DISTRIBUTION CAPACITY ANALYSIS AND PROCESS IMPROVEMENT AT COOPERVISION

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ABSTRACT

CooperVision is the second largest contact lens manufacturer in the world. Their manufacturing and distribution operations span the globe. This paper presents a Senior Design project executed by RIT students at the distribution center located in Henrietta, NY, the only distribution center supporting North America. The project accomplished two goals for the company. First, a capacity analysis tool was created to determine maximum output for the facility and required labor hours needed to support that demand. Second, a series of process improvements were developed and implemented to improve key metrics at the distribution center.

After the completion of the 22 week project, the team accomplished their goals that has been set forth by CooperVision and was able to determine the upper bound on the facility’s throughput, and improve key business metrics that are representative of the company’s performance.

NOMENCLATURE

CAT: Capacity Analysis Tool
ADM: Automatic Dispensing Machine

INTRODUCTION

CooperVision is the world's second largest producer of contact lenses. They operate a 250,000 square foot distribution center in Henrietta, New York. The facility is equipped with four different picking mechanisms flowing from an automatic dispensing machine (ADM) to Pick-to-Light to Pick to Voice and Carousel. Following Carousel, orders are sent to the packing area. The layout of these mechanisms at the time of the execution of this project is shown appendix A. These picking mechanisms are sequential and feed one another.

At the start of the project CooperVision had not determined their current capacity within the distribution center. Consequently, they could not predict when they would be unable to fulfill future orders due to labor and equipment constraints. The company wanted to know what their current capacity was and how best to fulfill staffing requirements to meet demand.

The scope of the project included two different tasks, one and the most important, was to address the following question: What is the maximum number of orders that the facility being studied, could process in a given time based on the current resources, equipment and software?. The second phase of the project consisted in the evaluation of the current state of the facility to make and potentially implement process improvement recommendations at the company.

The paper has been divided into two distinct section sections. The first section will address what the capacity analysis portion of the project; the second will address the process improvement aspects of the project.
CAPACITY ANALYSIS OF THE DISTRIBUTION FACILITY

CUSTOMER NEEDS AND SPECIFICATION

In order to develop a plan of action, the team identified the set of customer needs that captured the problem presented. Based on several meetings with the team and CooperVision staff, it was determined that the customer’s primary need was a computer tool to determine the capacity of the facility. The primary purpose of this tool was to be used as a planning and budgeting tool. For this purpose, it would need to incorporate the capacities of each of the different pick areas within the facility as well as the pack areas. In addition, it would need to be able to calculate the throughput of each individual area as well as for the entire facility. The team and CooperVision agreed that a validation report of the computer tool would be required to verify that the tool was accurate. The accuracy level set was to have an output of labor hours within 5% of historical data.

CONCEPT GENERATION AND SELECTION

In order to provide the customer with a useful solution to their problem, the team developed concepts for possible projects. Each team member brought their own thoughts and designs and a hybrid of these different ideas was chosen as the path to pursue. The resulting choice was a Microsoft Excel-based workbook. Other than Excel, the team considered Arena Simulation software, Visual Basic, and other computer-based solutions. Excel was chosen because it is very easy to modify, it is already used at CooperVision (none of the other software was), and minimal training would have to be done to familiarize users with its operation. The team’s idea was that an Excel worksheet would act as a form for CooperVision to fill out, and the CAT would then return the needed data to the user with. CooperVision noted that it was desirable to have the ability to input a predicted demand and have the tool output the amount of man-hours required to meet this demand.

The team quickly produced a first draft of the computer tool and named it Capacity Analysis Tool (CAT) as a means to show the customer what was planned. After receiving approval from the customer, a series of iterations were done on the original in order to produce a CAT that met all of the customer’s specifications.

After several meetings with advisors and CooperVision, it was determined that the original plan of calculating the exact capacity of CooperVision’s Henrietta plant was not feasible given both the timeline of the project and the availability of critical data. Since the facility’s capacity was unable to be calculated as a whole, it was suggested by CooperVision that the team look at each picking area separately and determine each capacity independently. Once the individual capacities were calculated, it could be assumed that the area with the smallest capacity was the bottleneck, and the overall systems capacity. While other methods were preferred to calculate this overall facility capacity, the data required for this calculation would not have been collected within the timeframe of this project and therefore a simpler but still very accurate approach was used.

DESIGN AND ANALYSIS

The design of the CAT followed basic human factors principles. There are color-coded areas showing the user which fields need to be filled in, and once filled in, all of the desired outputs are calculated and displayed in an easy to read manner. The CAT is laid out to flow from the top down. The user starts at the top and works their way down. At the top of the CAT are the inputs and selections for the global variables. Global variables are the variables that apply to the entire facility and not just one area. Examples of global variables are demand, shift length, and number of shifts. Since CooperVision had expressed that it would be favorable to be able to use the CAT over different time periods, this portion of the CAT gives the user the option to select daily, weekly, monthly, or yearly for the time period. These selections pull from a list of predetermined days and are used in some of the calculations.

Once the user has completed the global variable section, they can move down to the bottom of the CAT where each pick area has its own section. Since each pick area has different constraints, there are areas for each pick area where these values (inputs) are present. These values are used for the calculations (outputs) of each area. The outputs are just below the inputs. The inputs and outputs for a given area are color-coded similarly in order to help the user navigate the screen easily.

For all four pick areas the calculations are basically the same, where the demand is converted to lines, and the number of lines is multiplied by the average time to pick one line in that area. For the pack area the calculations are a bit different. Since there are four different packing lines that all get a percentage of the products coming out of the pick area, the pack area had to be broken down into these four respective areas.

Due to size constraints and the team’s desire to keep the CAT to one screen only, the pack station data was placed on a separate sheet in the same workbook. The front page of the CAT then pulls the data from this hidden sheet and the CAT remains a one-screen operation. Since the numbers that the CAT
uses to calculate the outputs change over time, CooperVision has the ability to edit these fields as needed in the future.

VERIFICATION

Throughout the development process, weekly meetings with the CooperVision staff allowed for checks of the formulations within the CAT verification. The purpose was twofold: one to ensure that the output provided CooperVision with the appropriate metrics and outputs that would be useful to management. Secondly, the meeting allowed for discussion on the formulas to verify they were calculating the output in the correct sequence and did not falsely manipulate the data.

This process was ongoing and gave transparency to the development. CooperVision simultaneously checked the validity of the CAT as mentioned in the next section.

VALIDATION

After the computer CAT had been created and designed, the design team had to check that the calculations provided accurate results that matched CooperVision’s data. The team held meetings with the customer to receive input into the testing process.

The first step in checking the model was to use historical data provided to the team by CooperVision. All of the necessary inputs were gathered and placed in the current working model. Upon processing, the output was checked against the historical data. A total of 25 observation points were used to compare against the CAT.

The first validation was against the number of lines that were picked in each of the four picking areas. These numbers were within 10% and passed the approval of CooperVision staff.

The second check was against the total number of labor hours required per pick area for any given demand. Based on the same 25 observations, a spreadsheet recorded the output by area as well as total labor hours for the pick department. Version 3.1 of the CAT was within 1% of the actual labor hours required for the facility, satisfying the CooperVision staff that accurate output was being processed. After the validation testing, CooperVision approved the CAT and considered the Picking area complete. The next step was to validate the Pack department.

Within the Pack department are four types of stations that process small orders. These include regular pack, regular pack with white box, multi-tote and multi-tote with white box. The validation procedure followed was similar to the pick method.

Historical data was obtained from CooperVision included demand and total pack labor hours. Using twenty days of data, the demand was entered into the system and the calculated labor hours were compared to the actual logged figures. There were some discrepancies between the calculated and actual numbers, but found that this was assigned to new Wal-Mart procedures being followed in addition to a newly implemented Workforce Management System. It should be noted that there were only four weeks a data available because of this new time tracking system and when reviewing the weekly figures, the team found that the actual hours and calculated hours were getting closer to each other as time elapsed (week 24 was closer than week 20). This gave confidence to the CooperVision staff and design team. The progress was continually monitored by staff to ensure that the shrinking gap was due to improvement in time data collection by CooperVision and not because of changes to order profiles. CooperVision staff approved this portion of the CAT in revision 3.3a.

Once the entire CAT was approved and accepted by CooperVision, the finalization process began. This included production of a training document that instructs new users how to enter the inputs and read the outputs from the modeling CAT. Also, all cells that do not require modification were locked so there is no accidental modification to the formulas. However, a password was provided to the Process Improvement Manager in order to make future revisions if the order profile changed.

RESULTS AND DISCUSSION

CooperVision was provided with CAT revision 3.4. This tool is able to calculate the needed number of labor hours for any given demand for the Pick and Pack areas. In addition, CooperVision was provided with their maximum order capacity based on data gathered up to May 2009. However, they are also able to generate new upper bounds for their capacity if the order profile changes in the future.

The specifications and customer needs were met and reviewed with the company. They approved the tool, took ownership and were trained to use the CAT.

PROCESS IMPROVEMENTS

INTRODUCTION

For the development of the process improvement phase of the project, lean principles were utilized. The main concept used to execute the process improvements was a series of Kaizen events. These events were led by two members of the team, who took charge each of a different customer need and targeted the improvements.
PLANNING

The plan consisted in an initial brainstorming session of the potential improvement opportunities. The team assembled in a concept generation session in which each member contributed with potential improvements ideas. This process served as the concept generation phase, and concluded with a total of 21 different process improvement opportunities (view appendix B). These ideas were pre-screened through a concept selection method that consisted in the definition of four basic categories to rate the opportunities. Each of these categories was assigned a weight based on their relative importance. This weight for each of the different categories is shown in table 1. The table shows how customer priority presented the highest weight in the selection process. The final prescreening process resulted with a total of eleven ideas.

<table>
<thead>
<tr>
<th>Improvement Idea</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADM Relabeling</td>
<td>Increase by 10% inventory location accuracy</td>
</tr>
<tr>
<td>Fix shipping conveyor</td>
<td>Reduce by 15% the number of boxes not diverted in the shipping conveyor</td>
</tr>
</tbody>
</table>

Table 1 – Concept Selection Categories

These resulting ideas were then presented to the customer in two stages. The first stage presented the top 11 ideas to the process improvement manager, who evaluated and rated them according to their respective interests. This first stage concluded the prescreening process with a total of five improvements ideas. These five improvement opportunities were later presented to senior management, under the explanation that due to time constraints at most two out of the five could be executed. Senior management approved two out of the five, and left a third one as an option. These final improvement ideas as well as the respective customer needs, and specifications for the project are shown in table 2.

**ADM Relabeling**

The initial situation on the ADM presented a large improvement opportunity. The metrics that track inventory location accuracy are metrics in the yellow. A root-cause analysis was conducted to determine the possible causes of this major problem, and it was determined that the labeling of the ADM was very poor and that travel time was large. This labeling is prone to generate confusion and may be having a large impact on this metric. Thus re-labeling and re-slotting policies must be considered.

**Shipping conveyor**

The shipping conveyor and subsequent shipping bins faced three major problems. The first two, packed boxes being placed on the conveyor upside down and packed boxes being flipped over in transit, led to packed boxes having to be re-sorted by hand which could cause errors. This process is also very wasteful and led to non-value added activities. The third problem was dangerous ergonomic conditions associated with the re-sort bins. Employees were asked to reach deep into X foot high bins to reach boxes, this led to strain backs and in one scenario broken ribs.

**METRICS**

Metrics were chosen in order to track the progress of the improvements. The metrics that were targeted to be improved were firstly the inventory location accuracy and the number of boxes not diverted into the shipping conveyor in the packing area along with a drop in reported injuries. The current state of these metrics was defined, to be compared with the future state, when the improvements take place.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of implementation</td>
<td>0.2</td>
</tr>
<tr>
<td>Cost/benefit ratio</td>
<td>0.2</td>
</tr>
<tr>
<td>Time to implement</td>
<td>0.1</td>
</tr>
<tr>
<td>Customer priority</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 2- Final Improvement Ideas

**KAIZEN EXECUTION**

Meetings were held with personnel from each of the affected areas. The purpose of these meetings was to generate potential solutions to the identified problems. The operators and involved personnel presented their ideas, and the combination of those ideas resulted in the final approach taken to make the improvement design. The conclusions from both meetings were different.

**ADM improvement planning**

The meeting held in the ADM represented a success. This meeting had people from the inventory department, systems department, replenishment department and personnel from the ADM (e.g. operators and supervisors). The problem of inventory location accuracy and its impact on performance was presented so that potential solutions could be brainstormed and discussed.
The solutions identified by the team to increase the location accuracy included a re-design of the labeling on the ADM slots and on its corresponding carton flow racks. Several designs were discussed and through vote, a final concept was selected. The new concept label will contain the same information as the current one but will have a different structure.

The new label will be a combination of colors and numbers of different sizes that will be consistent with the numbers on the current labels in the ADM. It was determined that the operators, when replenishing the carton flow racks only retain in their short term memory the three last digits on the current label. For this reason, these three digits were chosen to be highlighted and to have a larger size. The size of the numbers was determined based on their frequency of use. The largest size was chosen for those numbers that are used more frequently and the smallest size for those that are used less frequently. The sizes for the fonts and their mutual relationship are shown in Figure 1. The layout of the numbers has been carefully designed so that the numbers are separated and differentiated. This separation was done by dashes and the differentiation has been emphasized with the font type.

![Figure 1](image)

Color was been added to also aid in the memory retention process. This will provide the operator another option to retain the information on the items that must be picked, and scan the carton flow rack the matching combination. This visual aid along with the number coding, will contribute to the reduction of the error rate, minimizing the confusion generated by having similar labels across the ADM.

In both areas the size of the labels was chosen to maximize the total usage of the space available without compromising the operator’s ability to distinguish one label from the other. Considering the limited space available in the ADM slots, the size of the label for the ADM were designed to be smaller than the labels on the carton flow rack.

The idea of re-slottting the carton flow racks was also discussed in the meeting, but the team did not agree to proceed with its implementation due to the minimal gains obtained by executing such activity. In the meeting it was determined that re-slottting these racks would not represent a great improvement in terms of travel time reduction and inventory location accuracy increase. For this reason it was concluded that by the team.

**ADM relabeling implementation**

Once the design was agreed and the prototype finalized, it was determined that certain background colors could have a negative impact on the ability of the RF equipment to detect and read the barcode. For this reason, the vendor of the labels was contacted to further discuss this issue. The vendor specified that the barcode should have a white background in its immediate surroundings to avoid discrimination problems. A color scheme was agreed upon with the vendor and a request was made to CooperVision’s management to make a final decision whether to approve this project. To support this proposal, a cost-benefit analysis was proposed to the company. This proposal showed that the payback period of the investment associated with this improvement was estimated to be of 4.55 months (view appendix C).

The approval for the order of the labels was obtained, but the lead time associated with receiving the labels did not allow for the execution of this project. The team prepared a transition document to describe the open action items and the procedures to be taken to complete the Kaizen event. In this document, it was recommended that for implementation purposes, one label should be removed at a time to avoid potential errors.

**Shipping Conveyor Improvement Planning**

The Kaizen event held to address the issues with the shipping conveyor led to many positive outcomes. Representatives from the shipping, packing and engineering departments were all in attendance. Each problem was defined individually and then opened for discussion. The event was held on the facility floor so issues could be quickly visualized.

The first issue of packed boxes being placed on the conveyor upside down was met with surprise. This was known to be an issue but not on the scale that was shown. A solution to this issue to place visual reminders at pack stations was suggested but met with resistance from the packing representative. A final solution for the issue to be discussed more often at meetings was agreed upon by all parties.
The second issue of packed boxes being flipped over in transit was a known concern. All suggested improvements seem to have been tried on previous years at the facility. A consensus was made that if two conditions are met then this is a non issue; first if boxes are placed on the conveyor vertically and second if “Made to Order” shipments did not get placed on the conveyor. Even though a mechanical solution was not found new ideas were presented to help alleviate the problem.

The third issue of poor ergonomic conditions was agreed upon by all parties. A suggested improvement of adding spring held bottoms to bins was seen as a sensible solution. This solution would raise the depth of the bins to a safer height and prevent ergonomic problems in the future.

Shipping Conveyor Improvement
The first action item was to test the spring loaded bottoms in the re-sort bins. After this was completed the bins were ordered so they could be installed as soon as possible to fully utilize their addition. Improvement ideas continued to be generated for mechanical solutions. Labeling was also created to identify which bins were dedicated for re-sorting.

RESULTS AND DISCUSSION

The inventory location accuracy represents one of the major challenges for improvement at CooperVision’s Henrietta distribution facility. As part of the process improvements executed by the team in this project, this problem was addressed only for the ADM location. Further research should focus on increasing this metric in other locations such as Pick to Light and Pick to Voice, which are in similar situation.

The flag system proposed in the project presents a great opportunity to reduce waste associated with excess travel time in the ADM machine operation. The proposed design is to be tested and implementation of this concept will depend on the result of these tests. At the kaizen meeting in the ADM, operators demonstrated a large resistance to the flag idea, claiming the difficulty associated with tracking 512 flags on both sides of the ADM. Training and teaching of the importance of following these new procedures and standard work must be demonstrated to the ADM operators prior to implementation in order to have the support of these vital people.

The spring loaded bottoms were installed to the re-sort bins and their affect was immediately noticed. The re-sort bin is emptied about once an hour and the constant reaching could lead to a cumulative trauma disorder (CTD) for the workers in the shipping department. These workers also commented on how they can perform a re-sort quicker and more comfortably.

Lastly, employee meeting discussions helped with the issue of up-side down boxes. This led to a decrease in boxes being sent to the resort bin but it was decided that steps need to be taken to ensure that this improvement was more long lasting. A new idea that was generated was the checking of which employees often placed boxes on the conveyor upside down. This is not to reprimand employees but more to act check to keep the need to re-sorting of boxes down.

CONCLUSIONS AND RECOMMENDATIONS

CooperVision has been provided with a capacity analysis tool intended to serve as an aid in the strategic and operational decision making process. The focus of this tool should be used on a long term basis, as high variability inherent to the operations at the facility does not allow for accurate results. The model has been validated within 1% of labor demand for the pick areas and 2% for pack. With the workforce management system being so new in pack, the team hopes that in the next few months, the tool will prove to be more accurate than at present time.

Correct implementation and follow up of the labeling in the ADM will result in a considerable increase in inventory location accuracy. Incorporating the flag concept developed by the team will also reduce waste in the replenishment process and will require less effort to achieve better results. Ergonomic problems near the shipping conveyor were eliminated and further modification of the conveyor is needed to prevent boxes from flipping over and being misread.

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All the staff who participated in the Kaizen Events at CooperVision
Appendix A – Flow Layout for Pick and Pack Process

Value Stream Map
CooperVision Distribution Center, Henrietta, NY

Appendix B – Brainstorm of Process Improvement Ideas

ADM
- Find out how boxes get to the ADM.
- Use all 1024 slots on the ADM.
- Make numbers on ADM slots consistent.

Pick to Light
- PTL let queues build up to make picking more efficient.
- Why can’t one see inducts within PTL?
- PTL show which segment of the segmented order item will go to, put it in front of the product.
- The higher hit items should be slotted in the first 2 PTL sections.

Pick to Voice
- PTV Look at better anti-fatigue methods in floor level section (it's better to work upstairs).
- Additional headsets in voice picking area.

Carousel
- Ergonomics on the carousel (being able to reach the top, is difficult).
- Feasibility of eliminating carousel, including a voice instead.

Bulk
- Changing the way bulk is picked. Get rid of the separate bulk picking.
- Picking bulk in the morning. (3 hrs in the morning 6am-9am).

Packing
- Packing process modify the system to guarantee continuous flow.
- Utilize extra conveyors in packing areas.

General

Notes:
- Totes can be either segmented or non-segmented
- Totes can be label as “hot” and are pushed through the system with a higher priority.
- The “Hospital” is a waiting area for totes that are awaiting more items at the ADM.
• Eliminate segmented totes altogether.
• Hold orders for one day.
• Track expiration date. Explore possibility to fix that.
• Minimizing product write-off.
• Start employees at 9 am: rescheduling.
• Being able to batch orders in the same move. (Move forward with a few totes, increase pick density).
• Being able to pick an entire side of PTL instead of going from section to section.
• Get rid of waves.
• Re-slot entire facility.
• Fix shipping box conveyor transfer (sometimes it flips the box over).
• Supply gloves to all workers.
• Differentiate between high and low ratio of units per pick. Higher ones should be in different areas then lower ones.

Appendix C – Cost Analysis of new ADM Labels

<table>
<thead>
<tr>
<th>Cycle Count ADM - Results</th>
</tr>
</thead>
<tbody>
<tr>
<td># of locations</td>
</tr>
<tr>
<td>Nov.08</td>
</tr>
<tr>
<td>Dec.08</td>
</tr>
<tr>
<td>Jan.09</td>
</tr>
<tr>
<td>Feb.09</td>
</tr>
<tr>
<td>Total defects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs - Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of defects (1)</td>
</tr>
<tr>
<td>Number of hours per defect (2)</td>
</tr>
<tr>
<td>Cost of labor hour (3)</td>
</tr>
<tr>
<td>Total cost of defects (1x2x3)</td>
</tr>
</tbody>
</table>

Time spent on a single defect

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Packing defect recognition</td>
</tr>
<tr>
<td>3</td>
<td>Packing notifies the search and rescue team</td>
</tr>
<tr>
<td>12</td>
<td>Fill out form and travel to and from ADM to pick the right product</td>
</tr>
<tr>
<td>2</td>
<td>Repack the order</td>
</tr>
<tr>
<td>5</td>
<td>Check the slot that contained the wrong product potentially remove items that are not supposed to be there.</td>
</tr>
</tbody>
</table>

TOTAL minutes per defect | 24

Cost of labels | $1,200.00
Cost of defects | $3,168.00
Payback period (months) | 4.55

New Ergonomic Bin Design
Bin Depth = 1’

Old Bin Design
Bin Depth = 3’