Vital Vitamins®
New Warehouse Proposal

By

Patrick Ackerman
Emily Null
Raul Rios-Violante
Trey Roady

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"On my honor as an Aggie, I have neither given nor received unauthorized aid on this academic work."

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1.0 Introduction

Vital Vitamins© manufactures and distributes a selection of over the counter nutritional supplements for sports nutrition, general health, and weight management. They not only operate retail stores but also provide direct-to-customer shipping services through both internet and phone orders. Their products consist of a mix of Vital Brand™ generic supplements and third party product lines.

Recent success has pushed Vital Vitamin's© demand beyond their production capabilities and they wish to create a new shipping and manufacturing center. This new center should also serve as corporate office space and an on-site outlet store.

In this report, Integrity Engineering© strives to provide not only a competitive production facility design, but one that is also strategically appropriate. All effort is focused on providing solutions which fulfill production requirements without the usual waste provided by under-designing and over-mechanizing a facility. All recommendations are focused on space efficient, circumstance appropriate, time-tested solutions to make this facility a reliable foundation for Vital Vitamins© operations for years to come.

However, Integrity Engineering© will not be providing detailed timeline predictions or production process advisement. This report is purely intended as a framework for facility design. No information was given for mean annual return rates, so all equipment is analyzed based on base cost with no regard to financing options or product life cycle. All predictions are based entirely upon growth rate predictions supplied by Vital Vitamins©.

1.1 Problem Statement

The anticipated growth of direct-to-customer sales, at 2%, and store sales, at 20%, requires a new facility. The best material handling, storage, and product flow must be developed to efficiently use the manufacturing space and support peak requirements for the next five years.

The following issues need to be addressed:

- Should the new facility be 173,000 ft^2 or 215,000 ft^2?

- Should current manufacturing lines be upgraded?
- Should additional manufacturing lines be installed?
- How many dock doors would be required to handle shipping and receiving?
- What storage and handling equipment will be required?
- Should price-ticketing be handled at the point of sale or in the manufacturing facility?
- What staffing changes need to be made to justify equipment purchases?

2.0 Approach and Methodology

For this analysis emphasis was placed on the efficient use of facility floor space. Great attempts were also made to avoid using mechanization for mechanization's sake. Recommendations are provided to assist in the simplest, most cost efficient solution for this facility. The first step in the process was to establish the minimum functional number of dock doors and manufacturing line requirements for the next five years. This facilitated calculation of staffing requirements for shipping and receiving operations.

After shipping and receiving were accounted for, flow rates were analyzed to determine required storage space. Then, material handling equipment was selected to fulfill storage method requirements. The forward pick area was determined during the calculations of storage area by considering utilization of finished goods pallets.

Multiple picking systems were considered until a reliable alternative was found to fulfill time requirements. Employees were then scheduled based on the labor requirements for each area.

The current price ticketing system was compared against two alternatives: a manual price ticketing method in-facility and an alternative method of automatic sticker labeling. However, all analysis had to be performed based on current costs alone as no data was provided for ticketing growth rates.

For facility information, please see *Meller* reference.

2.1 Layout Methodology

No formal layout algorithms were used due to consistent interdepartmental relationships. Some facilities, such as bulk storage and receiving, are clearly intended to be in close proximity. Facilities would be located primarily based upon their position in product flow.

Because of this, departments were placed in a counter-clockwise path along their relative positions in product flow. This keeps production moving in a clear, non-overlapping pattern without the conceit of quantitative relationships. Below is the recommended final layout for the Vital Vitamins© facility in Figure 1.

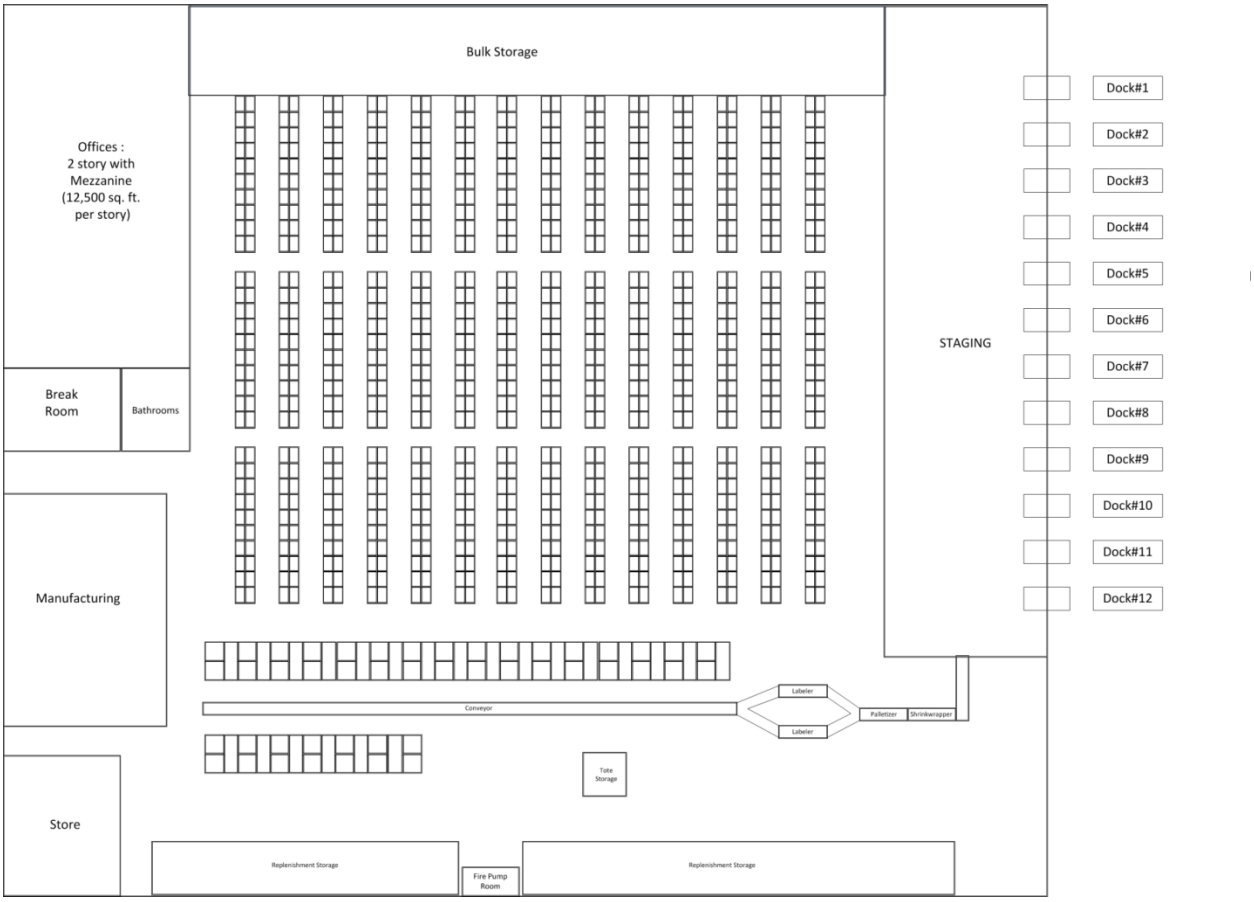

Figure 1: Facility Layout

2.2 Dock Door Requirements

The average loading and unloading time for each truck and the truck arrival and departure schedules were used to calculate the facility dock door requirement. This was accomplished by multiplying the number of docks per hour with the turnaround time for each truck to park, load, and leave. This allows the facility to accommodate the peak period flows. Detailed calculations of the following processes are provided in *Appendix B.*

2.2.1 Receiving

The receiving docks have an expected number of trucks entering the system. The number of trucks are calculated by the product of the arrival rates and the average time a truck spends in the system. There is a 7 hour receiving day based on operation hours from 8 AM to 3 PM. Receiving is divided into three different types: raw materials, finished goods from consolidator, and finished goods from small distributors. The number of trucks per hour was obtained based on the arrival rate and the operation hours. This value and the time it takes to unload each different type of truck were used to obtain the expected number of docks needed to satisfy the demand. The needed number of docks for each type of arrival was combined to acquire a total number of 2.314 receiving docks.

2.2.2 Shipping

Shipping calculations were very similar to those for receiving. Operations were based on a nine hour day. Shipping is divided into two different types: stores' replenishment orders shipped in palletized totes and customers' orders shipped in individual cartons which are directly loaded onto parcel carriers. The calculated departure rate needs to satisfy the daily forecasted demand for the next five years. First, the number of trucks per day was determined to allocate the number of required docks. To accomplish this task the number of totes per pallet and additionally the number of pallets that fit in a truck were both estimated. Assuming an equal loading time as unloading, the operation period of nine hours produces an estimated total number of 9.187 shipping docks.

Shipping and receiving operations require a combined total of 12 docks.

2.3 Storage System

The storage system controls layout of the warehouse and constrains material handling and picking processes. There are four different areas of storage, each with their own method to meet their specific demand type. These categories were determined by incoming pallet volume and utilization.

2.3.1 Bulk Raw Material

Bulk materials arrive in 48” x 40” pallets that are 78” high. From receiving, they are sent to either manufacturing where they are packed into Vital Brand™ products or they are sent to bulk storage. It is assumed that the pallets received are in sturdy crates suitable for stacking.

Given that these pallets are 6.5 feet high, they are clearly ergonomically unsound for manual material handling and automated equipment must be used. Also, when product height was considered, it was discovered that 13 feet and 17.5 feet vertical height would be required to stack the pallets 2 units and 3 units high, respectively.

Table 1: Space requirements of Bulk Storage

	Area	Height
1 High	10280 ft^2	5.8 ft
2 High	5140 ft^2	11.7 ft
3 High	3426.67 ft^2	17.5 ft

Bulk storage space requirements were developed by analyzing the footprint of each pallet and allowing 1.5 inches of positioning space between stacks. Honeycombing issues were analyzed utilizing SKU volume densities, which were then used to make a judgmental decision between block stacking and shelf stacking materials. Detailed calculations are provided in Appendix C.

2.3.2 Finished Goods Material

With the amount of material coming into the facility on a peak day it is beneficial to split the material into two different sections: low throughput and forward picking. Detailed calculations of the following are provided in Appendix D.

2.3.2.1 Low Throughput Area

The low throughput area has the lower pick percentages but receives 4,499 pallets on a peak day. Different available pallet storage options are compared in the table below.

Table 2: Comparison of Rack Systems

Low Throughput		
	Push-Back Rack	Double Deep Rack
Height	5 High	5 High
Price per pallet	$155	$55
Total Pallets	3220	4500
Space	12,000 ft^2	12,000 ft^2
Aisle Width	8 ft	10 ft
Total Cost	$499,100	$247,500

The above table was calculated by taking into account the total amount of pallets coming into the facility to determine the overall area required. Each holds up to 5 pallets high, therefore the area was divided by 5 to obtain the base area. This, in turn, was divided by the area of of storage system type to determine the number of racks required.

The double deep rack method was chosen after considering the space saved and overall cost of each method. These racks are stacked 5 high to accommodate high demand. The double deep racks are $55 per pallet and hold up to 4500 pallets. This method also utilizes deep reach lift trucks and accommodates a minimum of 10 foot aisles. The overall rack cost comes out to $247,500. The low throughput area requires a minimum of 12,000 square feet.

2.3.2.2 Forward Pick Area

The forward pick area will contain the remaining 882 pallets which constitute 80% of order volume, assuming that the finished goods material received from small distributors was included in the preliminary data. Putting them in this area reduces time and makes the order picking more efficient. They are unloaded and placed into case flow racks which have 4 shelves with 6 rows on each shelf. To accommodate the remaining pallets for this pick area there are 46 case flow racks. The racks are $1,050 each. The total cost for this method is $48,300 and requires 11,760 square feet. In front of the racks there is a powered roller conveyer that leads to the staging/packing area to prepare the orders for shipping.

2.3.3 Tote Storage

Since the totes from the small distributors are assumed to be included in the forward pick area, the space required for totes is relatively small. The small distributors will bring 500 totes on a peak day. If the totes are stacked 3 high, they would only require an area of 334 square feet for temporary storage before being placed in the case flow racks. There will also need to be a space for the totes that will be shipped to and from the store sites. This space will be in close proximity to the forward pick area to allow waiting nearby the replenishment areas prior to shipping. Replenishment totes will be the stack and nest totes with integral hinged covers. This allows nesting during return shipping to the warehouse and reduces loading and unloading of empty totes. The replenishment and tote storage area will use open shelving that costs $75 per unit. The warehouse will require 150 units which will cost $56,250.

2.3.4 Storage Material Costs

Combining the costs for each type of storage area, excluding the staffing and conveyer system, the total cost comes out to be $391,050 as shown in the following equation.

$$\$39{,}000 + \$247{,}500 + \$48{,}300 + \$56{,}250 = \$391{,}050$$

Equation 1: Total Storage Material Cost

2.4 Material Handling Equipment

Each storage method will require a different type of equipment. The equipment recommended is sit-down counterbalance lift trucks, deep reach lift trucks, dock levelers, walkie pallet jacks, and conveyors.

2.4.1 Equipment Cost

Each job's requirement determines equipment use in the facility. There is a need for 2 sit-down counterbalance lift trucks, at $23,000 each, which were selected for bulk storage to allow lift heights of more than 12 feet. The deep reach lift trucks are used for the low throughput finished goods which requires 2 trucks at $26,000 each. Each dock requires a dock leveler to keep the back of the 18 wheelers level with the floor of the warehouse and reduces potential hazards for workers. The warehouse requires 12 edge dock levelers at $750 each. Also, each dock requires pallet jacks to move pallets from the trucks to the staging area. Lift trucks move the pallets from staging and place them in storage. The warehouse needs a total of 20 walkie pallet jacks to accommodate each employee unloading a truck. The walkie pallet jacks cost $4,500 each. Finally, conveyers are necessary to move material from the forward pick area to the staging area for order finalization. The conveyers cost $200 per linear foot and will require a total of 450 feet. Accounting for the all of the equipment utilized, the total cost will come out to $287,000, as shown in the equation below.

$$2 * \$23{,}000 + 2 * \$26{,}000 + 12 * \$750 + 20 * \$4{,}500 + \$200 * 450 = \$287{,}000$$

Equation 2: Total Material Handling Equipment Cost

2.5 Manufacturing Lines

The current manufacturing lines have worked well in the past, but in order for Vital Vitamins© to handle there ever growing customer demands; the manufacturing lines must be upgraded. To

upgrade the two existing lines it will cost $570,000 per line upgrade. The benefits of an upgraded line are the time it takes to change the product lines will be cut and the upgraded line can handle 36,000 units per day instead of the current 17,550 to 22,000 units per day. The time will change from one and two hours down to thirty minutes per line. This allows there to be eleven changeovers a day and could help to prevent there being a bottleneck in production.

The projections for the next five years of customer growth show that the demand for Vital Vitamins© products will be at approximately 83,087 units per day. The facility is required to handle all demands without being upgraded for the next five years, therefore it has been determined that the two existing lines must be upgraded and an additional line must be purchased to meet the demand. The additional line costs $1,000,000 and will require 3,000 square feet be added to the manufacturing department. Though this may seem costly, it is a necessity if the warehouse is going to meet the demand over the next five years. It is also worth noting that even with the additional 3,000 square feet required in manufacturing; the overall facility size will not have to be increased due to efficient allocation of space. Calculations are provided in Appendix E.

2.6 Pick System

The recommended pick system for Vital Vitamins® is the case flow rack in the forward pick area with a RF-scan and LED light pick system. The employee will receive a tote with a barcode on it and they will scan it with the RF-scanner. LED screens on the flow racks will display the tote(s) in that employee's zone that require an item to be picked. After all their items have been picked they put the tote on the conveyer to continue down the line of flow racks. The employee will then get another order tote and scan it. If it doesn't require any of the items in their specific area, they will simply replace it on the conveyer and continue in this manner. Every employee will repeat the same process for each tote that comes to their station. More employees will be at the end of the conveyer to inspect the order and ensure its correctness and finalize the packing requirements for shipping.

RF scan systems will also be integral in the implementation of the automatic ticketing system. Remotely identifying individual units allows ticketing to be assessed on the fly for products coming from picking on their way to staging for shipping.

2.7 Staffing Requirements

It is assumed that employees get 9 hours of pay with an unpaid 1 hour lunch break and two paid 15 minute breaks. They are on-site for 10 hours with only 8.5 hours of productivity.

The storage system staffing requirements vary for the individual designated areas. All employees work 10 hour shifts and are paid $12 per hour. Vital Vitamins© needs 2 employees for bulk raw material, which is one employee per lift truck. The forward pick area requires 23 employees. Each employee will has 2 case flow racks, or 48 slots, to pick from. These pickers are responsible for picking orders and also filling totes that will go to the outlet stores for replenishment. The tote area also has 2 employees to unload the empty store totes and the small distributor totes, and then replenish the case flow racks as needed.

There are 20 employees for unloading the trucks at the docks. After they are done with the unloading they work in the staging area prepping orders for shipping. When the shipping trucks start to arrive they begin to load those trucks.

The manufacturing lines require 5 workers per line. Therefore, there are a total of 15 employees to run the lines.

The warehouse requires 8 supervisors for the 64 employees on the floor. Supervisors are paid $15 per hour and manage 8 employees.

The total payroll is $7,992 per day, not including any overtime, as shown in the following equation.

$$\left(64\ employees * \frac{\$12}{hr} + 8\ supervisors * \frac{\$15}{hr}\right) * \frac{9hrs}{day} = \$7{,}992\ per\ day$$

Equation 3: Total Staffing Cost

3.0 Results

3.1 Price Ticketing

Price ticketing is highly dependent upon unit processing time. Only store replenishment goods were considered, as direct-to-customer goods will not need to be ticketed. Given values were based on current costs for the ticketing process. By considering our current model of paying employees $12 per hour and assuming that there are 360 days per year, unit process time will take 0.136 minutes, roughly 8 seconds per item, to be able to break even with the current cost of pricing at point of sale. This would require a total of 28 employees, consuming roughly 231.5 hours per day.

Manual price ticketing within the facility would require 28 employees and 231.5 hours of labor per week. To balance this price with the current $1 million spent on this activity, a unit process time of 8 seconds *per item* must be achieved. Current time standard estimations place item process time at 0.57 minutes per item.

However, by purchasing two automatic sticker labeling systems and placing them between picking and shipping, it becomes possible to easily handle peak loads at a fraction of the price. Initial utilization for both machines would be roughly 57% in the current year, rising to 68% in 5 years. This allows Vital Vitamins© to replace a decentralized, highly inefficient manual system with two automated machines, increasing reliability and efficiency.

While specific quotes were not available for the cost of the automatic ticketing machines, numbers provided for the current off-site labeling system show an initial cost of $1 million per year. It is assumed that these costs will either hold at the current level or expand. This would require the total cost of operation for two automatic sticker labelers to exceed $5 million in 5 years. Even if costs must be recouped within the year, an individual automatic sticker labeling machine would have to cost more than $481,500 to offset its installation.

For calculations and time standards, please refer to Appendix F.

3.2 Employee Scheduling

The goal of employee scheduling is fill demand by placing employees in the right time slots. First, we needed to determine the workload requirements. Next, we had to design a scheduling framework to meet demands, and then build the employee schedule. Production demand translated into employee requirement for time intervals. Business demand varies according to the time of the day with specific peaks. Once we determined the number of employees needed, the next step was to determine the number of shifts, length of shifts, and rotation patterns of the shifts. The timeline for shifts is illustrated in Figure 2.

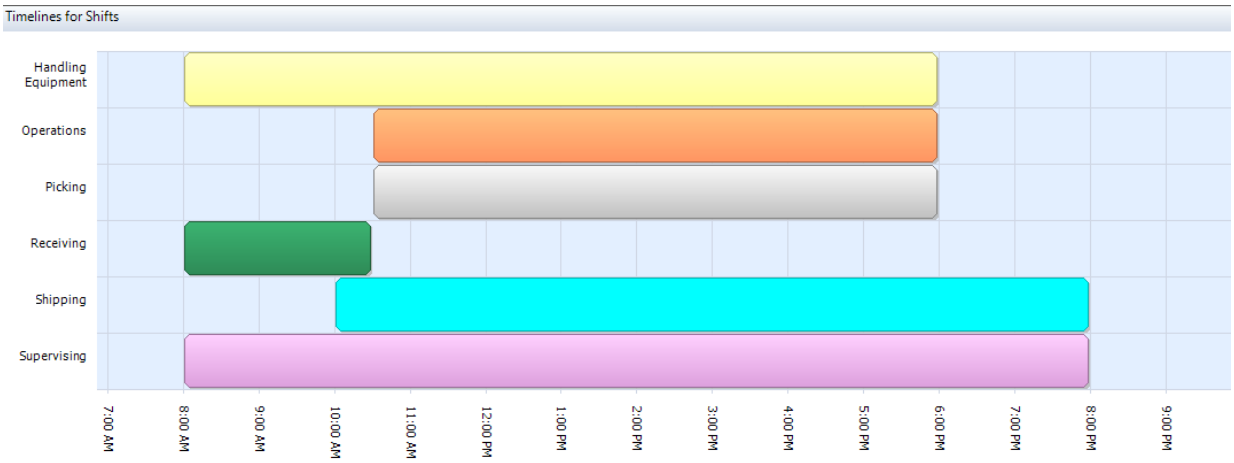

Figure 2: Shift Timelines

To avoid paying overtime each employee must work no more than forty hours. There are five different types of employees: line operation, material handling equipment operation, receiving, shipping, picking, and supervisors. Below in Figure 3 is a list of five different work teams needed and the times allotted to each.

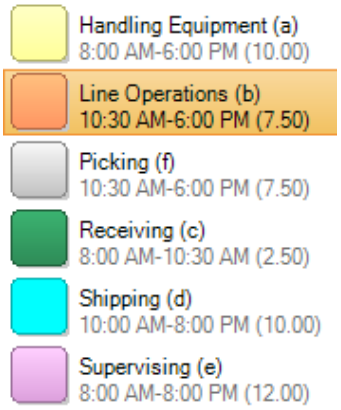

Figure 3: Team Time Allotment

Operations are limited from 8 A.M. to 8 P.M and are best facilitated by shiftwork scheduling. A critical component of scheduling is the number of teams needed to cover the labor demand. By establishing teams, members work consistently with the same coworkers. Two teams, A and B, will rotate according to the following pattern:

Table 3: Team Rotation Schedule

	Week 1	**Week 2**
Team A	Mon - Thur	Mon - Wed
Team B	Fri - Sun	Thur - Sun

An ideal timetable avoids overtime payments to employees. This reduces both payroll costs and labor relation problems. This schedule requires employees to work forty hours in any given calendar week to avoid paying overtime. A table of the schedule for the whole week from Monday through Thursday and a list of five different work teams needed and the times allotted to each is illustrated in Figures 4 & 5.

Employee	Monday	Tuesday	Wednesday
15 Line Operators Line Operators Main Location	Line Operations Main Location 10:30 AM-6:00 PM	Line Operations Main Location 10:30 AM-6:00 PM	Line Operations Main Location 10:30 AM-6:00 PM
4 Operators Material Handling Equip... Team1	Handling Equipment Main Location 8:00 AM-6:00 PM	Handling Equipment Main Location 8:00 AM-6:00 PM	Handling Equipment Main Location 8:00 AM-6:00 PM
4 Receiving Employees Receiving Team1	Receiving Main Location 8:00 AM-10:30 AM	Receiving Main Location 8:00 AM-10:30 AM	Receiving Main Location 8:00 AM-10:30 AM
4 Shipping Employees Shipping Team1	Shipping Main Location 10:00 AM-8:00 PM	Shipping Main Location 10:00 AM-8:00 PM	Shipping Main Location 10:00 AM-8:00 PM
8 Supervisors Supervisor Main Location	Supervising Main Location 8:00 AM-8:00 PM	Supervising Main Location 8:00 AM-8:00 PM	Supervising Main Location 8:00 AM-8:00 PM
Employee 7 Picking Main Location	Picking Main Location 10:30 AM-6:00 PM	Picking Main Location 10:30 AM-6:00 PM	Picking Main Location 10:30 AM-6:00 PM

Figure 4: Employee Schedule (Part 1)

Thursday	Friday	Saturday	Sunday
Line Operations Main Location 10:30 AM-6:00 PM	Line Operations Main Location 10:30 AM-6:00 PM	Line Operations Main Location 10:30 AM-6:00 PM	Line Operations Main Location 10:30 AM-6:00 PM
Handling Equipment Main Location 8:00 AM-6:00 PM	Handling Equipment Main Location 8:00 AM-6:00 PM	Handling Equipment Main Location 8:00 AM-6:00 PM	Handling Equipment Main Location 8:00 AM-6:00 PM
Receiving Main Location 8:00 AM-10:30 AM	Receiving Main Location 8:00 AM-10:30 AM	Receiving Main Location 8:00 AM-10:30 AM	Receiving Main Location 8:00 AM-10:30 AM
Shipping Main Location 10:00 AM-8:00 PM	Shipping Main Location 10:00 AM-8:00 PM	Shipping Main Location 10:00 AM-8:00 PM	Shipping Main Location 10:00 AM-8:00 PM
Supervising Main Location 8:00 AM-8:00 PM	Supervising Main Location 8:00 AM-8:00 PM	Supervising Main Location 8:00 AM-8:00 PM	Supervising Main Location 8:00 AM-8:00 PM
Picking Main Location 10:30 AM-6:00 PM	Picking Main Location 10:30 AM-6:00 PM	Picking Main Location 10:30 AM-6:00 PM	Picking Main Location 10:30 AM-6:00 PM

Figure 5: Employee Schedule (Part 2)

3.3 Staging Area

Dock staging requires a location behind the dock-maneuvering aisle. Based on demand estimation and the daily truck arrival it was concluded that staging area should be limited to one truckload of material per dock. Staging area pallet allocation was estimated by analyzing the shipping and receiving patterns. A 12 foot aisle space also allows for bidirectional traffic.

The needed pallet count was estimated by determining the number of trucks served and the processing time for a truck load.

4.0 Recommendations and Implementation

We recommend that there be at least 12 dock doors to handle expanded demand for shipping and receiving. It is feasible to use only 10 doors to handle the current demand, but the extra 2 must be added later to maintain effectiveness.

It is also recommended that the facility only be constructed for 173,000 square feet with a mezzanine of 12,500 square feet to accommodate the offices. This is sufficient to handle current operations and allows the opportunity for future facility expansion without incurring un-needed capital costs.

Both current manufacturing lines should be upgraded to the high speed lines along with the addition of a new high speed line to accommodate for predicted demand in 5 years.

Price ticketing should be moved from off-site operations to within the facility to be handled by automated systems. This frees up labor off-site and allows greater shipping flexibility for Vital Vitamins©.

Picking should utilize RF scanners to increase picking accuracy, shipping ease, and to enable automated price ticketing.

5.0 Conclusion

After the execution of all the above processes and calculations, the facility designed will sufficiently fulfill the requirements set by Vital Vitamins©. Containing operations within 173,000 square feet allows future expansion into the extra 42,000 square feet without incurring the current cost. The storage and picking systems can be easily expanded if the facility grows and the manufacturing space can also be shifted to meet further requirements. The overall cost of the new facility including all storage racks, material handling, manufacturing lines, picking, and employee costs roughly comes out to be $18,662,130. This is a reasonable amount for a brand new facility of this caliber and Vital Vitamins© cannot afford ignore future demand.

6.0 Bibliography

Works Cited

Automatic Sticker Labeling Machinery Manufacturer. Denmark Machine Tools. Web. 04 May 2011. <http://www.denmarkmachine.com/sticker-labelling.html>.

Crown Equipment - Sit-Down Counterbalanced Trucks. *Spec Sheet*. Crown Equipment - Sit-Down Counterbalanced Trucks. Crown Equipment Corporation, 2011. Web. 04 May 2011. <http://www.crown.com/usa/products/usa_electric_forklift/sit_down_counterbalance/FC_4500_Series/>.

Meller, Russell, and Janet Wolf. *Vital Vitamins: A College-Industry Council on Material Handling Education Case Study*. Issue brief. Blacksburg, VA: Virginia Tech, 2002. Print.

Online Rules of Thumb. Gross & Associates, 2007. Web. 4 May 2011. <http://www.grossassociates.com/resources/online-rules-of-thumb/>.

Works Referenced

Material Handling Equipment Taxonomy. Material Handling Industry of America, 8 Oct. 1999. Web. 04 May 2011. <http://www.mhia.org/industrygroups/cicmhe/resources/mhe_tax.htm>.

MHIA Equipment Guidelines. Material Handling Industry of America, 2011. Web. 04 May 2011. <http://www.mhia.org/industrygroups/cicmhe/resources/guidelines/equipment>.

Tompkins, James A. *Facilities Planning*. 4th ed. Hoboken, NJ: Wiley, 2010. Print.

"Welcome to the MH Multimedia Bank." *Material Handling Multimedia Bank*. Material Handling Industry of America, July 2003. Web. 04 May 2011. <https://www.cirrelt.ca/mhmultimediabank/>.

“Warehouse Cost Calculations.” <https://lms.tamu.edu/webct/urw/ssinboundNetID.snWebCT.si20926..C04CD068EADB41B9E0340003BA2CAE2A/cobaltMainFrame.dowebct?appforward=/webct/viewMyWebCT.dowebct>

Appendix

A. Forecasting

Table 4: Year 5 Predicted Order Summary

PREDICTED ORDER SUMMARY			
Year 5 Order Data			
	Direct Consumer	**Store Retail**	**Total**
At Peak:			
Pieces per day	40,063	211,715	251,778
Orders per day	4,763	8,348	13,111
Lines per day	13,211	67,844	81,055
Totes(carton) per day	6,007	6,013	12,021
Lines per order:	2.77	8.13	5.33
Units per line:	3.03	3.12	3.10
Units per order:	8.41	25.36	16.51

Table 5: Vital Brand Sales Forecasting

Vital Brand Sales Forecasting			
Year	Vital Brand Sales (% of Total)	Total Sales	Total Vital Brand Sales
1	25%	139,112	34778.0
2	28%	160,272	44876.2
3	30%	185,531	55659.4
4	32%	215,706	69026.0
5	33%	251,778	83086.6

B. Dock Calculations

For peak periods:

B.1 Receiving

8 AM – 3 PM: 7 hour day

Raw Materials: $\frac{1.2\ trucks}{day}\ \frac{day}{7\ hours}\ \frac{1\ hr*dock}{truck}$ = 0.1714 docks

Finished Goods – from Consolidator: $\frac{5\ trucks}{day}\ \frac{day}{7\ hours}\ \frac{1.5\ hr*dock}{truck}$ = 1.08145 docks

Small Distributor: $\frac{3\ trucks}{day}\ \frac{day}{7\ hours}\ \frac{1.5\ hr*dock}{truck}$ = 1.0715 docks

RECEIVING TOTAL= 2.31435 docks

B.2 Shipping

9 hour day

Stores' Orders: $\frac{500\ totes}{day}\ \frac{1day}{3\ trucks}\ \frac{1\ truck}{106.67\ totes}\ \frac{6007\ totes}{1\ day}\ \frac{1\ day}{9\ hrs}\ \frac{1.5\ docks*hr}{1\ truck} = 6.0068\ docks$

Customers' Orders: $\frac{87.5\ pallets}{1\ day}\ \frac{1day}{5\ trucks}\ \frac{6013\ totes}{1\ day}\ \frac{1\ pallet}{30\ totes}\ \frac{11.5\ trucks}{day}\ \frac{1\ day}{9\ hrs}\ \frac{2.5\ docks*hr}{1\ truck} = 3.1805\ docks$

SHIPPING TOTAL= 9.1873 docks

TOTAL NUMBER OF DOCKS: 2.31435 docks + 9.1873 docks = 11.5 ~ 12 docks

C. Bulk Storage

Pallets required: 771

Pallet size: 48" * 40" *70"

Stacking area:

1 deep = $\frac{48in*40in*771pallets}{12^2in^2}$ = 10,280 ft^2

2 deep = $(\frac{48in*40in*771pallets}{12^2in^2})/2$ = 5,140 ft^2

3 deep = $(\frac{48in*40in*771pallets}{12^2in^2})$ /3 = 3,426.67 ft^2

D. Finished Goods

D.1 Low Throughput

Low Throughput: 630 pallets + 1,425 pallets + 2,444 pallets = 4,499 pallets

Double Deep Racks:

2 deep and 5 high =($\frac{48in*40in*4499pallets}{12^2in^2}$)/5 ≅ 12,000 ft²

1 rack = 10 pallets

Total racks = $\frac{4499\ pallets}{10\ pallets}$ ≅ 450 racks

D.2 Forward Pick Area

Forward Pick Area: 480 pallets + 402 Pallets = 882 pallets

Case Flow Racks:

Total area with 4 high: $(\frac{48in*40in*882pallets}{12^2in^2})$/4 = 2,940 ft²

Area of one rack: 8 ft * 8 ft = 64 ft²

Racks required: $\frac{2{,}940\ \text{ft}^2}{64\ \text{ft}^2}$ ≅ 46 racks

Cost: 46 racks * $1,050 = $48,300

E. Manufacturing Lines

Table 6: Vital Brand Forecasting

Year	Vital Brand Sales (% of Total)	Internet and Catalog (pieces/day)	Store Sales (pieces/day)	Total Sales (pieces/day)	Vital Brand Sales
1	25%	37,012.0	102100.0	139,112	34778
2	28%	37,752.2	122520.0	160,272	44876.23
3	30%	38,507.3	147024.0	185,531	55659.39
4	32%	39,277.4	176428.8	215,706	69025.99
5	33%	40,063.0	211714.6	251,778	83086.59

Units Needed/day = 83,087

Current Lines # Units produced/day = 39,550 units

2 Upgraded Lines Peak produced/day = 36,000*2 = 72,000 units

3 Upgraded Lines Peak produced/day = 36,000*3 = 108,000 units

Table 7: Final Data for 3 lines

3 Lines Data	
Units processed/hr	10800
hours used/day	7.693202584
downtime/day	2.306797416
Cost of 3 lines	$ 2,140,000.00

F. Price Ticketing

Table 8: Time standards

Time to prep area for ticketing	1	minute	per order
Time to finalize order	45	seconds	per order
Time to obtain item for order	0.25	minutes	per unit
Time to ticket (utilizing RF and smart ticketing)	0.083333	minutes	per unit
Time to box	0.166667	minutes	per unit

Total Time = 0.25 + 0.0833 + 0.1667 + (1.75 / 25) = 0.57 minutes

Total Units = 102,100 units

0.136 minutes per item

Daily time: 102,100 units * 0.136 minutes per unit = 13,889 minutes per day = 231.5 hours per day

Employee cost: $12 per hour * 231.5 hours = $2,777.78

Yearly cost: 360 days * $2,777.78 = $1,000,000

For Automatic Sticker Labeler

Bottle Rate	150 bottles / min	
Peak units	102100	
680.6666667	min / day	
11.34444444	hrs/day	
	10 hours max per day:	
If two machines are used:		
5.672222222	hours / day	
Utilization=	5.6722/10	0.49998
	roughly 56.7%	
Assuming 20% Growth:		
11.3444 hrs/day * 1.2	13.6133	
Utilization = (13.6/2)/10	68.0%	

Employee Cost =
2 * ($9 / hr)*(52 wks/yr)*40 hrs =
$37,000 per year

Break Even Machine Cost
($1,000,000 – $37,000) / 2 =
$481,500 *each*

G. Total Costs

Table 9: Total Facility Cost

Equipment List and Costs				
Amount	Equipment	Cost	per	Total Cost
12	Dock Levelers	$ 750.00	dock	$ 9,000.00
112	Open Shelving	$ 50.00	pallet	$ 5,600.00
4500	double deep racks	$ 55.00	pallet	$ 247,500.00
1	Stretch Wrap Machine	$ 10,000.00	machine	$ 10,000.00
12500	Solid Steel Plate Deck Mezzanine	$ 18.00	sq.ft.	$ 225,000.00
2	Counterbalance Lift Truck	$ 23,000.00	truck	$ 46,000.00
2	Double Deep Reach Truck	$ 26,000.00	truck	$ 52,000.00
2	Line Upgrades	$ 570,000.00	line	$ 1,140,000.00
1	New Line	$ 1,000,000.00	line	$ 1,000,000.00
257	Powered Roller Conveyor	$ 200.00	linear ft.	$ 51,400.00
1	Palletizer	$ 65,000.00	machine	$ 65,000.00
500	Totes(Stack and Nest w/ Integrated Hinge Cover)	$ 20.00	tote	$ 10,000.00
46	Carton Flow Rack	$ 48,300.00	racks	$ 2,221,800.00
2	Pop-up Wheel Sorter	$ 415.00	foot	$ 830.00
8	Supervisors	$ 273,750.00	5 yrs	$ 2,190,000.00
52	Employees	$ 219,000.00	5 yrs	$ 11,388,000.00
		TOTAL COSTS OVER 5 YEARS		$ 18,662,130.00