CHAPTER 5
ANALYSIS AND DISCUSSION

5.1 Pareto Analysis

The aim of the research is to reduce the time losses. Having performed a detailed OEE investigation we now have data concerning the six major losses for each stage of the process. It is now necessary to determine what the dominant loss categories are for each stage. In order to do this a Pareto analysis method was used. The theory behind Pareto Analysis was formulated by the Italian economist Vilfredo Pareto who discovered that 20 percent of Italian people owned 80 percent of the country's wealth. This relationship where 20 percent of something accounts for 80 percent of results has been found to fit many types of scenarios. In quality improvement literature it is often suggested that 80 percent of quality problems are the result of just 20 percent of the causes. For this investigation it was used to highlight the loss categories that need to be reduced if the time losses are to be efficiently reduced.

Data for Pareto Analysis

Data will be taken directly from the OEE investigation. The categories for each stage are:

1. Planned Downtime
2. Unplanned Downtime
3. Setup Time
4. Minor Stoppages
5. Speed Losses
6. Defects

The exact time losses for each stage have already been recorded with the exception of defects where only the quantity has been measured so far. The time loss caused by the manufacture of defective parts was approximated as the number of defects multiplied by the ideal cycletime. The losses of the different categories must be ranked in descending order, expressed as percentages and finally as a cumulative percentage. The Pareto graph can then be drawn for each manufacturing stage.

5.1.1 Cutting

Loss Category	Lost Time (mins)	Percentage	Cumulative Percentage
Speed Losses	345	28.0	28.0
Minor Stoppages	328	26.6	54.5
Planned Downtime	285	23.1	77.6
Setup Time	155	12.6	90.2
Unplanned Downtime	110	9.0	99.1
Defect Lost Time	11	0.90	100

Table 17: Pareto Data for Cutting Stage

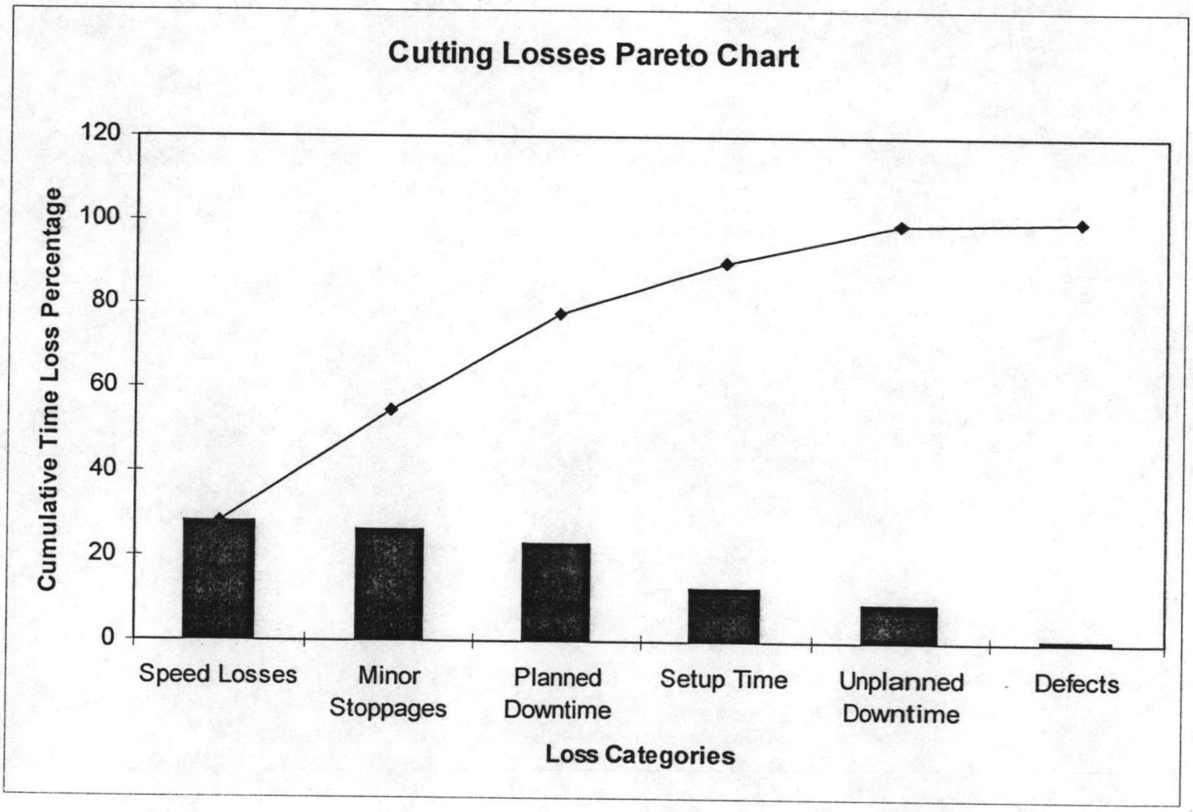

Figure 22: Pareto Graph for Cutting Stage

As can be seen from the table and diagram above, the first three categories, speed losses, minor stoppages and planned downtime account for approximately 80% of the total time losses for the cutting stage.

5.1.2 Shearing

Loss Category	Lost Time (mins)	Percentage	Cumulative Percentage
Planned Downtime	405	32.8	32.8
Setup Time	310	25.1	58.0
Minor Stoppages	205	16.6	74.6
Speed Losses	181	14.7	89.3
Unplanned Downtime	130	10.5	99.8
Defect Lost Time	2.6	0.21	100

Table 18: Pareto Data for Shearing Stage

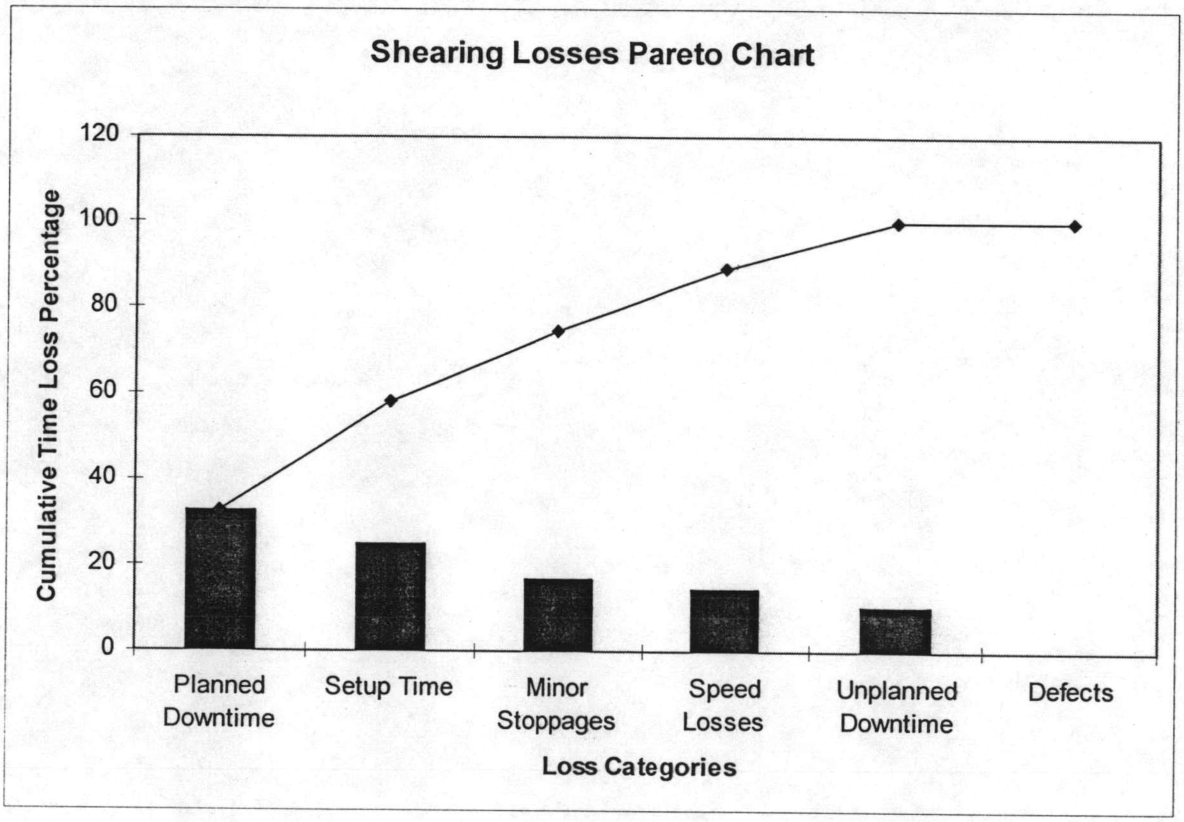

Figure 23: Pareto Graph for Shearing Stage

Planned downtime, setup time and minor stoppages are the main losses in the shearing process, producing 75% of total lost time. The low number of defects produces almost no lost time in this stage.

5.1.3 Forming

Loss Category	Lost Time (mins)	Percentage	Cumulative Percentage
Minor Stoppages	2978	49.1	49.1
Setup Time	1775	23.3	78.4
Planned Downtime	660	10.9	89.2
Unplanned Downtime	320	5.3	94.5
Speed Losses	310	5.1	99.6
Defect Lost Time	22.5	0.37	100

Table 19: Pareto Data for Forming Stage

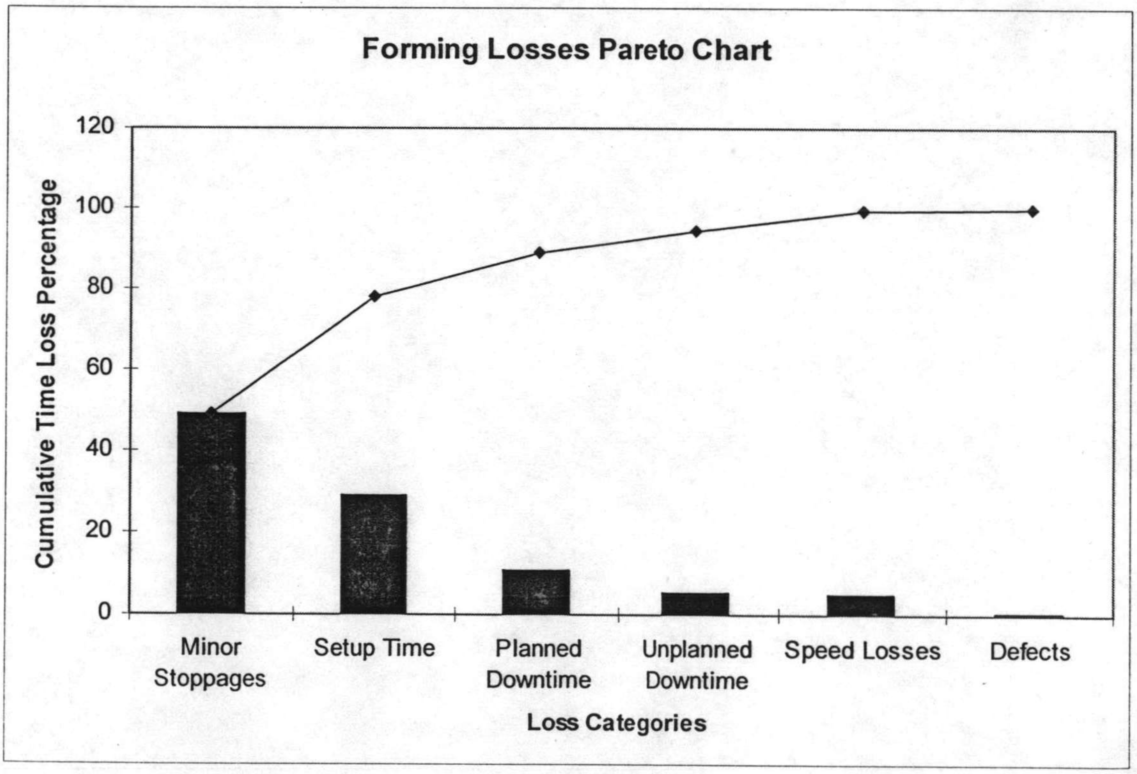

Figure 24: Pareto Graph for Forming Stage

In this stage the first two categories, minor stoppages and setup time account for approximately 80% of total time losses. This matches up with the 80/20 principle more accurately than the first two stages because the vast majority of time losses come from only two of the six losses rather than three previously.

5.1.4 Welding

Loss Category	Lost Time (mins)	Percentage	Cumulative Percentage
Unplanned Downtime	885	48.2	48.2
Defect Lost Time	864	47.0	95.2
Setup Time	84.3	4.6	99.8
Speed Losses	3.5	0.20	100
Planned Downtime	0	0	100
Minor Stoppages	0	0	100

Table 20: Pareto Data for Welding Stage

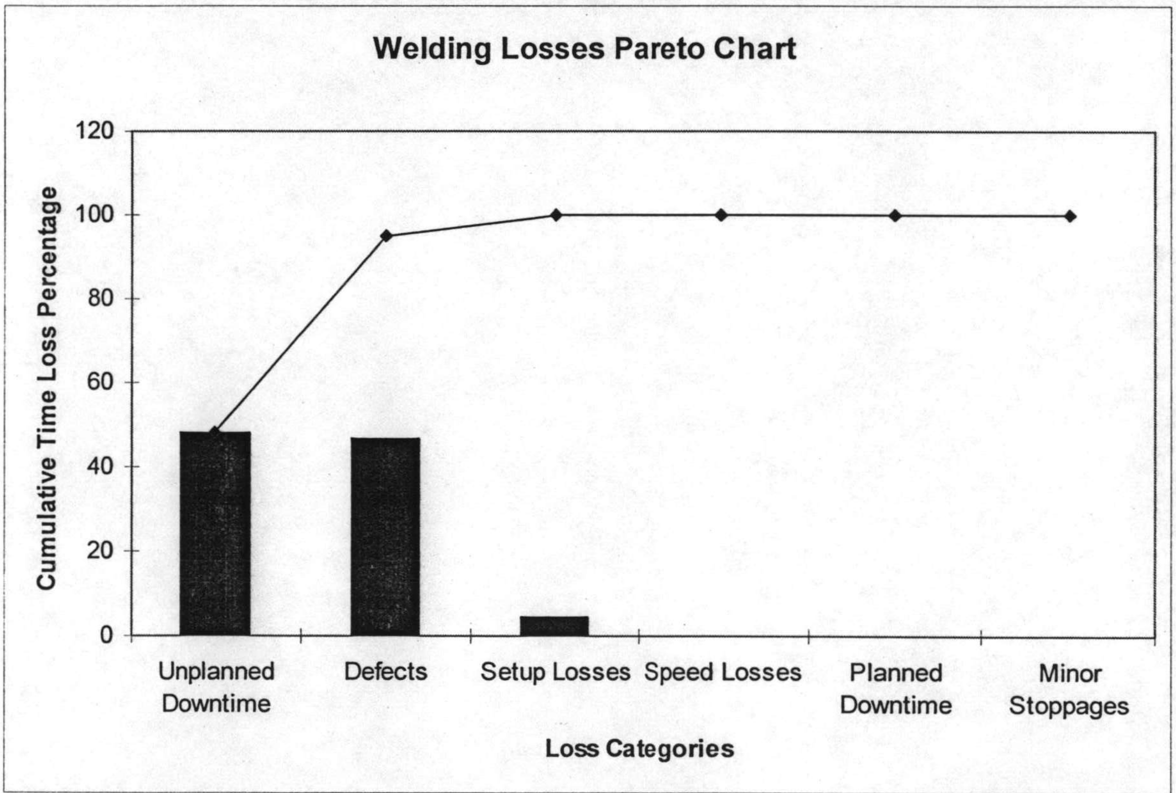

Figure 25: Pareto Graph for Welding Stage

Due to the difficulty of measuring the losses and the definition of the ideal cycletime, this stage had zero minor stoppages. Of notable mention is the time loss due to defects which is second only to unplanned downtime. Unplanned downtime and defects are the dominant losses, accounting for 95% of total losses.

5.1.5 Galvanising

Loss Category	Lost Time (mins)	Percentage	Cumulative Percentage
Setup Losses	1250	43.1	43.1
Minor Stoppages	826	28.5	71.6
Speed Losses	334	11.5	83.1
Unplanned Downtime	295	10.2	93.3
Defect Lost Time	195	6.7	100
Planned Downtime	0	0	100

Table 21: Pareto Data for Galvanising Stage

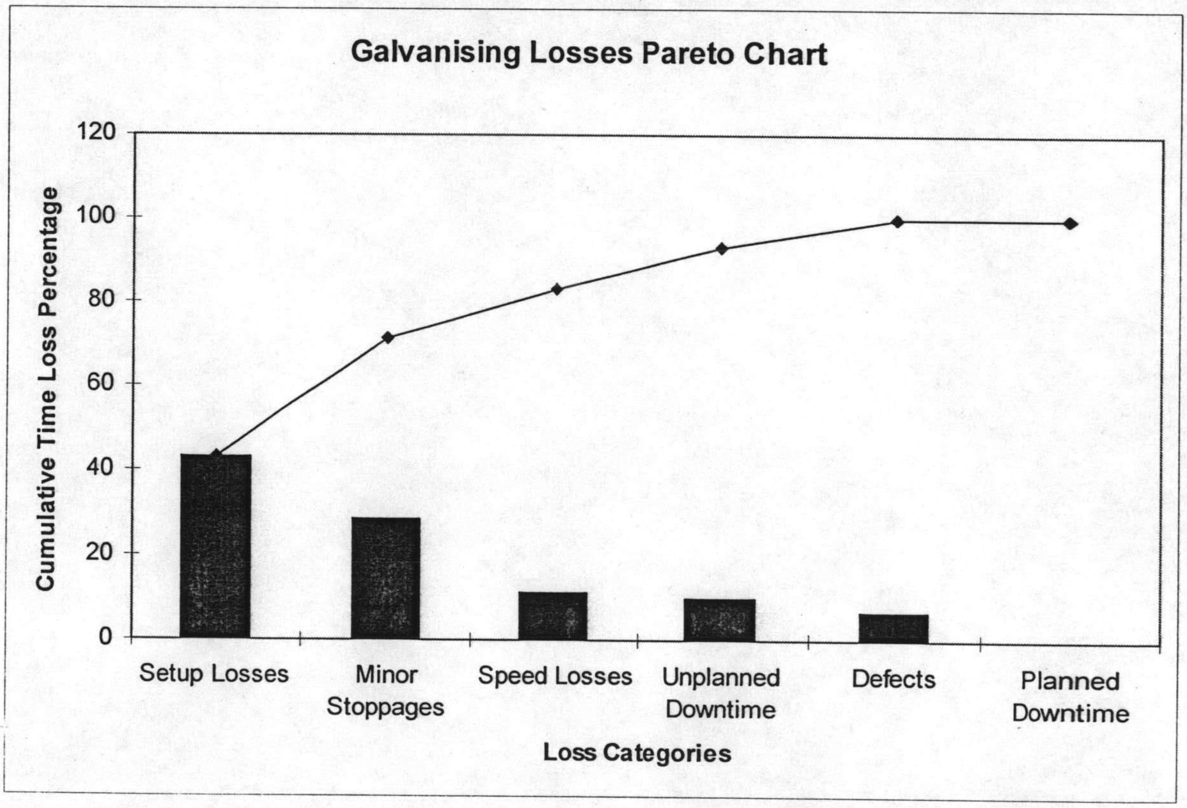

Figure 26: Pareto Graph for Galvanising Stage

The setup losses are mainly due to the 'heating-up' period for the zinc which is required at the start of every day. The dominant cause of the minor stoppages is the WIP starvation resulting from the die-change in the forming stage. Together, setup losses and minor stoppages account for 72% of the total time losses in the galvanising stage.

5.2 Cause and Effect Analysis

The dominant categories for the lost time have now been identified, measured and ranked. The next stage is to identify the causes of the losses. Once the causes have been found the solutions can be generated. One of the most widely-used tools to solve problems of this type is the cause and effect diagram. These were developed in 1943 by Kaoru Ishikawa at the University of Tokyo and are also known as Ishikawa diagrams after the founder. Cause and effect diagrams are used to generate and illustrate possible causes to any situation. The general structure is shown below:

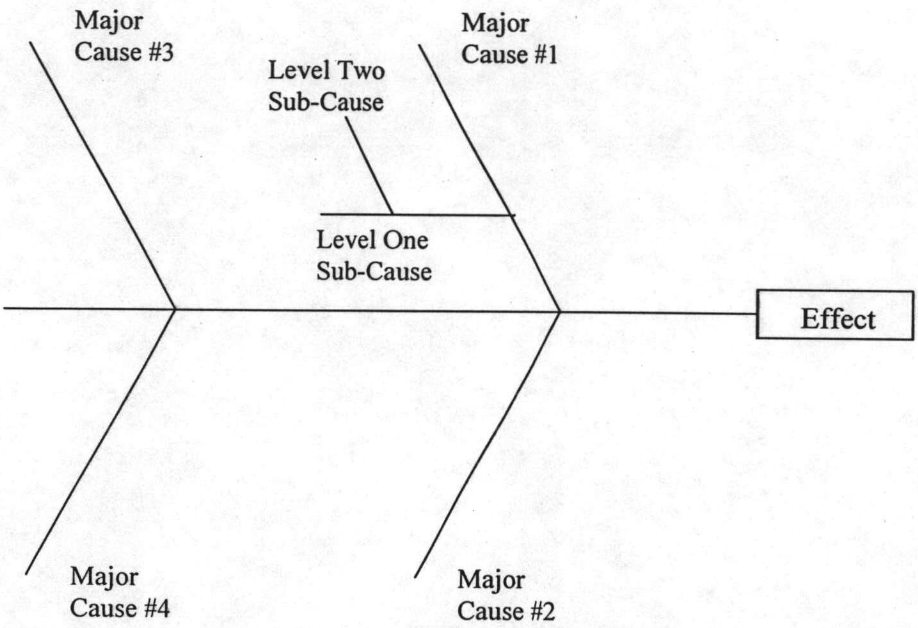

Figure 27: Example of Cause and Effect Diagram

5.2.1 Methodology

For each stage the Pareto graph was used to select the major causes of the time losses. For the selected categories, the causes of the losses were identified. The foreman supervising each stage was consulted to help generate ideas as they were considered the best sources of information regarding the manufacturing losses.

The main ideas generated about the causes of the lost time are discussed below. The cause and effect diagram is presented after the discussions.

5.2.2 Cutting

Speed losses, minor stoppages and planned downtime are the three largest loss categories that together contribute to approximately 80% of total lost time and so these are the categories for which the causes are to be found.

Speed Losses

There are many reasons why the actual cycletime did not match the ideal cycletime. The major cause is the high level of human involvement as humans do not always work at the same speed.

As mentioned before many times the sheer size of the product makes it difficult to handle. For instance the product needs at least two people to carry and manoeuvre. Accurate positioning is essential for accurate cutting and the size issue means the time taken for positioning can be longer than ideal. The input material is in the form of coils which need levelling which occurs both before entering the cutting machine and also as part of the machine itself.

Teamwork is essential for the process to run smoothly as much of the process is team-based. Although the operators do not have to be highly skilled, experience working in the cutting team helps. However, since the cutting process does not occur daily the operators are shifted to other areas and do not always return when cutting does start. Furthermore, the absenteeism rate is such that the team does not always have the same people available. The temperature within the factory is hot with fumes coming from the welding section. This can tire the workers quickly and make them work slower. The factory floor is covered with work in progress or raw material because due to the size, storing it further away would require considerable material handling.

Minor Stoppages

Material handling is one of the major causes of the minor stoppages. This includes the transportation of raw material to the cutting area and the storage of the cut metal. The steel coils are also passed through a set of rollers to help straighten the metal before being introduced into the cutting machine. Included in the minor stoppages are short breaks the operators take for refreshment or meetings. The temperature of the environment makes these breaks necessary.

Planned Downtime

Planned downtime is necessary to prevent unplanned downtime. The length of planned downtime is determined by the length of time it takes to service the machine. The servicing of the machine is the responsibility of the maintenance crew. If they are busy on another job then the maintenance time will be increased. The frequency of the planned downtime is dependent on the maintenance schedule (often set by the manufacturer of the machine) and the number of operations the machine is performed. It is unlikely that it will be possible to reduce planned downtime.

5.2.3 Shearing

Planned downtime, setup time and minor stoppages contribute 75% of the total time losses in this stage and so are the focuses of the cause and effect analysis.

Planned Downtime

As mentioned in the cutting section the planned downtime is necessary to try to prevent unplanned stoppages i.e. breakdowns. The cause of planned downtime is the maintenance policy of the company and the number of operations the machine has performed since the previous maintenance activity. The length of time the maintenance requires is dependent on the maintenance crew and how fast they can work.

Setup Time

Setup time is affected by the complexity of the setup procedure and the ability/competence of the operators in setting up the machine. The time allowed for setting up the machine is 10 minutes but it the foreman suggested that this is a little over-generous and could be reduced.

Minor Stoppages

Similarly to the cutting stage the minor stoppages are almost completely the result of material handling as the large steel sheets must be put brought from their storage onto the machine and then placed back into storage afterwards. The short breaks and meetings are also included in the minor stoppages. The harsh conditions are a cause of this.

5.2.4 Forming

In the forming stage 78% of total lost time is caused by minor stoppages and setup time.

Minor Stoppages

The reason for the large amount of time lost to minor stoppages in this stage is due to the change in form of the material. Before forming it is a flat sheet, heavy and cumbersome but easy to store as it can be stacked up. However, after forming the material is now a long cylinder, it remains large and heavy but is also much more difficult to store. Therefore, the operators must take each pole to a storage area before commencing the next pole. Furthermore, once each pole has been formed the die is partly trapped on the inside of the pole and must be slid off along its length. These two factors result in minor stoppages being so large. Another reason for the minor losses being so high in this stage is the definition of ideal cycletime. In previous stages the ideal cycletime included the time for operators to position metal and insert and remove the product. In the forming stage the ideal cycletime is defined as purely the time for the machine to perform its forming actions and is therefore a more accurate measure of cycletime. The speed losses for this stage are small whilst the minor stoppages are large. This highlights the fact that the actual machine causes little time losses but the supporting operations performed by the operators are the source of much lost time.

Setup Time

The setup time would not be the second biggest loss if it were not for perhaps the biggest problem in the entire manufacturing process – the die-changes. The delays caused by the die-changes upset the continuity of all stages that follow and cause the forming machine to cease output for hours each time. The cause of the lost time here is the length of time required to change the die, itself dependent on the competency of the changeover crew and procedure for changeover. However, also responsible is the sequencing of production as efficient sequencing can reduce the number of changeovers required per month. A problem can arise when the marketing department demand that an order be rushed to satisfy a customer and the production department must put all plans aside and change the die to meet that order. This is when the greatest time losses occur.

5.2.5 Welding

Unplanned downtime and defects account for 95% of all lost time in the welding process and so will be the two categories for which the cause and effect analysis will be carried out.

Unplanned Downtime

Of the 885 minutes of time lost due to unplanned downtime, 745 minutes were due to lack of WIP due to the die change of the previous section. The remaining 140 were due to power outages. Therefore, the unplanned downtime was not caused in any way by the welding stage but was a result of a problem in a previous stage.

Defects

The 192 defects caused by unsatisfactory welding are the result of human error. If a machine were doing the work then the likeliness is that the defect rate would be much lower and the weld speed would also be higher. It must be stressed that this is the only stage where all processing work is performed purely by humans and so a higher defect rate is to be expected. However, it is also necessary to investigate why the human errors are so prevalent. First of all, it is improper to expect 100% welds from welders as mistakes will always be made. Second, the welders may not always be able to see that the welds are defective as specialised equipment must be used to test welds.

5.2.6 Galvanising

72% of total time losses in the galvanising stage were caused by setup time and minor stoppages and so these are the important categories to investigate.

Setup

The setup time is approximately 50 minutes a day first thing in the morning when the zinc kettle is heated up to its operating temperature of 450 degrees Celsius. During this time the other baths are checked to ensure they contain the correct chemical compositions for efficient performance. The foreman must be present for this time because of the high responsibility with working with such potentially dangerous materials.

Minor Stoppages

The minor stoppages in this stage were largely caused by the time taken to fix the poles into the jig which allows 2 poles to be galvanised at the same time. Other than that there were times when the dips had to be refilled with certain chemicals or when the zinc had solidified on the jig, making it difficult to release the poles.

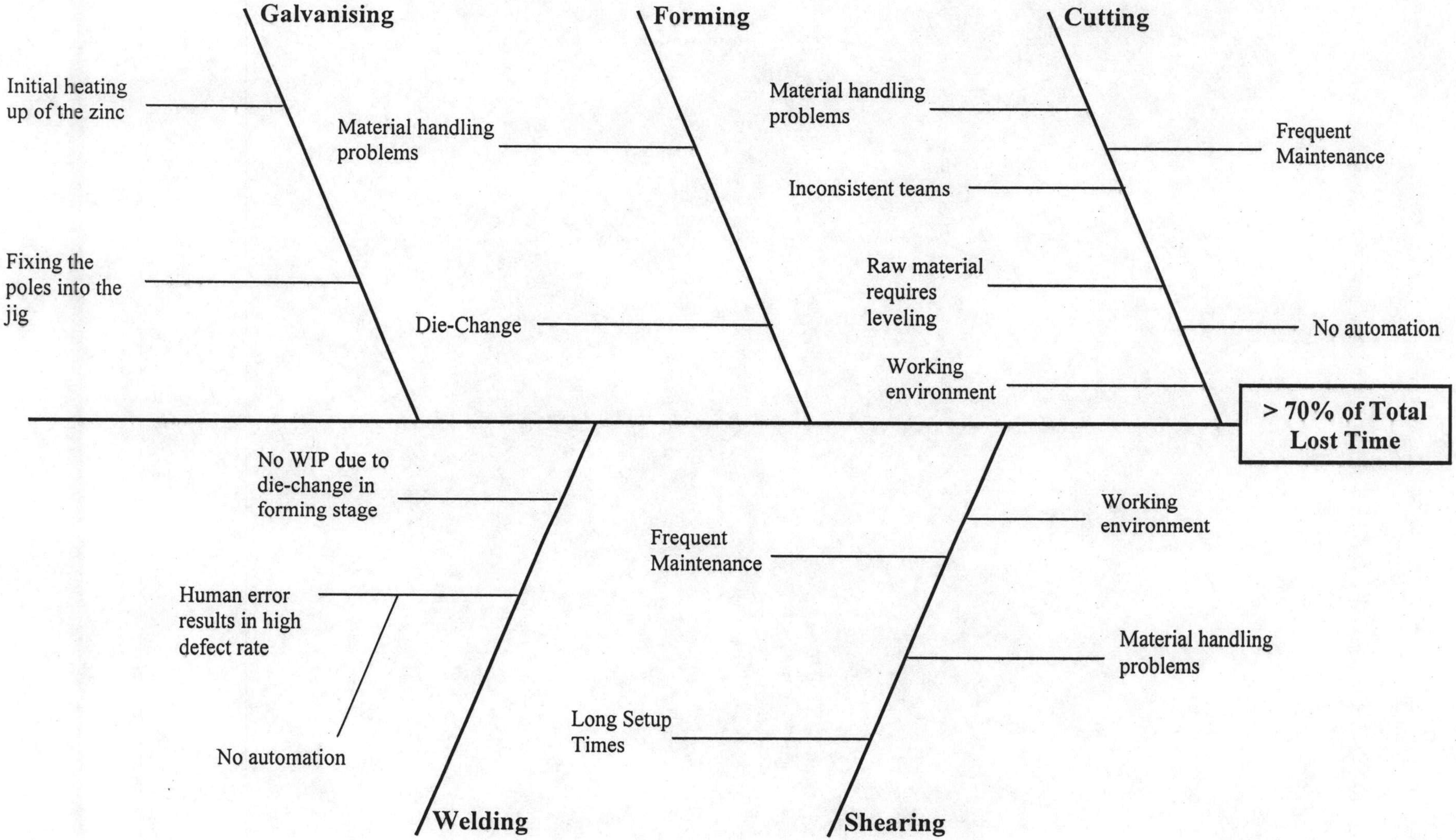

Figure 28: Cause and Effect Diagram of Time Losses

5.3 Suggested Solutions

The OEE of each stage has been found and the biggest loss categories have been identified. From the loss categories the cause and effect analysis attempted to find the causes of the time losses. The final stage of this investigation is to suggest solutions that can solve the problems, resulting in a reduction of total lost time. Solutions that are general and can be applied throughout the manufacturing process in each stage will be presented first, followed by stage-specific solutions.

5.3.1 General Solutions

1. Implementation of Japanese 5S

This does not require much capital investment but is often cited as one of the first steps companies should make to improve productivity (Gunasekaran et al, 2000). The first 'S', Seiri (organization) helps to keep the workplace tidy, increases floor space, reduces raw material and reduces fetching times. This should ease the material handling difficulties that reduce efficiency in the first three stages as there should be more space and less work in progress occupying work floor space. The second 'S', Seiton (Neatness) involves systematic arrangement of tools for faster retrieval. This can help to reduce setup times which are the main causes of lost time in the shearing and forming stages. Seiso (cleanliness) is the third 'S' and ensures the workplace is maintained in a clean state. This makes it easier to detect leakages, misalignments and promotes more frequent checks to be made. The 5S program should be combined with a program to improve the working conditions by installing improved ventilation and/or screening off certain areas. The improved conditions would reduce operator fatigue, thereby reducing speed losses and minor stoppages due to breaks. The final two concepts, standardise and sustain, are to ensure the 5S become firmly established within the company and continue to be applied.

2. Employee Training and Empowerment Program

The employees should be given more thorough training which would give them a more detailed knowledge of the machinery they work with and also how they can work more efficiently. The goal of this could be for operators to perform their own maintenance without the need to send for the maintenance crew except in more technically difficult situations, reducing both planned and unplanned maintenance times. The increased responsibility would reduce absenteeism rates and improve team working skills which are important in the processing of the large, heavy metal items. Setup times would be reduced as the operators would not always need to summon the supervisors to check the machinery before commencing work.

3. Reducing Setup Times

In three of the five stages setup time is the biggest source of lost time or the second biggest. Reducing this setup time in all stages would therefore have a significant effect on the overall lost time. One solution to this problem is the single minute exchange of dies setup (SMED) reduction methodology. Developed over a 19 year period by Dr. Shigeo Shingo it is the aim of SMED to reduce the length of time for any setup or changeover to a single digit number of minutes (less than 10 minutes). Prior to his work, long setup times were considered a fact of manufacturing life and managers tended to work around the setup problem rather than remove it. SMED consists of four stages. The first is to study the existing setup method. The second is to distinguish between internal and external elements of the setup process. Internal elements are those that require the machine to stop. External elements can be performed whilst the machine continues to operate. The third stage is to convert as many internal elements to external elements as possible thereby reducing the time the machine needs to be stopped. The final step is to continue to reduce or eliminate internal elements.

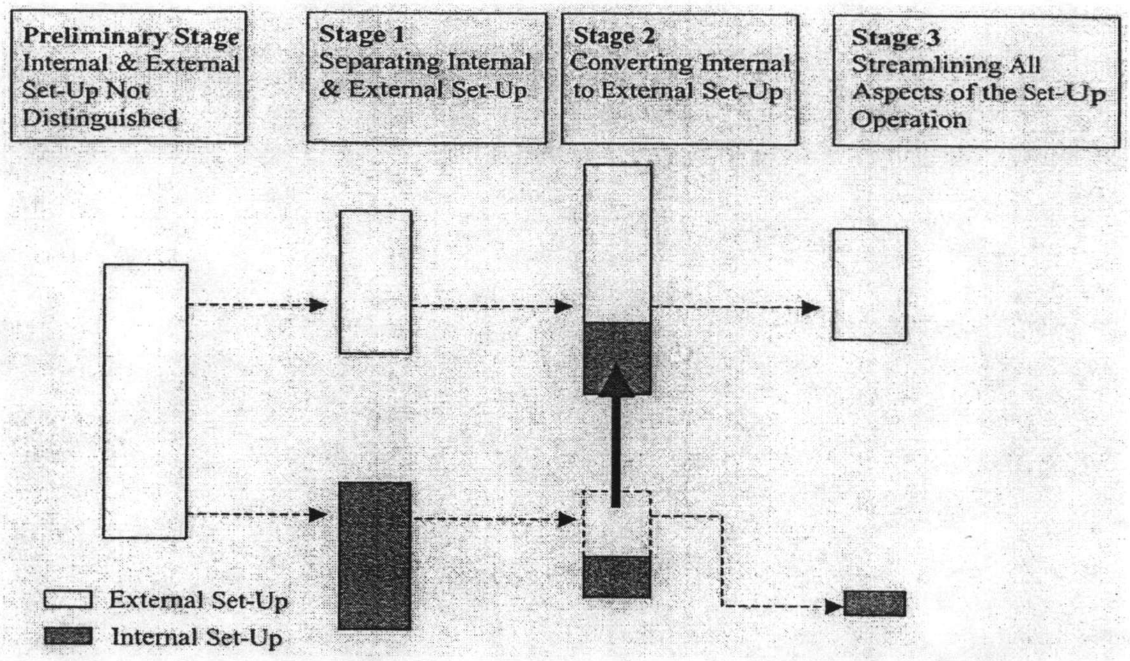

Figure 29: SMED Conceptual Stages (Shingo, 1985)

SMED was originally developed to reduce the setup time of die-changes but has been used for many other applications. One relevant example is at Terry Suchard's Bridgend factory where the cutter cleaning and replacement time was changed from an internal function to an external function. Previously the machine needed to stop to allow the cleaning of the cutters but the cleaning is now done offline and the machine only needs to be stopped to switch blades. The 'maintenance' time has been reduced from 23 minutes to 138 seconds well within SMED standards (Kirby, 1998). This technique could therefore be applied to reduce the maintenance times at CCH.

5.3.2 Note on Reducing Maintenance Times

The reduction of maintenance times will only be accomplished by performing the current maintenance activities but in a shorter period of machine downtime. The maintenance activities themselves including frequency will not be changed as they are set by the machinery manufacturers and reducing planned maintenance often has the effect of increasing unplanned downtime. Increasing planned maintenance has the opposite effect (Jeong and Phillips, 2001).The aim is to reduce downtime by reducing the time it takes to perform necessary maintenance activities, not reduce the activities.

5.3.3 Stage-Specific Solutions

Cutting Stage

The raw material comes in the form of steel sheet rolled into coils. As mentioned before this generates lost time due to the need to straighten the metal before it can be cut. This increases the speed losses and minor stoppages for this stage. The company may want to consider changing to a raw material of flat sheet metal. This would not need levelling before being cut and so save time. This uncoiled steel may have a different price to buy, or need different transportation from the manufacturer and so a feasibility study should be carried out to weigh up the difference in cost to the savings made from the reduced lost time in the cutting stage.

At this time the high labour intensity of the cutting process does not warrant buying a more modern machine. The cutting process only operated for 2,483 minutes during the month of data collection compared to 12,210 minutes for the forming stage. Although an automated cutting machine would reduce speed losses there is no currently not a sufficient need for such a machine.

Forming Stage

The die-change is an issue that needs to be addressed because it has such a large affect not only on the availability of the forming machine, but also on the welding and galvanising stages which follow. The application of SMED techniques to reduce this changeover time would subsequently reduce the unplanned downtime of the other two stages.

The other major loss in this category, minor stoppages, needs to be addressed because it results in such a large amount of lost time. The process is labour intensive, requiring operators at all times and material handling is an issue. There needs to be a support team purely to handle the raw material and store the machined product leaving the operators free to concentrate on the forming process and keep the machine operating for as much time as possible. The 5S implementation will also reduce minor stoppages by making the workplace tidier, facilitating material handling.

<u>Welding Stage</u>

In this investigation the results for the welding stage are the least reliable due to the difficulty in collecting accurate data and the assumptions made about the welding process that were necessary to calculate OEE. However, the losses that have been highlighted in the labour-intensive welding stage are a high number of defects and unplanned downtime. The unplanned downtime is largely due to the die-change of the previous stage which is dealt with separately. The defects are due to poor welding quality which can be resolved by advanced training of the welders or supplying them with equipment for testing the welds as they are made, facilitating instant re-welding where necessary. Other companies in this market have invested in automatic seam welders which improve the weld reliability as well as welding quickly and this is one option for CCH.

<u>Galvanising Stage</u>

The OEE of the galvanising stage was 0.77 which is not much lower than the figure Nakajima stated was world class of 0.85. The biggest loss was the setup time which was largely due to the time the process needed to be prepared each day first thing. Applying a SMED philosophy would lead to making so this setup being performed 'offline' therefore the process would not waste any shift time. There should be someone responsible for coming in early specially to get the galvanising process ready for when the shift time starts, so as to reduce the lost time in this stage.

5.4 Reduction of Lost Time

The solutions above all provide methods for reducing the lost time during the manufacturing processes at CCH but without implementing those solutions it is impossible to verify or measure the reduction of lost time. It was not possible to implement all the suggested solutions as part of this project due but it was possible to apply some of the solutions and measure the results. Some of the remaining solutions have been applied in similar situations in other companies and the results from those can be used to predict what effect they would have at CCH.

Cutting Stage Reduction

The cutting stage was used to prove that maintenance times could be reduced using SMED techniques. The cutting machine is cleaned and lubricated every day of operation and a major service is required once per week for maintenance of the cutting blades and cutting mechanism. One of the core principles of SMED is to convert internal elements to external elements. This means performing as many of the necessary maintenance tasks as possible whilst the machine continues to operate.

Firstly, the operators were instructed to periodically clean the machine during the day. This could be done during the 'free' time after one sheet is cut and the next had to be entered into the machine. The theory was that the machine would not be so dirty at the end of the day and would require less maintenance time. Secondly, the maintenance crew were instructed to perform as much of the weekly servicing offline as possible. Normally the cutting machine's blades are removed, maintained and reattached during the planned downtime but the crew was instructed to replace the blades with a 'fresh' set and perform all maintenance on the used cutters at a separate time. A similar solution was implemented at Terry Suchard's Bridgend factory (Kirby, 1998) and the maintenance time on cutters in that example was reduced from 23 minutes to 138 seconds.

Shearing Stage Reduction

The shearing stage suffered from long setup times and a simple solution was devised to attempt to reduce them. Stemming from the concept of improved employee training and empowerment the operators were given an extra responsibility. Previously, the supervisor was required to confirm all setup changes before shearing of a new batch could commence. The foreman had commented that this was largely unnecessary as it was the operators who performed all setup tasks and were very knowledgeable about the working of the machine but had to follow company policy. During a test period the policy was ignored and operators were able to commence work after having checked the setup themselves. The risk was that the level of defects would increase as the supervisor would not check the setup before work began.

Forming Stage Reduction

The minor stoppages were the biggest cause of lost time during this stage and it was suggested that a support team should be deployed to allow the operators to spend as much time as possible forming steel poles rather than material handling. To test this idea a two-man support team was assigned to the forming stage purely to help with material handling. The team's priority was to prepare the next metal sheets for forming, providing easy access for the machine operators. They were also to help remove the finished poles from the machine and store them for use in the next stage.

Fair Test

In order to try to make the test as fair as possible only one solution was implemented to each machine. If more than one change were made then it would be impossible to attribute any changes, good or bad, to any single solution. Once the success was confirmed the solutions could be applied to other stages at a later time.

5.4.1 Implementation of Solutions and Results

The above solutions were implemented for a trial period of two weeks and the losses were monitored in a similar fashion as for the original OEE calculation. The results are displayed in Appendix B. The solutions were not particularly complicated and so minimal employee training was required.

It is important to note that OEE before implementation and OEE after implementation cannot be compared as the manufacturing conditions will have changed. Different staff may be working on the machine, different product types may be processed etc. There are too many variables that contribute towards OEE and even towards the 3 loss groups of Availability, Performance and Quality. The exact conditions will have changed sufficiently to prevent the calculation of OEE from being compared to the original data. It was not the aim of this study to increase OEE, it was merely used to identify and measure the losses and the areas where the losses were prevalent. Therefore, the focus of the next section is to measure the reduction time losses.

<u>Cutting Stage</u>

The theory was that by performing proportionately more maintenance while the machine continued to operate would reduce the time for planned maintenance.

Planned Maintenance Before (per day of operation)	**Planned Maintenance After (per day of operation)**	**Reduction in Lost time (per day of operation) (%)**
19	6.6	12.4 (65%)

Table 22: Cutting Stage Loss Reductions

As can be seen from the data, the planned downtime has been substantially reduced by the implementation of SMED techniques. Per day of operation the maintenance time has been reduced from 19 minutes to 6.6 minutes, a reduction of 65%. Over the course of one full month (26 days) the saving would be 322 minutes.

Shearing Stage

The changes in the shearing stage were to reduce setup times by allowing the operators to verify their own settings.

Setup time Before (per day of operation)	Setup Time After (per day of operation)	Reduction in Setup time (per day of operation) (%)
25.83	14.8	11 (43%)

Table 23: Shearing Stage Loss Reductions

As can be seen from the data, the setup time has been substantially reduced. Per day of operation the setup has been reduced from 25.8 minutes to 614.8 minutes, a reduction of 43%. Over the course of one full month (26 days) the saving would be 287 minutes. Of other importance, quality levels were unaffected, confirming that the operators are capable and responsible enough to monitor themselves.

Forming Stage

The minor stoppages accounted for almost 3000 lost minutes during the original data collection period and so the solutions were implemented to reduce these stoppages.

Minor Stoppages Before (per day of operation)	Minor Stoppages After (per day of operation)	Reduction in Minor Stoppages (per day of operation) (%)
114	70	44 (39%)

Table 24: Forming Stage Loss Reductions

As can be seen from the data, the minor stoppages have been substantially reduced by the implementation additional material handlers. Per day of operation the minor stoppages have been reduced from 114 minutes to 70 minutes, a reduction of 39%. Over the course of one full month (26 days) the saving would be 1144 minutes (over 19 hours).

Although it was not possible to implement SMED to the die-change as part of this investigation, it is possible to estimate the benefits such an implementation would have. Famously Shigeo Shingo, whilst working at the main Toyota Factory in Japan in 1969, reduced the die-change of a 1000 ton press from 4 hours to 1 and a half. Later, the time was further reduced to just 3 minutes by shifting many internal elements to become external. Shingo also suggests that a 30-50% time reduction is possible with little or no investment by identifying and separating internal and external elements of the die-change process. Assuming a similar reduction could be possible for the die-change at CCH could bring the time from the present 4 hours plus down to a conservative estimate of 1 hour. During a month where the die is changed 4 times this would save a total of 12 hours or 720 minutes.

The SMED reduction would also require the improved scheduling of overhead cranes. The crane is needed to transport the heavy dies as well as other machinery and so the scheduling would certainly play an important part. However, as explained previously, the overhead cranes as well as plant layout are being investigated as part of another study for the upcoming plant relocation and so are not considered here.

5.4.2 Implementation Issues

It became apparent during the course of the investigation that there was a certain level of resistance from nearly all levels of the workforce.

1. Top-level management are always keen about projects to save costs or time but are often cautious when committing company resources into such projects.
2. Middle managers such as the production department are also keen to improve operations but are concerned with disrupting the day-to-day working of the company.
3. The machine operators and others on that level of the workforce are suspicious when told that someone is going to analyse the manufacturing process to try to find problem areas that can be improved. The employees can feel as if they themselves are being investigated and can have negative feeling s towards the project.

4. All members of the company resist change as it is moving away from what is familiar and doing something in a new way is seen as moving into the unknown.

It is therefore necessary to educate all members of the workforce as to why the analysis is being performed and why the changes are necessary. In this project management were sceptical about assigning an extra team to the forming process purely for material handling as they saw it as a waste of manpower without adding value. Minor stoppages are a hidden loss in many manufacturing companies as the losses are difficult to measure and are seen a necessary part of the business. However, having seen the benefits of assigning the support team management now understands why it is necessary. It is extremely important to have the support of management before setting out on any project as without that support the project is unlikely to succeed. It is also important to involve as many people as possible from as early a stage as possible as this guarantees increased support because people will feel involved.