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**As-Is Evaluation & Process Design of the 17/18 foot Refrigerator at
General Electric in Decatur, Alabama.**

ISE 429

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Due: May 2, 1997

Spring 1997

**The Industrial & Systems Engineering Department
The University of Alabama in Huntsville**



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ABSTRACTS

General Electric in Decatur, Alabama has been in appliance production for twenty years. Through the years, the company realized its need for an "As-Is" program in order to reduce the number cabinets being scrapped out in the factory. This was done by allowing visually defective cabinets to be sold to "As-Is" dealers for a reduced cost. Since then, this program has been abused and used as a safety net. It has given the line and staff a way to justify sending a cabinet through as a visual defective cabinet, rather than taking the time to repair it. Their argument was that sending it through labeled as an "As-Is" cabinet takes less time and does not slow the line down. The purpose of this project was to improve the process by reducing the number of variables that cause an "As-Is" cabinet to occur. This involved evaluating and observing the line structure, and communicating with the employees and the staff about the impact of producing an "As-Is" cabinet. The intention was to educate everyone involved about the consequences, as well as disadvantages to producing this type of cabinet instead of striving for a quality product.

Description of General Electric Decatur Plant Operations

- General Electric Appliances in Decatur-Alabama specializes in the refrigeration industry.
- In 1973 GE purchased a manufacturing facility in Decatur that was previously owned by Fedders Corp.
- Initial start-up was in 1977 with approximately 300 employees producing 11 and 14 cu-ft. single door manual defrost models in 300,000 sq. ft. of manufacturing space with a 90,000 sq. ft. warehouse.
- In 1983 the Notice of Intent was signed to redesign the Top Mount Cycle Defrost 12 and 14 cu-ft. refrigerators and move them to Decatur as the 13 and 15 cu-ft. models.
- In 1984 Decatur began production of the 13 and 15 cu. ft. cycle models, with an employment level of 730 and with 316,000 sq. ft. of manufacturing space.
- In 1987 an announcement was made to redesign the 14 and 16 cu. ft. refrigerator models produced in the Cicero plant and to move the product line to the Decatur Plant.
- In 1989 Decatur increased the plant size to 650,000 sq. ft. and the warehouse to 135,000 sq. ft. with an employment level of 1500.
- In 1993 Decatur start to redesign line 1 - Small manual defrost models, to line 3 - 17 and 18 cu. ft. models.
- In 1994, 17 and 18 cu. ft. models were manufactured.
- In 1995 Decatur increased the employment level to 1550. Decatur also received its ISO 9002 certification- Model for quality assurance in the production and installation of a manufacturing system. This certification meant that the Decatur Plant Operation facility was approved by the International Standard and would remain competitive in the global economy. 1995 was a successful year, Decatur exported the first international model to Japan.
- The product line has grown from two sizes of one type to four sizes of one type. The Plant now makes 14, 16, 17, and 18 foot refrigerators.
- Domestic customers include retail stores such as Sears and Circuit City, as well as housing authorities, apartment complexes, and mobile homes. Two of the biggest international customers include Japan and Puerto Rico.

Background of the Problem

General Electric Appliances at the Decatur Plant Operation (DPO) implemented the As-Is program in 1990. The As-Is program was initiated in order to sell a non-repairable defective product to an As-Is dealer that only has a visual defect (dent, scratches, etc.) on the body that cannot be reworked. This includes such things as a scratch on the case of the refrigerator where the gasket touches when the door is closed. If this area is touched up, the paint will contaminate the gasket and may eventually cause a hole to form. This defect does not influence the performance of the refrigerator; however, it fails the appearance standard necessary to ship out the cabinet to a customer. The policy of the company is to scrap out a cabinet as close to the beginning of the process to prevent this from occurring. However, the company kept the program for exceptional cases in which the product made it to the end of the process and a small defect as described above occurred.

Statement of the Problem

Since 1990, the Decatur plant has had an increase in the number refrigerators that have been sold to an As-Is dealer instead of being sold to demanding customers. These refrigerators are sold to the As-Is dealer at slightly below factory cost. This leads up to the most important point, the company does not make a profit. Since the As-Is program has slowly become a culture of the company, it has caused the workers to use the program as a "cushion". Therefore, this has taken the pressure off of the employees to make acceptable refrigerators because there is always an alternative. As a result, the cabinet is being sent all the way through the process instead of scrapping it out at the beginning of the process where the only thing lost is the raw material. As stated earlier, sending one out as As-Is cabinet causes the company to lose the profit of the entire refrigerator instead of just the cost of the raw material. Therefore the policy of the company is to (if absolutely necessary) scrap out a refrigerator as close to the beginning of the process as possible in order to reduce waste as well as eliminate As-Is cabinets.

Design Objective

The objective of this project is to decrease or possibly eliminate the number of defective refrigerators shipped out of the General Electric Refrigeration Plant to "As-Is" Dealers.

The contact manager: Heidi Weisenberger
2328 Point Mallard Dr.
Decatur, AL 35601
Phone: (205) 552-1295
Fax: (205)552-1316



SCOPE OF WORK

The steps necessary for reducing or eliminating the As-Is product are as follows: First, identify the quantity and cost of the As-Is production on the 17/18 foot assembly line. Second, analyze the root causes of each As-Is product and focus on the top problems found. Third, observe workstations, layout process, and try to understand and improve the production process. These observations may include ergonomics studies, plant layout, simulation, etc. Fourth, communicate this idea with the Managers, Business team leaders, Quality Control Analysts, operators, etc. Finally, implement the solution with the approval of the people listed above.

- Phase 1: Identify the quantity and the cost of producing an As-Is product on the 17/18 foot assembly line.
- Task 1. The first step is to meet with the shop manager, quality analyst, and the industrial engineers in order to fully understand the As-Is program. These include such things as how the program works what the appearance standards are that judge if the cabinet is sent out as an As-Is product or not, and how much profit the company is losing by continuing this process .
- Task 2. The second task includes retrieving, analyzing and sorting the data found in the database according to the defect description and the location of the defect on the 17/18 foot refrigerator. This data is stored in a database by an operator at the end of the assembly process before the refrigerator is placed in a box to be shipped out to the consumer. Afterwards, the data can be accessed, analyzed and sorted according to the problems causing the cabinet to be sent out as an As-Is cabinet.
- Task 3. After retrieving, analyzing and sorting the data, formulate the top root causes of problems found that have a major impact on the As-Is product.
- Task 4. After formulating the top root causes the next step is to break down the root cause information by the defect description. This will identify the exact location on the refrigerator that has the non-repairable defect. Therefore, the number of occurrences in that area can be tabulated and the next phase can be conducted.

Phase 2: Analyze the root causes of the As-Is defects & focus on the top issues

Task 1. Observe the top As-Is product issues on the shop floor in order to visually identify the defective location as well as the severity of the defect.

Once the top problems have been identified, the next step is to visually see the defects on the shop floor. The cabinets to look at are those that have been scrapped out on the line because of one of the top defects identified in Phase 1. Other cabinets that can be looked at are those on the deadline (End of Line Audit) that are about to be sent to an As-Is dealer. This will provide a much better understanding of the magnitude as well as the severity of the problem. Also, this will help in understanding the standards that govern the labeling of an As-Is cabinet.

Task 2. Discuss the written information found on the database as well as the visual information observed on the shop floor with the Quality Analysts.

This will provide an understanding of the possible workstations or queues on the line that might cause this type of defect. These resources may lead right to the source of the problem or at least provide a starting point to work from. Also, the analyst may be able to identify any other areas on the shop floor that may be a contributor to the visual defects that causes the cabinet to be marked as an As-Is cabinet.

Phase 3: Observe workstations & layout process

Task 1. Consult with the Industrial Engineers assigned to the 17/18 foot assembly line to obtain the layout of each workstation on the line. This will include the vacform, case line and main line areas. Also, consult with the Industrial Engineer about any areas that they are aware of that might be a factor in causing defects. Ask them to walk through the line and point out any of these particular areas.

Task 2. Investigate each workstation on the 17/18 foot assembly line to determine the possible tools, operator motions or conveyor problems that are causing the defects such as dent, scratches, and etc. to occur.

This task involves going to each individual workstation on the line and investigating it to determine if that workstation may be causing a refrigerator to be sent out as an As-Is cabinet. These things might include such things as sharp screwdrivers, sharp components added to the refrigerator, belt buckles and so on.

Task 3. Discuss with each individual operator the possible problems encountered at their workstation that may contribute to the "As-Is" product.

The first thing that the operators need to understand is the objective of the project. Let them know that their job is a vital part of the process and tell them the reasons. This task gets the operators involved in the improvement process. Since they are the ones who know the most about their particular station, they can be a very valuable asset to the solution process.

The goal in this task is to listen to each operator and write down their suggestions on how to improve the station they are working on to try to eliminate an As-Is cabinet from being formulated at that station. Their suggestions may start to form a pattern on down the assembly line. It may be found that a particular problem may be the root cause of creating an As-Is cabinet. Therefore, there should be not be a suggestion that is not examined.

Phase 4: Understand & improve the process of the production line (Ergonomics, plant layout, time study, simulation, etc.)

Task 1. Analyze the problems encountered by the operators and discuss the difficulties with the Industrial Engineer to improve the process and decrease the possibility of creating an As-Is product.

This task follows the conversations with the individual workstation operators. The first thing to do is to identify the problems visually seen while walking down the line, as well as those identified by the workstation operators. Next, sort through and categorize problems and suggestions in a professional manner before presenting them to the appropriate Industrial Engineer (there is a separate Industrial Engineer for each area of the plant).

Task 2. Acquire the motion time studies that have already been done on each workstation from the appropriate Industrial Engineer and then conduct another one to determine if the workers are utilized properly.

Contact the Industrial Engineers for the Pre-Assembly, Main Assembly, Vacform, and Final Assembly areas and ask them for their time studies. Next, conduct the time studies again to verify that their results have not changed. This may have changed due to a removal of a job, line speed change, increased production and so on. This task will cause any of the bottlenecks, as an example, to surface as well as the identity of any over or under utilization's of operators on the line. This may also cause any other reasons that might cause the production of an As-Is product to surface.

Task 3. Determine the probability that an As-Is cabinet will be made at each particular workstation. Afterwards, use simulation to compare the process before and after the proposed changes have been made to determine if this is the right approach to the problem. This study will help to justify the improvements made. It will allow the Industrial Engineers to see the impact of implementing these changes before they are actually changed on the shop floor. This will also help in spotting any other changes that might need to be included in the improvements proposed.

Phase 5: Communicate ideas to the managers, Business Team Leaders, QC Analyst, operators, etc. (Presentation & awareness)

Task 1. Set up meetings with the affected managers, Business Team Leaders(BTL's), Quality Control Analyst, and operators to discuss the proposed ideas and changes to improve the process. Gather all of the appropriate managers, BTL's and Analyst together in one room to discuss the ideas formulated from the previous phases. The next step is to obtain the approval of these team members to go ahead and implement any changes that need to be made.

Task 2. Set up a formal presentation of the ideas formulated in front of the FIRST team (Field Invoice Response Service Team) and the Quality Council to gain support and resources needed. The FIRST team is a voluntary group of employee that specialize in a particular area in the plant. These areas may include such things as: Temperature Controls, Timers, Freezer Fans, Damage and Concessions, 17/18 foot Line 3 and so on. The Quality Council is a group of upper management employees that are in charge of implementing and making sure that projects happen when and where they should. This will be a good asset in acquiring any money needed to improve the process.

Phase 6: Implementation

Task 1. Take contractor bids on the jobs that need to be implemented. After acquiring the proper approvals above and the funds to make any changes, the next step is to take bids on the job. Write up the changes that need to be made and receive bids from contractors to determine who will implement any of the changes.

Task 2. Work with the contractors in designing the appropriate tools, and workstation changes needed.

Effectively portray the changes needed to improve the process with the contractors. Explain to them the purpose of implementing the changes needed to improve the process.

- Task 3. Design workstation instructions and job aids to improve operators performance.
After establishing the solution to the problem, design workstation instructions and job aids for the stations that are causing the defects. This will let the new, as well as, old operators on that particular job know the consequences of putting a visual defect on the cabinet. It will also let them know what can be done to prevent it from occurring again. It will also let them know that producing an As-Is cabinet is unacceptable and the cabinet should be scrapped out instead of sending it down the line.

Phase 7: Follow up Implementation

- Task 1. Observe the possible difficulties encountered from the implementation and optimize the process.
While conducting a trial run of the process designed, note the difficulties encountered. Afterwards, work with the industrial engineers and contractors to optimize the process until it works properly. This may include re-evaluating a portion of the solution and revising it to accommodate the problem encountered.

Phase 8: Follow up Presentation

- Task 1. Do a formal presentation in front of the plant manager and the management staff.
After the project has been implemented, the next step is to present it to the management staff and the plant manager. This will show them what has been done and the effect it has made on the product. Afterwards, they can take note of the changes made and watch for continuing improvements. The next step for them may be to implement this project on the 14/16 foot assembly line.
- Task 2. Formulate a cost savings analysis.
Several months after implementing the project, formulate a cost savings analysis. Conduct a regression analysis to determine if the project is working effectively and is continuing to be a financial benefit to the company.

** See table. 1 for the task schedule

TABLE I: TASK SCHEDULE

Mar'96
Apr'96

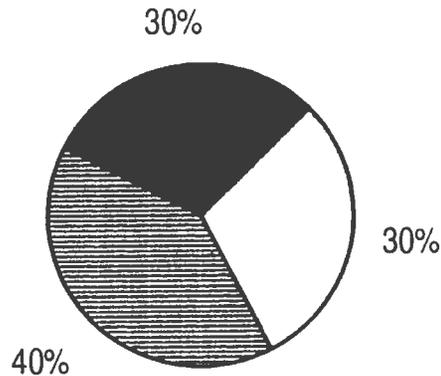
No	Task Name	Start	Finish	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
6	Implementation: 6.1. Work with the maintenance 6.2. Design work station instruction & job aids	2/14/97	3/21/97															
7	Follow up implementation: 7.1. Observe & optimize possible process	3/21/97	4/4/97															
8	Follow up presentation: 8.1. Present solution to the staff managers	4/11/97	4/11/97															

Note: Black : action has been accomplish ; : future action



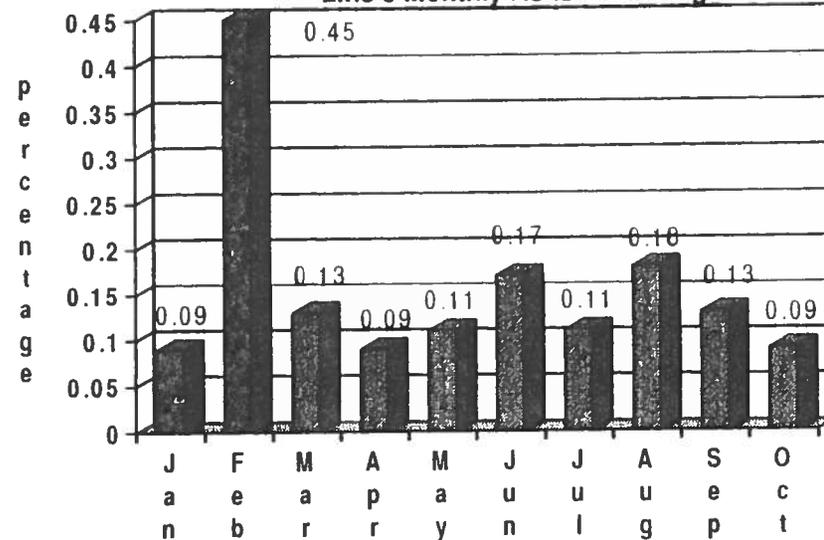
As - Is Evaluation & Process Design on 17'/18' Refrigerator at GE DPO

DPO As-Is 1st Qtr - 3rd Qtr 1996:

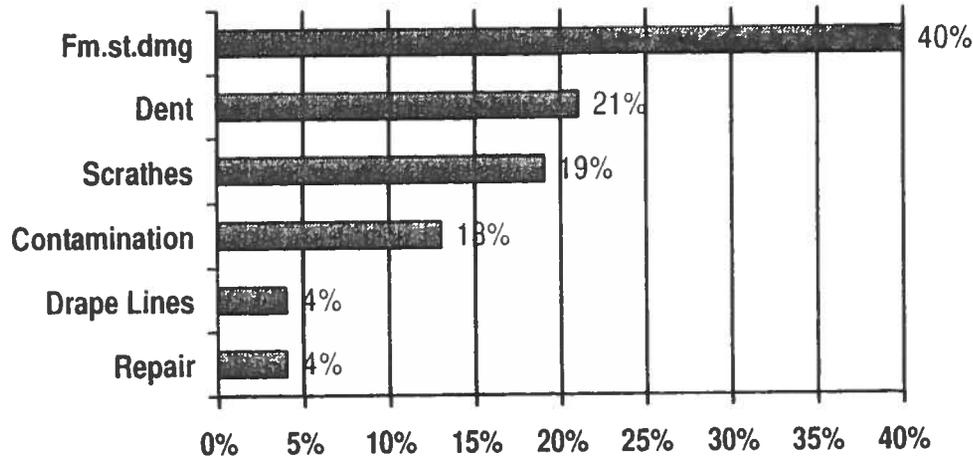


□ warehouse ▨ line 3 ■ line 2

Line 3 Monthly As-Is Percentage



Line 3 Top 6 As-Is Problems



■ # of As-Is

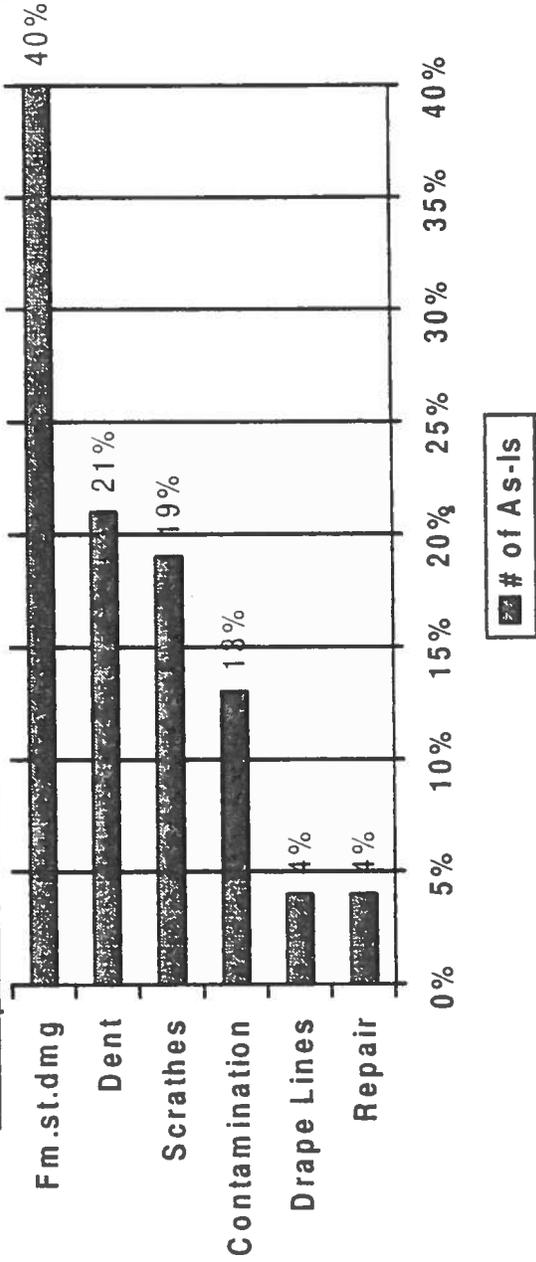
Facts:

Percentage = Total as-is / Total production
 Total Line 3 As-Is problems=400 units
 Average prod./month = 30,540 units
 Year to date Line 3 As-Is cost = \$102 K
 Projected 1996 As-Is cost for Total Decatur = \$232.3K

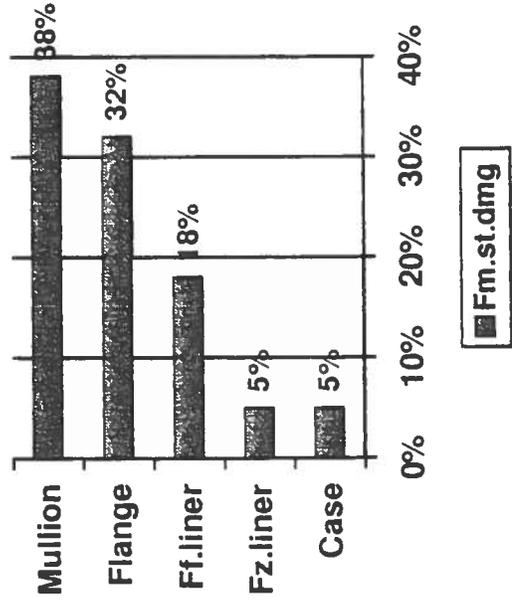
Action Plan:

- After identifying the Top 6 rootcause of As-Is, the next step is to study/observe each rootcause.
- This study will involving productivity, ergonomics/motion time study, quality, safety , etc.
- From this study, we will come up with suggestions / recommendation to reduce each problem.
- Implementation

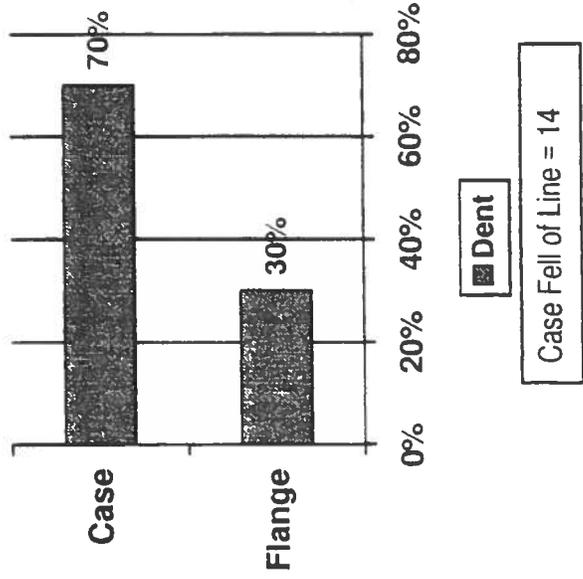
Line 3 Top 6 As-Is Problems



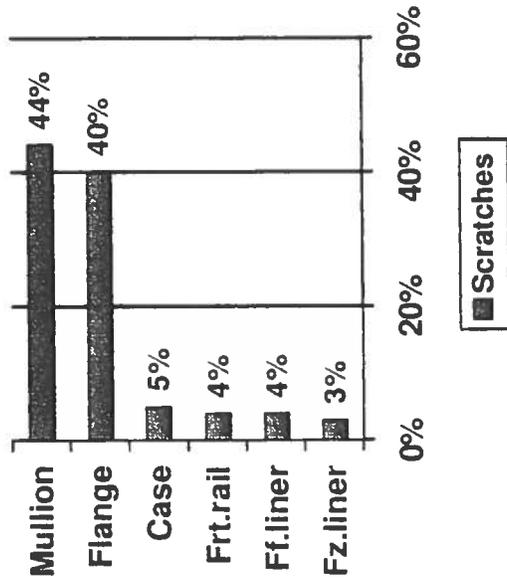
1. Foam Station Damage



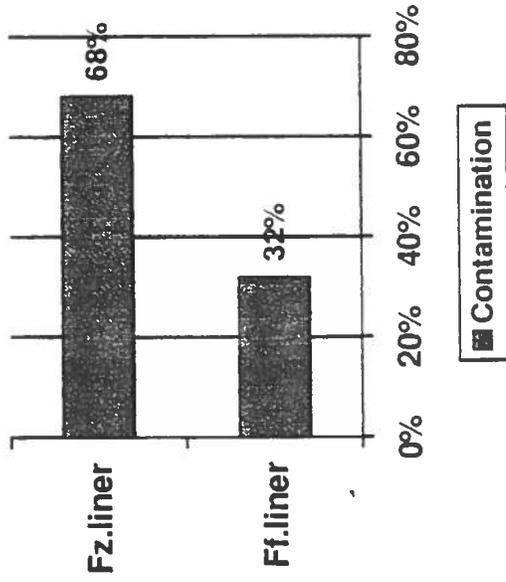
2. Dents



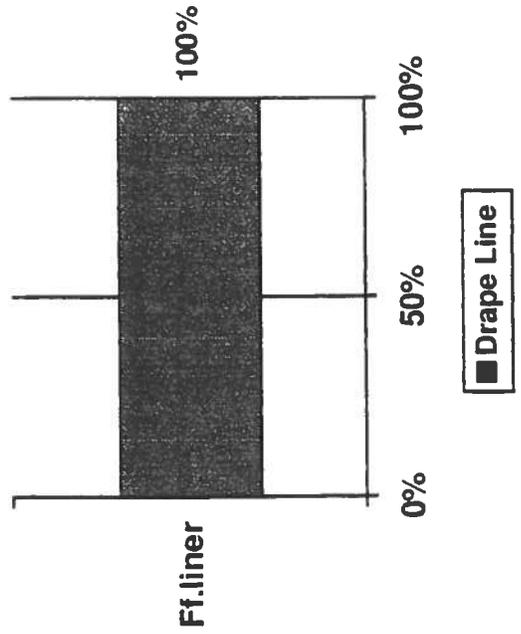
3. Scratches



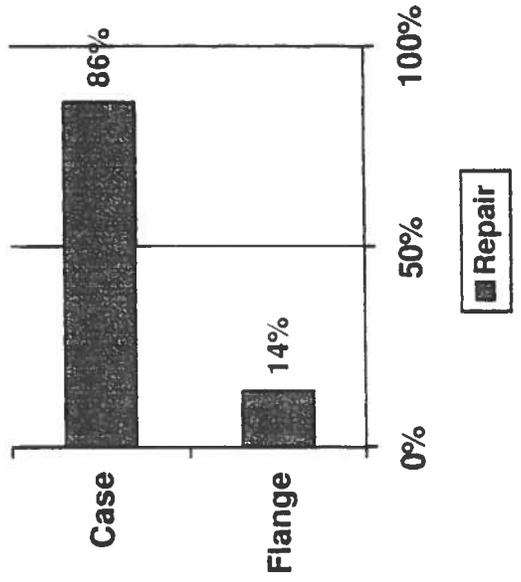
4. Contamination



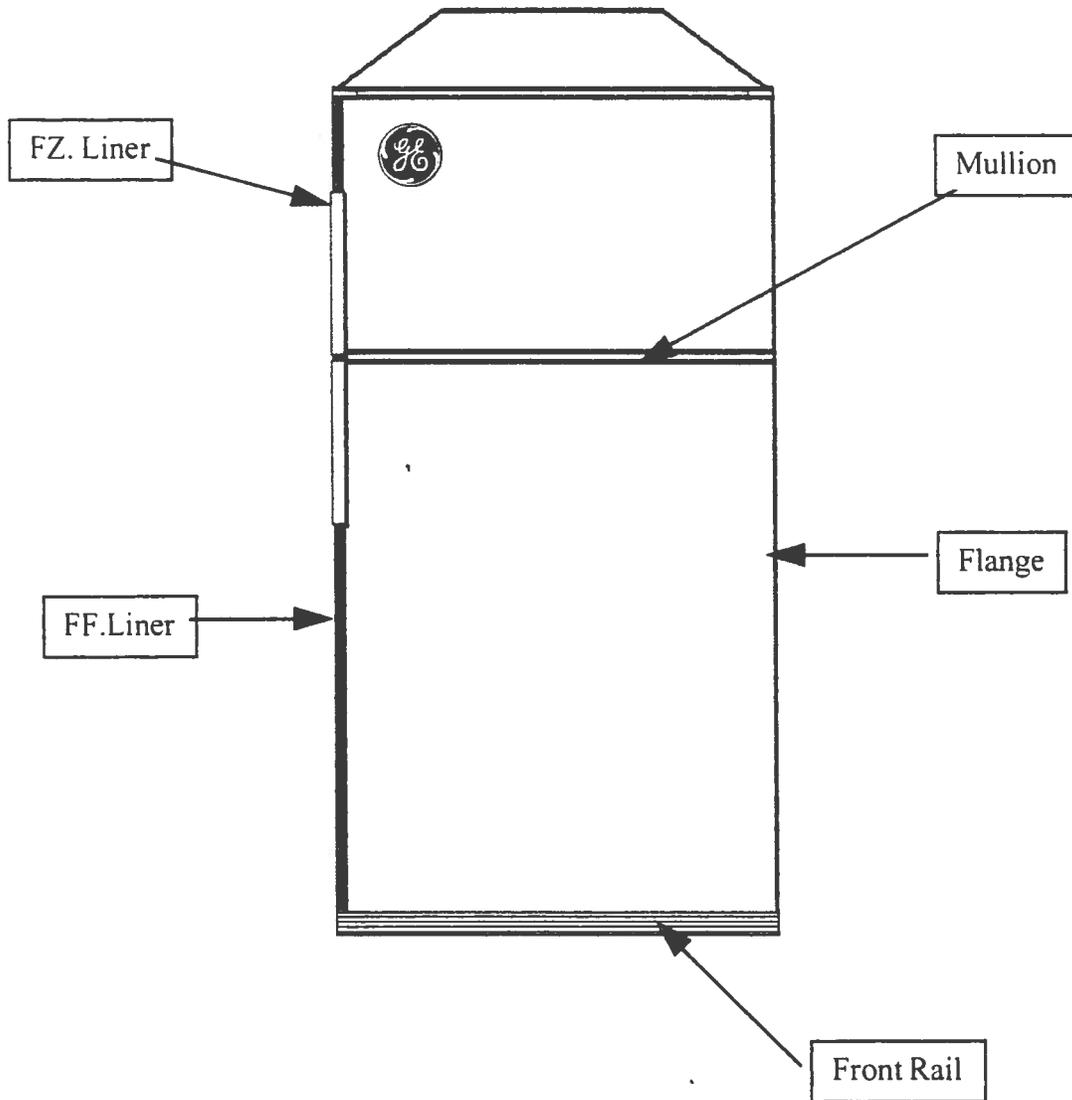
5. Drape Line



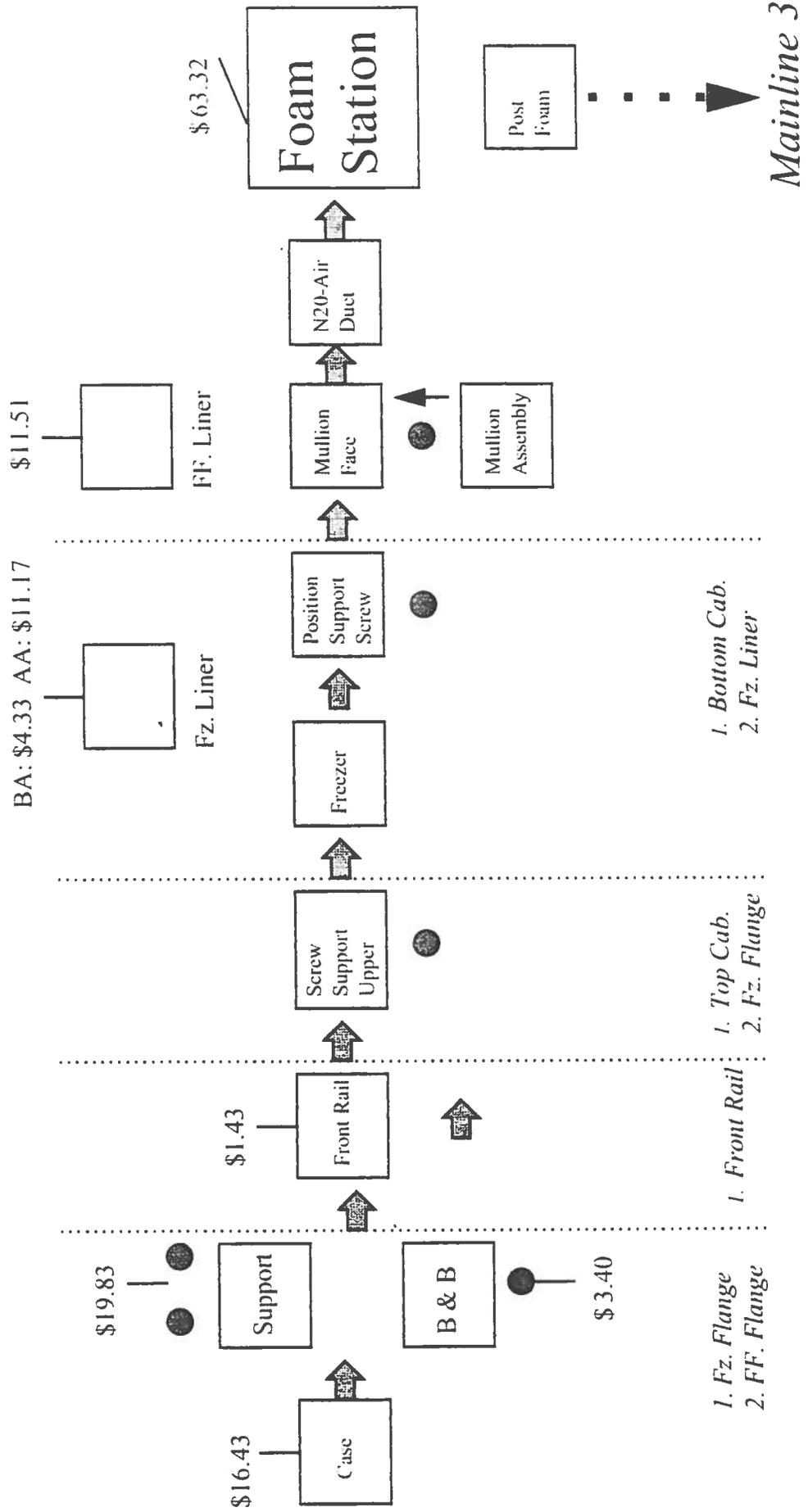
6. Repair



Refrigerator Diagram:



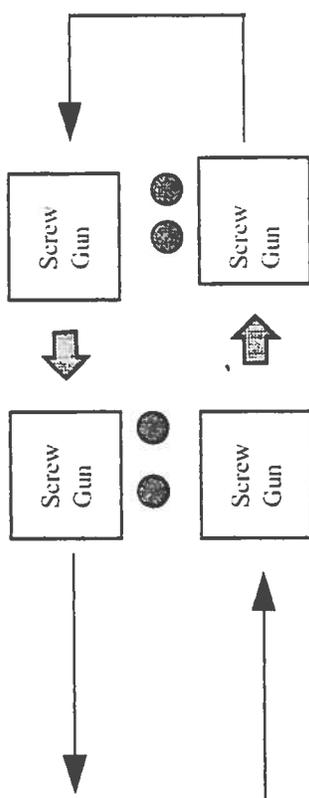
Case Line - Line 3



Main Line 3

\$ 300

EOLA



\$125.67

Post Foam

F 36
Gun
Screw

F 31
Gun
Screw

F26
Cold Control
Gun Screw

F45
Gun
Screw

P13
Gun
Screw

Heater
Wire

- 1. Fz. Flange
- 1. Front Rails
- 1. Mullion
- 2. Fz. Flange
- 3. Ff. Flange
- 1. Mullion
- 2. Fz. Flange
- 3. Ff. Flange
- 1. Mullion
- 2. Fz. Flange



FORMULATE SOLUTION

Preliminary Findings

By January 1997, we identified 19 issues and presented recommendations to the Shop Manager in order to improve the process and reduce the As-Is problem. The following are actions that we identified but had difficulty implementing:

- Place a foam covering over the screwguns, especially in the back & bottom area to prevent sharp metal from scratching the cabinet.
- Install workstation instructions to emphasize that all operators should be cautious when using any sharp instruments that might cause the cabinet to be labeled As-Is.
- Recommend to the Business Team Leader to use radios as a tool of effective communication.
- Form a voluntary team that has one or two people responsible for the top six As-Is problems. These people would meet once a month to report on progress/update.
- Apply a drape curtain in the Caseline "L" braze support area as well as the back & bottom workstation to prevent scratching on the flange caused by metal supports and back & bottom installation.
- Use closed pouches for the screwguns on the mainline to prevent scratches on the case while the gun is in the holder.
- Check recycled screws before using them to avoid screw gun slippage.
- Check into using a flat screws in the mullion area instead of pointed ones.

As we communicated each of these actions with the individuals that are going to be affected, we realized that some of the actions are not feasible. Others, such as the flat screws in the mullion area, are already being addressed by changing to an entirely new mullion design. The recommendation was made to the business team leader to use more radios before and after the foam station area; however, the suggestion was not implemented by the Quality Analyst. Even though a voluntary team was a good idea, there was no one who would take the responsibility to coordinate the activity. The Industrial Engineer thought the drape curtain was a good idea and supported it; however, later on it was found out that a six sigma team was already addressing the issue. This was an example of the lack of communication in the facility. The closed pouches were reviewed; however, due to the number of screwgun changes that occur on the line, it was impossible to use closed pouches. The guns are different sizes, and this is the reason the open pouched guns were bought for the assembly line.

Final Findings to Reduce Line 3 Visual Scrap Defects

#	Findings	Responsible	Timing
✓ 1	<p>Put out Newsletter (poster). To educate operators on the impact of producing an As-Is cabinet. To make sure that they understand GE's policy on that the cabinet should be scrapped out as close to the beginning of the process as possible. Convey that creating an As-Is is unacceptable if it can be scrapped out. Also, educate the BTL that this is the policy of the company.</p> <p>Case Line..... Mainline.....</p>	<p>Heidi.W Renee.S Hagood.N Thio. Y</p>	2/27/97
✓ 2	<p>Develop a cleanup procedure check sheet (ISO document) in the foam station areas. To ensure that the person in the foam station area need to clean up foam equipment (Initial check sheet - 5 times/ day).</p>	<p>Hagood.N Thio. Y</p>	3/7/97
3	<p>Find an environmentally safe touch up paint for the flange, liner, mullions, and front rails.</p>	<p>Brown. A</p>	6/2/97
4	<p>Analyze the mechanism of the conveyor in the repair area/near PQA loop and design a back support to avoid dents.</p>	<p>Johnson.M</p>	4/28/97
5	<p>Place rubber or tape in the Vacform delivery conveyor system. To protect from scratches on the inside of the liners.</p>	<p>Bragwell.T</p>	6/20/97
6	<p>Redesign - 'L' braze support & Back & bottom workstation To prevent scratching on the flange cause by metal supports and back & bottom installation.</p>	<p>Nicholas.C</p>	7/25/97
7	<p>Install carpet on the floor in the vacform area To eliminate dirty liners going into the regrinding machines. This will help with the black spots found on the liners after they are formed (contamination)</p>	<p>Floyd.G</p>	5/16/97
✓ 8	<p>Educate operators in Vacform and mainline deck on the 2nd floor to check for scratches in liners before sending them to the floor. (communication)</p>	<p>Carlisle.G</p>	3/21/97
9	<p>Guide the operator to communicate accidental occurrence in the grinder area. To avoid dropping any material in the grinder. (Monthly/weekly awareness between BTL & operators) For example: flash light, wood, broom, etc.</p>	<p>Neal. L</p>	4/11/97
10	<p>Improvements on mullion to help scratches.</p>	<p>Higdon.D</p>	6/27/97
11	<p>Twisted drill bits shatter & cause small as well as large scratches on the refer. The bits also shatter and cause scratches on the refer.</p>	<p>Brian .H Joyce (2nd)</p>	4/18/97
12	<p>Modify back & bottom gun with 2 screws sticking out of the top of the gun to eliminate dents in the top of the case at that station.</p>	<p>Gary Carlisle</p>	5/30/97
13	<p>Some case blanks on line 3 have scratches & dents in them before they are formed. They are coming from the machine on line 2.</p>	<p>Steve Slaten</p>	4/4/97



CONCLUSION

Summary Results

The implementation of these projects will provide General Electric with a better understanding of the impact of producing an As-Is cabinet. It will also decrease the number of cabinets sent to the dealers in the first place. The As Is program was initiated in order to sell a non-repairable visual defective product to an As-Is dealer for a lower cost. These defects do not influence the performance of the refrigerator; however, they fail the appearance standards. The project was designed to evaluate and observe the process on line 3, and then formulate possible solutions/recommendations to the problems. The next step was to take these findings and assign some of them to six sigma teams to incorporate into their projects. Also, other solutions were given to the senior design students in order to provide them with experience, as well as to acquire an understanding of implementing projects in a company.

In summary, the following conclusions were made:

- A foam station check sheet was the key to providing a way for the foam stations to be cleaned in a timely manner. This will reduce the As-Is costs by 30% (\$90K).
- The As-Is newsletter was very important because it gave the operators on the process line a better understanding of the As-Is product, its impact to the company, and possible prevention methods.

Economic Analysis

This project dealt with evaluating the line and presenting suggestions to reduce the number of As-Is products produced in the factory. After formulating these findings, the next step was to incorporate these projects into the six sigma teams that were working on that area of the plant. The priorities of these projects on the six sigma teams varied from one team to the other. The economic analysis cannot be calculated in a definite dollar figure of savings until all of the projects have been implemented by these teams. Also, at the beginning of this year, the General Electric Plant in Decatur eliminated the As-Is program completely. Now all the cabinets with non-repairable defects are being scraped out instead of being sold to a dealer. However, all of the programs that have been identified to improve the process still apply and will be implemented. We are unable to use the database to evaluate the impact of our solutions on the production floor. The foam station check sheet, that has already been implemented, is expected to reduce the number of "As-Is" cabinets by at least 30% since it was the number one problem on the list. This would be approximately ninety thousand dollars. When all of the projects are implemented, it should save the company approximately two hundred thousand dollars.

Lessons Learned

This project provided many learning experiences that proved to be frustrating yet challenging. The first challenge was to understand that the real world seems to only want to make money. It does not matter whether a project is the best solution to a problem. The question is how much it will cost the company to implement it and how much return they can get from it. Instead of initiating long term goals for the company, they seem to look at what will make money now. Another lesson learned was that communication and teamwork is vital to any organization. If people work as a team and communicate between teams, projects will get done a lot faster and be more effective. Also, if the employees that will be affected by a project are included in the decisions, then they will be more willing to work with the changes instead of against them. Third, an employee has to continually be looking for changes to occur. There is no guarantee that his or her job will be there the next day. During our project, the plant manager as well as a staff manager underneath him, were fired and told to have their belongings out before Monday morning. Afterwards, other jobs were in jeopardy and none of them knew whether they would have a job from one day to the next. The realization that this could happen at any company at any time was very real after this incident. Therefore, the project was left to be finished without a supervisor.

Areas for Further Research

There are a couple of areas which would be beneficial for future research. One is looking into a way to keep up with the age of the screws recycled in the plant. This would prevent screws from stripping while putting them in the refrigerator. Two screws have to be driven into the refrigerator to plug up the door hinge holes before the cabinet goes through the foam stations. These screws are taken out further down the line and recycled over and over again. This causes scratches on the top of the refrigerator that have to be touched up down the line. Another area to improve would be the communication between management and employees within the plant. If employees are not given any feedback on whether they are doing their job right or wrong, then they start to think that no one really cares whether it is done correctly or not. This prevents the company from being productive and unified as a team. Everyone should be on the same team, working to improve the product as well as the process. Therefore, everyone should know what is going on inside the plant.



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