

MTP2 Report for Roots Kitchen & Cannery for their Preserves Manufacture

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Structured Abstract— Background: The following report describes in detail Roots Kitchen & Cannery’s P2 opportunities and recommendations observed throughout the MTP2 Internship (June – August 2023). Methods: The report includes Lean manufacturing practices, 5S, WI, Value Stream Map, Systematic Layout Planning and Total Production Maintenance (TPM’s) in place. Results: By automatizing the labeling process, it is expected to see a decrease in the cycle time. Also, their CO2 will diminish by 50% approx. after doubling the number of batches currently produced from 4 per week to 8 per week. When looking at the Lean and 5S practices, it was found that it would be beneficial to standardize processes and start inventory tracking. As for the data from the 5S audit table, the result was 2.36 out of 5 with the current layout in the warehouse and production areas. For the Systematic Layout Planning, 5 designs were presented for the warehouse and production areas. Conclusion: By implementing a better flow of product, improvement of inventory sorting methods, and conducting data analysis obtained after Roots Kitchen & Cannery Company will automate their labeling process and will upgrade their equipment during the filling stage, P2 applications will be enhanced. Future endeavors will continue the process of Lean manufacturing, 5S training, time studies, and learning curves as those results will change over time with the new equipment in place.

Index Terms— automatization, layout planning, lean manufacturing, pollution prevention (P2), production.

Practical Impact Statement— The best possible method for manufacturing preserves at Roots Kitchen & Cannery required systematic layout planning, lean practices, and 5S implementation due to the need of decreasing CO2 emissions per batch of jam produced.

I. INTRODUCTION AND NEED

THIS report reviews Roots Kitchen & Cannery’s goal of reviewing their current method of manufacturing preserves, considering their current & future Value Stream Map, the flow of production, and better sourcing of materials required during all the stages of production.

When manufacturing preserves, only a few steps are involved in the process, which can become energy-intensive over time. Furthermore, the process can be improved with the automatization of each stage, but they add a complex factor to the overall layout, therefore increasing the amount of capital invested initially.

During the production of 2 batches of jam per day, it was noted in the Value Stream Mapping initial phase of the internship, that the unplanned downtime in the cycle times was caused by the cooling and labeling steps. Manufacturing action recognition is significant for manual manufacturing monitoring and ergonomic analysis of process operations.

In today’s society, data is becoming increasingly relevant with the rise of Industry 4.0 or Smart Manufacturing, measuring, monitoring, and processing data obtained from manual operations, becoming the next big step to a human-centered process design layout [1].

The objective of this internship is to find the constraint in the current preserves manufacturing Value Stream Map, and how these opportunity areas can be solved using a Pollution Prevention approach decreasing the CO2 emissions per batch, throughout the overall process [2].

It will take time to train new employees using 5S, Lean practices, and WI for assessing the preserves manufacturing. Furthermore, using learning curves to evaluate each process allows the company in the future to research the preserves manufacturing process more thoroughly, specifically how long it takes each time cycle with the automatization of the labeling process and optimization of the current filling process.

II. METHODS

Throughout the first week of the internship, the 3rd, 6th, and 7th phases of the Methods Engineering Steps were implemented. (3rd Analyze Data, 6th Develop Job Analysis, 7th Establish Time Standards).

Three times a week the production and packaging methods were observed being fulfilled in the kitchen facility throughout the duration of the internship. The number of batches of jam produced per week was 4. The amount of jam per batch was 40 Gallons.

The preserves flavors that were made throughout the internship were i. Strawberry lemon, ii. Blueberry Lavender, iii. Raspberry vanilla. The tasks from the manufacturing were timed using the stopwatch function of an iPhone 10X, the general timing for each was determined to obtain the average time (OT), number of cycles (n), and unplanned downtime.

The frozen fruit came from Columbia Fruit Company, averaging 3 months in between delivery times, and was kept in the freezer in pallets. Manufacturing required prior dethawing of the fruit 12 hours before production day started. Two workers were required for the preserves manufacture. Observations were able to provide the necessary data to complete the Value Stream Map.

The steps required were i. Cooking the jam, ii. Filling the jars, iii. Cooling, iv. Labeling, v. Boxing and putting away. The step of filling the jars (iii) was made using a piece of pro-filler equipment, and within that stage, the steps of closing the lids and CIP (clean in place) are involved for each of the jars. The setup of the cooking process of the jam took 1hr –1.5hr throughout the manufacturing steps, shown in Figure 1, having an energy consumption of 29.3 kWh.



Fig. 1. Preserves manufacture steps include cooking (40 Gallon SteamMaster kettle), filling, cooling, and labeling.

The Value Stream Map of the current production state was made using Microsoft Excel for Mac, Version 16.70 (23021201). The same software was used to complete a 5S audit chart for the warehouse and production areas. The unplanned downtime was mainly caused by the lack of precision in the filler equipment, due to accumulated pressure and solidification of jam through the nozzle causing delays throughout the filling. The cycle time was 1-1.5 hours for this step and the energy consumption was 17 kWh.

A small quality check was performed when closing the lids for each individual jar, by cleaning the extra product on the edge of the jars, since spills avoided the sealing of the jar. This was noted as an opportunity area also caused by the filler equipment.

The process of cooling down was identified as another P2 opportunity area since it took 30-40 minutes per batch. Causing delays throughout the process, since the quality of the label was affected by the jar glass heated surface. It was done with the aid of 2 industrial fans, with an energy consumption of 0.075 kWh.

Labeling was done manually, with the help of a mechanical labeler device. The cycle time for the task was between 30-40 minutes. This was identified as one of the main constraints. Calculating the total energy consumption, and adding the storage of the frozen fruit, the total CO₂ was ~1.86 lb CO₂ per lb of jam manufactured [Appendix A].

Another need recognized was standardized steps in the packaging stage. By observing repetitive motions and through the development of Work Instruction (WI), the operator can be accurately assessed to determine their overall productivity with the tasks of packaging when fulfilling orders both for retail and wholesale [Appendix B-D].

The set of instructions was made by using the drafting function of the app Good Notes Version 5.9.88 on an iPad 9th generation (model number MK2L3LL/A, iPadOS version 16).

A Systematic Layout Planning was performed to develop a better flow of the product throughout the production and packaging areas. Measurements were taken of the 2 previously mentioned rooms. The layouts were made on a scale of 1 square = 1ft² by using the drafting function of the app Good Notes Version 5.9.88 on an iPad 9th generation (model number MK2L3LL/A, iPadOS version 16). These can be found in the Appendix section [Appendix E].

During the ninth week of the internship, the 5th phase of the Methods Engineering Steps was implemented, which is: Install New Method. The layouts were changed for the warehouse, production, and storage areas.

This involved getting rid of unused equipment and relocating tables with various items on the storage shelves. Optimizing the use of space, a manual forklift was also implemented in the storage area for facilitating inventory sorting throughout the pallets of the product [Appendix D].

III. RESULTS

TABLE I
P2 OUTCOMES

Recommended P2 actions	Annual reductions	Barrier to implement
Automatization for the filling and labeling processes	50% reduction in CO2 by doubling the number of batches during production throughout the week.	Equipment consultation is in process.
5S and Lean Practices	Reduction of unplanned downtime.	Future workforce training.
TPM	Reduction of unplanned downtime caused by equipment failure.	Equipment consultation is in process.

All of the presented P2 Outcomes in Table I were set for future implementation within the next 5 years. [5S audit score Appendix F].

IV. DISCUSSION

To analyze each process efficiently, Lean practices should be implemented by Roots Kitchen & Cannery in the automatization of the cooling & labeling process. That would result in improving the flow of products. By implementing Management Inventory Systems with the aid of the Sortly app., a stable system would keep conciseness by the use of technology tools controlling risks, cash, and time.

By adding a worker-machine relationship into the manufacturing process, Roots Kitchen & Cannery can guarantee a higher production rate. The same can be said for the sub-operations and how the future equipment will be situated.

As for the inventory sorting process, it was observed that if the movements used to move and load jam boxes are continued for a longer duration, there could be CTD risk factors for the workers. This can include repetitive motions, like lifting, twisting on the wrists, static posture, and mechanical compression of the soft tissues in the hand.

Roots Kitchen & Cannery should consider having job rotations, with the appropriate designation of workstations and assignments of tasks and workers, so that ergonomic risks could be mitigated as well.

Finally, to accomplish a reduction of costs and environmental impact in the future, Roots Kitchen & Cannery should conduct a preliminary trial to evaluate the advantages of the production and warehouse layout improving the use of space, with the new equipment in place. There can be used many methods to analyze their data, one of the most useful assessments being the learning curves. They have many good qualities, for instance, they help set labor standards when new or unskilled operators perform a task for the first time. Not only that, but the employer can determine from these regressions the number of cycles the operators need to gain familiarity with the necessary movements to perform proficiently

V. CONCLUSION

Future research should include reducing the complexity of the preserves manufacturing while reducing the CO2 emissions of the process. An emphasis on making the process ergonomic and productive should be kept throughout all the different stages. Future endeavors will continue the process of Lean manufacturing, 5S training, time studies, and learning curves as those results will change over time with the new equipment in place. This is the list of the summarizing points of the findings throughout the entire study:

A. Systematic Layout Planning

Testing the different layout methods measuring cycle times will allow further analysis of the overall proficiency of each process. Specifically, to keep a recommended flow of the product from the production stage until the packaging and delivery stage, the number of employees to test the implementation of the new method would be 3.

B. Methods Studies

By applying the 3rd, 6th, and 7th phases of Methods Engineering Steps, Analyze Data, Develop Job Analysis, and Establish Time Standard, the intern reckoned the importance of developing and analyzing the methods used to establish a proficient and standard process for preserves manufacture. This was observed during the application of the 5S method defined as Sort, Simplify, Sweep, Standardize, and Sustain. By

maintaining a clear, clean, and organized space, the company can achieve Lean manufacturing practices throughout the entire production process.

C. Work Instructions

To help set labor standards when new or unskilled operators perform a task for the first time and help the employer determine from these data the number of cycles, the operators need to gain familiarity with the necessary movements to perform proficiently, having them clear and visible to reduce mistakes.

D. Ergonomics

It is necessary to take ergonomics into account in the design phase of the manufacturing process of Roots Kitchen & Cannery. A solving approach due to workers being exposed to cumulative trauma risk related to repetitive motions and work-related injuries, safe production systems that are also profitable should be developed. There is a high correlation between good ergonomic practices and better economic performance.

APPENDIX/SUPPLEMENTARY MATERIAL

- A. Value Stream Map
- B. WI: Packaging, Online & Wholesale.
- C. WI: Inventory Tracking
- D. WI: Sorting Through Inventory
- E. Systematic Layout Planning: Warehouse & Production Areas
- F. 5S Audit Score

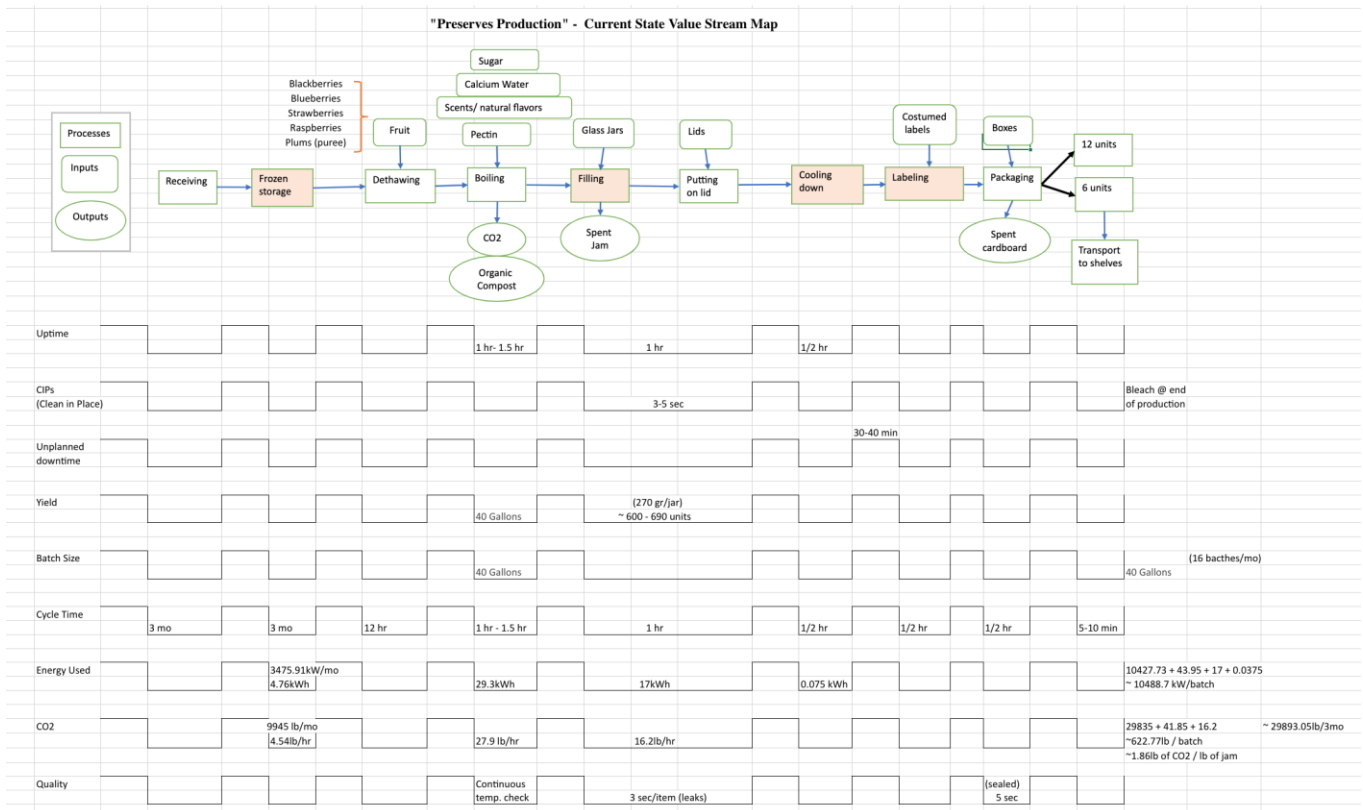
REFERENCES

[1] Peña, C., Romero, D., & Noguez, J. (2022). Workforce Learning Curves for Human-Based Assembly Operations: A State-of-the-Art Review. *Applied Sciences*, 12(19), 9608. <https://doi.org/10.3390/app12199608>

[2] Engel-Cox, J. A., & Fowler, K. M. (2017). Pollution Prevention Opportunity Assessments. Blue Agama Books.

APPENDIX/SUPPLEMENTARY MATERIAL

A. Value Stream Map



B. WI: Packaging, Online & Wholesale

ROOTS KITCHEN & CANNERY

PACKAGING

MATERIALS

- Cases of product (A)
- Boxes (B)
- Recycled carboard (C)
- Packing paper (D)
- Tape (E)

WHOLESALE FULFILLMENT

This task involves some motor control and self-checking quality control.

SETUP

Lay out the orders on the packaging table, no more than 5 at once.

PROCEDURE

- Make a list of the 6 packs and 12 packs that will be needed for each order.
- Take a utility cart and get all the associated items on the orders.
- Place the cases (A) with their associated packing slip. Once a packing slip is completed, flip the paper.
- Once all packing slips are flipped over, record the batch numbers on the shipping log.
- Build boxes required for each order (B).
 - o 1-2 "6 packs" fit in a 15 x 12 x 7
 - o 3 "6 packs" fit in a 22 x 12 x 8
 - o 4 "6 packs" fit in a 15 x 12 x 4
- Place 4 layers of cardboard (C) on the bottom of each box.
- Place the cases in the box and put packing paper (D) around the perimeter according to level.
- Put the packing slip on the top and write the name of the business on the outside of the box.
- Tape the box (E) and weigh.
- Repeat the previous steps to assemble the remaining orders.



QUALITY CRITERIA

Each box must contain parts A through E and must feel compact when the box is taped. Record weights and box size on the shipping log. Completed orders must be set aside.

www.rootskitchencannery.com

(406) 219-7461

Packaging Work instructions

ROOTS KITCHEN & CANNERY

PACKAGING

ONLINE RETAIL

PROCEDURE

- Place the items in the box and put U-Haul paper (D) around the perimeter and in the void spaces.
- Add more U-Haul paper on the top of the items and pack securely.
- Put the packing slip on the top and write the last 2 digits of the order number on the outside of the box.
- Tape the box (E) and weigh.
- Repeat the previous steps to assemble the remaining orders.



QUALITY CRITERIA

Each box must contain parts A through E and must feel compact when the box is taped. Record initials and box size on the shipping log. Completed orders must be set aside.

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Packaging Work instructions

ROOTS KITCHEN & CANNERY

PACKAGING

ONLINE RETAIL

This task involves some motor control and self-checking quality control.

MATERIALS

- Items of product (A)
- Boxes (B)
- Corrugated carboard (C)
- U-Haul paper (D)
- Tape (E)

SETUP

Lay out the orders on the packaging table, no more than 10 at once.

PROCEDURE

- Take a utility cart and get all the associated items on the orders.
- Place the items (A) with their associated packing slip. Once a packing slip is completed, flip the paper.
- Once all packing slips are flipped over, build boxes required for each order (B).
- Place 2 layers of corrugated cardboard (C) on the bottom of each box if "L" or "XL" box size.
- Place 2 layers of U-Haul paper (D) if "S" or "M" box size.
- Place 2 layers of corrugated cardboard around each jam jar, or 3 layers around each pickle jar.



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Packaging Work instructions

C. WI: Inventory Tracking

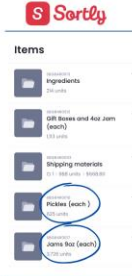
WHOLESALE INVENTORY

This task involves the use of a mobile device with Sortly App installed and a calculator.

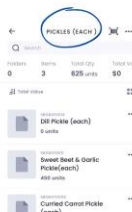
JAMS & PICKLES (EACH)

Perform a walk throughout the warehouse and storage areas and count wholesale individual units (WEEKLY).

PROCEDURE



- Open the Sortly App on the mobile device. Version: 10.0.5 (100005300)
- On the items list, select the folders to be edited:
 - Pickles (each)
 - Jams 9 oz (each)



- Verify that the correct folder is selected on the top section of the screen.


RETAIL INVENTORY

This task involves the use of a mobile device with Sortly App installed and a calculator.

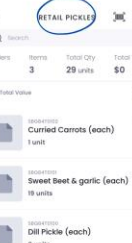
JAMS & PICKLES (RETAIL)

Perform a walk throughout the warehouse "Retail" section only and count individual units (WEEKLY).

PROCEDURE




- Open the Sortly App on the mobile device.
- On the items list, select the folders to be edited:
 - Retail Jam
 - Retail Pickles

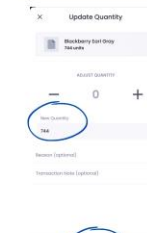


- Verify that the correct folder is selected on the top section of the screen.


WHOLESALE INVENTORY




- Once a product is selected, click on the "Quantity" section.



- Using the calculator add up all the individual items, including:
 - Boxes of 12
 - Boxes of 6
 - Individual units
- Type in the updated amount.

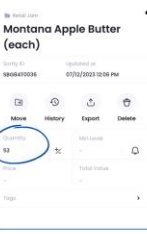


- Save the changes.

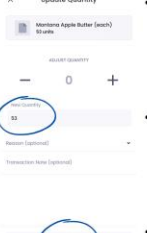


- Repeat the process until all the individual item amounts are up to date.


RETAIL INVENTORY




- Once a product is selected, click on the "Quantity" section.



- Using the calculator add up all the individual items.
- Type in the updated amount.



- Save the changes.



- Repeat the process until all the individual item amounts are up to date.

D. WI: Sorting Through Inventory

ROOTS KITCHEN & CANNERY INVENTORY

SOURCING THROUGH INVENTORY

This task involves the use of a manual forklift and precise motor control.


PROCEDURE



- Bring into the storage room the utility cart with the batch load of product.



- Make sure that the pallet and the forks are aligned.
- Using the lift control, the foot pump, set the forks to the desired level aligning them to the pallet.




- Move forward the utility cart making sure that the forks are inserted into the pallet.




ROOTS KITCHEN & CANNERY INVENTORY


SOURCING THROUGH INVENTORY




- Using the lift control, the foot pump, move the pallet up so that it doesn't rest on the utility cart.



- Remove the utility cart from underneath the pallet and put aside.



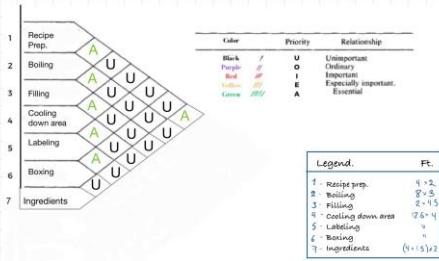
- Move the manual forklift into the product shelf.



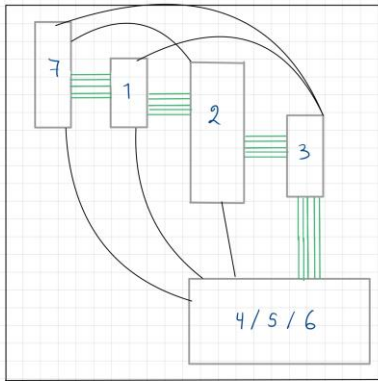
- Using the foot pump, move the loaded pallet up to the desired level of the storage shelf.
- Place the loaded pallet into the corresponding shelf according to the product.

E. Systematic Layout Planning: Production/Warehouse Areas

Relationship Diagram for Production Layout



Total: 443.17 ft²



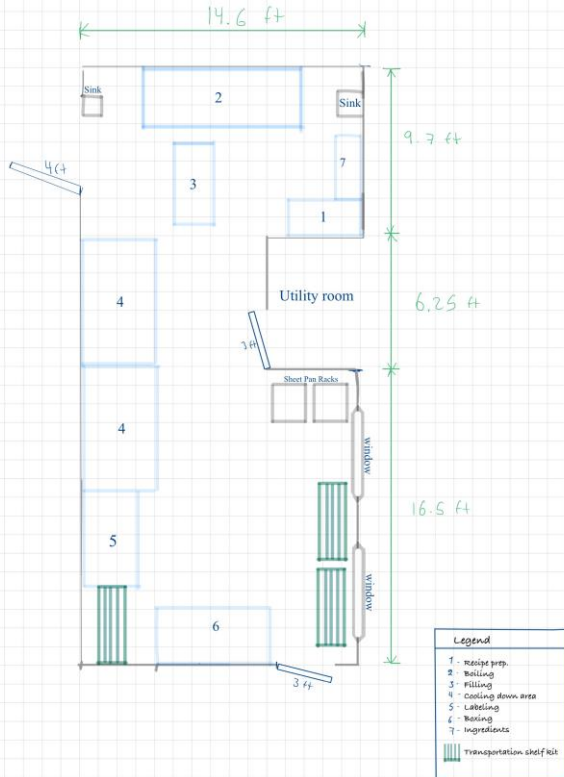
Scale: 1 square = 1 ft²

Proposed layout # 1
Scale: 1 square = 1 ft²

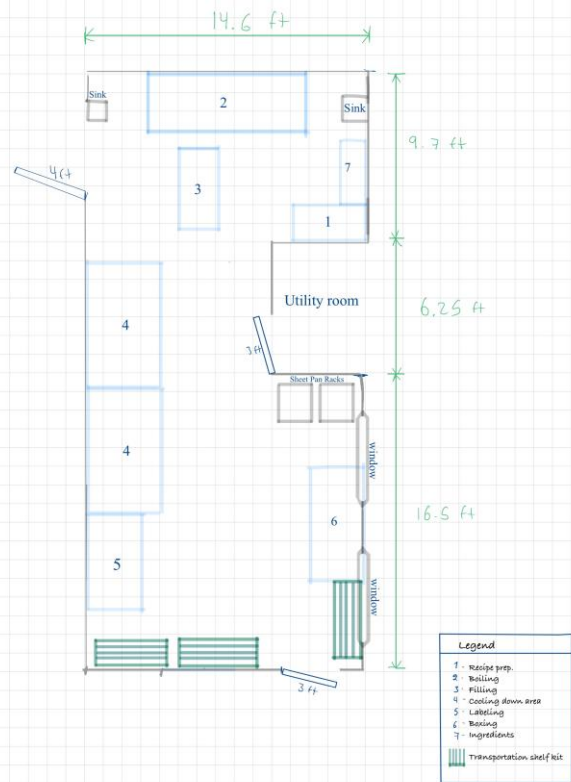


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Proposed layout # 2
Scale: 1 square = 1 ft²

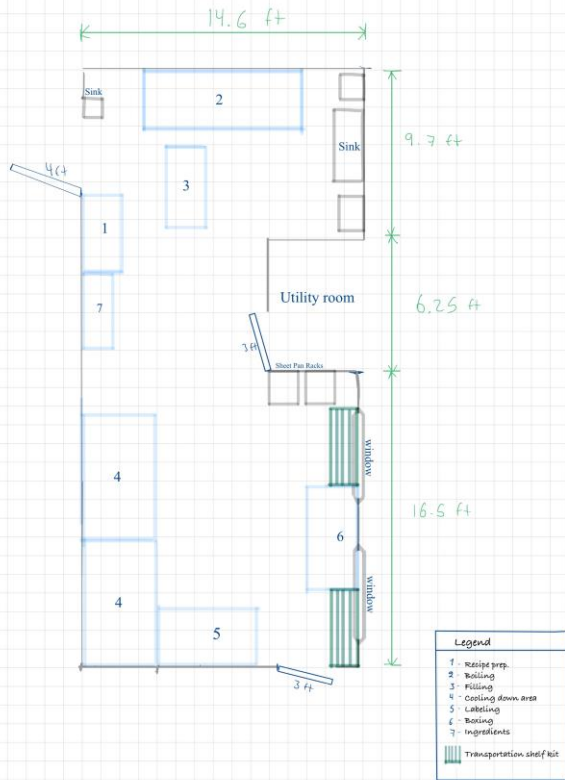


Proposed layout # 3
Scale: 1 square = 1 ft²



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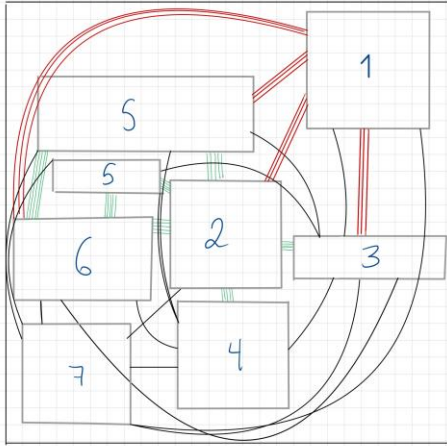
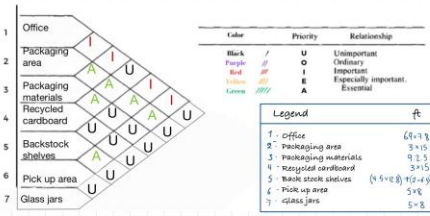
Proposed layout # 4
Scale: 1 square = 1 ft²



Proposed layout # 5
Scale: 1 square = 1 ft²

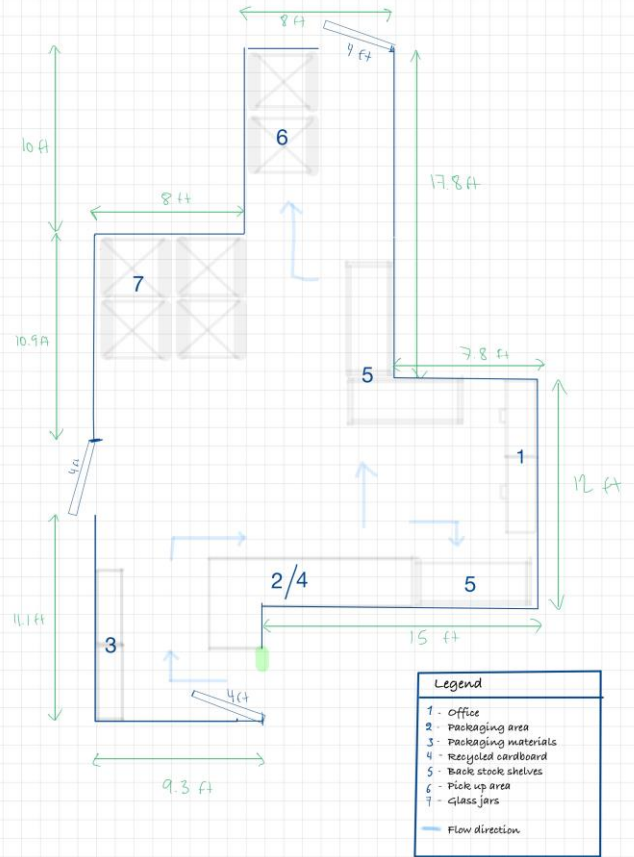


Relationship Diagram for Warehouse Layout



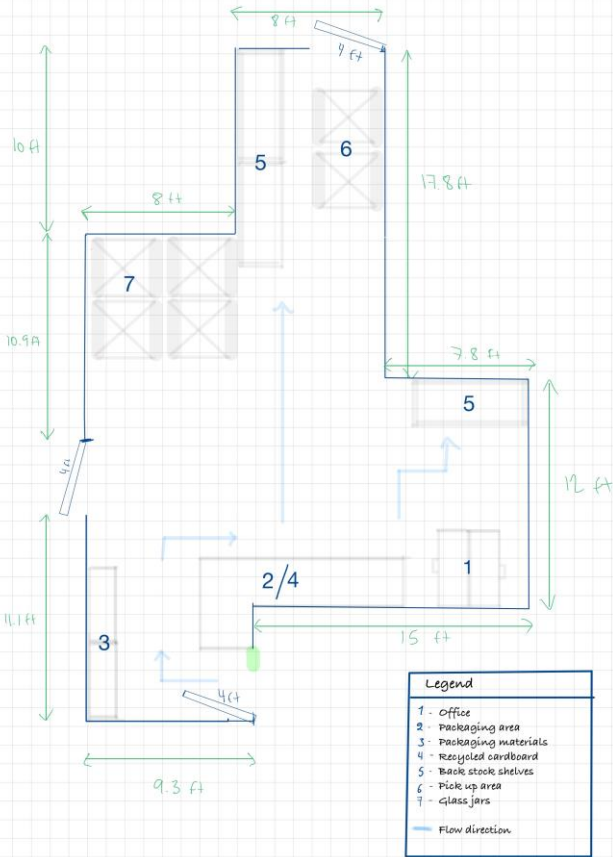
Scale: 1 square = 1 ft²

Proposed layout # 1
Scale: 1 square = 1 ft²

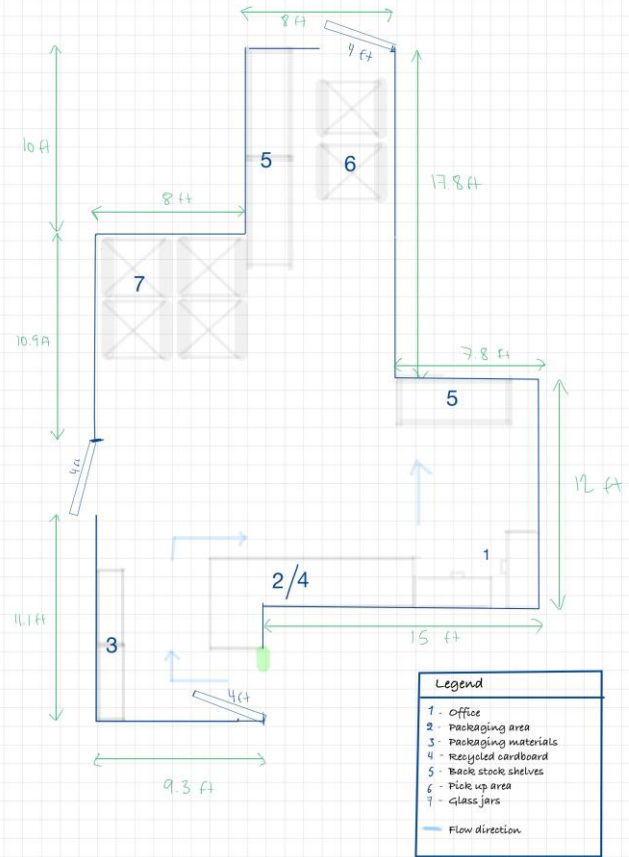


MTP2 ROOTS KITCHEN & CANNERY REPORT

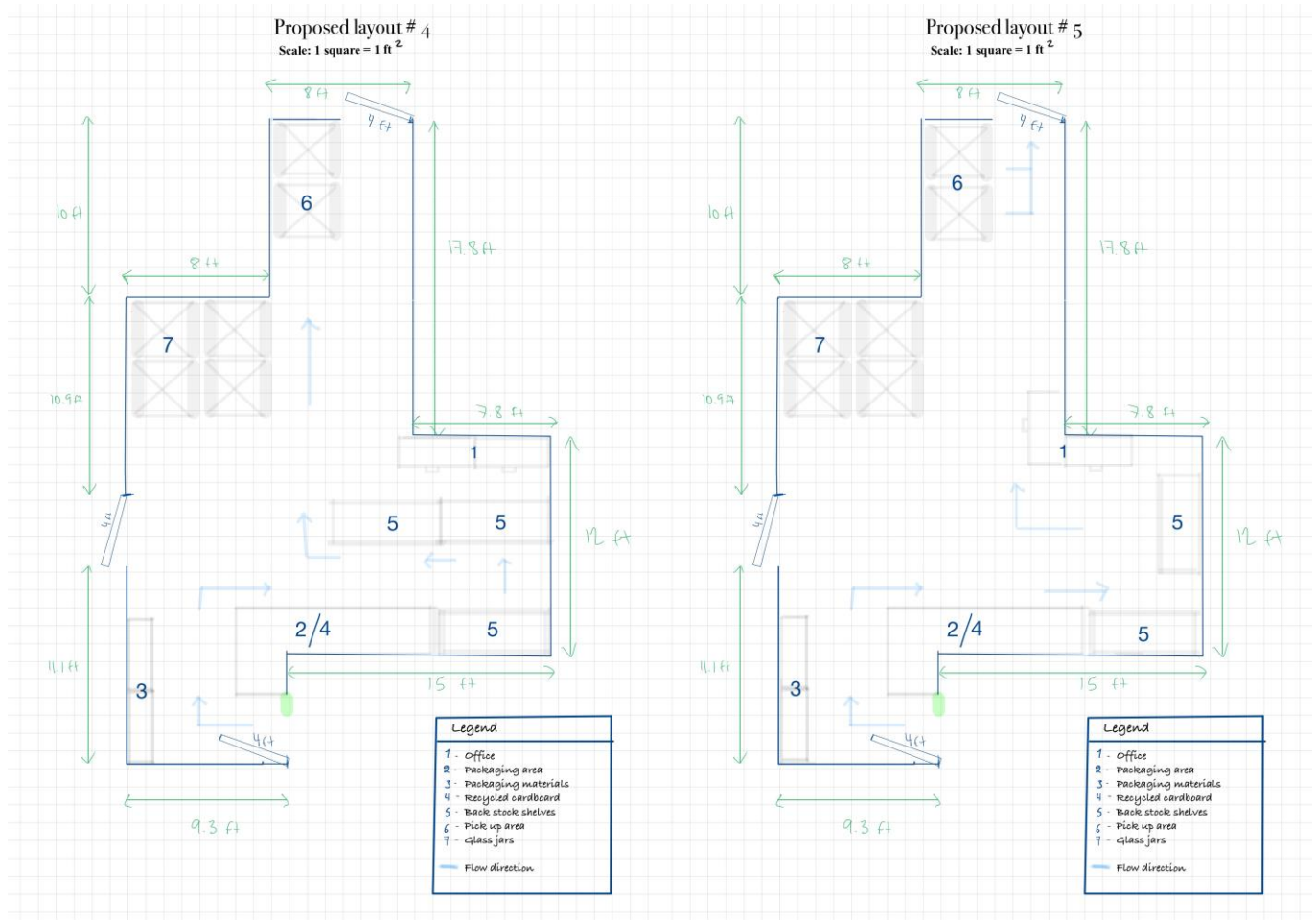
Proposed layout # 2
Scale: 1 square = 1 ft²



Proposed layout # 3
Scale: 1 square = 1 ft²

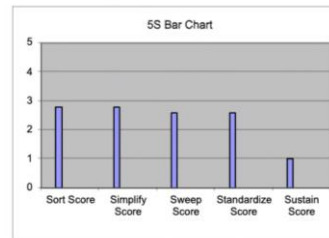


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F. 5S Audit Score

5S ScoreCard	Area: Workstation/production	Prior Score:	1=No Evidence 2=Little Evidence 3= Main processes meet requirements 4=Main and a few auxiliary processes meet requirements 5=All processes meet requirements			
Date: 7/5/23	Auditor: KN	Score: 2.36				
NO.	NO.	NO.	NO.	NO.	NO.	Observations/Evidence
Sort 15min / 5-2.8 "Keep only what is needed"	1	"Junk" drawers and catch-alls have been eliminated.				4
	2	Obsolete documentation is purged from areas. All information posted on the bulletin boards/walls is current.				4
	3	All tools and supplies are in regular use.				3
	4	All excessive inventory has been eliminated.				2
	5	Evidence of regular sorting exists. If a Red Tag area exists, it is clearly marked and has schedule for disposition posted.				1
Simplify 15min / 5-2.8 "Arrange and classify for ease of use, organize"	6	Equipment/supplies are located at the point of use and by frequency of use.				4
	7	All shelves, frequently used items, etc. are clearly labeled as to content and responsibility of control and revision.				3
	8	Common areas and aisles are identified and clearly marked.				3
	9	Clear indicators of max. and min. inventory quantities exist. Storage areas contain clear replenishment instructions.				1
	10	Open storage of all raw material, WIP, and finished goods is well organized and labeled.				3
Tidy 15min / 5-2.8 "Managing at a glance, a visual sweep"	11	Common areas and aisles are kept clean and orderly. Fire Extinguishers, exits, and control panels are unobstructed.				5
	12	All shelves, desks are kept clean. No items are unidentified or laying on top of cabinets/shelves.				2
	13	It is visually obvious what items are ready for work, what items are in work, and what items are finished.				3
	14	The current status of the area is visually obvious. Is the area ahead, behind, how does the work flow?				2
	15	Due to the use of visual control methods it is easy to distinguish what belongs in the area and what does not.				1
Sweep 5-15min / 5-2.6 "Eliminate variation, make standards obvious"	16	Cleaning and checking are completed routinely per a controlled checklist.				4
	17	There is evidence of a standard process for each product.				4
	18	There are Standard workoperation instructions at all work stations.				2
	19	Visual controls are consistent in appearance throughout the work area - i.e. same colors mean same things.				1
	20	Minimizes the work required to maintain the first 35% by insuring waste cannot accumulate over time.				2
Standardize 15min / 5-2.6 "Eliminate variation, make standards obvious"	21	Internal Audits are performed at scheduled intervals and are on-time and current.				1
	22	External Audits are performed at scheduled intervals and are on-time and current.				1
	23	5S Audit Scores are displayed in work area and communicated regularly.				1
	24	Methods and evidence exists to continue to improve. Sorting events continue to happen. Visual Controls are improved, etc.				1
	25	It is apparent that Standard Work, Cleaning Checklists, etc. are strictly followed.				1



Calculations	
Sort Score	2.8
Simplify Score	2.8
Sweep Score	2.6
Standardize Score	2.6
Sustain Score	1
Total	11.8
Total / 5 = 5S Score	2.36