1. Abstract

L.A. Enterprises, a packaging company under the authority of the cosmetic company L’Oréal, currently employs a packaging process directed by humans. Because of growing consumer demand, the packaging process of products must be improved to meet the stipulations of the market. Currently, a process utilizing human labor is used, and all products are packaged within each box. However utilizing an automated process would be best to meet these requirements, as human labor has been found to be less efficient and safe than mechanized methods. Ultimately, packaging each cosmetic product into separate boxes would enable higher efficiency than packaging all of the requested cosmetic products at the same time. This method will save time and effort for L.A. Enterprises, L’Oréal, and beauty assistants in malls.

2. Introduction

2.1 L’Oréal and its Subsidiaries

L’Oréal is a major cosmetic company dedicated towards supplying worldwide access to products that enhance well-being and physical appearance. As a worldwide leader in cosmetics, L’Oréal produces 27 global brands with products that span 130 countries and has consolidated sales amounting to about $25 billion in the last year. Its five main areas of expertise are hair care, hair color, skincare, make-up, and fragrances [1]. However, even with over a century of expertise in cosmetics, L’Oréal is still undergoing constant changes with its manufacturing process to support the rising demands of the public and to better contend with other industries in the increasingly competitive market. Through this project, we hope to be able to advance the manufacturing process at L’Oréal by providing recommendations to improve their packaging process, which is currently implemented predominantly through manual labor. L’Oréal owns many subsidiary companies such as Lancôme, Biotherm, Ralph Lauren Fragrances, Garnier, and Redken, as well as many others [2].

L’Oréal incorporates a variety of marketing tactics including premiums. L’Oréal provides a supplementary bundle of cosmetics to consumers who spend a certain amount on products. For example, Lancôme, one of L’Oréal’s many subsidiaries, offers a “7-piece gift, free with any Lancôme purchase of 39.50 or more, up to a $140 value” [3]. The gift includes a set of sample cosmetics, from serums to eye creams and more. The offered free-samples, however, are not the same size or shape as the original products, and are usually smaller. Therefore, these samples require different packaging. To package its cosmetic free-samples, L’Oréal commissions L.A. Enterprises, a minority-owned firm which specializes in packaging services for cosmetics. L.A. Enterprises assembles, packages, and delivers L’Oréal cosmetic products to various areas in the country [4]. Improving the
packaging process at L.A. Enterprises would help to increase L’Oréal’s profit margins.

2.2 The Current Packaging Process

The manufacturing process at L.A. Enterprises is currently managed through a human workforce and relies on balances, weight checks, an automated taper, and a conveyor belt to package products. The production line that we will be focusing on in this project employs approximately 50 people, producing a total of fourteen different products, including lip gloss, blush, mascara, and others (See Appendix A). Products are manufactured and shipped from L’Oréal to L.A. Enterprises where they are packaged into boxes in an extensive process before becoming commercially available. First, a large box is folded into shape with compartments for different cosmetics. A sticker label is placed on the box. The products are packaged into plastic bags in small groups. These bags are then checked for weight to ensure that the products are of a suitable quality. All the materials are placed into the folded cardboard box, and the box is checked for weight once again. In the event that the box of products passes inspection, an information booklet is placed within the box along with one or more sheets of protective filler paper, colloquially termed “bogus paper,” meant to protect the contents of the box when the box is being opened by sharp objects such as scissors or knives. The box is sealed with tape by a machine and stored until it is shipped out, and the waste is then disposed of. L’Oréal’s current method produces an average of 3 boxes per minute, with 5% of all boxes failing inspection due to box weight checks [5]. This process is slow and inefficient, as it produces many boxes that are unable to be commercially used. Our objective is to shorten the number of people required on the production line, as well as to improve efficiency and increase profit.

2.3 Packaging Process Approaches

There are three available approaches: completely automating the process, partially automating the process and partially utilizing human labor, and solely utilizing human labor. Automating the process, at least partially, through machinery would irrefutably increase throughput (product output), reliability, and overall productivity. Exclusively using machinery would not be feasible because of the costs involved with purchasing the correct machinery, the limited floor-space provided, and the limitations of machinery in contrast to free-thinking humans. On the other hand, exclusively relying on human labor would be less efficient than relying on other options such as a partially automated packaging process to effectively meet production requirements in a timely manner. Products produced and packaged through human labor have been shown to be less efficient and reliable than those produced and packaged through an automated process due to human errors and flaws. Machines, unlike humans, have no risk of inadvertent damage to their person and have no conditions or fluctuations in mood or fatigue that may affect the quality of their work [6]. Using a hybrid of automation and human labor would ultimately be most profitable for L.A. Enterprises, and therefore L’Oréal by extension as well, by saving time and spending. It will be able to be used successfully even in the future, which means that L.A. Enterprises will not have to alter the packaging process for years to come.

2.4 Arena and Google Sketchup

Several programs were used in the process of understanding and improving the manufacturing process at L’Oréal. Arena is a program made by Rockwell software. It can be used to create simulations of an industrial process. In Arena, users place modules and connector lines to represent steps of a process
or logic. Data, such as throughput and hours approximated, from the simulation can be extrapolated using the software.

Google Sketchup is a free, beginner, 3D-modeling program released by Google. This software allows users to create just about any kind of 3D model. Measurements may also be used to create the model in order to accomplish a realistic scale. Google Sketchup also gives users several different viewing tools so virtually every angle of the model can be accessed.

2.5 Beneficial Qualities

There are many qualities that must be considered when deciding on the most advantageous automation process. Most importantly, the throughput associated with efficiency and productivity of the production line must be taken into consideration. High quality of the end-product is also essential, as consumers will not be satisfied with substandard products, which could negatively affect sales. The lower the sales, the less profit made. Similarly, high return on investments is another aspect that must be considered, as this also deals with the same monetary difficulties. Machinery with low profit yield may not be worth the installment and purchasing costs. The ease of use is imperative for any workers who may be maintaining machinery or otherwise be involved in the packaging process. The improved manufacturing process should be neither overly work-intensive nor unsafe to put into practice, in order to make it comfortable for human workers to control. Without humans to oversee the mechanical processes, the machines may not receive the necessary maintenance to ensure high productivity. Limited floor space also restricts the extent we can mechanize the process. Also, on top of considering all of these aspects, the process requires strong durability and should be practical and advantageous enough that it can be used even decades from its installment without significant maintenance. Energy usage and waste production also influence the final design of the production line.

However, these are not the only factors involved in improving the packaging process. Not only must the process be easy to use and efficient for L.A. Enterprises and L’Oréal, the process must also be easy for the beauty assistants in malls as well. The beauty assistants are an integral part of the packaging process at L’Oréal, as they are the main bridge between the producers and the consumers. The boxes of products must be created to be manageable and easy to store, as there is not a sufficient amount of space behind beauty counters for box storage. Instead, there are storage rooms in which product boxes are stored, and a restricted number of each product is kept in a display on the counter for better accessibility. By making sure that beauty assistants are also considered, the packaging process at L.A. Enterprises will be most efficient for all parties involved.

2.6 Advantages of Automation

By fully utilizing a combination of machinery and human labor to satisfy these beneficial characteristics, L.A. Enterprises and L’Oréal will ultimately be able to gain larger profits in a shorter amount of time with the new packaging process. There will be less waste produced, and more of it will be able to be reused or recycled, which will allow effective saving of costly resources. Although the initial investment in automating part of the packaging process at L.A. Enterprises will be costly, as the machines will most likely be custom-designed due to the specialized forms of the cosmetic containers, the return on the investments over time will indisputably lead to larger profits for L.A. Enterprises and L’Oréal, as machines are more efficient than humans.
2.7 Machinery

The different categories of accessible machinery are as follows: standard, off-the-shelf machinery which can be bought and utilized immediately upon shipping and arrival, custom-designed machinery which must first be manufactured, and machinery manufactured by in-house engineers from L.A. Enterprises. Custom-tailored machinery would be most realistic, as L’Oréal products are very specialized and require delicate handling to prevent scuffs and otherwise abrasive inflections on the surface of the products. There are many types of machinery that would be useful in the particular production line that we are working on to improve. For example, some types of packaging machinery are packing, unpacking, conveyor-belt, boxing, product feeding (to feed products into the machinery), identification and labeling, weighing and weight-checking, and wrapping machinery. By utilizing these various types of machinery, we can focus on creating a packaging line of custom-designed machinery that will automate the majority of the packaging process at L.A. Enterprises.

3. Methods

3.1 L.A. Enterprises

Our research began not at L’Oréal’s headquarters, but at L.A. Enterprises, where the cosmetic products for L’Oréal are packaged and shipped. We observed the manufacturing line first-hand and were able to glean rudimentary knowledge on the packaging process. With an average of about 48 people per production line, L.A. Enterprises consisted of a large warehouse filled with several assembly lines, each working on packaging an array of different cosmetic products for shipment to different cosmetic retail stores.

3.2 Arena software

Early in the research process, a simulation of the current manufacturing process was created using Arena software. The software was obtained by emailing Rockwell software, to which the company responded by sending a free program. A functional simulation was made, but due to difficulties in learning the program, further research was not conducted using the program. Different machinery and automating methods were researched and contrasted in order to create a partially automated process that would improve the current packaging process at L.A. Enterprises.

3.3 Rate-limiting step

From what we observed of the current packaging process, the most time-consuming step was dealing with packaging a small quantity of each product into plastic bags. The rate limiting step appeared to be counting out the exact number of product required for each bag. Identifying the rate limiting step was important because this step determined the overall speed of the whole process. No matter how effectively the other steps are improved, if the rate limiting step is not refined, the overall process will remain slow and unproductive. Therefore, the foremost qualities that were taken into account were those that affected the slowest and most inefficient steps of the entire process. Because of this, it seemed most feasible to automate the process of placing products into boxes.

3.4 Recycling

We also decided to reduce the waste that would be produced in our packaging process to save resources and money. The current packaging that L’Oréal uses for this specific shipper includes a cardboard insert that acts as a separator and “bogus paper”. The
cardboard separator is used to create compartments for proper separation and organization of the packaged products. These separators are counted as waste because it is disposed of after the customer receives and unpacks the products. Not only is this separator inefficient because of the waste it produces, but also because L.A. Enterprises has to dedicate a whole job to folding and creating these pieces to put in each box.

“Bogus paper” is added to the box after all of the products are put in. This layer of crumpled paper is used as a buffer so that the products are not damaged when the box is cut open. Yet again, this creates more waste and is part of the laborious process of the packaging process at L.A. Enterprises. The cardboard separator and the bogus paper are not efficient because they cost money to produce and money for the labor required to assemble it, and are unrecyclable.

One solution we came up with for improving the efficiency of the packaging process was to completely get rid of the disposable paper components inside of the box. The cardboard separator and bogus paper could be replaced with a reusable container. A prototype of the proposed container was designed on Google Sketchup software. The container itself would have similar dimensions to the cardboard separator already in use; it would have compartments to separate the products. There would be a lid to the container to seal off the compartments as well as create a barrier like the bogus paper did. This reusable container would be put directly into the cardboard box that is already in use.

The idea of a reusable separator stemmed from a container already in use at L.A. Enterprises. While analyzing the assembly lines at the facility, there were blue plastic trays that were used to transport lipstick tubes. The trays looked similar to the image presented:

![Figure 1: Lip balm tray [7]](image)

The trays would be sent to the facility with the lipstick in them and then shipped back to the manufacturer to be reused after the tubes were removed. These trays are efficient because they could be stacked and did not take up too much space.

The proposed separators would be similar in design with these lipstick trays. Assuming that the lipstick trays are made of a durable plastic, the same material should be used for the reusable separator. As for the lid, the base of the lid would be made of the same plastic material as the containers, but there would also be an outer container. The separator is also designed with notches in the top and bottom layers of polypropylene, which provides a scratch-proof film to elongate the life span of the containers in order to make the containers stackable and save space [8]. These containers would be paid for by L.A. Enterprises to be shipped back from the customer after all products have been unloaded. A scale model was created using Google Sketchup (See Appendix B). However, this method was soon found to be too expensive to be viable.

### 3.5 Redesign of packaging process

Another approach was thought of after a trip to Macy’s. When asked, the beauty assistants expressed their want for boxes to contain only one type of product. They pointed out that if one type of gift is popular (i.e. mascara), then they would have to open more and more boxes just to get this one product.
This system is inefficient because the other products in the box take up unnecessary space in the counter when they could be in storage. We propose redesigning the packaging process at L.A. Enterprises to package only one of their Lancôme gift products per box. There are many benefits to this one product per box approach. Inserts will no longer be needed to divide the multiple products in boxes. This approach will save money on inserts by reducing the 180 inserts needed per hour to 0 and will also take a job off the line. L.A. Enterprises has to devote a whole position to fill the inserts in these boxes. Without the inserts, boxes will be much more economical with their use of space, fitting much more product per box.

We recognize that not all of L’Oréal’s customers might order a large enough value where a 19.375x15.375x7.75 box would be appropriate. Because of this, we propose using a cube-shaped box, a 13.75x13.75x13.75, which can still hold a multitude of any product. Cube-shaped, single-product boxes will lead to fewer errors. Any box rejected by the weight-checker simply needs each bag in the box checked for the respective amount of product that belongs in each bag. A simple comparison test of the bags could be used instead of the tedious method of checking each bag for the respective amount of product that was supposed to be in that bag.

With this proposed method, a new organization of the line is necessary. The most effective solution appears to be our proposed hybrid automated process, which includes both human labor and mechanized processes. However, rather than combining production of products in a single production line, working on only one product at a time would be most efficient. With all workers working on a single product at a time, the process will be much more effective for both L.A. Enterprises and the beauty assistants in department stores. After one product in the order is complete, the whole line shifts to a new product in the order. This method is performed until the order is complete and then all boxes will be shipped to the customer.

4. Discussion

4.1 Human Labor

Human labor produces complete packages slower than a mechanized process would. The workers at L.A. Enterprises work from 7:30 to 4:00, with 10 minute breaks in the morning and afternoon and a half-hour break for lunch, which is about 7 hours and 40 minutes of actual production time. However, a machine does not require breaks and can work as much as can be supported by resources. By having working shifts for different times, a machine can yield over a 200% increase in working hours, which would beneficially affect the packaging rates.

4.2 First Box Draft

Our main proposal to supplement the current packaging process was to implement machinery which would package products into a reusable container. The products would be shipped to department stores, and the boxes would be shipped back to be reused. In this way, L.A. Enterprises would be able to save the resources necessary for the continual production of cardboard boxes while at the same time producing less waste.

4.3 Problems with First Box Draft

However, a visit to Macy’s department store, a carrier of Lancôme products, yielded that the alternative container would not be a feasible idea. The two beauty assistants who were interviewed both agreed that the current packaging for the products is inefficient. However, they did not believe that having to send back every single reusable box back to L.A. Enterprises would save enough resources
to make up for the lost time and money from shipments. They also confessed that having all the separate cosmetic products in each and every shipment box is inefficient because labor is needed to sort the items once the mixed boxes of products arrive at the store. They suggested having only one type of product packaged in each box. Even though the reusable container would be efficient in reducing waste, the entire concept of compartments in a shipment box encumbered the beauty assistants who would have to sequester the products. It was also revealed that most department stores had very limited storage space, so not much of the stockroom can be assigned to storing the reusable containers until the return delivery. The beauty assistants pointed out that new jobs would be required for the purpose of organizing and returning the reusable containers and that even with these new jobs it would still be impractical with their limited storage space, meaning many shippers would end up being thrown out.

4.4 Second Box Draft

Because of the discerning and critical assessments of the beauty assistants, a new box design was created. We decided to have a single type of product packaged in a box, rather than having a compartmentalized box with many types of products together in every box. Also, there would be seven different automated lines to package similarly shaped products, rather than having all of the products packaged on the same line, in order to reduce confusion between products or mix-ups inside the boxes. This automated method would ensure faster packaging of the products, benefiting L.A. Enterprises, while the segregation of the products would allow the beauty assistants in department stores to save time and effort on sorting out the products.

4.5 Machinery Types

While the initial investments may be costly, the throughput, efficiency, and durability of the new machines should be more than enough to quickly recompense and even overcome the initial costs. The machinery used in the new packaging processes would incorporate much of the same apparatuses already used in the current packaging process, including Interpack Carton Sealers, Ohaus digital scales, AllFill Inc. LPHA Checkweighers, and conveyor belt and wrapping machines. However, the new process would also integrate additional equipment such as Genesis box-labeling and label-dispensing machines to correctly identify boxes, Fresh Automation feeding and orienting machines to collect and organize products for placement into boxes, Inline Filling Systems Inc. accumulating machines to bring all the products together, Siemens packaging and unpackaging machines to physically place products into the appropriate boxes, and TapTone container inspection systems to perform box weight checks. Purchasing used versions of these machines would save money on investment, bringing the total cost for all seven product lines to approximately $350 thousand [8, 9, 10, 11, 12, 13]. However, despite the large investment, the increased throughput of the machinery would allow swift recuperation of costs.

4.6 Final Box Design

The proposed box design, a 13.75x13.75x13.75 design is more beneficial than the old design in a few different aspects. A 13.75x13.75x13.75 box has a more economical design than the original 19.375X15.375X7.75 design because the new design maximizes the volume of the container, increasing the volume of the box by 12% and increasing the volume to surface area ratio by 13% while using the same amount of materials to generate the box.
We determined the average bag size to be 4x4x3 inches, which means the average volume of a single bag is 48 in$^3$. Our original box can hold about 48 bags on average. Our redesigned bags can hold approximately 55 bags, which is a significant increase of 15% (See Appendix C).

5. Conclusions

By utilizing key components and qualities necessary in an automated process along with the professional opinions of advising engineers and beauty assistants, we found that a hybrid packaging process including both manual labor and automated machinery would be most advantageous and accommodating for all parties involved, counting the cosmetic manufacturers at L’Oréal, product packagers at L.A. Enterprises, and beauty assistants in department stores. However, instead of implementing a single, concentrated automation process containing a specified number of each ordered cosmetic product, the new process would utilize dispersed packaging lines to package similarly-shaped product separately, meaning there would be approximately seven lines in use at any time. Rather than having uniform boxes packaged with identical numbers of each product, it would be more effective to have separate boxes, each containing a single type of product. This method reduces counting errors and enables greater efficiency and higher quality packaging of products. Also, beauty assistants in department stores would be more comfortable storing the appropriate products in their proper positions, because the separated boxes would allow for easy partitioning and storage. This new packaging method would ultimately be beneficial for L.A. Enterprises and L’Oréal as well.

6. Acknowledgements

First and foremost, we would like to profusely thank our project’s residential teaching associate (RTA), Kristin Stevens, who tirelessly encouraged us and offered indispensable counsel. We are grateful to our project mentor, Arlene Yard, for her invaluable insights and fundamental knowledge of L.A. Enterprises. Our gratitude also goes out to Adrianne Swerdlow, a director in charge of information management and market supply logistics at L’Oréal USA. We’d also like to thank the various individuals involved in running, maintaining, and overseeing the program, including the assistant director, Mr. Jean Patrick Antoine, the director, Dean Ilene Rosen, Ed. D., the Governor’s School Board of Overseers, and all of the RTAs involved in editing our paper and making the program into a memorable experience. Finally, we’d like to appreciatively acknowledge the various sponsors who made it possible to attend the NJ Governor’s School of Engineering and Technology: Rutgers, the State University of NJ, the State of NJ, Morgan Stanley, Lockheed Martin, South Jersey Industries, Inc., and PSE&G. We are sincerely thankful for this incredible opportunity.

7. References


Appendix A
Current Packaging and Products

Figure 2: Full box of products

Figure 3: Bogus paper and inserts

Figure 4: All products

Figure 5: Empty box with separator
Figure 6: L’Oréal products (left to right: Juicy Tube Ultra Shiny Lip Gloss - Beach Plum (0.33 oz.), High Resolution Eye Refill 3X Triple Action Renewal Anti-Wrinkle Eye Cream (0.25 oz.), Renergie Lift Multi Action Lifting and Firming Cream SPF 15 Sunscreen (0.5 oz.), High Resolution Refill 3X Triple Action Anti-Wrinkle Cream SPF 15 Sunscreen (0.5 oz.), Renergie Lift Multi Action Eye Lifting and Firming Eye Cream (0.25 oz.), Bienfait Multi-Vital SPF Sunscreen High Potency Daily Moisturizing Cream (0.5 oz.), Blush Subtil Delicate Oil-Free Powder Blush- Aplum, Bi-Facil Double Action Makeup Remover (50 mL), Hypnose Custom Volume Mascara - Black (2.07 mL), Cils Booster XL Super-Enhancing Mascara Base (2.07 mL), Nutrix Royal Body Intense Lipid Repair Cream (2.0 oz.), Genifique Eye Youth Activating Eye Concentrate (0.25 oz.), Juicy Tube Ultra Shiny Lip Gloss - Coral Rush (0.33 oz.), Color design Sensational Effects Eye Shadow - Daylight / Exhibition /The New Black / Trendy (0.12 oz.))
Appendix B
Reusable Box 3D Modeling

Figure 7: Lid, box, and container (front)

Figure 8: Lid, box, and container (angled)

Figure 9: Notches for easy stacking

Figure 10: Top view of interior

Figure 11: Frontal view of lid and container

Figure 12: Top view of lid
Figure 13: Stacking notches on lid top

Figure 14: Stacking notches on lid bottom
Appendix C
Mathematic Calculations

Original Box (19.375x15.375x7.75)

Volume:
19.375" * 15.375" * 7.75" = 2,308.65 in³

Surface Area:
2(19.375" * 15.375") + 2(15.375" * 7.75") + 2(19.375 * 7.75) = 1,134.41 in²

Volume to Surface Area Ratio:
\[
\frac{2,308.65 in³}{1,134.41 in²} = 2.035
\]

The approximate dimensions of each bag of cosmetics are 4x4x3

Volume of Bag:
4 * 4 * 3 = 48 in³

Number of Bags per Box:
\[
\frac{2308.65 in³}{48 in²} \approx 48
\]

Optimized Box (13.75x13.75x13.75)

Dimensions:

If the surface area of the old box was arranged in a cube we would have edges of size:
\[
\sqrt[6]{1,134.41 in²} = 13.75 in
\]

This would yield a volume of:
13.75" * 13.75" * 13.75" = 2600 in³

And produce a Volume to Surface Area Ratio of:
\[
\frac{2,600 in³}{1,134.41 in²} = 2.30
\]

The approximate dimensions of each bag of cosmetics are 4x4x3

Volume of Bag:
4 * 4 * 3 = 48 in³
Number of Bags per Box:
\[
\frac{2600 \text{in}^3}{48 \text{in}^2} \approx 55
\]

Volume increase from original box:
\[
\frac{2600}{2308.5} \times 100\% = 112\%
\]

Comparing Optimized to Original Box’s Volume to Surface Area Ratios:
\[
\frac{2.30}{2.035} \times 100\% = 113\%
\]