University of Michigan Health System

Industrial and Operations Engineering (IOE) 481:

HomeMed Pharmacy and Med Surgical Warehouse Redesign

Final Report

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Executive Summary

HomeMed, a branch of the University of Michigan Health System (UMHS), provides professional services to help patients in the transition from the hospital to home care. The HomeMed staff has noticed several work-flow and storage problems and has called on an IOE 481 senior design team from the University of Michigan to evaluate the current state of the warehouse and recommend changes to the warehouse. The purpose of this report is to detail our findings, conclusions and recommendations for the project.

Background

The warehouse is experiencing storage and work-flow problems. These warehouse problems include but are not limited to: workers bumping into each other as they search for drug/equipment retrieval, confusion of items displaced in the shipping area, and confusion of where items are stored and why or when they were stored there in the first place.

Key Issues. The key issues were improving the work practices in the warehouse, lack of organization in the warehouse, and a lack of space in the environment.

Goals and Objectives. The primary goal of this project is to improve the overall work environment at the HomeMed warehouse through recommendations for a redesigned layout and workflow. The objectives consisted of understanding the way work was currently done in the warehouse, analyzing the work-flow, implementing lean principles, and recommending layout changes in the warehouse.

Methods

The team performed six data collection tasks. The data methods included surveys, time studies, video recordings, inventory maps, spaghetti diagrams, and illumination readings.

Surveys. The team collected 19 responses to the surveys they developed. The survey consisted of a Likert scale question about current state satisfaction and 3 other general response questions about what the workers would change in the warehouse.

Time Studies. The team collected 33 times. These times reflect the length of time it took an employee to collect the items in an order. In addition to the time it took to pick the order the number of items and number of different product codes on an order were recorded.

Video Recordings. The team also recorded about two hours of video from warehouse. Most of the video was of general shipping area processes as well as specific packing and loading tasks. Some of the video was also used to complete the time studies.

Inventory Mapping. The team recorded the different places on the shelves of each item in the warehouse, from section 1 to section 46. These grid maps gave the team a visual of how all the items were arranged on the shelves and in sections.
Spaghetti Diagrams. The team followed workers around as the workers picked orders. Then the different paths that each worker took to gather the items needed for an order were recorded. Eight different workers were followed, and 33 paths were recorded from those eight workers.

Illumination Readings. The team took measurements of the amount of light falling on surfaces throughout the warehouse and shipping area. Measurements were taken on product code tags on each shelf in at least one section of every aisle, and also in 3 locations in the shipping area.

Findings
The findings are divided by method to show what information was obtained from which source.

Surveys. At least five of the Likert scale responses were crossed out due to a confusing scale so that question was disregarded. Responses in the last 3 questions that were suggested at least 5 times were rearranging the inventory, ergonomic concerns with items, and improving the lighting.

Time Studies. Table 1 below summarizes the time study data. The table shows a large amount of variability in picking time since the standard deviation is at 2.23 minutes. Also, the mean time is large for picking items.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Average</th>
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<td>70.09</td>
<td>2</td>
<td>271</td>
</tr>
</tbody>
</table>

Video Recordings. The team observed in the video recordings that the packing room is somewhat disorganized, as tape rolls and other packing utilities are difficult to find at the table. For the shipping dock, the video showed that workers have trouble finding the orders that need to be packed on the truck to be shipped out, and this packing takes 15-20 minutes long.

Inventory Mapping. The team found that almost all the sections had a mix of the four major types of drugs and supplies in them. The back aisle – sections 36-44 – had almost all the drugs in them already. Sections 6 and 12 had many items that belonged to the enteral type. Clean room and patient supplies were distributed among many sections.

Spaghetti Diagrams. For the most part flow in the warehouse is followed, however some workers found the shortest path between items and disregarded the flow. This could cause collisions among the workers picking the orders in the warehouse.

Illumination Readings. The warehouse illumination readings ranged from 53 lux in one of the most poorly lit sections (11) to 280 lux in a section directly under a light. A general reading in the warehouse measured 230 lux. In the shipping area the three readings were 260 lux, 450 lux, and 260 at pre-check table, packing table, and on an order stack respectively.
Conclusions
Following from findings conclusions have been drawn regarding each method.

Surveys. Given the frequency of the responses on surveys it is evident certain changes should be considered:
- Rearrange the drugs and supplies
- Move heavier items up from lower shelves
- Need better lighting
- Clean room items need to be grouped together closer to the clean room.

Time Studies. There is a very weak correlation (R=.48) between the time it takes to pick an order and the number of different product codes on an order. There is no correlation between picking time and number of items. This variability is due in part to both work process variability and work efficiency problems.

Inventory Mapping. Rearranging the way items are organized could eliminate the mix of item types in most sections. Options include rearranging by product type or by therapy type. Any reorganization of items should make an effort to relocate clean room inventory closer to the clean room.

Spaghetti Diagrams. To maintain standard work the defined workflow in the current layout and any prospective rearrangements should always be followed. Workflows should try to shorten the walking distance involved in picking an order. Using arrows on floors to demonstrate flow may increase adherence.

Illumination Readings. There is not enough light in the warehouse. Ergonomic standards dictate a range of 300 to 500 lux should be present for the kind of work being done. This level is not met in the warehouse and is only met in one area in the packing/shipping room. New lighting options must be considered.

Recommendations
From the findings, the team has formed recommendations, including two layouts, for the warehouse and shipping area; as well as what future IOE 481 groups can focus on in upcoming projects. These recommendations are summarized below.
- Alternative Layout 1: Employs minimal changes to current shelving layout organizing items by product type.
- Alternative Layout 2: Employs extensive changes, arranging the five most common order therapy types in a ‘U’ shaped cell
- Shipping area will be organized by route

During observation and analysis, the team noticed new topics of interest that could be useful for future teams to investigate. These are listed below:
- Implementation of the recommendations and layouts
- Manner in which orders are chosen to be picked and how they are then logged after shipping.
- The cancellation system of orders.
Introduction

HomeMed, a branch of the University of Michigan Health System (UMHS), provides professional services to help patients in the transition from the hospital to home care. HomeMed facilitates this aid through the use of their warehouse, which holds, ships, and receives medical equipment, patient treatments, and supplies. The warehouse itself is in a growth state that is creating storage and work-flow problems. HomeMed is addressing these problems and has asked an IOE 481 team from the University of Michigan to evaluate the current state of the storage and shipping area, address workers’ complaints, and implement lean health-care tools to develop recommendations for an improved layout and corresponding workflow. The purpose of this report is to detail our findings, conclusions and recommendations for the project.

Background

The HomeMed Warehouse is a vital department of UMHS’s outpatient services. For the most part, it is responsible for receiving and storing drug, medical/surgical, and equipment products for discharged patients from the University of Michigan Hospitals and then shipping these items to the patients’ homes. However, it is also responsible for in-house distribution of chemotherapy treatments to the hospitals, the storage of products for future patient orders, and other specially requested items from the hospital systems. The existing work-flow and storage processes are causing minor problems due to space constraints. These warehouse problems include but are not limited to: workers bumping into each other as they search for drug/equipment retrieval, confusion of items displaced in the shipping area, and confusion of where items are stored and why or when they were stored there in the first place. As the inventory of the warehouse increases, these current issues may become larger problems in the future. As a result, HomeMed has requested for a redesign of the warehouse layout and an improvement of work-flow processes.

Key Issues

The key issues driving the need for this project are:

- A desire to improve the work practices involved with shipping drugs and equipment
- A lack of sound organization for the warehouse inventory
- A growing inventory and the space constraints associated with that

Goals and Objectives

The primary goal of this project is to improve the overall work environment at the HomeMed warehouse through recommendations for a redesigned layout and workflow. The objectives completed during this project were as follows:

- Understanding the way work is currently done in the HomeMed warehouse
- Analyzing inventory volumes and turnover for potential warehouse reorganization based on product types and demand
- Implementing basic Lean principles such as 5S
- Recommending layout changes for better warehouse utilization
In addition to these primary objectives the team also examined certain ergonomic concerns in the warehouse area such as task lighting and load lifting levels.

**Project Scope**

Included in the scope of this project were the redesign of the work flow and warehouse layout. This involved the picking and packing of patient orders, the storage process, and the location of drugs and supplies within the warehouse. Ergonomic factors of the warehouse and shipping areas were considered as well. This included task lighting and load lifting levels.

Not included in the scope of this project were the aspects of HomeMed which occur outside of the warehouse/shipping environment. These aspects included but were not limited to: the way in which products are delivered to patients, order slip receiving from the hospital and pharmacies, and post-order paperwork. The clean room, offices, and any other areas outside the warehouse and shipping areas were not examined. The HomeMed division of Michigan Home Care Services is the only division involved in this project.

**Data collection**

The data collection tasks for this project lasted from February 2, 2012 to April 13, 2012. The primary tasks completed during the data collection phase were:

- HomeMed warehouse employees surveyed
- Order picking process timed
- Packing/shipping room videotaped
- Inventory Locations charted
- Spaghetti diagrams formed
- Illuminance in warehouse measured

Data provided from the client included a complete list of inventory and sample orders of common therapy types.

**Surveys**

The team developed a survey that was handed out to employees at the HomeMed warehouse. Nineteen employees responded out of thirty surveys handed out. The first question was a Likert scale (1-10) question asking about employee satisfaction with the warehouse’s current state. The remaining questions asked for specific comments on problems with the current layout and work practices and ideas to improve the work environment. A copy of this survey is available in Appendix A.

**Time Studies**

The team timed employees as they picked orders in the warehouse and was done using stopwatches. The times started when an employee first obtained an order sheet and ended when the picked order was set on a shelf to await pre-checking or awaiting other drug items. In addition to recording the time to pick an order, the total number of items on the order and the
number of separate product codes on the order were recorded. The data collection sheet is in Appendix C.

**Video Recordings**

The team used video recordings to observe work in the packing/shipping area. Altogether the four videos total about 2 hours in length. The specific videos are as follows:

- 1 video of an employee packing a single order
- 1 video of an employee loading orders onto a delivery truck
- 2 videos of general work being performed in the packing area

Both a stationary HD camera and a mobile phone camera were used to record. These recordings are included on the disc provided to the client.

**Inventory Location Charts**

The warehouse is divided into sections numbered 1-46. Each section has an alphanumeric grid labeled on its shelves. With the exception of sections 1-4, 41 and 43, each item was documented in representative grid layouts. An example of this grid layout can be found in Appendix B. The excluded sections included medical refrigerators, overstock and special items in the warehouse. The combination of these charts reflects the current layout of the inventory in the warehouse.

**Spaghetti Diagrams**

Eight employees were observed when they picked orders. During their order picking process, team members traced the path the employees took through the warehouse. Thirty-three different paths were labeled for each order in an overhead view of the warehouse.

Orders often contain similar items based on the therapy type. The 5 common therapy types the team examined are:

- Enteral
- Chemotherapy
- Antibiotic
- Total Parenteral Nutrition
- Total Enteral Nutrition

Using sample orders of each therapy type path diagrams were drawn for the hypothetical picking of these order types. The paths for these orders strictly follow the current workflow and go from item to item directly down the order form. Diagrams are included in Appendix G.

**Lighting Measurements**

The team members obtained a photometer from the IOE Ergonomics Department at the University of Michigan. This photometer was used to find the illuminance, which is the light that directly falls on the surface, and the luminance, which is the light that is reflected off of a surface. The team collected these values from one section in each different aisle in the warehouse, and also collected these values at the pre-check table and the packing table in the packing and shipping room.
Data Analysis

Each of the previously described methods explains a specific type of data and how it was collected. The following describes the reason for collection, how the raw data was used, and the manner in which findings were conceived.

Survey Data

The survey was intended to provide two main pieces of information:

- The level of employee satisfaction with current layout and processes
- A list of ideas employees would like to see in the warehouse

The Likert scale question was intended to reflect the level of employee satisfaction with the current layout and process. The team observed that these values could not be contributed to the report because of the confusion in the scale. The ideas brought up the most in the later questions were grouped by type and considered for recommendation. More survey responses would have been more optimal to foster employee interest and gain more input. However, no statistical conclusions were drawn from responses so the limited sample size does not invalidate any other conclusions.

Time Studies

The time recorded to pick an order was compared against two independent variables: the total number of items and the number of unique product codes (different items) on an order. The team performed single regression analysis and double regression analysis against these variables.

Video

The videos recorded became the observational data the team examined to identify problem areas or areas for improvement in the packing and shipping area.

Inventory Mapping

The charts showing positions of inventory in the warehouse were color coded by four inventory classifications: Enteral, Clean Room (CR), Patient Supply, and Drugs. These color coded charts were laid out in an orientation matching the section map of the warehouse. The mapping of warehouse inventory provided knowledge about the level of product type mixing currently in the warehouse.

Spaghetti Diagrams

The spaghetti diagrams showed the path that the worker took for the current warehouse layout, and for the five common order types in the warehouse. The team analyzed this path to see if it followed the flow, and if the path was not a large distance to walk. The spaghetti diagrams gave the team some insight on how the items are collected, and how the path could be shortened and how the flow could be followed.
Lighting Measurements

The lighting measurements were averaged out and compared to an industry standard. When compared to the standard, the team was able to draw conclusions on the lighting situation in the warehouse.

Findings and Conclusions

After performing the methods described above, the team analyzed the data and observations to establish findings, and drew conclusions for the recommendations. The findings and conclusions for the surveys, time studies, inventory mapping, spaghetti flowcharts, and video are described below.

Surveys: Responses Included Different Ways to Improve Warehouse

The questions on the survey proved very helpful in understanding the current issues and worker needs in the warehouse. The team decided that every issue that was recorded over five times from the collected surveys was regarded as a “frequent response” and treated the response as a change that must be taken into consideration. The changes or ideas that were stated five or more times are:

- Rearranging the drugs and supplies in the warehouse
- Moving the heavy items in the inventory to the middle shelf from the bottom shelf, or rearranging the inventory in an ergonomic manner
- Improving the lighting in the warehouse
- Shifting the clean room supplies closer to where the clean room is located

All of these ideas were taken into strong consideration by the team. Other responses that were not as frequent were still taken into consideration. These less frequent responses were taken into consideration if they either offered highly attainable solutions to current problems or if the team felt it was important enough to consider while conducting the remainder of the study. These responses included:

- Moving the shipping coordinator’s desk to face the shipping dock or packing area
- Putting an electronic resource or board near the clean room which states which items are in-stock, out of stock, or on back order and when they will arrive to the warehouse
- Placing the shipping labels for packaging all in one place
- Enlarging the labels on the shelves where the items are stored in the warehouse so that the labels are easier to read
- Relocating the coolers to another spot in the packing room so they do not take up as much space
- Shifting the special order items all in one area
- Rearranging drugs of the same type into a picking cell in the warehouse
- Using the wall space more efficiently
These ideas along with the frequent responses set the context for the conclusions that were drawn.

Conclusions. Four main changes need to be made:

- Rearrange the drugs and supplies by product type or order type
- Place heavy items on lower shelves to the middle shelves so workers do not place extra strain and stress on their backs while lifting these heavy items
- Improve the lighting in the warehouse.
- Group the clean room items closer to the clean room.

Secondary changes that could be implemented as well:

- Hang an electronic board or other resource near the clean room that shows which items are on back order and when they should arrive at the warehouse
- Enlarge labels on the shelves
- Relocate the coolers in the packing room to free up much needed space in the packing and shipping room.

Time Studies: No Correlation Between Picking Time and Order Size, Number of Items

After the initial collection stage, the team looked at the size of each order(number of unique product codes) from the time studies and compared that with the time it took to pick the order. Figure 1 below shows the comparison.

![Figure 1: Average Time Per Order Size](Source: Time Study Data; Collection Period: 2/4/12 – 2/18/12; Sample Size: 33)
From Figure 1, generally the time needed to pick an order increases as the order size increases. However, the graph has a small correlation at 0.48, and this could be due to the variability in the speeds of the workers or to the variability in the type of order (i.e. picking five enteral cases could take longer than picking five syringes).

Next, the team compared the time it took to pick an order with the total number of items in the order. Figure 2 below shows the comparison.

![Figure 2: Times Per Number of Items](source)

As shown in Figure 2, the times are very scattered even when the item size is low. The comparison shows that there is some factor contributing to the scatter of the times per item size. One reason could be that the times were taken from several workers, and the times could vary by worker. Another reason for this scatter could be that the time taken varies by product type.

The team generated statistics for data related to picking time, order size, and number of items that was collected in the warehouse. The statistics are shown below.

<table>
<thead>
<tr>
<th>Statistics</th>
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<th>Standard Deviation</th>
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<td>Times (min)</td>
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<td>Order Size</td>
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<td>6</td>
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<td>59.94</td>
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<td>70.09</td>
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</tr>
</tbody>
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Table 1 shows the statistics of the time studies. This table shows that the average time it takes to pick an order is about four minutes, and this time has room to be lowered. Another key statistic is...
the standard deviation of the times, which is at 2.23 minutes. This statistic shows the variability of the times for the workers. This variability is attributable to both work efficiency and work process factors.

Finally, the team performed a regression with the two predictors being order size and number of items. The team tried to find a correlation and significance of the factors. Table 2 below shows the results.

**Table 2: Regression with Predictors**
(Source: Time Study Data; Collection Period: 2/4/11 – 2/18/11; Sample Size: 33)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.6396</td>
<td>0.9458</td>
<td>0.68</td>
<td>0.504</td>
</tr>
<tr>
<td>Order Size</td>
<td>0.4601</td>
<td>0.1393</td>
<td>3.30</td>
<td>0.002</td>
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<tr>
<td>Number of Items</td>
<td>0.008901</td>
<td>0.004763</td>
<td>1.87</td>
<td>0.071</td>
</tr>
</tbody>
</table>

As shown in the table above, the only predictor for the amount of time it takes to pick an order that is significant when comparing the order size and number of items is the order size. However, the correlation coefficient is very small, $R^2 = 0.32$. Therefore, there is not a strong way to predict the time based on the collected data.

**Conclusions.** The team concluded several ideas from the findings in the time studies. First, there is a small correlation between the time it takes for an order to be picked and the size of the order (counted by the number of unique product codes). Next, there is no correlation between the time it takes to complete an order and the total number of items in the order. For example, one order had about 275 items in an order, and it took almost two and a half minutes longer than picking an order with about 175 items.

In addition to the correlations above, the team discovered that the average time it takes to complete an order is 3.96 minutes, with a standard deviation of 2.23 minutes. This shows that there is a wide range of times that could occur for each order. This discrepancy could be explained by different workers being timed, since each worker picks the order and his or her own speed. However, this time needs to be minimized as much as possible.

Finally, the team concluded that when order size and the number of items in an order are compared together to predict time, only the order size is significant. This conclusion coincides with the one above, which states that this small correlation could be due to the variability in the workers’ speeds in collecting all the items necessary for the order.

**Inventory Mapping: Multiple Product Types and Order Types in Different Sections**

After recording all the positions of the items on the shelves, the group color coded each item by its specific product type. The group found the following:

- Most sections contain a mixture of the four major product types: drugs, patient supplies, enteral, and clean room
• Almost all the clean room items are scattered among 8 different sections
• A majority of enteral items are in sections 6 and 7
• Most drugs are located in sections 36-44

Conclusions. The items on the shelves in the warehouse should be reorganized, either by product type or by order type. Many sections have a mix of different types of items, which is very inefficient. For example, one section has clean room supplies, enteral supplies, and patient supplies all in one. This way of organization is one of the main sources of confusion among workers in the warehouse when picking orders.

The team needs to rearrange the clean room supplies into one area in the warehouse; situating these supplies near the clean room. This re-organization would help the pharmacists easily find the supplies that they need in a more efficient manner. Also, enteral, patient, and drug supplies all need to have their own separate sections in the warehouse.

Spaghetti Diagrams: Some Workers Do Not Follow Flow

After the paths were defined, the team studied the completed charts. Most of the workers followed the workflow paths as described in the standardized work process. However, a couple of the workers did not. Some of these workers took paths that were off from the designated warehouse’s flow. These paths took the shortest route to the items that were needed for the order.

When these shorter routes were taken, they took less time. However, if every worker performed the picking task this way, workers may collide and run into each other as they tried to collect every item needed for an order.

The team also studied the order type spaghetti charts, and noticed that even if the flow was followed according to the order form, the workers walked a large distance to obtain every item in the order. An example of an order type spaghetti chart is shown in Appendix G.

Conclusions. The spaghetti charts showed that most of the workers follow the flow that the original warehouse layout dictates, but some do not follow the flow. The team needs to create a flow that all the workers will follow. This flow should be created so that the workers do not try to take the shortest path to the items on the shelves, but rather that they follow the flow to the items. In the best case, the majority of the items will be located so that the shortest path and the flow coincide.

The spaghetti charts done by order type, show that workers walk a large distance to obtain all the items if they follow the current flow. To fix this problem, the items in the warehouse need to be rearranged.

Video Recordings: Packing Inconsistencies and Shipping Problems

The team analyzed the videos that were taken of the packing/shipping room. The following are the most important problems that the team noticed while watching the video on the packing room:
• Tape rolls and other utilities used to pack need to be on the table in a designated spot, as workers sometimes could not find it initially
• Boxes packed for ground were sometimes packed at the pre-check table
• Orders that are finished are not placed in a designated area, but rather wherever there is room
• Workers that pack items at ground retrieve bubble wrap from main packing station

Also, there are several difficulties for the workers who pack the trucks with orders that need to be delivered to the patients. These difficulties are listed below:

• Leaving the door open to pack the truck in a temperature controlled environment is not optimal
• Finding orders was difficult, the worker had to look through several piles to find the correct orders to pack
• Lifting the boxes from the door puts strain on the worker’s back when loading the truck
• Finishing the job takes about 20 to 40 minutes; packing a vehicle should take significantly less time

Conclusions. From the videos, the team observed several problems in the packing and shipping areas of the warehouse. For the packing area, tape rolls and other utilities need to be placed on the packing table so that these items are not lost and need to be found by the other workers. Labels for packing need to be placed in one area, and the packages that need to be checked by the pharmacist should all be in the same area, instead of scattered around the packing area. In addition, items that are packed at the ground table should have their own roll of bubble wrap by the table.

For the shipping area, finished orders need to be organized by route, so that orders are not lost or missing. This reorganization would help the workers who pack the truck find the orders much easier, and would take relieve stress and strain on their backs from bending over and picking up every single finished order from around the shipping area.

Lighting Measurements

The illuminance levels in the sections throughout the warehouse ranged from 56 lux to around 300 lux. The most poorly lit section measured was section 11 and the best lit section measured was section 19 (directly under a light). The readings were taken at noon on a sunny day. Values for illuminance levels in the packing room ranged from 230 lux to 470 lux. The 470 lux was the highest reading taken anywhere in the warehouse and that was at the main packing table.

Conclusions. The task of reading labels is a high contrast task because they are printed black on white. The labels are very small however, about a 12 point font. With these two factors in mind and consulting a standard published by the Illuminating Engineering Society a range of 300 – 500 lux was considered adequate lighting. This standard is not met anywhere in the warehouse and in only one location in the packing room, although values in that area do come closer to the
low end of the range. The inadequacy of lighting across the board leads to the conclusion that each section must be better illuminated to make reading labels easier.

**Recommendations**

From the findings, the team has formed recommendations for the warehouse and shipping area, as well as what future IOE 481 teams can focus on in upcoming projects. After careful analysis of the collected data, the team has developed two alternative layouts that will improve the overall safety and workflow of the warehouse and the shipping area.

**Alternative Layout 1**

The first layout (shown in Appendix H) employs minimal change to the warehouse’s current shelving units and current order-picking paths, and instead rearranges the supplies and drugs in the inventory by type, so that the walking distance is minimized. These inventory types include: Enteral, Clean Room (CR), Patient Supply/Unclassified, and Drugs. The specific changes are detailed and shown below.

- Designate active (non-overstock) Enteral items for sections 6, 7, 14 and 16. This organization will minimize the distance need to travel for enteral order picks.
- Designate sections 21, 22 and 24 for the CR. This organization will greatly shorten the amount of time for retrieval for the CR employees.
- Designate sections 36 through 44 for Drugs.
- Add upper shelf to section 4, move pallets and refrigerators under section 6 to this middle-section.
- Add additional slide racks/shelves below row B in section 6 and move all items from sections 8 through 11 to these new racks.
- Overstock and Special Items to remain in their current respective areas.
- Utilize the remaining sections for Patient Supply and Unclassified.
- Elevate the Inventory Staff offices 4 to 5 feet above the ground to provide enough space underneath for:
  - Bins and carts used to pick orders
  - File cabinets

The team also developed recommendations for the packing and shipping area of the warehouse. The recommendations are shown below.

- Shipping Coordinator turned to face the packing process
- New ergonomic packing table with bar for bubble rolls, a shelf for centralizing packing materials, and adjustable height to replace current packing table
- Remove bottom shelves of the current racks to create room for storage of route carts.
- Move employee lockers to break room or restrooms
- Move the medical refrigerators near current lockers in shipping area next to section 3 and place the coolers in this area.
This shipping layout will employ an Enteral/Bulk item cart system that corresponds to route and day of delivery. This will decrease the amount of time it takes to load a truck since all items for a particular route would already be organized and would only need to be carted to the truck and loaded for delivery. Since orders are picked and packed for up to two days ahead of time, a cart for each day would be employed. With 3 routes per day there would need to be a total of 9 carts.

**Alternative Layout 2**

The second layout (as shown in Appendix I) is a complete overhaul of the current layout that will require new shelving in addition repurposing of current shelves and rearrange items in inventory according to order therapy type. This layout organizes the five most common order therapy types in a U-shaped cell. These order therapy types include: Enteral (ENT), Total Parenteral Nutrition (TPN), Total Enteral Nutrition (TEN), Antibiotic (ABT), and Chemotherapy (CHM). The details of this particular layout are described below.

- Move pre and post check racks as well as the pre-check table to the center of the ‘U’ cell.
- Place the CR items in a ‘L’ cell across from the CR such that the forklift can reach the flow racks for the bulk items
- Place the remainder of non-bulk items in a section across from the ‘U’ cell; Bulk and overstock items are away from the U cell to separate forklift and Order-Picking traffic.
- Elevate the Inventory Staff offices 4 to 5 feet above the ground to provide enough space underneath for:
  - Bins and carts used to pick orders
  - File cabinets
- The workflow would be as shown in Appendix I

The team also developed recommendations for the packing and shipping area of the warehouse. The recommendations are shown below.

- Shipping Coordinator turned to face the packing process
- New ergonomic packing table with bar for bubble rolls, a shelf for centralizing packing materials, and adjustable height to replace current packing table
- Remove bottom shelves of the current racks to create room for storage of route carts.
- Move employee lockers to break room or restrooms
- Pre- and post-check shelves, and pre-check table are moved into middle of U cell
- Racks and corresponding carts nearest the windowed area in the Shipping room are moved to where current pre-check table is located; coolers then move to windowed area

This shipping layout will also employ an Enteral/Bulk item cart system that corresponds to route and day of delivery, as described in Alternative Layout 1. The same system will result in 9 carts, with 3 carts each for up to two days into the future.

**Overall Warehouse Recommendations**

In addition to the above points, the team believes the following will improve the work-flow and safety of the current condition based on survey results, time studies, and spaghetti diagrams:
• Eliminate the ‘junk drawer’ near the inventory workstations so that the order-picking carts can be placed in this area.
• Place arrows on the warehouse floor to indicate the direction in which staff should walk when retrieving an order.
• Elevate boxes that weigh over 15 lbs. at least 3 ft. above ground level.
• Place the angle of labels above ground at a 50 degree angle and increase the size of the font on the labels. A possible solution is shown in Appendix J.
• Eliminate the ‘Loose Items’ section. Place loose items on or near their corresponding product. Possible solutions are shown in Appendix K.
• Utilize LightPath Digital to inform the CR staff of items that are in-stock, out-of-stock, or backordered.
• Each section should have its own light and be bright enough so that the lowest label can be read from eye-level. Possible solutions are shown in Appendix L.

The team believes that these recommendations will not only make order picking more efficient, but will also increase the satisfaction and safety of the workers on the floor.

Future Project Recommendations

During observation and analysis, the team noticed two main topics of interest that could be useful for future teams to investigate. The first topic of interest the team believed to be useful was the manner in which orders are chosen to be picked and how they are then logged after shipping. Below are some of the problems associated with the current system:

• No exact queuing system according to priority or size for orders received often leads to a lack of load leveling in order picking among workers (i.e. one person will do 5 small orders, while the next worker will do 6 large orders).
• All order tracking is currently being done on paper. This causes:
  o Lost order slips
  o A large amount of time wasted in backtracking
  o Unnecessary stress added to employees

An electronic system to some extent could be useful for both of these situations. This focus was outside the realm of the current project, but could be looked into by a future project team.

Another topic that the team believes should be looked into is the cancellation system of orders. Currently there is no exact system for cancellation. This has resulted in:

• Many orders laying idle in the inventory system
• Extra space used up in areas that could be used for other items
• Confusion between items to be shipped vs. cancelled items

A future team could look into coming up with recommendations on different cancellation systems that move these items out of idle and into the proper location they belong.
**Expected Impact**

Overall, the team believes the recommendations that have been created address the current concerns HomeMed is facing in their warehouse and shipping area. The recommendations address the need of a reorganization of warehouse items, an improvement of order-picking and workflow, a reorganization of the shipping area and packing process, and the improvement of the overall safety of all employees.

The team employed time studies, spaghetti diagrams, surveys, videos, inventory mapping, and lighting measurements to improve the work environment within the HomeMed warehouse. The team believes the recommendations will result in:

- More efficient workflow environment
- Safer work environment
- More space in the shipping area
- Overall worker satisfaction
Appendix A: Survey

Workflow/Inventory Survey

1. How would you rate the current setup of the warehouse on a scale of 1 to 10?

   1    2    3    4    5    6    7    8    9    10
   (1 being exceptional, 10 being unacceptable)

2. Do you feel that certain areas of the warehouse could be re-arranged or re-purposed?

   Yes  No
   a. If Yes, please explain in small detail what this might be.

3. Please indicate which area you work in. (Please circle all that apply)
   a. Office area
   b. Shipping
   c. Receiving
   d. Warehouse Stock/Storage area
   e. Clean Room
   f. Other (please specify)________________________

Please list your top three ideas/changes that you would like to see be implemented in the Warehouse department (If nothing desired please mark n/a).

1. _______________________________________________________
2. _______________________________________________________
3. _______________________________________________________

Additional Comments:

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
Appendix B: Inventory Grid Sheet

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Appendix C: Time Studies Sheet

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<tr>
<td>End Time</td>
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<tr>
<td>Total Time (min)</td>
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<tr>
<td>Size of Order (items)</td>
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<td>Follow Path</td>
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</table>
Appendix D: Original Picking and Receiving Area Layout
Appendix E: Original Packing and Shipping Area Layout
Appendix F: Examples of Spaghetti Charts By Following Workers
Appendix G: Example of Spaghetti Diagram by Order Type
Appendix H: Alternative Layout 1
Appendix I: Alternative Layout 2
Appendix J: Possible Solution for Labels

Appendix K: Possible Solutions for Loose Items Rack

Appendix L: Possible Solutions for Lighting
