Creating a Lean Warehouse

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Abstract
Lean got its start in factories and for many years was called Lean Manufacturing. However, if you analyze movement of people, there is often a greater opportunity in creating a Lean Warehouse. When your warehouse is Lean the tools and information you need to receive, pick and pack are right where they are needed. The order flow is streamlined, with no unnecessary paper and all of the information needed is in the hands of the operators. The layout is designed to put floor stock, shelf items and rack items in the optimal locations relative to the dock-doors. SKUs are located to minimize movement of the heaviest items that are picked most often and stock items that are lighter and lower velocity are further away and up on higher levels.

We will case study a few projects, showing you the analysis and design that goes into Creating a Lean Warehouse.

Understand the Current State

- Process Flow Mapping of Warehouse Processes and Order Information Flow
- Spaghetti Diagrams & Time Studies of Warehouse Operations

Lean Practitioners always seek to understand the current state to identify the non-value-added steps. Future state warehouses are designed to make sure the non-value-added work is eliminated or reduced. We primarily use three Lean tools to identify and eliminate non-value-added work: Process Flow Mapping, Spaghetti Diagrams and Time Studies.

Process Flow Mapping: Streamline Warehouse Processes and Order Information Flow

When working on a warehouse layout, the first thing we do is map the “business processes” and information flow. This is to identify and eliminate non-value-added steps in the purchasing-to-receiving-and-putaway and the order-pick-pack-ship processes. Once all steps are mapped, we classify each step as either green, yellow or red:

- Green: Value-Added to the Customer
- Yellow: Non-Value-Added but Necessary
- Red: Non-Value-Added and should be eliminated

Figure 1 has an example of a process flow map of two major warehouse processes (purchasing-to-receiving-and-putaway and the order-pick-pack-ship). As you can see there are 73 steps in these two processes, with 22 identified as red, which will be designed out of the future state information flow.

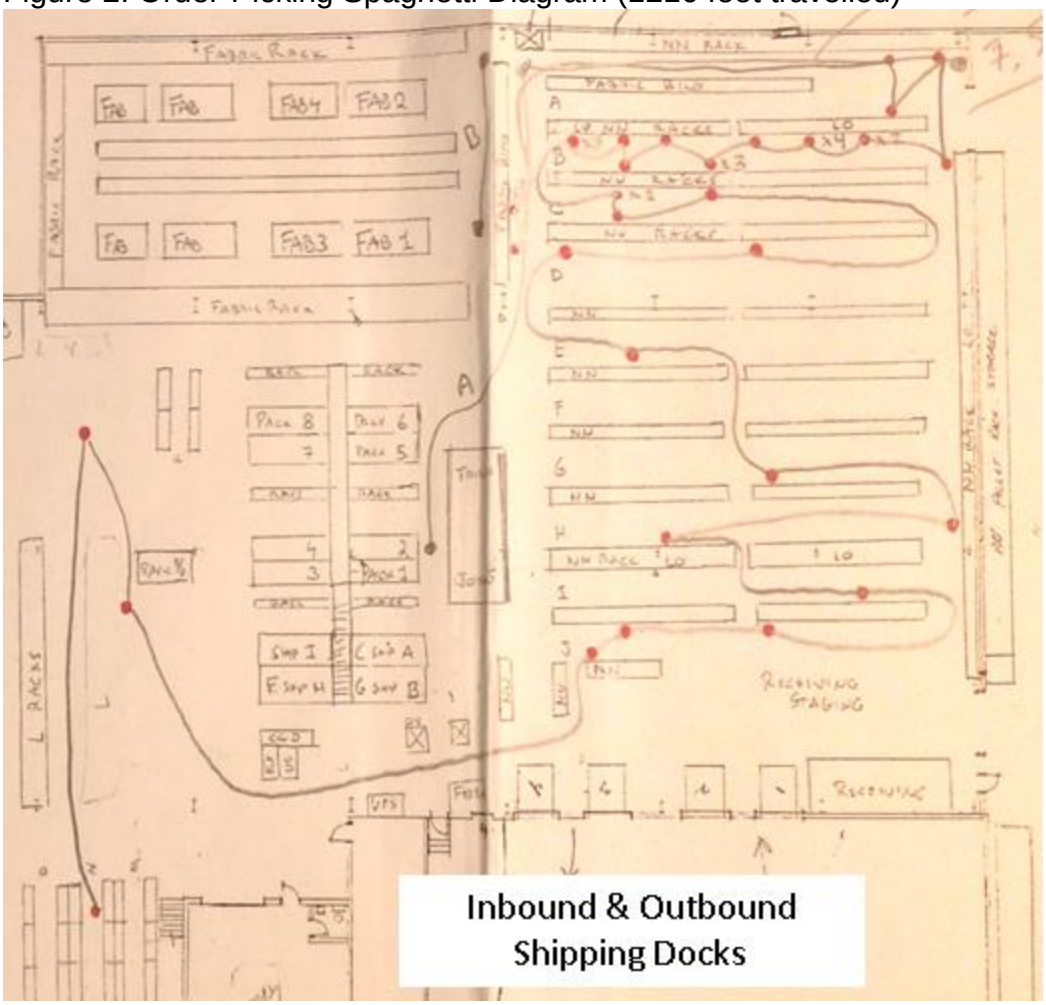
Figure 1: Warehouse Process Flow Map

Spaghetti Diagrams and Time Studies: Non-Value-Add in Labor and Material Movement

All warehouse operations are time-studied and spaghetti-mapped to understand labor and material movement in warehouse operations. The data will help identify the non-value added steps required in the current layout and provide insights into the new layout and new processes. The time study provides the quantitative proof of how much time is wasted in warehouse processes. The spaghetti diagram provides a compelling visual to support the need for change.

Figure 1 shows the need for this change at a mid-size ecommerce company. Below is a spaghetti diagram for an operator picking all items in an ecommerce order. The current state layout is causing the operators to travel to almost every corner of the warehouse.

Figure 2: Order-Picking Spaghetti Diagram (1216 feet travelled)



This spaghetti diagram showed us many opportunities for improvements.

- Racking/shelving is aligned 90 degrees to the inbound and outbound dock-doors, blocking off the natural inbound and outbound flow
- Pack/ship workstations are not directly in front of the outbound dock-door creating extra movement to put boxes or pallets in delivery trucks
- A light assembly area is using important warehouse space (upper left corner of the warehouse) when these items are rarely on orders
- Most SKUs on this order are stocked very far away from the dock-doors
- One storage area, in the lower left corner of the warehouse, is far away from all other racking/shelving/floor-stock, guaranteeing extra travel for these items

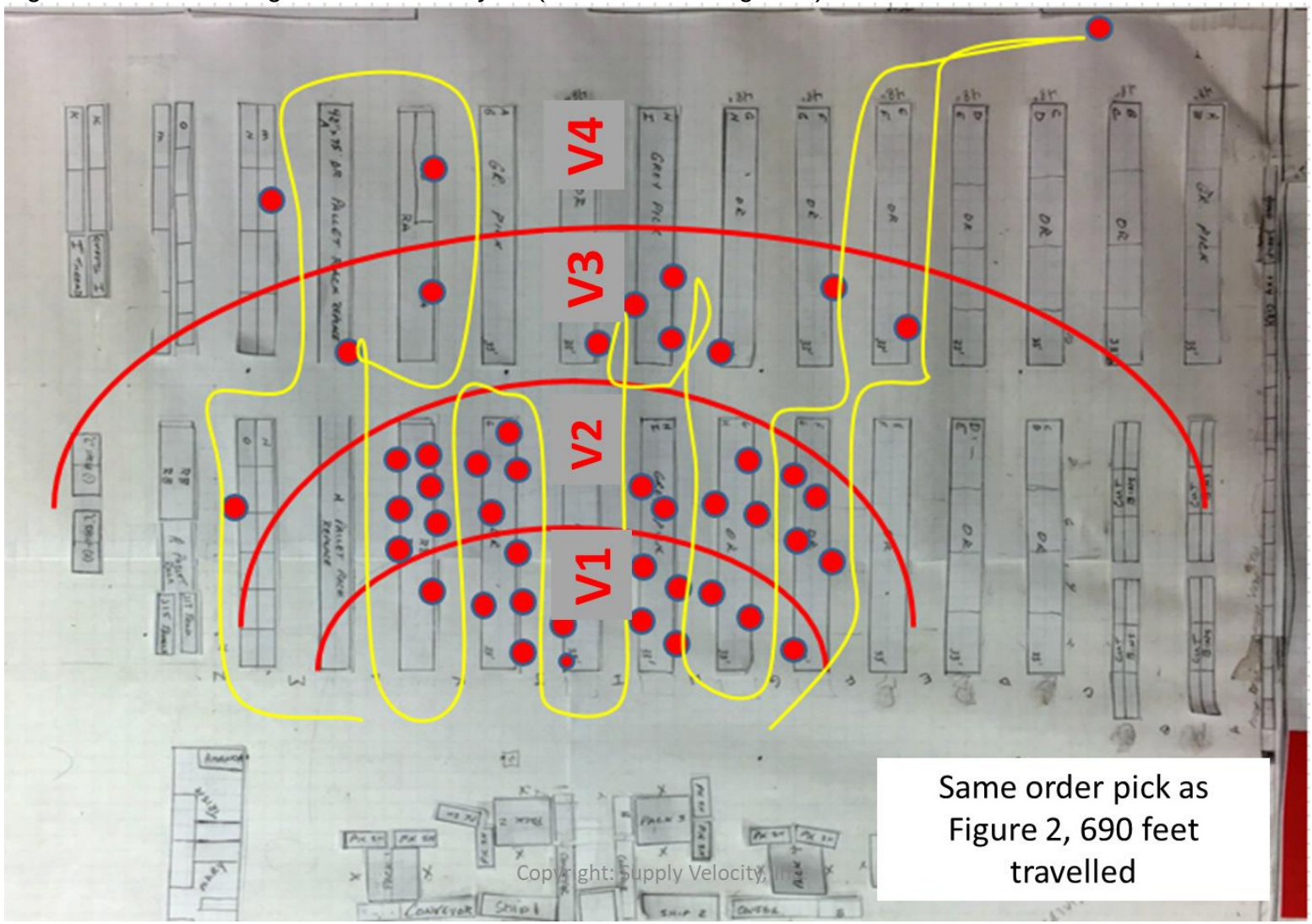
(For comparison purposes, Figure 4 shown on the following page, depicts the Lean / Future State layout of the warehouse shown above in Figure 2 as Current State.)

Figure 3 shows an example of a Time Study for receiving. While less visually interesting than the Spaghetti Diagram, time studies capture the detailed non-value-added steps that turn into process improvement action items and ideas for improving the layout. In addition, this information allows us to quantify specific improvements, calculating a return on investment when justifying expenditures.

Figure 3: Inbound Receiving Time Study

5	Date:	12/20/2012									
6	Time Study #:		13		Technician		BO				
7	Product Family:		PF 1		Operation Description		Receiving 7th Street UPS				
8					Units per load:		32	bags and boxes			
9	Team Names:		Dorth & D' Bobs								
10	T/S #:		Run time		Run Time Sec	Secs per Seq	Min per Seq				
11	A/I #	Activity/Step Description	Min	sec				red	yellow	green	
12		arrives at receiving (conveyor belt)		17	17	17	0.3			17	
13		presorts boxes an moves to WO print area		25	25	8	0.1			8	
14		moves more boxes to WO print area		45	45	20	0.3			20	
15		moves more boxes to WO print area	1	5	65	20	0.3			20	
16		grabs dolly and delivers 5 boxes to hanging station	2	33	153	88	1.5			88	
17		returns to receiving	2	54	174	21	0.4			21	
18	#23.2	carries 3 boxes to WO print area	4	26	266	92	1.5	92			
19		brings 3 boxes to conveyor	4	43	283	17	0.3			17	
20		back at receiving	4	51	291	8	0.1			8	
21		puts 1 box at WO print area	4	55	295	4	0.1	4			
22		tosses box at WO print area	5	5	305	10	0.2	10			Opens all box
23		tosses box at WO print area	5	23	323	18	0.3	18			
24		tosses box at WO print area	5	37	337	14	0.2	14			
25		tosses box at WO print area	5	51	351	14	0.2	14			

Figure 4: Order Picking in New Lean Layout (same order as figure 2)



Designing the Lean Warehouse

- The Ideal Lean Warehouse Layout
- Velocity, Size & Weight Analysis
    - SKU Codes: V1, V2, V3 (Different from SKU Classification A, B,C)
- SKU Locations
- Choosing Racking, Shelving, or Floor-Stock
- Bin Location Coding
- 5S Visual Management

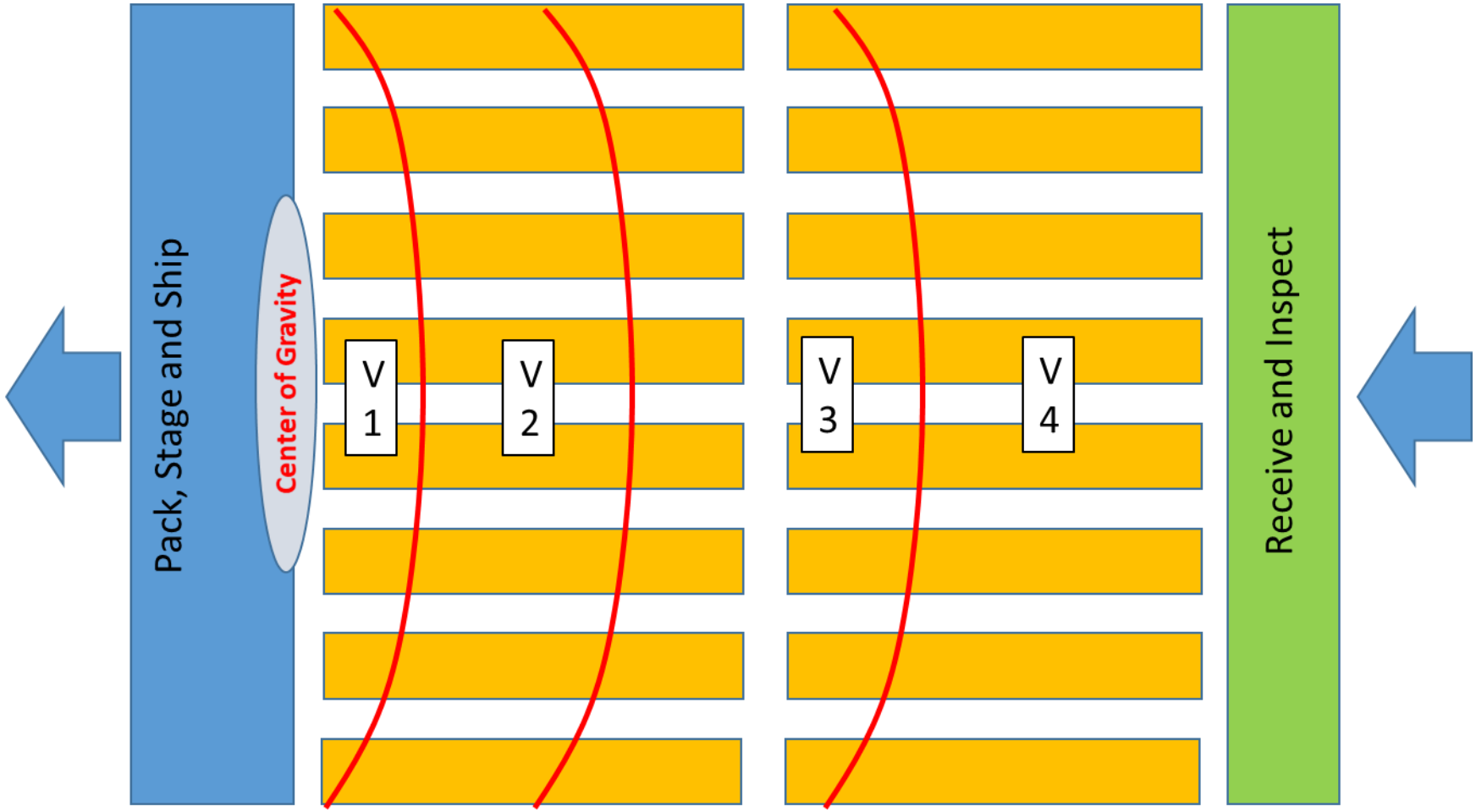
With a good understanding of the labor movement and time required in the current warehouse we can now design the Lean Warehouse. This is a combination of best practices, using ideas generated during the process flow mapping, spaghetti diagrams and time studies, and considering item velocity, size and weight.

The Ideal Lean Warehouse Layout

An idealized Lean warehouse is depicted in Figure 5. It is unlikely your building looks exactly like this but ideally we would want as many of these characteristics as possible:

- The inbound receiving docks to be on one side the building and the outbound shipping docks on the other.
- There is space allocated for receiving to organize products for putaway and to do required incoming receiving inspection. (I know that in an ideal Lean world there would be no need to do receiving inspection because all suppliers are certified, but the real world can be different.)
- Racks, shelving and floor locations are aligned with the flow of the incoming and outgoing dock doors. Specifically, it is more important to align them with the outbound dock doors because in most warehouses picking is a much larger component of labor than putaway.
- There is sufficient space in front of the outbound dock doors for the packing lines or shrink-wrapping outbound pallets and staging boxes or pallets for loading on trucks (or drones!).
- There is a defined “center of gravity” which is the busiest part of the warehouse. This is usually located in the staging area by the packing / shrink-wrapping lines.
- Items are located by velocity, with the heaviest and fastest-moving items located closest to the center of gravity. Lower velocity and lighter weighing items are located further back and higher up. The slowest moving items are located near the back of the warehouse close to receiving.
    - Note: SKU location should be based on picking-velocity to receiving. Items are usually received in larger quantities than they are picked.

Figure 5: The Ideal Warehouse Layout



Velocity, Size/Weight Analysis / SKU Locations / Floor-stock, Racking or Shelving

Instead of ABC we use V1/V2/V3/V4 as the warehouse velocity code designation for SKU warehouse location importance. Where ABC SKU classification may be determined by item profitability, unit volume, and/or how many customers buy an item, the warehouse velocity code is a function of the number of times an item is picked, the size and weight.

Velocity is the number of lines on sales orders for each SKU. For weight and size we often categorize items as Small (S), Medium (M), Large (L) and Extra-Large (XL). Small and medium items are often stocked on shelving, although we will often separate small from medium parts. Large items are often stocked on pallet racking and extra-large items are often floor stocked.

The fastest moving items are often the smallest but to consider size and weight we will have shelving, racking and floor stock around the center of gravity (COG).

In Figure 6 on the following page, we show a real Lean Warehouse Layout for a parts and equipment distributor, with spaces for all sizes of items. The approximately concentric ovals show the locations of V1 through V4 items. Not shown in this top-view is that V1 items that are small, medium or large would be located on the most convenient shelves or be on the lowest pallet level of pallet racking.

SKU Locating during the Transition/Move

When doing the actual transition/move to the Lean Warehouse Layout, we have found it is practical to set up fixed locations for V1 and V2 items and fill in the extra spaces with V3 and V4 items. V1 and V2 will get the locations closest to the center of gravity and on the most convenient levels of shelving and racking. Since V1 and V2 items are a minority of the total number of SKUs in most warehouses, it is a best practice to physically tag these items to make the move to the new location visually easy for the people moving items. V3 and V4 will fill up the rest of the floor/rack/shelf space in the new layout. It is not realistic to give fixed locations for all items because the business typically cannot know the exact space required for all SKUs over the entire year. By making sure V1 and V2 items have the space needed at their maximum stocking levels, in the best picking locations, you will maximize productivity over the entire year.

Bin Location Coding

Bin location coding is an important aspect to reducing labor of picking and eliminating “looking around” in warehouses without warehouse management systems. We created a detailed whitepaper explanation of options.
https://www.supplyvelocity.com/lean-warehouse-aisle-bay-level-position-bin-location-coding/

Figure 6: Warehouse Layout with Small, Medium, Large and Extra-Large Parts on Shelving, Racking, Floor Stock

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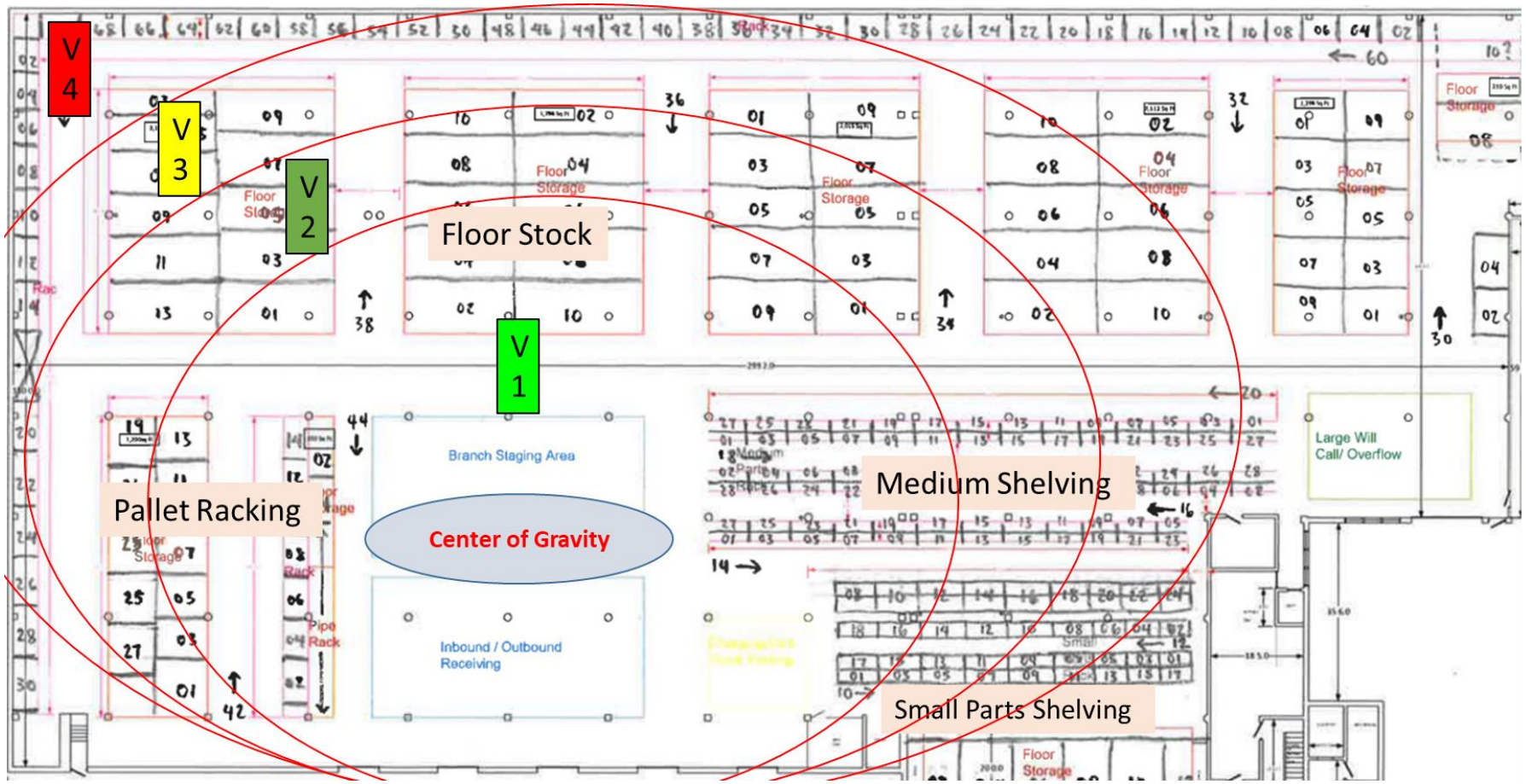

5S Visual Management

The 5S's are well known in manufacturing and industry. The application in warehousing is similar. At Supply Velocity we give careful attention to the 4th S, Standardization. Figure 7 below shows one example of achieving standardization in visual organization. This poster is placed throughout the warehouse to help ensure safety, cleanliness and maximal productivity for the people picking product.

Figure 7: 5S Standardization Poster