.0 min	Per .5 hr
2. Miscellaneous Jobs		
A. Clean drip pan on #1 draw at startup each day	1.4 min	1/.5 hr
B. Clean screens as iron accumulates, take full gons to sort area	0.2 min	1/.5 hr
C. Perform histograms on 16 samples of suspect iron	0.3 min	1/.5 hr
D. Pull off specials, storing in Brinell area	1.7 min	1/.5 hr
E. Truck histogram iron to dept. 16 upon approval	0.3 min	1/.5 hr
Total Miscellaneous Jobs	3.9 min	Per .5 hr.

TIME STUDY
Finishing-Pangborn/Draw Furnace Truck Driver

Done By: Navin Khubchandani

Date of Study: 5th & 6th of September 2002 on 1st, 2nd, 3rd Shift.

Study: Observing and documenting the job of Pangborn/Draw Furnace Truck Driver in the Finishing Department.

Reason: To determine utilization of the Pangborn/Draw Furnace Truck Driver.

How: Observed and documented over three shifts, the job of Pangborn/Draw Furnace Truck Driver. Referenced operating procedures.

Results (Shown without loading pangborn machines and staging):

Utilization on 1st Shift 40%
Utilization on 2nd Shift 40%
Utilization on 3rd Shift 36%

Recommendations:

1. Boxes can be staged at last ½ hour of shift thus utilizing last ½ hour.

Note:

1. Sufficient boxes were already staged in front of draw furnaces. Truck drivers on 2nd and 3rd brought additional boxes from empty storage.

2. Draw furnace #1 down for ¾ of 3rd shift. Doubled up on #2/3.

1st Shift					
No.	Task	Boxes	Avg.Min/Box	TotalAvg.Min	TotalActual
1	Remove/Load Box At #1 Draw Furnace	16	4	64	63
2	Remove/Load Box At #2 Draw Furnace	19	2	38	41
3	Remove/Load Box At #3 Draw Furnace	16	2	32	37.4
4	Miscellaneous			30	30
	Total			164	171
	Utilization			38%	40%
2nd Shift					
1	Remove/Load Box At #1 Draw Furnace	20	4	80	74
2	Remove/Load Box At #2 Draw Furnace	18	2	36	33
3	Remove/Load Box At #3 Draw Furnace	20	2	40	36
4	Miscellaneous			30	30
	Total			186	173
	Utilization			43%	40%
3rd Shift					
1	Remove/Load Box At #1 Draw Furnace (Down ¾ shift)	5	4	20	19
2	Remove/Load Box At #2 Draw Furnace	23	2	46	45
3	Remove/Load Box At #3 Draw Furnace	32	2	64	62
4	Miscellaneous			30	30
	Total			160	156
	Utilization			37%	36%
	Total Boxes (All 3 Shifts)	169			

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[2] Spada, Alfred.
[3] Spada, Alfred
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[7] General Motors Powertrain. Saginaw Malleable Iron Safe Operating Procedures. ANN30, ANN32
[8] General Motors Powertrain. Saginaw Malleable Iron Safe Operating Procedures. 30-15-6, ANN1
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[11] Brockner, J., M. Konovsky, R. Cooper-Schneider, R. Folger, C. Martin, and R.J. Bies. “Interactive Effects of Procedural Justice and Outcome Negativity on Victims and Survivors of Job Loss”. Academy of Management Journal. 37:397-409. April, 1994.
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