University of Michigan Hospitals Laundry Services
Final Report for Soiled Linen Storage and Handling
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Management Systems Department

For Tom Peterson, Manager, Laundry Service

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**Executive Summary**

The purpose of this project was to find viable alternatives to the fact that each bag of soiled linen is double or triple handled on the dock of the Laundry Services plant. This triple handling is caused by a severe lack of storage space, and the fact that the plant operates five days a week while soiled linen is received seven days a week.

During the data collection stage of the project, two other institutions (St. Catherine - McAuley and Henry Ford Hospitals) were contacted to learn what types of systems they used and what problems they were experiencing, if any. Also, two vendors of laundry systems were contacted to find out what alternatives they had to offer. Also, the linen process was flowcharted from it's start at the hospitals to it's finish at the plant.

The alternatives produced were evaluated on the following criteria: Increase in Capacity, Cost, Effects on Production, Flow Implications, Acceptability by Employees, and Ease of Implementation.

Some alternatives were not examined. Since the plant is nearly able to handle the amount of clean linen needed (by running overtime quite often), the processing portion of the plant is not in need of additions. Also, since the plant is classified under Alternative Revenue, it is assumed that they may one day want to add another shift or some such in order to contract in laundry from other institutions. This rules out the alternative of contracting out the laundry produced on the weekends, since these outside sources would then be making profit off the plant, instead of vice versa. This also rules out the alternative of joining a co-op with other hospitals, since this removes the opportunity for alternative revenue.

Although there is no room for soiled linen storage, the rest of the plant has plenty of space for operation. This makes it unpractical to move the entire operation to a larger building, such as leased property.

There were four alternatives that were considered. The first was a building addition alone, to provide for the complete storage of all the laundry received over the weekend. This would require an addition of 2912 square feet and the purchasing of 63 new carts for a total of $124,800. This alternative would solve the triple handling and storage problem, but would have no effect on production. By eliminating the triple handling, one FTE currently used on the dock would be recovered, for an savings of $26,000.

The second alternative was the removal of the current hook/rail system and the implementation of a new conveyor belt system. This system would be able to store all the excess linen in conveyors above the plant. The initial cost would be about $175,000 to $200,000 dollars. This system would also have no effect on production, but would recover 1.5 FTE's from the dock, for an annual savings of almost $39,000 a year.

The third alternative was the altering of staffing. Three such plans were examined. These include operating the plant at full capacity all weekend by staggering the current staff work weeks, adding 15 part-time workers to run bulk
items on the weekends, or staggering shifts during the day to keep the plant in operation longer. The first and third option are quite costly over the long run. The second option is the least expensive of the three, but it would not completely process all the laundry received over the weekend. Although production would be increased and shortages eliminated there would still be a need for some storage space.

This leads to the fourth alternative, running a 15 person crew on weekends with the addition of a smaller space for the storage of incoming soiled linen. It is estimated that the 15 person crew can process 28,000 pounds of the 34,000 pounds expected over the weekend. This leaves a need for the storage of 6,000 pounds of soiled linen. Allowing for heavier weekends, an addition of 1100 square feet could accommodate 10,000 pounds of soiled linen. The estimated cost of the crew is $144,000 annually. The cost of the addition is estimated to be $38,500. The savings of one FTE from the dock area amounts to $26,000 dollars.

This alternative solves the problem of triple handling the soiled linen, provides ample storage space, increases plant production to reduce shortages, and relieves pressure on the entire system, eliminating backups at the plant and at the hospitals. This is the alternative the project group believes is the most viable solution and offers the most to several areas of improvement.
# TABLE OF CONTENTS

**INTRODUCTION**
- Purpose of Project
- Background Information

**APPROACH AND METHODOLOGY**
- Data Collection
- Production of Proposed Solutions
- Evaluation of Proposed Solutions

**CURRENT SITUATION**

**ALTERNATIVES CONSIDERED**

**ALTERNATIVE I - BUILDING ADDITION**

**ALTERNATIVE II - NEW CONVEYOR BELT SYSTEM**

**ALTERNATIVE III - STAFFING**
- Seven Day Work Week
- Part-time Staff
- Afternoon Staff

**ALTERNATIVE IV - PART-TIME STAFFING AND SMALL BUILDING ADDITION**

**RECOMMENDATIONS**

**PLAN OF ACTION**

**APPENDICES**
INTRODUCTION

Purpose of Project:

The purpose of this project is to find the most viable alternative to two areas offering an opportunity for improvement. The first issue is that all the soiled linen coming into the laundry services plant is double or triple-handled by the plant's employees before it is processed. This stems from the second issue, a severe lack of storage space for soiled linen. The goal is to find a system that will allow maximum storage of soiled linen apart from the clean linen area with the minimum amount of manual handling involved.

Background Information:

The laundry services plant operates five days a week, with one shift per day (from 6 am to 2:30 pm). Often, the plant will work an extra day on Saturday. The main customer, the University of Michigan Hospitals, delivers soiled linen to the plant seven days a week. In the current system, the linen is brought in over the weekend and stacked wherever the drivers can find space to put it. The dock area is too small to handle this flow, and the laundry is stored in mass quantities in the aisle ways of the plant. Once all the carts are filled, the drivers must remove the bags from the carts and pile them on the floor in order to bring empty carts back to the hospitals. This creates massive piles of linen stacked in the aisles and on the dock. The plant then works at a steady pace all week, and by Friday or Saturday the excessive pile of soiled linen bags is significantly reduced. However, during the week, the workers who load the current hook/rail system must spend much of their time loading soiled linen bags off the floor where they are piled back into carts. These carts are then pulled over to the system loading area, where the bags are taken from the carts and placed on the hooks. The soiled linen causes inconvenience in the aisle ways and, since it is very near the processing point of the clean linen, the possibility of violating health codes is increased. Also, it takes a long time for the linen on the bottom of the pile to be processed, causing an increase in stained linen.

APPROACH AND METHDOLOLGY

Data Collection:
The first and most important step was gathering data about the current process. To find the bottle necks in the system, the entire soiled linen path was flow charted from it's start at the hospitals to it's processing at the plant (for Flowchart see Appendix #1). This provided an in depth understanding of the current situation.

Next, data was collected on the capacity and costs of the current hook/rail system and it's components, including the carts.

Finally, data on current staffing and output was acquired. Time trials were used to determine how much time the dock workers spent emptying carts on to the floor and reloading them off the floor. Current statistics on machine outputs and staffing requirements were gathered in order to determine the smallest crew able to operate the plant.

Production of Proposed Solutions:

The next step in the process was to take the knowledge gained through flowcharting and data collection to generate viable alternatives. Many ideas occurred during the data collection stage. Other alternatives were suggested by the client, Tom Peterson, during weekly meetings with him.

Also at this point, other area institutions were contacted, including Henry Ford Hospital and the co-op plant used by St. Catherine McAuley Hospitals. The purpose of this was to find out how their system works, what type of equipment they use, and what problems they were having, if any.

Finally, two vendors of laundry systems were contacted, Rapistan of Grand Rapids, Michigan, and R. W. Martin and Sons of Kent, Ohio. All this would help to uncover solutions which might not have been apparent, and also show the success or failure of ones that were.

Evaluation of Proposed Solutions:

The final step was to evaluate each proposed alternative using the criteria formulated in the previous steps and discussions with the client. These evaluation criteria are as follows:

**Increase in Capacity:** Does the solution solve the storage problems?

**Cost:** A very significant factor. Includes Initial Cost of system, Annual cost, and Other Cost Implications.

**Effects on Production:** Does the solution increase the output of the plant?

**Flow Implications:** Does it smooth out the linen flow from it's start at the hospitals to the end of it's processing?
Acceptability by employees: Will there be problems for the employees to adjust to the new system?

Ease of Implementation: Will it hinder production during implementation?

Other Considerations: Will it affect any other aspects of the process such as the types of bags used, hospital workers, etc...

Using these criteria all of the proposed solutions will be evaluated and compared, and then a recommendation can be made about the optimal solution.

Current Situation

The project group was charged with trying to find viable alternatives to alleviate the triple handling of soiled linen bags on the plant dock. Several factors attribute to this problem:

Storage Space Nonexistent:

Huge backups occur throughout because there is no space in the entire system for the storage of soiled linen awaiting processing. This is the largest factor in finding an alternative.

To understand how and why these backups occur, the interaction between the hospitals and laundry service must be looked at. First, the hospital requests a certain number of empty carts at certain times in the day. The laundry is supposed to send these carts at the correct times and have them filled by the hospitals. The carts are then sent back to the laundry service to be processed. At that point the laundry should have enough carts emptied to go back to the hospital for another load.

One problem is that these carts often are not ready. This occurs because the dock workers alternate between emptying carts and picking laundry up off the floor to try and reduce these piles. In order to fill the trucks with empty carts, the full carts are unloaded back on the piles on the floor. This causes a cycle in which the linen on the bottom of the pile never gets processed until the end of the week, when the laundry service begins to catch up.

Due to the delays in receiving empty carts, backups begin to occur in the hospitals. Piles of soiled linen similar to those at the plant begin to take up the limited dock space at Mott's. An average of 10 to 20 robo carts, with the number getting as high as 50 or 60 on the weekends, begin to line the hallways in the basement of the Main
hospital. Not only does this take up needed space but it also puts a strain on the robo system as it becomes short of needed carts. So, it can be seen that the current problem that the laundry services plant is having is not an isolated problem and that among all stages of the laundry process the system is lacking in it’s ability to accommodate excess soiled linen.

Increased Expectations:

When the plant was originally planned, it was designed for production of approximately 100,000 lbs of laundry per week. Now it is currently being asked to produce between 120,000 and 130,000 lbs per week. This higher demand for laundry is the main reason for shortages which occur way too frequently and subsequently, the large amount of overtime currently being worked. The current system cannot keep up with the expectations placed upon it. This causes backups of dirty linen and shortages of clean linen.

Pneumatic Tube:

One aspect of the process which may effect any proposed system changes is that the Main hospital uses a pneumatic tube to transport the bags of soiled linen from the decontamination room in the basement to the dock. This tube requires sturdy bags or it will destroy them, thus this must be considered before any system changes involving changes in bags can be implemented.

Upkeep of Old System:

Another important issue to be addressed is the age and unreliability of the old hook/rail system. Since it has been operational since the 1960s, the system is beginning to give the plant problems with breakdowns and upkeep is getting more expensive. In addition, parts for the system are very expensive and this increases the problem. The system is currently costing the plant about $1000/year in upkeep in parts and if kept in operation a $1000 chain oiler must be purchased. In addition, a new chain will need to be purchased in the near future.

Excessive Overtime Hours:

Since the plant has to process much more linen than was planned in order to meet the hospitals needs, it has to operate on Saturdays, paying out overtime, quite frequently. In the nearly seven month period from September of 1990 to the middle of March 1991, the plant was in operation 21 out of 29 Saturdays. This results in quite a large sum of wasted money for the plant (for exact overtime figures see appendix #2).
Alternatives Considered

Before examining the alternatives being considered, several alternatives being ruled out must be discussed. Since the plant is nearly able to handle the amount of clean linen needed by running overtime, the processing portion of the plant is not in need of additions. Also, since the Laundry Service is classified under Alternative Revenue, it is assumed that the plant may one day want to add another shift or some such in order to contract in laundry from other institutions. This rules out the alternative of contracting excess linen out, since these outside sources would then be making profit off the plant, instead of vice versa. This also rules out the alternative of joining a co-op with other hospitals, since this removes the opportunity for alternative revenue from the plant.

Although there is no room for soiled linen storage, the rest of the plant has plenty of space for operation. This makes it unpractical to move the entire operation to a larger building, such as leased property. Since the triple-handling of linen can be solved without complete restructuring of the Laundry Services, the afore mentioned alternatives have been ruled out, while the following have been considered in more detail:

Alternative I - Building Addition

The purpose of a building addition is to provide enough storage capacity over hours of non-operation to alleviate the need for emptying loaded soild carts onto the floor. This would be accomplished by allowing enough room for all the incoming full carts and space for enough empty carts to be reloaded on the trucks.

As trucks arrive with soiled linen carts, the carts would be pulled into the new addition and lined up 4 carts deep along the outside wall furthest from the entrance. Empty carts lined along the inner wall could then be reloaded on the truck. This would continue with each additional arrival. The hook loader would then pull the carts furthest from the entrance over to the current dock area, unload the cart and line it up along the inner wall of the addition closest to the door.

Increase in Capacity

With an average of 17,700 pounds of soiled linen arriving daily, this system must accommodate an average of 35,400 pounds for the two day period of Saturday and Sunday when the plant is not in operation (See appendix #3 for complete computations of these figures). At worst case, this figure becomes 43,300 pounds. This number is obtained by allowing two standard deviations to accommodate the days where the actual incoming flow exceeds the average. This number will be used to assure that the new addition can accommodate even the heaviest flow. This also leaves a little leeway...
during the average week to keep stress off the system and make sure it flows correctly. A building addition 32 feet wide and 91 long would accommodate this amount of linen. Each cart can hold an average of 290 pounds of soiled linen. This requires an average of 150 carts to store the linen backed-up over the weekend.

**Cost**

**Initial Cost:**

In keeping with the current construction type of the building, the cost is estimated to be $35 per square foot (this may vary slightly according to area codes, permit costs, etc.). The square footage of the addition is 2912 square feet. This brings the estimated cost of the addition to $102,000.

In order for this system to flow correctly, 183 carts are needed. There are currently 120 carts in the system. The cost for 63 new carts at a price of $345 each, is $21,800.

The only other costs for this alternative would be for the new parts mentioned above that are needed for the current hook/rail system.

This brings the total initial cost of this alternative to $124,800.

**Annual Costs:**

The annual costs would be an estimated $1000 for upkeep of the current hook/rail system, plus negligible upkeep on the building addition.

**Other Cost Considerations:**

The two full-time hook loaders spend one-half of their time unloading full carts onto the floor (to be loaded on trucks and brought over to the hospitals) and reloading bags off the floor onto carts to be moved over to the hook system. All of this will be avoided with a building addition, allowing the recovery of one FTE. This is a savings of nearly $26,000 per year (For complete computation of reduction in labor savings, see Appendix #4).

**Effects on Production**

This alternative would have no effect on production rates.

**Flow Implications**
This building addition alternative allows a much better flow of soiled linen after it is received at the plant. If the routine described above is followed, it creates a first-in-first-out queueing system. This means the first soiled linen brought into the plant will be the first linen processed. As the case is now, the first linen brought in is processed last, as it is on the bottom of the pile. The new system is an improvement both in terms of sanitary conditions and in that there will be an undetermined amount of savings in linen that would otherwise end up stained from sitting on the bottom of the pile too long.

This system also would alleviate pressure on the other end of the system for the hospitals. Since all the soiled linen will be stored at the plant, there should be no back up at the hospitals. The Main hospital will have 18 carts on it's dock and Mott's will have 15. When these are filled, the trucks will bring an equal amount of empty carts over to the hospital and bring the full carts back to the plant. This will leave all the robo carts currently used for storing soiled linen at the Main hospital available for other uses. It will also alleviate the back up problem on the dock at Mott's.

Ease of Implementation

This alternative does not present any problems in implementation. If this alternative is chosen, blue prints should be ordered up, to start, and then open the project for bidding. The new carts should be ordered in advance, according to how long it will take to receive them, so that they arrive soon after completion of the new addition. This should be done to keep the new system flowing correctly from the start. The construction of the addition should not affect the normal operation of the plant in any way.

Acceptability by Employees:

This alternative should not pose any labor relation problems. The excess dock worker can be put to work in other parts of the plant as needed. Thus, no jobs will be lost due to the building addition.

Alternative II - New Conveyor Belt System

Another alternative which would address the current storage problem is the replacement of the hook/rail system with a new system. In order to determine what type of system would be best for the plant's situation an outside laundry systems company, with experience in this area, would have to be consulted. Prior to our investigation, it was found that this had already been done by the plant. A laundry systems company, R.W. Martin & Sons, has looked at the current situation at the plant and proposed a customized conveyor belt laundry system to best suit the needs of the U of M laundry. In this
system, the laundry would be loaded onto the conveyors directly from the carts via a cart dumper, and then proceed up to the sorting room on a series of conveyor belts. In the sorting room, the conveyor would split into three separate conveyors, each with almost four foot tall side panels. The primary benefit of this solution is that this system would be capable of accommodating a great deal of excess linen within itself and thus reduce the need for linen storage elsewhere in the plant. In addition, because the linen would be stored directly on the system, the waste of labor caused by the current triple handling of the bags would also be eliminated.

Capacity

To measure the approximate capacity of this system the total cubic footage of storage space was computed and then that space capacity was compared to the average maximum excess of laundry for a Monday morning to see if it could accommodate all the excess laundry. It was found that the total space capacity of the conveyor belt system was 5,894.95 cubic feet. (For complete space computations see appendix #5) Then we computed the average excess laundry which is present on Monday mornings and found it to be approximately 35,500 lbs. (For complete laundry computations see appendix #3) Using an equation of 7.5 lb of linen per cubic foot obtained from the manufacturer, the calculated capacity of the system would be 39,712 lbs. This is over four thousand pounds greater than the average maximum excess of laundry. The system has the capacity to accommodate the excess linen at the plant.

Cost

Initial Cost:

The estimated cost of the system as given by the manufacturer would be between $175,000 and $200,000. With this would come the complete conveyor system, two control panels located in the loading area and sorting room, assembly and set-up, training of employees to run the new system, and also a 1 year warranty on manufacturer parts. The only thing which this does not cover is the removal of the old hook/rail system which would be the responsibility of the plant.

Annual Costs:

The upkeep of the new system would be the only annual costs.

Other Cost Implications:

One of the main cost advantages of the new conveyor belt system is that it eliminates much of the wasted labor which the laundry
service was using to load the soiled linen bags onto the hook/rail system. Due to the ease and speed of loading which the cart dumper will provide, the number of loaders needed will be reduced from two to one, and even that one loader will not be occupied for more than half the day. This employee will then be freed up to work elsewhere in the plant. This reduction in labor will save the plant almost $39,000 per year. (For complete computation of reduction in labor savings see appendix #4)

Another cost advantage provided by the conveyor belt system would be the upkeep cost of the hook/rail system would be eliminated. Since the hook/rail system has been in operation since the 1960s its upkeep costs are getting higher and the parts for the system are quite expensive. By removing this system these costs are also saved. Also, the current hook/rail system would have some undetermined salvage value.

Effects on Production

The implementation of the new conveyor belt system will not have an effect on the production of the plant. Since the bottleneck in the process comes at the ironing machines, the new system will not increase production at all. Due to this, the plant will still be running at a capacity less than the hospital requires and despite an elimination of the laundry backup problem, all of the shortage problems to the hospital will remain.

Another aspect of the new system is that the current process of opening bags and letting the clothes fall out will not work anymore. The sorters are now going to have to pick the bags up, open them and shake the clothes out, or a new type of bag will have to be used. If the same bags are maintained, then the sorters may not be too appreciative of the new system. If the bag types are changed, aspects such as the pneumatic tube system of the hospital and the ability to go through the ironers must be considered.

Flow Considerations

Another very important quality of the conveyor belt proposal is that it would smooth the flow of the laundry quite a bit. Since the cart dumper would be able to empty the carts much faster than could be done by hand, the empty carts can be returned to the hospital faster than before. Also, the lack of excess laundry throughout the plant would free up more space for some storage of extra carts to be sent to the main hospital and to Mott's. Due to this, there would be much less backup in the hospitals, as the hospitals would be able to get rid of their laundry much more quickly.

Acceptability by Employees
There should be no problems with the employees excepting this new system, except for the sorters. Their job will be a little more physical, because they must now pick up each bag in order to empty the soiled linen. Before, this lifting was done on the dock by the loaders.

**Ease of Implementation**

The conveyor belt system would take approximately a week to implement fully. However, during this time the plant would still be operation. By working after the plant closes at 2:30pm, the system can be installed without hindering production. The only adjustment which would have to be made is that the soiled linen bags would have to come up to the sorting room via carts on the elevator during that week.

**Alternative III - Staffing**

The most straightforward and yet most costly method of addressing the problems of the plant would be to change the staffing by increasing it and expanding it to cover the weekends. However, it is understood that this option is a very costly one and so there has been an attempt to keep this cost to a minimum by devising a few different alternative staffing changes to see how they compare to the other alternative improvements. The three options come up with were operating seven days a week full time, keeping the schedule at five days a week but hiring a small part time staff to work on weekends, or to keep the schedule at five days a week and have the work day extend beyond 2:30 pm. However, it seems that all three alternatives have serious problems with at least one of the criteria. The following overview of each will indicate where these problems lie.

**Seven Day Work Week**

In this proposal the plant would run on Saturdays and Sundays with a full time staff just as it does during the week. This would be done by either hiring more full time workers and staggering their shifts to accommodate the change or hiring part time workers to work only on the weekends.

**Capacity**

Although this solution will not add any storage space to the system, it will eliminate any need for additional storage of soiled linen. By working a full shift on both Saturday and Sunday there will be no excessive laundry on Monday mornings and no gluts formed by lack of production. Ideally, this solution will keep the stored soiled linen to a minimum.
Cost

The cost of increasing the plant’s work week from five to seven days will be quite large. Not only will the extra workers be a great expense but also the utilities costs of keeping the plant open the extra two days will be expensive.

Annual Cost:

The annual costs of this solution can be broken down into two sections, the labor cost and the maintenance cost. The labor cost will come to approximately $603,200 per year and the maintenance costs will come to about $78,000 per year. By adding these, a final annual cost of approximately $681,200 per year is obtained. (For complete calculations of both labor and utilities costs see Appendix # 7)

However, with this plan there are certain cost advantages. First, and most importantly, all of the overtime costs of working extra days on Saturdays will be eliminated. For the last year this amounted to $203,809. (For complete overtime data see Appendix # 2) In addition all of the maintenance costs for those days must be removed from our costs. This amounts to approximately $29,250. With the elimination of these costs, our new total annual cost becomes $448,141 per year.

Other Cost Implications:

The only other cost implication is one which this solution has in common with all of the other staffing solutions proposed. The old rail and hook system will have to be kept and as a result, all of the upkeep costs for it will have to be incurred.

Effects on Production

By implementing a seven day work week the production of the plant will increase by 40%. This means all of the linen necessary will be processed by the plant in a week. (For complete capacity calculations see Appendix # 8) This will result in a complete lack of pile-ups in the system and lack of shortages to the hospital. In fact, with the plant working seven days a week, they will actually be working below capacity per day (Doing 17,700 lbs per day instead of the 23,000 that it is capable of).

Flow Implications

The lack of a major glut in the system at any time will greatly improve the flow of the system. However, if there are any problems with production which are unexpected, the plant will still not have the capacity to store more than a few excess bags of laundry.
Acceptability by Employees

Besides the cost, the biggest problem with this solution is the fact that it will be very difficult to staff these weekend shifts. If it is decided to stagger the shifts of the current workers and just add some more than there will be a lot of unhappiness at having Tuesday-Saturday or even Wednesday-Sunday shifts. If entire new crews of part-time workers are brought in to fill the weekend shifts it will be difficult to find 55-60 people who would like to work part-time on the weekends. These problems, although not seemingly insurmountable, could cause major problems with the implementation of this change.

Ease of Implementation

As mentioned before, the ease of implementation for this change will depend wholly on whether or not the employees can be found and the change can be made acceptable to them.

Part-Time Staff

The second option looked at was having a part time staff come in and work a half-crew shift of 8 hours on both Saturday and Sunday. These workers could do only bulk items such as sheets and blankets, and as a result only have a shift consisting of fourteen workers. (For complete part-staff schedule see Appendix # 9)

Capacity

Like all the other staffing solutions, this option does not increase the storage of the actual plant but it attempts to reduce the need for the storage by increasing production and keeping the flow smooth. Unlike the full-time solution, the need for storage is not completely eliminated by this solution. In fact, over the weekend a glut of approximately 6,000 lbs of laundry will still accumulate. However, this is much better than the 35,400 lbs which were there before.

Cost

The cost of this solution is much less than the cost of the full-time solution due to a decreased labor cost.

Annual Cost:

Since the part-staff schedule equals approximately ? FTEs the cost will be approximately $144,000 per year. Adding this to the additional utilities costs of $ 48,425 per year we get a total annual cost
of $192,425 per year. (For complete calculations of both labor and utilities costs see Appendix # 7)

However, with this plan there are also the cost advantages which came with the full-time schedule. All of the overtime costs of working extra days on Saturdays will be eliminated, and all of the maintenance costs for those days must be removed from our costs. As before these add up to a total of $233,059 saved per year. This makes our new annual cost approximately - $40,634 per year. We would actually make money.

Other Cost Implications:

The only other cost implication is again the one which this solution has in common with all of the other staffing solutions proposed. The old hook/rail system will have to be kept and as a result, all of the upkeep costs for it will have to be incurred.

Effects on Production

The effect this solution has on production will be far less dramatic than the full-time solution but it will still be quite significant. The production of the plant will increase by a significant amount during the weekend (For complete production analysis calculations see Appendix # 8). However, this will not be enough to avoid a bit of a pile-up by Monday morning. The reason for this is that the plant will be processing about 14,400 lbs of laundry per weekend day as opposed to the 17,700 lbs of laundry coming in, so the excess will have to be stored and done early the following week.

Flow Implications

The flow between the hospital and the plant will be smoothed a good deal by the addition of Saturday and Sunday work days. Although the plant will not run at full capacity during the weekend, the huge pile-ups found on Monday mornings will be greatly reduced by this process.

Acceptability by Employees

The major problem with this solution is going to be the feasibility of obtaining part-time labor for only the weekends. For the current employees of the plant, the acceptance should be fine because their workload will actually decrease and the inconvenient storage problems will be reduced. However, this is contingent on the ability to find the fifteen required employees to fill the part-time positions.

Ease of Implementation
To implement this plan of action would only require a few things. First, the new part-time staff would have to be hired and then trained to handle their respective jobs. Following this, all that would be needed is to begin running the weekend shifts and observing the results.

**Afternoon Staff**

The main objective of adding a afternoon shift would be to increase production during the week by extending the work day from eight hours of production to ten hours of production. The effects of this would be to enable the plant to finish their production by Friday thus eliminating any need for overtime. (For complete afternoon staff schedule see Appendix # 10)

**Capacity**

The storage capacity of the plant will not increase at all, and by continuing to not work on the weekends, the pile-ups of Monday mornings will still be apparent.

**Cost**

The primary cost of implementing this solution would be the additional labor cost it would entail. In addition there would also be some extra maintenance costs for keeping the plant operating an extra two hours per day.

**Annual Costs:**

The biggest annual cost would be the addition of the 7 extra FTEs in the plant. This would cost approximately $168,000/year. In addition there would be maintenance costs of approximately $125 more per day or $32,625 per year. Thus, the total annual cost of this plan would be $200,625 per year. (For cost calculations see Appendix #7)

However, with this plan there are also the cost advantages which came with the full-time and part-time schedules. All of the overtime costs of working extra days on Saturdays will be eliminated, and all of the maintenance costs for those days must be removed from our costs. As before these add up to a total of $233,059 saved per year. This makes our new annual cost approximately -$32,434 per year. Again it seems as if the cost benefits outweigh the annual costs.

**Other Cost Implications:**
The only other cost implication is once again the one which this solution has in common with all of the other staffing solutions proposed. The old rail and hook system will have to be kept and as a result, all of the upkeep costs for it will have to be incurred.

**Effects on Production**

This solution is primarily dealing with an increase in the weekly production of the plant. In does this by increasing the production of the plant by approximately 3,882 lbs per day or 19,410 lbs per week. (For complete capacity calculations see Appendix # 8) Due to the fact that we cannot pinpoint the increase in production by having more staff these numbers are very approximate, and if this plan was implemented there would have to be data collection done to see how accurate it actually was.

**Flow Implications**

The flow between the plant and the hospital will not be improved greatly by this plan because of the fact that the weekends will still be causing major backups in the plant, and as a result, in the hospital.

**Acceptability by Employees**

The only foreseeable problem with this plan is that the sorters are going to have to sort clothes for ten hours of production as opposed to eight hours of production. They might not appreciate their workload being increased in this manner. However, other than this there are no major acceptability problems with this solution.

**Ease of Implementation**

This plan can be implemented very easily provided that the new workers can be found and trained easily. We believe that this should not be a problem and so the plan could be implemented as quickly as possible.

**Alternative IV - Part-time Staffing and Small Building Addition**

This alternative would combine option two of the staffing alternative, the 15 person crew, with the addition of a small building to accommodate the decreased amount of excess linen accumulated over the weekend.

**Increase in Capacity**
As mentioned before, the 15 person crew could process approximately 14,000 pounds of laundry per day, for a total of 28,000 pounds over the weekend. With the plant receiving an average of 34,000 pounds per weekend, this leaves an excess of 6,000 pounds of soiled linen. To accommodate this, a building addition of 1100 square feet would be added. This building would be 22 feet by 50 feet, and would provide space enough for the storage of 10,000 pounds of linen in 35 carts, plus room 18 empty carts, and 3.5 feet of extra space to keep carts from getting crushed too close together. No new carts would be needed for this alternative.

**Cost**

**Initial Cost:**

The initial cost of the building, estimated to be $35 per square foot to be consistent with the current building structure, would be $38,500. This would be the only initial cost.

**Annual Cost:**

The annual costs of hiring the 15 part-time workers is estimated to be $144,000 (See appendix #7 for complete computations). The upkeep of the current hook/rail system would be the only additional annual cost.

**Other Cost Considerations:**

As mentioned before, the addition of staffing eliminates the need for the plant to work overtime. This creates an annual cost advantage of approximately $203,000 saved by implementing this alternative.

**Effects on Production**

The output of the plant, as before, would be increased by approximately 28,000 pounds of linen per week (See appendix #8 for complete computations).

**Flow Considerations**

This alternative should smooth the flow through the entire linen process. It removes the backup of soiled linen at both the hospitals and the plant dock. It also increases the output of the plant, reducing shortages, and smoothing flow at the hospital receiving end.

**Acceptability by Employees**
There should be no problem with the current employees. The workload is not increased and the neither is the physical aspect of their jobs.

**Ease of Implementation**

No problems can be seen in implementing this alternative except for the possible difficulty in finding part-time workers to fill the weekend spots. The building addition can go up immediately without interrupting or interfering with the current operation of the plant in any way.

**Recommendations**

It is the belief of the project group that Alternative IV, part-time staffing with the smaller building addition, is the best alternative of all those considered. Not only does this system eliminate the double handling of soiled linen by providing ample storage for any excess, it also increases production by nearly 28,000 pounds of linen per week. Although the cost of the new employees is quite high, it is still nearly $60,000 less annually than what is currently being paid to workers for overtime compensation. Not only that, it also will drastically reduce, if not eliminate, the frequent shortages occurring in the current system.

The flow of the entire system is smooth and more even. Dock space and robo carts will not be needed at the hospitals for storage of the soiled linen. The linen will not need to piled on the floors at the plant, eliminating triple handling and cutting back on linen lost due to unremovable stains. Also, since the soiled linen will stored in an addition removed from the clean processing area of the plant, possibilities of health violations are eliminated.

It is this groups recommendation that this alternative be implemented as soon as possible.

**Plan of Action**

In order to implement this, staffing for the part-time crew should be hired as soon as possible, as this will most likely be the most difficult and lengthy task. This crew should be trained immediately, and ideally, most members would have the training to work several stations. These individuals must be reliable, and must be made to understand the importance of showing up every day. The system will begin having troubles on Saturday and Sunday if more than 1 or 2 people miss work on the same day.

At the same time, the process of the building addition can begin. Specifications and prints should be ordered up immediately. After that, bidding should opened and construction begun as soon as possible.
APPENDICES #1
Figure 1. Hospital Flow Chart

Soiled linen from patient rooms is collected and placed in laundry bags

House Keeping collects laundry bags from floor and places on an empty robo cart

Robos deliver soiled linen carts to B2

Filled robo carts are lined up in hallway outside decontamination room

Are there empty laundry carts on the dock? 

Yes

Robo carts brought into decontamination room. Laundry bags transported to dock by pneumatic tube system

Laundry bags drop directly into laundry carts on dock

Laundry carts are stored on dock until truck arrives

No

Filled robo carts back up in hallway

DELAY
Figure 3. Plant Flow Chart, part 2

- Sorted linen is placed in washers
- Linen is placed in dryers
- Linen is pressed
- Linen is placed on conveyor and sent to clean storage area
- Linen is placed on storage racks
- Linen is loaded on carts according to par orders for day
- Carts are stored on dock awaiting trucks
Appendix #2. Plant Overtime

<table>
<thead>
<tr>
<th>Group</th>
<th>Actual amount paid in first 8 months of current fiscal year</th>
<th>Amount projected for 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>P &amp; A employees</td>
<td>$11,976</td>
<td>$17,964</td>
</tr>
<tr>
<td>AFSCME employees</td>
<td>$123,897</td>
<td>$185,845</td>
</tr>
<tr>
<td><strong>Total for 12 months:</strong></td>
<td><strong>$203,809</strong></td>
<td></td>
</tr>
</tbody>
</table>

Projected Amount = \( \frac{4}{3} \) (Amount in 8 months)

Appendix #3. Pounds of Laundry Received per Day

Several collection methods were used to try and record the incoming flow of laundry. These included checking trucking reports and taking hourly samples. All were unsuccessful or inaccurate.

Therefore, it was assumed that the average flow of linen out of the plant for one week was equal to the average flow of linen into the plant for one week. Since the flow should be relatively even for all the days, the average amount coming in per day is equal to the average amount put out per week divided by 7:

\[
\text{Average Flow in per day} = \frac{\text{Average Output/week}}{7}
\]

The weekly outputs were tabulated from the Production Distribution forms kept by laundry services for the period from November 1 of 1990 to March 19 of 1991. The following information was obtained:

- Average Output/week: 123,943 pounds
- Standard of Deviation: 13,787 pounds

Average per day: 17,706 pounds
Worst case = \( \frac{\text{Average per week} + 2 \times \text{Std. Devs.}}{7 \text{ days}} \) = 21,645 pounds

Appendix 4. Building Capacity for
Alternative One

Average Flow In /day = 21,645 pounds
Total for Saturday and Sunday = 0.2 x 21,645 = 43,290 pounds

Ten empty carts were weighed: Average weight of empty cart = 144 pounds
Twenty full carts were weighed: Average weight of full cart = 432 pounds

Average amount of soiled linen per cart = 288 pounds

Total number of carts needed for storage of soiled linen =

Total Flow in for Saturday and Sunday = \( \frac{43,290}{288} = 150 \) carts

The carts 2.5 feet wide and 4 feet long. The width of the building is determined by having 4 rows of soiled linen carts lined up length wise (16 feet), plus a ten foot aisle way for easy mobility, plus one row of empty carts on the inside wall (4 feet), plus 2 feet of spare space, for a total of 32 feet.
The length is determined by having 35 columns of carts width wise, 35 x 2.5 = 87.5 feet, plus 3.5 feet of extra space, for a total of 91 feet.

Appendix 5. Reduction in Labor Savings

Using 31% as the amount of benefits paid on a yearly wage, the following is obtained:

For Building Alternative:
1 FTE at Pay Grade 5 for one year = \( ($9.53/\text{hour}) \times (2080 \text{ hours/} \text{year}) \)

\[ + 0.31((9.53/\text{hour}) \times (2080 \text{ hours/} \text{year})) \]

\[ = $25,967 \]

For Conveyor System Alternative:
1.5 FTE at Pay Grade 5 for one year = 1.5(25,967) = $38,951

Appendix 6. Conveyor Capacity
<table>
<thead>
<tr>
<th>Base Side Panel</th>
<th>Length</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width(ft.)</td>
<td>Height(ft.) (ft.)</td>
<td>(ft. cubed)</td>
</tr>
<tr>
<td>Incline #1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>152</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incline #2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>450</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Storage Belt</td>
<td>4</td>
<td>3.75</td>
</tr>
<tr>
<td>Cross Conveyor</td>
<td>3.5</td>
<td>2</td>
</tr>
<tr>
<td>133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Volume of System = (Incline #1) + (Incline #2) + 3x(Storage Belt) + (Cross Conveyor) = 5294.95 cubic feet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are 7.5 pounds of linen per cubic foot.
Total capacity of system in pounds = (Total Volume of System)x(Pounds per cubic foot)  

= 5294.95(7.5) = 39,712 pounds

**Appendix 7. Cost Analysis for Staffing Alternatives**

**Labor Costs:**

**Full time:** 58 employees x 2 days x 8 hours /day = 23.2 FTEs

23.2 FTEs x $24,000/employee (obtained by finding average wage per employee)  

= $603,200/yr

**Part Time:** 15 employees x 2 days x 8 hours /day = 6 FTEs

6 FTEs x $24,000/employee (obtained by finding average wage per employee)  

= $144,000/yr

**Afternoon Shift:** 7 employees x 5 days x 8 hours /day = 7 FTEs

7 FTEs x $24,000/employee (obtained by finding average wage per employee)  

= $168,000/yr

**Maintenance Costs:**
Full Time: A average of the utilities costs was taken for the last month to obtain an average cost of $743.00/day

Part-Time: Running part-time would definitely require less maintenance costs than full-time, but it is hard to predict so we estimated it to be production x regular utilities cost =

$$14,414\text{lbs}/23,000\text{lbs} \times 743/\text{day} = 465.63/\text{day}$$

Afternoon: Again we have to assume that the utilities costs are proportional to the production if we are to be able to estimate the costs.

utilities cost =

$$26,882/23,000\text{ lbs} \times 743/\text{day} = 868.40/\text{day}$$

Appendix 8. Production Analysis for Staffing Alternatives

New Capacity:

Full-Time: This will cause capacity on the weekends to be comparable to that of the weekdays. Thus, an average of 23,000 lbs (This average obtained by looking at production rates for laundry was done on the weekends) of original production will be done on the weekends.

Part-Time: This will have an increase in production on Saturdays and Sundays. To measure this increase we assumed that both ironers could be run eight hours at capacity and that only items which ran through those would be done.

Using the data from the last two months the average rate of each ironer was found (pieces/hr), the average weight of each ironed piece was found (lbs/piece) and we used the corresponding lbs/hr as our bottleneck process and thus it produced the production rate.

$$693\text{ pieces/hr} \times 1.3\text{ lbs/piece} \times 8\text{ hours/day} \times 2\text{ ironers}$$

$$= 14,414\text{ lbs}$$
Afternoon Staff: It is very hard to estimate the increase in production which will be caused by seven extra workers in the process for six hours a day. To do this the assumption that the production was proportional to the number of workers had to be made. By doing this we are able to estimate the increase in capacity.

\[
58 + 7 \left( \frac{6 \text{ hours}}{8 \text{ hours}} \right) / 58 \times 23,000 \text{ lbs day} = 25,081 \text{ lbs per day}
\]

Then this must be added to the additional production of the seven man two hour shift at the end of the day. Once again, the ironer is the bottleneck for this process.

\[
693 \text{ pieces/hr} \times 1.3 \text{ lbs/piece} \times 2 \text{ hours /day} \times 1 \text{ ironer} = 1,801 \text{ lbs}
\]

Total production = 25,081 lbs + 1,801 lbs = 26,882 lbs/day

Appendix 9. Part-Time Staff Schedule

Only run bulk items through iron. (i.e. Blankets, sheets etc..)

Run Production eight hours.

Breakdown of Staff

<table>
<thead>
<tr>
<th>Position</th>
<th>Number of Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unloading trucks</td>
<td>1</td>
</tr>
<tr>
<td>Sorters</td>
<td>4</td>
</tr>
<tr>
<td>Loading Washers</td>
<td>1</td>
</tr>
<tr>
<td>Operating Washer/Driers</td>
<td>1</td>
</tr>
<tr>
<td>Iron Operators (2 Ironers operating)</td>
<td>6</td>
</tr>
<tr>
<td>Basket Pusher</td>
<td>1</td>
</tr>
<tr>
<td>Shipping</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>15 Total</td>
</tr>
</tbody>
</table>

*Drivers and cart loaders are assumed to be already working and paid for.

Appendix 10. Afternoon Staff Schedule
Seven new employees come in every day at 9:30 (two hours after production has started) and leave at 4:30. Until 2:30 these workers aid in the regular production of the plant. At 2:30 they begin processing bulk items (sheet and blankets) running only one ironer. It is assumed that no sorting will have to be done. The breakdown of labor is as follows...

<table>
<thead>
<tr>
<th>Position</th>
<th>Number of Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loader</td>
<td>1</td>
</tr>
<tr>
<td>Washer/Drier operator</td>
<td>1</td>
</tr>
<tr>
<td>Iron Operators (1 Ironer Operating)</td>
<td>3</td>
</tr>
<tr>
<td>Basket Pusher</td>
<td>1</td>
</tr>
<tr>
<td>Shipping</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>