FACILITY REDESIGN AT THE SYSTECH CORPORATION

A Senior Project submitted

In Partial Fulfillment

Of the Requirements for the Degree of

Bachelor of Science in Industrial Engineering

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By

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Introduction

This senior project is a redesign of Systech's manufacturing floor as they move to their new facility to be able to support the expected increase in customer demand. Systech was chosen as a senior project because of the author's relationship with some company employees, as well as their willingness to work with an IE student on their current production requirements. As of January 2013, Systech was working near full capacity, and because of their new product release, they expect the demand to outstrip the production capabilities of the current facility. Because of this, Systech is moving their final testing operations in San Diego to a larger building. During this transition, they have expressed interest in redesigning the current floor layout in order to maximize the productivity of their employees. To accomplish this, floor plan analysis, ergonomic design principles, and facility planning expertise are used to determine the best fit layout for the new facility.

This report presents a production layout design that optimizes the floor space of the new facility, with accompanying financial justification for necessary changes and purchases. Systech can take these recommendations from the senior project and decide how to design the new facility layout, which is designed to increase productivity, visual management, and expected expansion planning.

The report outlines the history of the company, key individuals, and production details, as well as a comprehensive problem statement, literature review, and methodology that breaks down the necessary tasks that are used to complete the project.

Background

Company

Systech is an IP (Internet Protocol) Communication company, connecting non-internet capable devices to the web to allow for remote viewing and control, with a focus on IP communication. It was founded in 1981, and currently has about 40 full time employees at their headquarters in San Diego. As of 2012, there are over 350,000 units in operation in the field, and they are slated to begin large scale production of their new "cellular unit" that is expected to account for an increase of 60% in their production (even though they're already at maximum production).

To account for this expansion, Systech plans to move to a larger facility in April, increasing their production floor space by approximately 60%. This senior project will focus on a redesign of the current floor layout for implementation during the move to the larger facility. The design will focus on micro elements, like workspace layout (Ergonomics), as well as account for the expected increases necessary to meet the future demand.

Systech SysLINK M2M Gateway Modular System

Key Individuals

Identifying project critical individuals at Systech was required in order to know who to contact when issues or challenges came up. Below are the individuals who were involved with the author in this senior project:

Zen – Manufacturing, started at Systech in 1994, strategic focus, handling the increased volume expected in the coming years, focuses his time with supply chain management.

Nathaniel – Production, started at Systech in 2002, originally assembled, tested, and shipped the units himself. Now manages 5-15 workers, my main contact, extremely knowledgeable of the process, and recently introduced a version of single flow into the system, with time card management.

Rod – Planner, at Systech for 3 months, focuses his time with supply chain, and planning out the production schedule, works with Zen and Nathaniel so they're on the same page.

Jeff – Father, Director of New Products, focusing on the development of their new product line, which will heavily impact the manufacturing system in the coming years.

Don – VP, at Systech for 23 years, has seen the company grow over the years as it faces new challenges.

Manufacturing

Five years ago, all production at Systech was completed in-house with Nathaniel and a small team of assemblers/testers (3rd party companies were used for PCBs and enclosures). They were in charge of completing all assembly operations, doing all required testing/rework, as well as shipments. It was a very hectic and unorganized process that focused on pushing products out the door.

Over time, Systech shifted fabrication and assembly operations to third party manufacturing companies, currently Avalon in Chennai, India. With that shift, the San Diego headquarters facility workload now focuses only on final testing and shipping of new products, as well as rework for products in the field. Rework plays a major part in their inability to reliably ship out products in a timely manner to waiting customers. Many times during the week, products in the field are returned with defective hardware or software, requiring the workers to switch over from the single flow manufacturing system to working on old, non-value added products. But, because this rework issue is created during the manufacturing process in India, it is not the focus of this project.

In the past 3 months, Nathaniel introduced single flow design into the final testing area to increase visibility of the workflow. Still being implemented, the data collected needs to be analyzed for its usefulness. With high school students and older veteran workers, there's a diverse workforce on the manufacturing floor.

Currently, the Systech manufacturing floor is running out of space, with products being lined down the hallways to save space. This will be addressed with their planned expansion in April 2013, increasing the manufacturing floor space by approximately 60%. At the beginning of the senior project, there was no solid facility layout design for the new floor and no plan for the increase in production requirements with the new products coming online.

Production

Systech produces approximately five thousand units a month (from one thousand four years ago), depending on the amount of rework, as well as supplier delays. There are between 35 and 40 types of different products made during the month, and between 1 and 12 types made each day. Systech's new product is expected to account for the majority of production increases, but also has unknown elements that need to be addressed as products come back from the field with necessary reworks and repairs.

Problem Statement

To analyze current production operations of Systech's manufacturing floor using industrial engineering tools and provide an optimized layout for Systech's new manufacturing facility with economic justification.

Literature Review

Introduction

When analyzing the ways to improve a facility's production, efficiencies, and throughput, the topic of Lean Manufacturing usually surfaces. By looking into the history of lean manufacturing, as well as the current climate of how lean principles are introduced into the workplace, specifically related to cell design, this baseline of knowledge can be applied to the current manufacturing floor redesign at Systech.

Lean Manufacturing – Origins and History

Before the 1900s, manufacturing production was an organic process, with no expectation for accountability in regards to standardization, productivity, or output from work. But the introduction of industrial efficiency by Fredrick Taylor at the beginning of the 20th century changed the course of production and manufacturing goals. In his book "The Principles of Scientific Management," Taylor lays out the four main principles in this new philosophy for production management:

1. Replace rule-of-thumb work methods with methods based on a scientific study of the tasks.

2. Scientifically select, train, and develop each employee rather than passively leaving them to train themselves.

3. Provide 'detailed instruction and supervision of each worker in the performance of that worker's discrete task.'

4. Divide work nearly equally between managers and workers, so that the managers apply scientific management principles to planning the work and the workers actually perform the tasks.

(85, Taylor, Frederick Winslow, 1911)

Taylor's system marked the baseline from which all other production systems were founded upon. Ten years later, in the 1910s, the mass production assembly line concept at the Ford Motor Company contributed the concepts of standardized product lines, batch production, and worker movement reduction. But with the standardized lines and bulk orders, the manufacturing sector's ability to meet the fluctuating demand of the market was extremely poor, based upon their own demand expectations, leading to massive inventories or shortages across the marketplace.

The system of production did not experience much change until after World War II, sprouting in a post-war decimated Japan. During the time of rebuilding the nation, "the foundation of JIT (Just in Time) – and TQM (Totally Quality management) contributed to the global business in the latter half of the 20th century as a part of the larger Toyota Production System (TPS)" (Amasaka, Kakuro).

There are four main rules associated with TPS, as outlined in the article "The DNA Of The Toyota Production System:"

- Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome.
- Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.

- Rule 3: The pathway for every product and service must be simple and direct.
- Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

(Spear, Steven 1999)

Because of Japan's ability to engage customers at this new level of service, the global market responded by revamping their manufacturing processes in order to meet and exceed customer requirements when it came to new found focus on reliability and short order-to-fulfillment times. Lean Manufacturing was born during this time, being implemented in the production plants at large facilities, and soon crossing over into all vertical structures of a corporation.

In recent years, Lean Manufacturing's meaning has shifted, so that "Lean was not just manufacturing, but in fact a holistic logic and management system that starkly contrasted with the traditional mass production approach…and it included issues such as supplier management and product development" (427 Holweg).

Lean Manufacturing – Overview

The Lean Manufacturing process centers on delivering more value by reducing waste or work required to produce a product or service. Using scientific data gathering methods and analysis, it provides an objective way to view current processes on a production floor, with the ability to find and address areas for improvement.

The Lean Manufacturing methodology focuses on the optimization of two measures: throughput, which is the amount of product/service that can be processed in a defined window of time, and capacity, which is the total amount of raw materials, work in progress, and final product, that a production floor can accommodate. "The quicker the throughput of products, the more capacity the facility will have. The more demand we meet, the more money we make. If financial measurements were geared towards throughput and capacity, factories would be driven in a lean direction" (5 Duggan).

One of the most common methods to begin addressing throughput and capacity constrains is to create a value stream map. A value stream is a visual way of mapping the path that products follow on the production floor. It allows non-value added processes to be identified, reduced, and eliminated, creating a more efficient and effective process. At the same time, this method is used to identify common product paths that can be clustered and optimized. "Customers do not care whether you have a large warehouse and stock thousands of items for immediate delivery or if you make items to order with no inventory, as long as product is available when they need it." (4, Duggan)

The savings created by focusing efforts on throughput and capacity can result in a "drastic reduction of material handling, inventory, and manufacturing lead-time…[which] will flush substantial dollars to the bottom line…[and] the operational benefits to a lean facility design can yield more important benefits, those that impact future growth." (5, Duggan)

Lean Manufacturing – Cell Design

Before the use of lean manufacturing cell design, the facility design of many manufacturing firms focused on a single line production plan, where each process was designed taking into account only considering the process feeding into it. With the introduction of Lean Manufacturing, the creation of cell designs to optimize production floors took hold. The first step in implementing a cell based design is to create a process map, which "reveals a pattern that shows which productions follow similar manufacturing processes." Product lines that have similar process mappings are clustered and categorized (although it does not require each product to have the exact same process line).

After identifying and clustering certain processes, calculations on demand production for each cell is computed, as well as identifying which cells have a "shared resource," which is a process or sub-cell that is shared among different cells. Because the shared resource is needed in order for many other cells to continue running, they are common places where production is held up, termed a bottleneck. Because of the large impact these shared resources have on a production floor, it is crucial to optimize the throughput and capacity of the cell. For physical shared resources (such as a roller, sheet metal cutter, stamper, etc.), buffer inventory is usually stored next to the cell, and "The quicker the machines can be set up, the less inventory is needed to buffer. Programs such as SMED (single-minute exchange of die) are very effective in reducing set-up times" (3 Duggan).

Although most cell designs are unique to each production facility, they can be classified into five different categories:

- <u>Stable Product</u> cells – stable demand, stable supply, easy to forecast design specifications
- <u>Bulk Product</u> cells – physically large cells, usually stationed near shipping areas as well as receiving docks
- <u>Small Product</u> cells – designed to support small products, which can fit within a bulk product cell, or in hard to fit area

- New product cells – requires the most on-the-fly engineering design and solutions, since new products have unexpected problems with regards to variation in throughput, as well as demand requirements

- Mixed model cells – is a combination of product lines and production plans, designed with the ability to change depending on resource requirements or demand restrictions.

  (3 Duggan)

Lean Manufacturing – Terms

Although a cell design allows for a product line to be streamlined in order to reduce waste, it does not take into account variable demand of different products. In order to be considered designed with Lean Manufacturing principles, "continuous improvement and changes to match the value stream to the current product line would be necessary. But the facility or service has to be designed to accommodate change" (4 Duggan). In order to accommodate change, the system can be designed with the following in mind:

- Modular Workstations – design work areas with the ability to adapt according to variable throughput amounts in order to reduce down time, as well as provide on-site inspections to decrease rework down the line.
- Shared Resources – mentioned earlier, identify and factor in higher variability with work output requirements downstream from the shared resource location.
- Value Stream – recognizing the demand along the value stream, as well as identifying the rate of demand change over time, allows for reduced preparation times and more operational hours.

- Visual Management – layout design that allows for the complete assembly process to be seen, which allows processes to look upstream and downstream to recognize and prepare for unexpected delays or increased production requirements.

Lean Manufacturing – Non-Manufacturing Case Study

Lean manufacturing techniques are not just being used in the manufacturing floor setting. In recent years, lean principles are being utilized in customer service and information based systems. At one call center, the goal of improving call handling by reducing variation was addressed using lean principles. "Reducing this agent variation requires three things:

1. Agents have to have a process to follow (process standardization).
2. They have to want to follow that exact process because it allows them to deliver quality service and because it makes their work life easier.
3. Management has to have complete visibility into agent-by-agent and call-by-call performance so it can be continuously improved.

The introduction of a standardized calling filter program "drastically reduced the between and within agent variation for how this call type was handled" (Adsit). But reducing variation through standardization did not also take into account optimizing the entire process. By eliminating wait times and unnecessary steps (non-value added processes, termed Muda), average word counts were reduced by 27%, and average call times were reduced by 45%. A reduction in call times translated to a high up front cost for the changes, which was offset and surpassed by the long term savings in time and productivity of the employees.

But the lean production being applied to the call center did not just result in bottom line cost decreases. "Lean principles encouraged systemic, big picture thinking…[which] means that the results must be examined broadly in terms of their implications for customers, employees and shareholders" (Adsit).

Call centers that utilized lean production in their system planning have a more positive workforce, which translates into a better customer service experience, providing a competitive advantage in the global marketplace.

Lean Manufacturing has become the new standard for manufacturing and corporate facilities and services to optimize current product lines, as well as design future lines that allow for planned expansion and customization on the fly. The terms and ways to go about increasing throughput and capacity will be utilized at the Systech facility in order to create a facility layout that improves upon the current system, as well as buffers for an increased in expected production over the next year.

Design

Introduction

This portion of the project covers the overview of the manufacturing process at the Systech facility, identifies potential areas of improvement, and goes through the techniques used to develop a solution of the facility layout.

Overview

The manufacturing floor at the San Diego facility can be divided into two main categories: front end preparation in a BTS (Built To Stock) manufacturing form, and back end final testing and shipping in a BTO (Built To Order) manufacturing form. All processes at the San Diego facility place quality as an imperative for their customers and partners in the industry.

Front End: Unpacking, Inspection, Burn-In Preparation, Burn-In

The front end system begins with unfinished product arrivals from Systech manufacturing partners in India. With the variability of the lead times from their manufacturing partner, buffers are created by increasing stored inventory on the front end. Although this results in increases storage costs and uses up valuable space, it is the short term solution that adequately protects the manufacturing line from disruption due to supplier logistic issues. Reducing the variability of the lead times has been considered as a potential senior project focus, but Systech management placed a larger importance on the physical design of the manufacturing floor.

Before a select a small number of units to be tested in the burn-in oven area, they require unpackaging, inspection, re-equipping, and preparation at the staging area next to the oven/refrigerator area. All handling of the units is done along the back wall in a single-flow design (See Figure 1, 2, 3).


Figure 5


Figure 3


Figure 4

Due to the packaging of the units, about half the time in the front end manufacturing system is spent on unpacking the products and cleaning them. After cleaning, products go through a rigorous inspection, checked over for minute defects in the physical product. This includes the outer casing, exterior connectors, interior connections, and bond points. If the product has minute defects with the quality of material, it is discarded. Units that have cleared the individual inspection process are placed on a cart and are prepared for the burn-in testing (if it is a part of the test sample). Burn-in preparations includes adding adapters and other equipment to each unit, and placing the now prepared units next to the oven and refrigerators to begin the Burn-In process (See Figure 4, 5).


Figure 1


Figure 2

During the burn in process, special connectors are used for each unit. Recently the unit connections that are used inside the oven and refrigerator have been breaking due to continual usage. If current manufacturing practices were continued, this would develop into a bottleneck of the entire manufacturing process. This issue has been addressed by temporarily reducing the sample size of tested units, which adversely impacts Systech's quality standards among customers and competitive edge against competitors. Systech staff plan on making more custom connectors to address the potential issue, and is an appropriate plan of action for the short and long term benefit.

Post Burn-In units are then moved towards a temporary storage area near the final testing and packaging area, where they sit and wait for customer orders to be pulled and processed through the back end area before reaching the customer (Storage seen in Figure 6).

Figure 6

In Figure 7 (Google Sketch-Up), the front end manufacturing area is highlighted by the red floor area, as well as green surface for the burn-in oven and refrigerators.

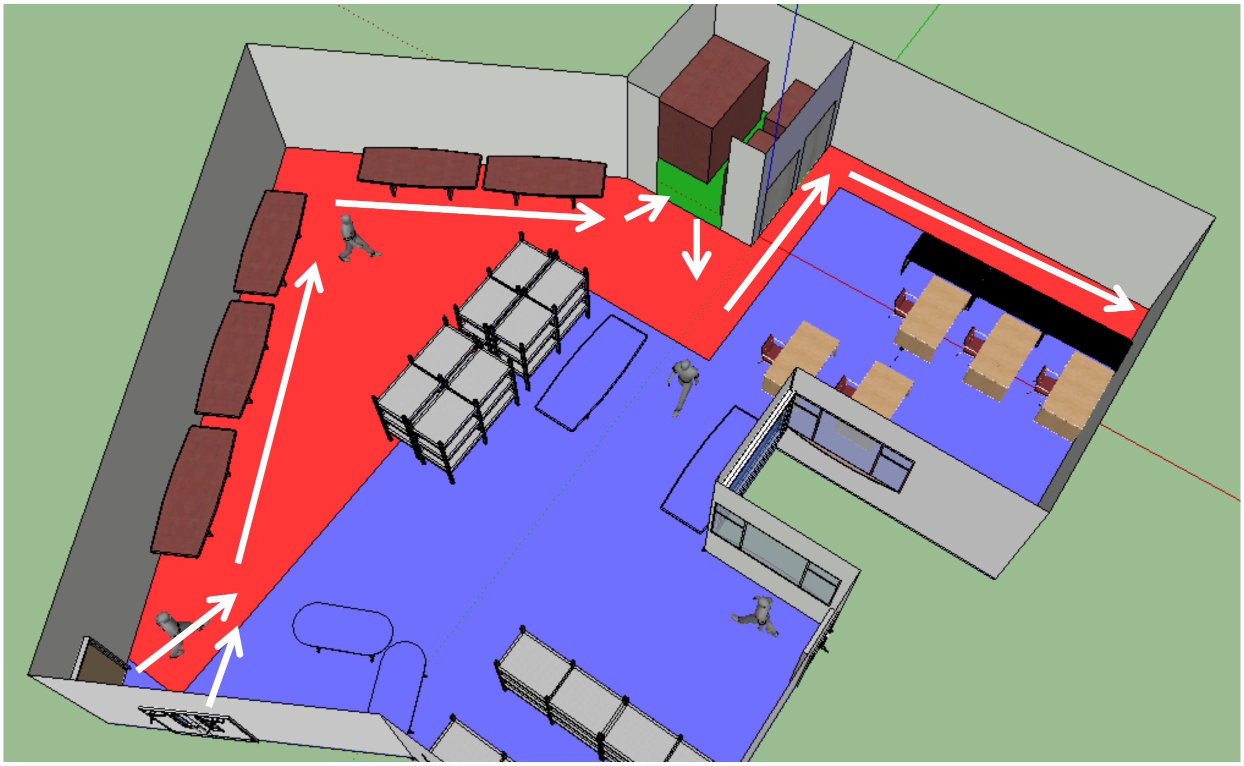


Figure 7

Back End – Final Testing/Packaging/Shipping

The back end manufacturing line of Systech can operate independently of the front end operations, only dependent on the front end operations to ensure the BTS products are properly stocked. The production requirements of the back end system have highly variable schedules. This depends on the number of work orders passed along from production planning the previous day, as well as potential re-work that arrives from the field.

During the back end manufacturing process, products are tested according to customer requirements, uploaded with most recent software updates, packaged, and placed for shipment.

In the testing phase, products go through software validation, antenna verification, product fit-and-finish, and specialty testing (depending on customer requirements). Products that have faulty hardware will be identified and fixed (if possible). Otherwise, the product will be discarded. Figures 8 and 9 show where product testing occurs.

Figure 8

Figure 9

After a product passes through the testing/verification stage, Systech units are then brought over for high quality labeling and packaging (as seen in Figure 11).

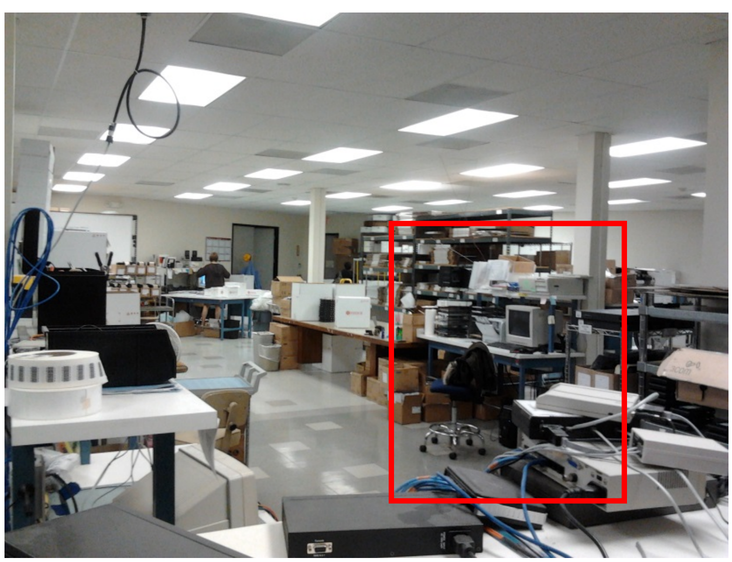


Figure 10

Before the units arrive for packaging, the packaging material needs to be assembled. Due to the complex cardboard cut-outs and packing material, a large portion of time is spent on preparing the packaging stage, usually before or in tandem with the product testing and verification. All of this is done with the same employees who are managing the front end manufacturing to make units ready for the Burn-In testing. Many employees are involved in multiple workstations, requiring work preparation whenever they move. Although this benefits the assembly process because it allows the employees to play a fluid role in the manufacturing process, moving to tasks that require attention where needed, this fluid role also results in more time spent in travelling from task to task and less time bringing value added activities to the system as a whole. This is an area that can be improved with a new facility layout that emphasizes defined processes for employees and better line balancing.

Once the units are properly packaged and labeled, orders are either placed for pickup by local delivery, or are stored in the hallways, depending on the customer financial arrangements with Systech (See Figure 12).

Figure 11

In Figure 13, the blue floor area shows the back-end manufacturing area, with the material flow marked by the white arrows.

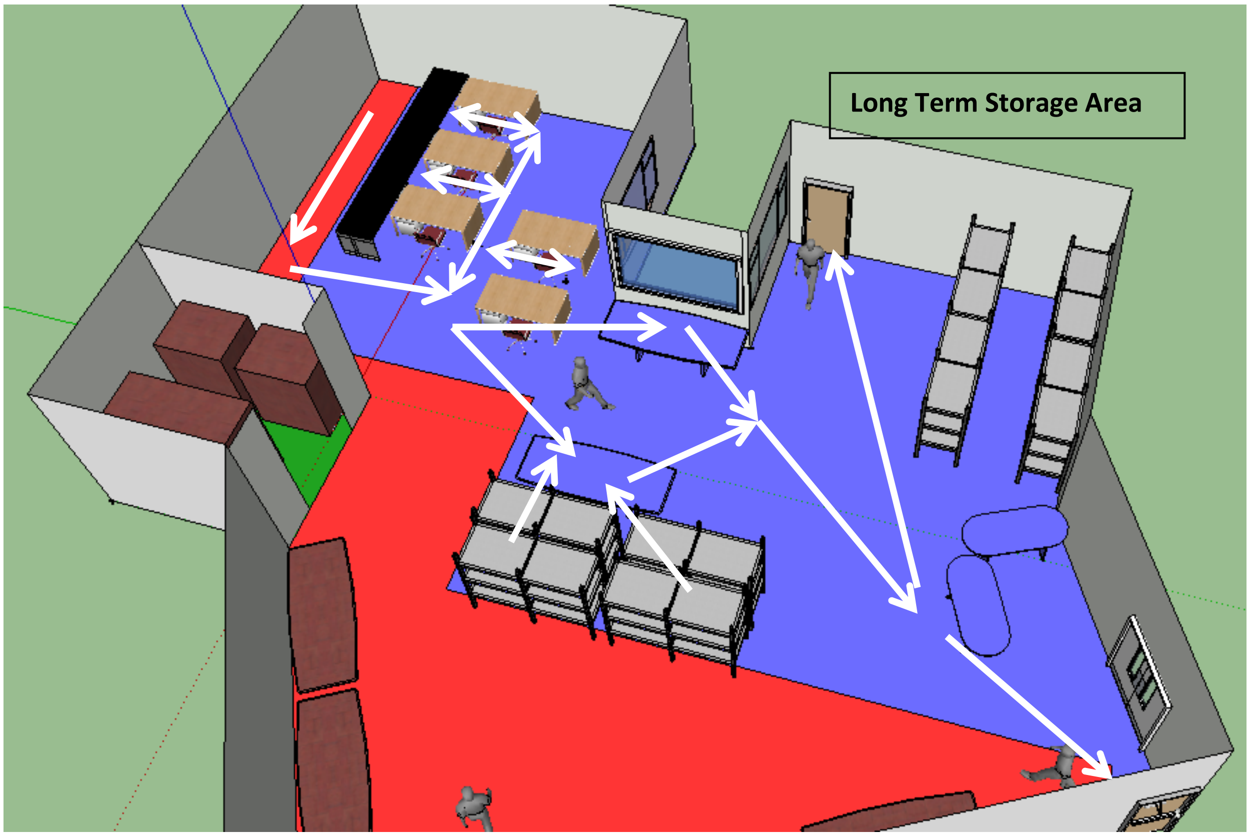


Figure 12

Observations

Recently, Systech has moved to a larger manufacturing facility. Due to the demanding environment on the individuals involved in the transfer process (required to manage daily operations, future production planning, and future floor plan layouts), the facility layout was based primarily on the original layout,. This new facility offers the potential for a redesigned floor, as well as a new approach towards manufacturing from the management at Systech.

The front end system follows a Built-To-Stock manufacturing process, where production is based off of the inventory levels of the back end system. Because of this differentiation in production methods, the quantities and amount of product pushed through is not dependent on the customer demand, but based on inventory levels at the staging area for final testing. Due to this batch production, unpacking and burn-in processes can occur independently or in parallel with the final testing process, allowing for workers to continually apply their work hours to either line depending on production demands. Because this worker variability is a very fluid process, the workstation details will not be modified. Instead, the physical layout will be modified to reduce the footprint and allow people to use visual management to better track the flow of material and to reduce travel time. The visual management capabilities of the current facility from the manager's perspective are walled off from the front end system due to the middle storage racks. This challenge could be addressed in the new facility, as well as the inability of management to see the software validation area from structural impairment.

When looking at the back end processes, a Built-To-Order manufacturing focus is utilized. Because there is less focus on batch production, and more emphasis on individual order output, the design of the system should be able to account for daily variations in required output. Like the front end system, the physical layout of the back end will be modified to allow for better single item flow of product, as well as integration with the variable packing requirements.

The current system will be used as a baseline comparison for future plans on the proposed design. There can be improvements to streamline the front end system so there is less distance between value-added processes, leading to more efficient uses of worker time. The proposed facility design will also take into account the requirement of increased production, allowing for future expansion with parallel lines in both the front and back end system to be added on once manufacturing levels approach current manufacturing limitations (space, as well as employee hours). Calculations will take into account reduced foot traffic movement and reduced time spent for non-value added activities; these calculations will be collected from a facility layout made in Google Sketchup, both of the original layout and the proposed layout. This will provide Systech management a visual roadmap of an optimized layout, as well as account for future expansion requirements. Excel calculations will be utilized to find numerical savings due to the proposed layout.

Methods

The Methods section of this report shows the proposed facility layout. The goal of this design was to reduce the footprint of the current design, as well as factor expected growth in customer demand in the design. The metrics for the justification of the proposed design are outlined below, as well as the sentiment behind the design.

Physical Redesign

The proposed facility design takes into account a visibly clear layout, using visual management techniques, as well as clustering similar tasks to optimize resources. Measurements of the new facility were made on site with a tape measure and printed file of the general layout. The proposed manufacturing area is one room in a large warehouse structure, so the design does not take into account departments outside the production floor (other offices, unrelated storage, etc.). Once main measurements were calculated, Google Sketchup was used to create the frame of the building. After the floor space was verified by Systech management, the layout was designed, which can be seen in Figure 14.

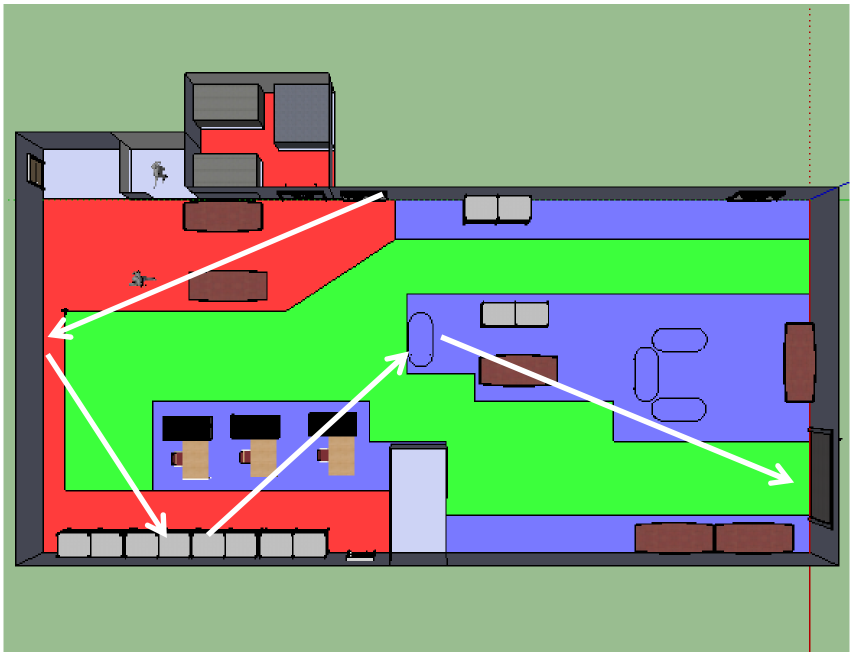


Figure 13

This design also takes into account a single flow design, avoiding repetitive and overlapping product flow. Multiple designs were created in a Sketchup form in order to find the best layout design to optimize the facility floor, with the best design shown below. This view shows the optimized proposed facility from a top down perspective, with white arrows indicating the general flow of material.

In Figure 15, the detailed flow of material on the front end is represented by the red floor area, with white arrows indicating the flow of material. The green floor space signifies areas that can be utilized for expansion on the front or back end, when required.

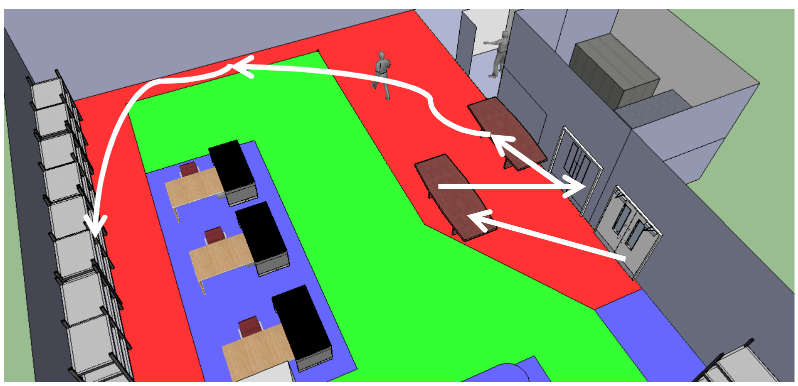


Figure 14

In Figure 16, the detailed flow of material on the back end is represented by the blue floor space area and white arrows.

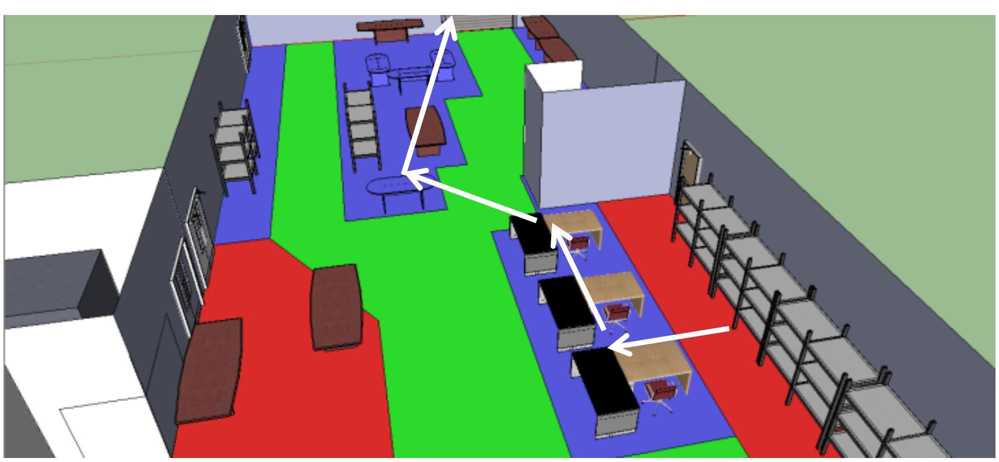


Figure 15

Calculated Savings

An Excel spreadsheet was created in order to calculate the financial savings associated with the redesigned floor plan. In Table 1, the workstation flow was recorded (divided into Front End and Back End categories), as well as the distance between each of those workstations. The distances were calculated based off the model designed in Google Sketchup, which was created as an accurate representation of the current and proposed work layout. The quantity of units moved per work element was also recorded, as it would impact the number of times workers would be required to walk the product to the next workstation. From this spreadsheet, the savings were calculated by finding the total number of feet saved per product, and then dividing it by the average worker walking speed to result in the number of work hours saved. Detailed calculations can be seen in the appendix.

	Description	Current Facility Dist (ft)	Proposed Facility Dist (ft)	Batch Amount
Front End Tasks	Product Arrival	11.5	10	30
	Unpackaging/Cleaning	12.0	6	30
	Inspection	13.0	6	30
	Oven Preparations	30.0	3	30
	Oven Testing	10.0	3	30
	Storage/Inventory	35.0	35	30
Back End Tasks	Software Validation	38.0	4	30
	Antenna Verification	8.0	8	30
	Fit-and-Finish Testing	10.0	8	30
	Labelling	15.5	6	1
	Packaging	14.0	5	1
	Package Verification	24.0	10	6
	Storage/Inventory	21.0	12	6
	Shipment	10.0	0	6

Table 1

Results and Discussion

The results of the new facility layout take into account an improved ability to use visual management on a day to day basis, as well as the planned expansion in the coming year due to increased demand. An economic analysis was also completed to justify this new design

Visual Management

Below is the before and after images of the view from the manufacturing manager's office location (Before – Figure 17, After – Figure 18).

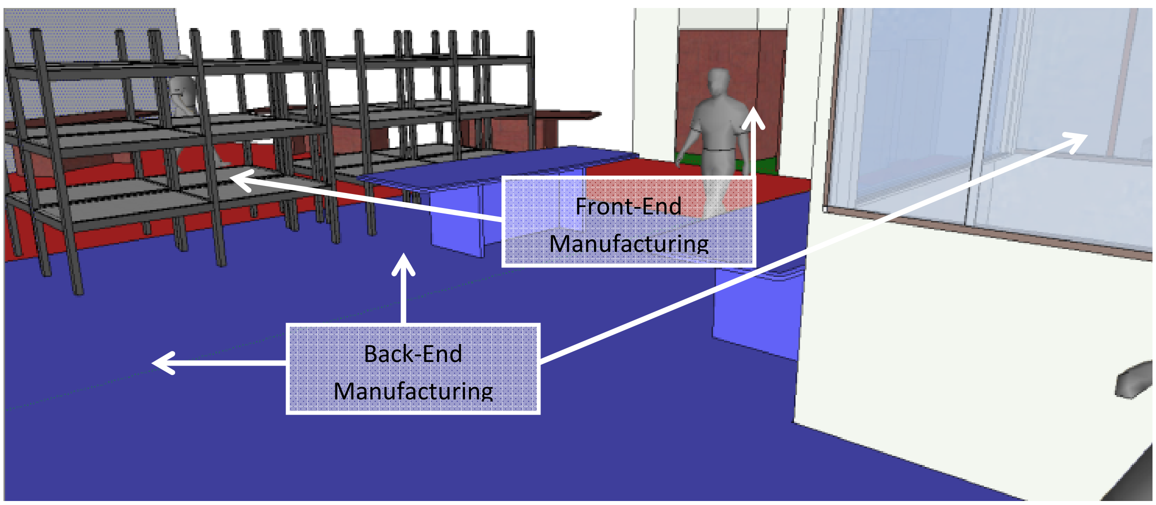


Figure 16

<u>Figure 17 Analysis:</u>

The front end system, signified by the red floor area, is impeded by the storage racks needed for the packaging area on the back end manufacturing system. Also, the testing area is not visible to the manager from this location, requiring him to stand up and walk to the location to assess the progress of the workstations. The isolation the manager experiences prevents him from being able to make a quick analysis of the current manufacturing status, causing a decreased ability to respond more quickly to manufacturing requirements or changes.

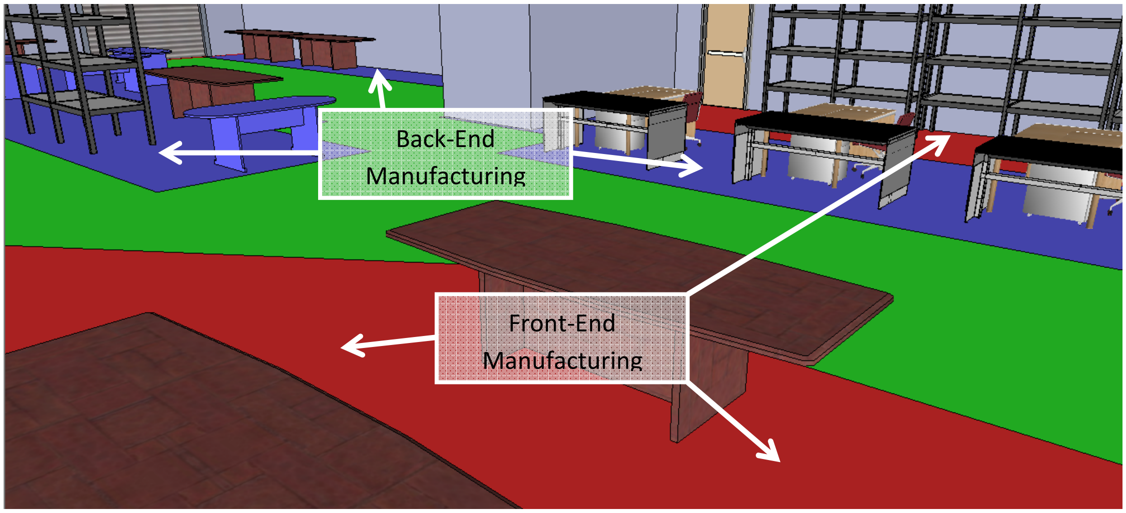


Figure 17

Figure 18 Analysis:

In the new facility, the manager is able to view the status of both the front and back end manufacturing systems. Because of the open layout and single flow system, people on the floor are also able to better assess where they can be best utilized on the line. Increased awareness of both management and employees allows for a more accurate response required for manufacturing demand variations during the day.

Future Expansion

With a new product line forecasted to double demand in the coming year, open growth areas were designed into the new facility layout. In the Google Sketchup of the new facility, this is signified by the green floor space area. The expansion takes into account both front end and back end expansion. For the front end system, capital expenditures for additional tables and chairs would be required, but the area for expansion exists to the left of the current table area. On the back end, the creation of a parallel line involves the process of duplicating the current system by placing additional desks and chairs to the left of the current desks in the final inspection area (equipment that Systech has in inventory), and one more long workspace bench next to the packaging area. With this expansion, additional workers would be required to work, but the fluid work schedule of the manufacturing employees will account for a temporary work increase as the workforce is expanded.

Economic Analysis

The calculated savings of the facility redesign justifies the changes and improvements made at the Systech facility. A summary of the savings are outlined in Table 2 below, with a larger version for reference in the appendix.

Financial Justification

	Description	Current Facility Dist (ft)	Proposed Facility Dist (ft)	Savings	Batch Amount	# Units/day	# Batches	FT Saved/day	FT Saved/month	Miles Saved/month
Front End Tasks	Product Arrival	11.5	10	1.5	30	250	8.3	12.5	250.0	0.05
	Unpackaging/Cleaning	12.0	6	6.0	30	250	8.3	50.0	1000.0	0.19
	Inspection	13.0	6	7.0	30	250	8.3	58.3	1166.7	0.22
	Oven Preparations	30.0	3	27.0	30	250	8.3	225.0	4500.0	0.85
	Oven Testing	10.0	3	7.0	30	250	8.3	58.3	1166.7	0.22
	Storage/Inventory	35.0	35	0.0	30	250	8.3	0.0	0.0	0.00
Back End Tasks	Software Validation	38.0	4	34.0	30	250	8.3	283.3	5666.7	1.07
	Antenna Verification	8.0	8	0.0	30	250	8.3	0.0	0.0	0.00
	Fit-and-Finish Testing	10.0	8	2.0	30	250	8.3	16.7	333.3	0.06
	Labelling	15.5	6	9.5	1	250	250.0	2375.0	47500.0	9.00
	Packaging	14.0	5	9.0	1	250	250.0	2250.0	45000.0	8.52
	Package Verification	24.0	10	14.0	6	250	41.7	583.3	11666.7	2.21
	Storage/Inventory	21.0	12	9.0	6	250	41.7	375.0	7500.0	1.42
	Shipment	10.0	0	10.0	6	250	41.7	416.7	8333.3	1.58
									Total # Miles/Month	25.39
									Avg Speed (MPH)	3.00
									Work Hours Saved/Month	8.46
									$/Hour	$25.00
									$ Saved/Month	$211.62
									Annual Savings	$2,539.46

Table 2

The basis of the savings was sourced from the number of man hours saved due to the decreased travelling distances required between workstations, multiplied by the hourly wage (including non-direct pay, like insurance, processing, etc.). The workstation-to-workstation distance savings was calculated by finding the original distance in the Google Sketchup of the original facility, and taking the difference from the new facility workstation-to-workstation distance. That number provides the total distance saved in feet, but does not take into account the number of times the individual would complete that distance. Depending on the workstation, the employee would transport a single unit, and other times, be transporting 30+ units. With that variation, the batch transport was also included in the calculations, which was developed by interviewing employees on the work floor, and from visual analysis during site visits.

The average number of units produced was gathered from management information regarding monthly production numbers. This number is expected to increase from 250 units/day to over 500/day, so the savings would also increase linearly.

After completing this analysis, the expected monthly distance savings were 25.4 miles, which can be extrapolated to an annual savings due to reduced transportation costs of approximately $2,500. As production is scaled, this savings would increase to $5,000+.

Conclusions

This senior project's task was to complete a facility redesign at the Systech facility as they transition to a new, larger facility to account for their expected increases in demand in the coming years. After the current facility design and flow was documented and recreated in a computer model, a proposed facility design was created that optimized the transportation distances, increased the use of visual management, and factored in the need for easy expansion of both front and back end production lines. The resulting savings from the proposed design resulted in an annual savings of $2,500, which would scale linearly as the production increases.

This proposed layout design can be utilized by Systech management as a roadmap as they move forward with the production in the new facility. Ideally, the proposed facility design should be implemented to gain the most savings as operations increase in the coming months.

In the coming months, receiving feedback about the proposed design and report from Systech will help in understanding how to complete a facility redesign in the future. If there was more time, a more in depth study of the workstation design would be completed to optimize each station output. Also, analyzing the front end supply chain of the Systech manufacturing process would be a large but rewarding task, due to the impact it causes to the final testing facility in San Diego.

This project provided a great opportunity for the utilization of multiple Industrial Engineering techniques to help Systech in identifying ways to improve their production line. The redesign also showed that when approaching a problem, the financial justification shouldn't be the only factor that goes into the design. Understanding the company values and their own objectives helps the designer approach the problem with the motivation and objective of all involved parties in mind.

References

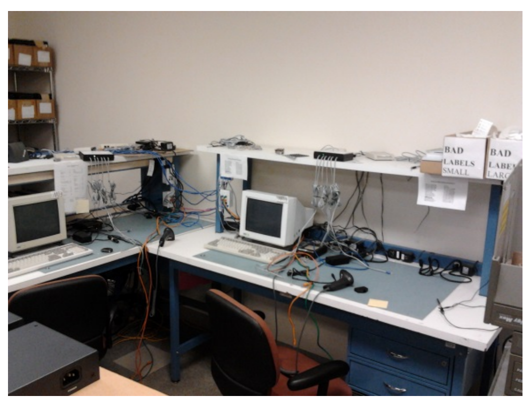
1. Adsit, Dennis, (2008) "Cutting-Edge Methods Help Target Real Call Center Waste." *ISixSigma*. CTQ Media LLC. Web. 24 Feb. 2013. <http://web.archive.org/web/20080414194658/http://www.isixsigma.com/library/content/c070611a.asp>.
2. Duggan, Kevin J, (1998) "Facilities Design for Lean Manufacturing." *IIE Solutions* (1998): 30-34. Web.
3. Holweg, Matthias, (2006) "Geneology Of Lean Production." *Journal of Operations Management*. Web. 24 Feb. 2013. <http://www.sciencedirect.com/science/article/pii/S0272696306000313#>.
4. Amasaka, Kakuro, (2007) New Japan Production Model, An Advanced Production Management Principle – Key To Strategic Implementation Of New JIT
5. Taylor, Frederick Winslow, (1911) *Principles of Scientific Management*. New York, NY, US and London, UK: Harper & Brothers. 1911.
6. Spear, Steven, and Kent H. Bowen, (1999) "September 1999." *Harvard Business Review*. The Magazine, n.d. Web. 24 Feb. 2013.

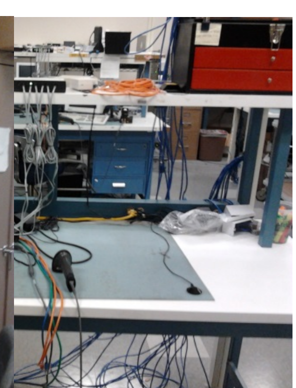
Appendix

Financial Justification

…acility (ft)	Proposed Facility Dist (ft)	Savings	Batch Amount	# Units Per Day	# Batches	FT Saved Per Day
[illegible]	10	1.5	30	250	8.3	12.5
[illegible]	6	6.0	30	250	8.3	50.0
[illegible]	6	7.0	30	250	8.3	58.3
[illegible]	3	27.0	30	250	8.3	225.0
[illegible]	3	7.0	30	250	8.3	58.3
[illegible]	35	0.0	30	250	8.3	0.0
[illegible]	4	34.0	30	250	8.3	283.3
[illegible]	8	0.0	30	250	8.3	0.0
[illegible]	8	2.0	30	250	8.3	16.7
[illegible]	6	9.5	1	250	250.0	2375.0
[illegible]	5	9.0	1	250	250.0	2250.0
[illegible]	10	14.0	6	250	41.7	583.3
[illegible]	12	9.0	6	250	41.7	375.0
[illegible]	0	10.0	6	250	41.7	416.7

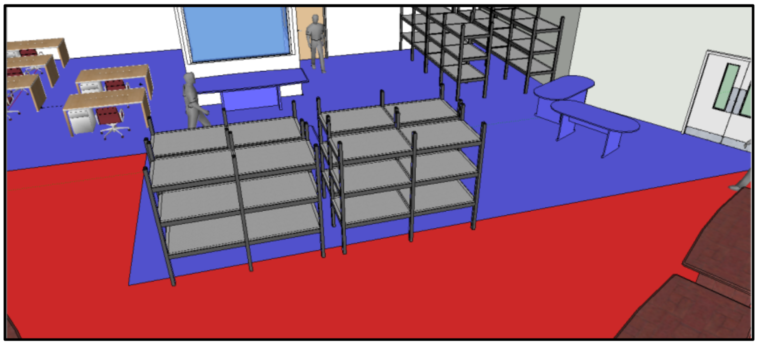
<u>Software Validation Area Photos:</u>

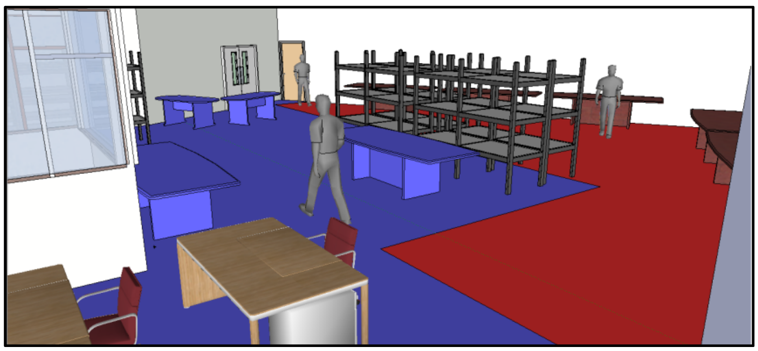


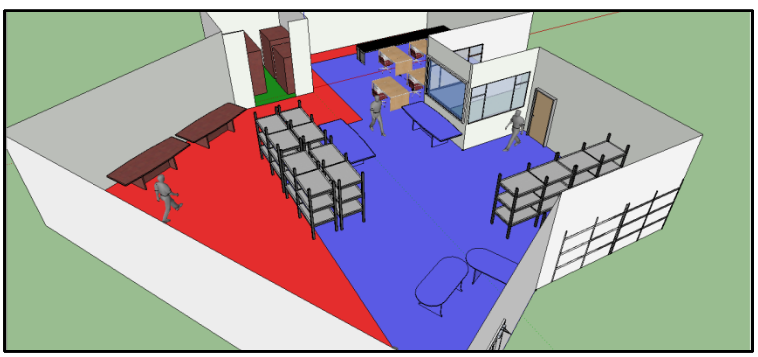


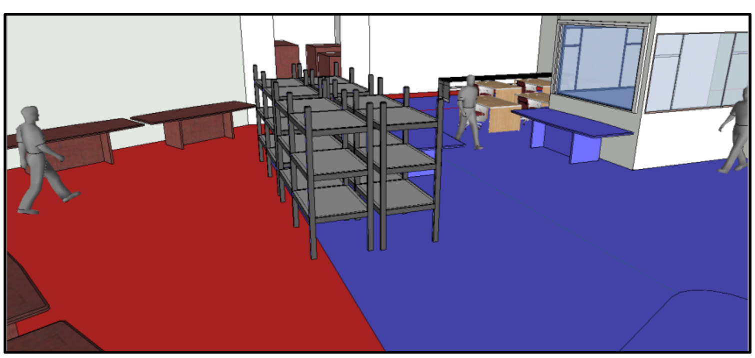
Packaging and Labeling Area Photos:

Current Layout, Sketchup:









Proposed Facility – Photos:

Proposed Layout, Sketchup: