Pet Supplies Automated DC Simulation

September 5, 2024

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Speakers

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2011 Established

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Consulting. Software. Training.

problem solving, with a passion.

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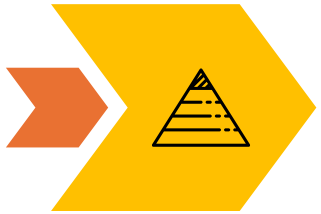
Designed Conveyor Systems

DCS has spent 40+ years serving e-commerce and multi-channel fulfillment, parcel handling, and various distribution applications by utilizing engineering, consulting, project management, installation services, and customer support- we know we only succeed if our customers succeed.

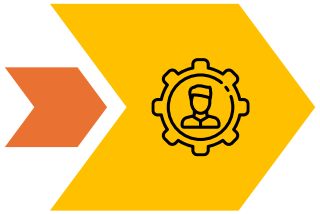
Supply Chain Consulting

The DCS Supply Chain Consulting team offers a range of services to help your operations address the challenges it faces.



System Design and Integration

DCS offers a broad range of services including automated system design, installation, and integration services for a multitude of projects.



DATUM

Built from the ground up and independent from the software offered by OEMs, DATUM can deliver on the promise of scalability, availability, flexibility, and reliability.

Customer Service Team

Keeping your warehouse operations and material handling systems running smoothly and at the peak of productivity are the goals of DCS' Customer Service Team.

DCS & MOSIMTEC

- Client is a leading pet supply company
- Designed Conveyor Systems (DCS) is designing the automated components of a new distribution center for the client
  - DC moves products from manufacturers to stores
  - Products include dog food, cat food, other bagged products
- MOSIMTEC provided simulation-based solution built on Anylogic

Project Questions

- Can the system complete daily store order demand in expected timeframe?
- Double checking large capital expense subsystems.
  - What is the throughput of the picking subsystems?
  - How many Autonomous Mobile Robots (AMR) are required?
- How does downtime and crew breaks affect throughput?

System Purpose

- Single-SKU pallets arrive from manufacturers

- Multi-SKU pallets built and shipped to stores

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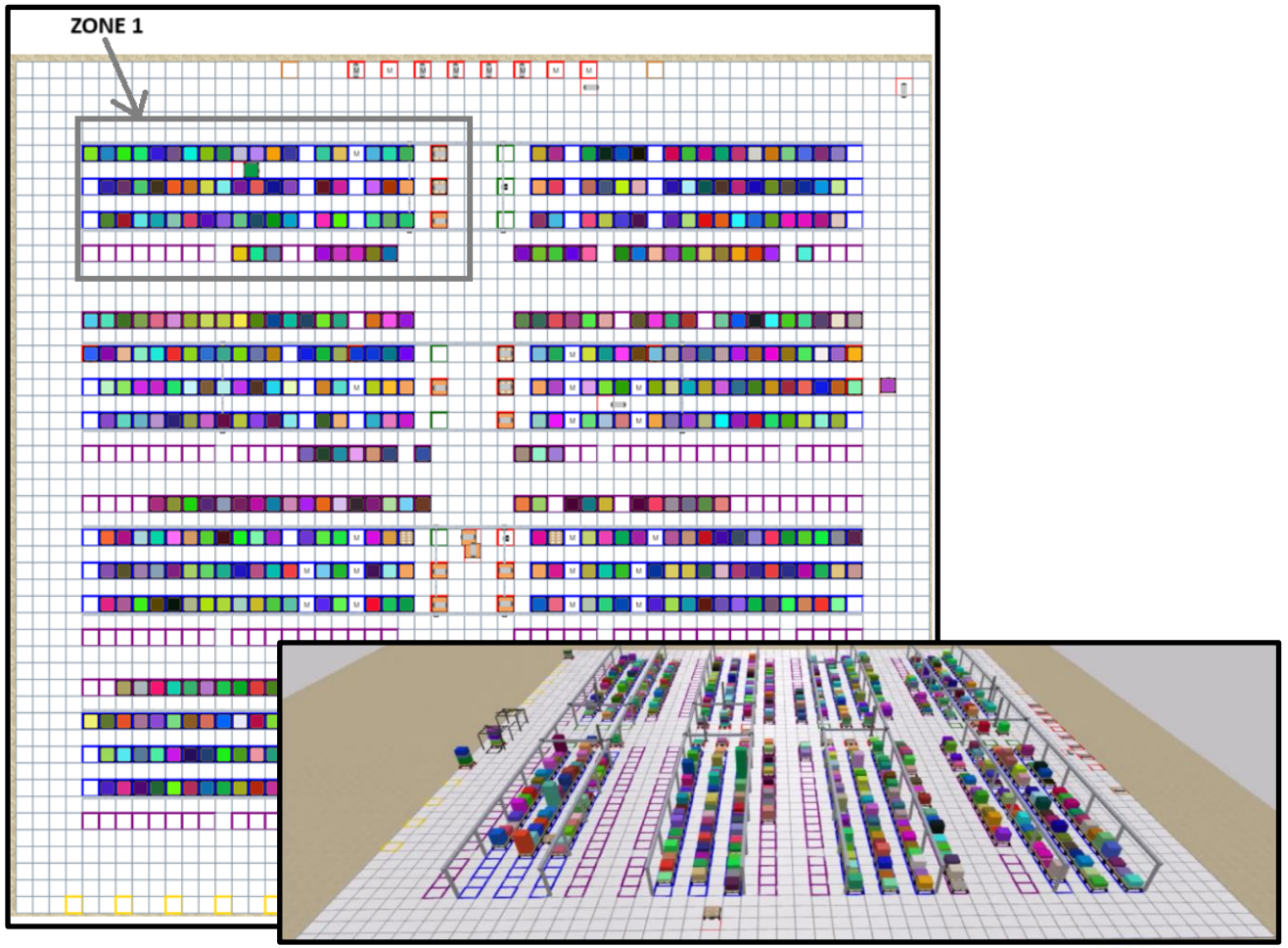
Automated Pallet Building Grid

- Automated grid
  - 53 X 49 cells
  - Cells organized into zones
- Autonomous Mobile Robots (AMRs) transport pallets
- Pallet cell stations
  - Empty Pallet Pickup/Dropoff
  - Intake
  - Wrap
  - Labeling
  - Outbound



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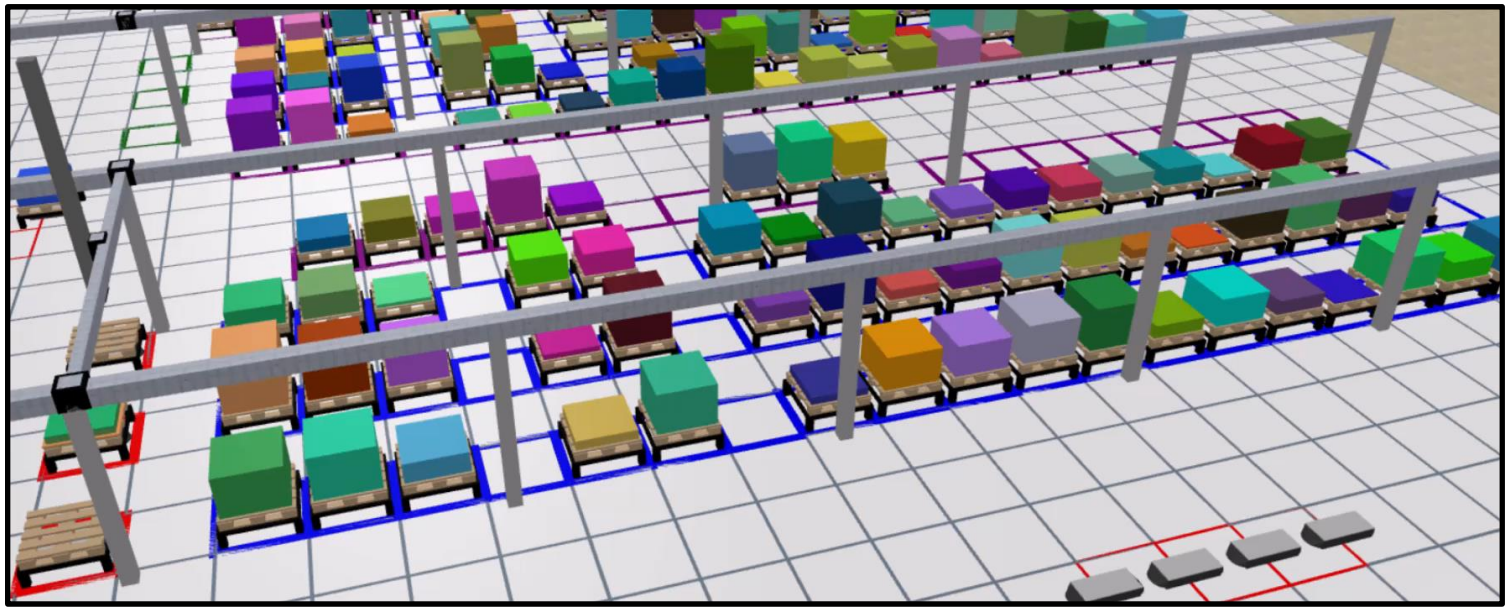
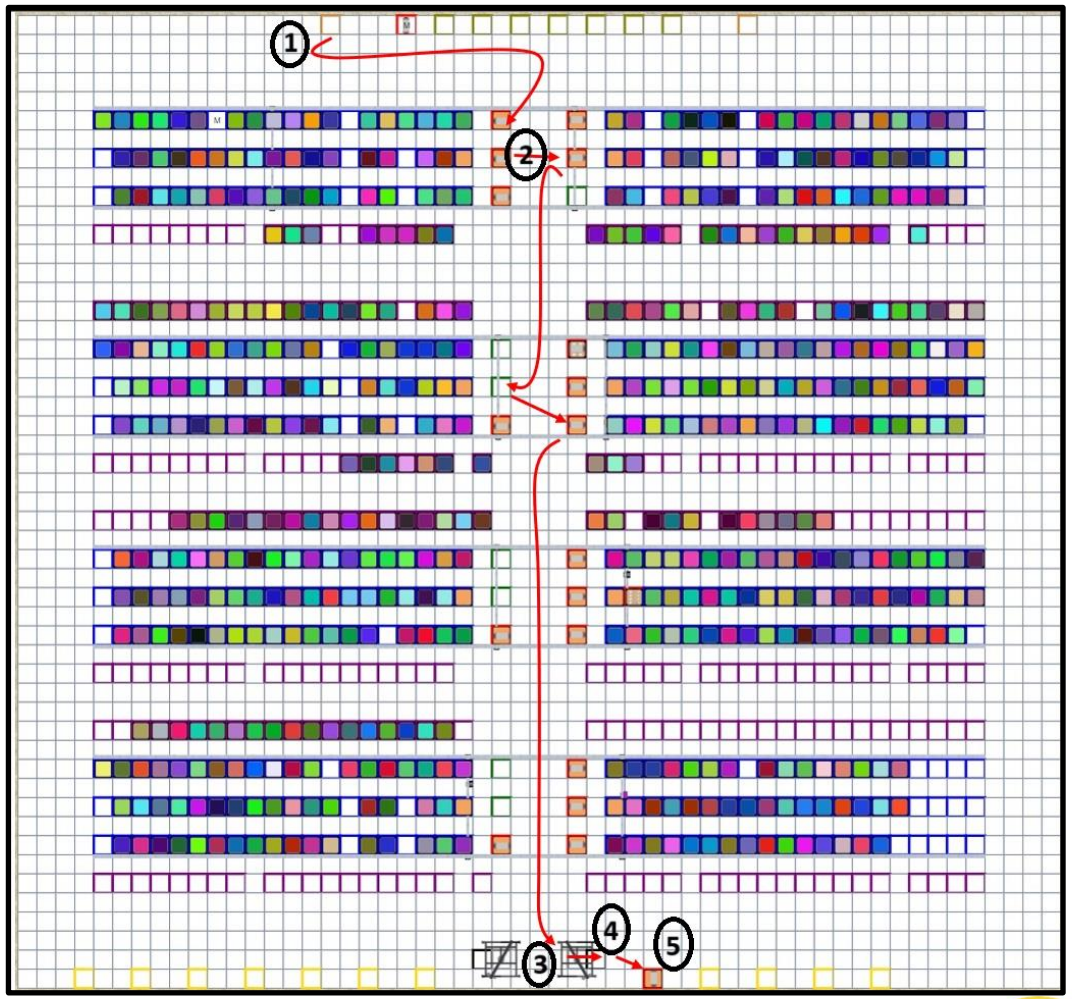
Automated Pallet Zone

- 8 Zones
- 1 suction surface crane head per zone
- One picked at a time
- 60 picking slots
- 40 staging slots
- 3 store pallet slots



Store Pallet Building Process

1. Retrieve empty pallet
2. Visit 1 or more zones
3. Plastic wrap
4. Label
5. Outbound (exit grid)



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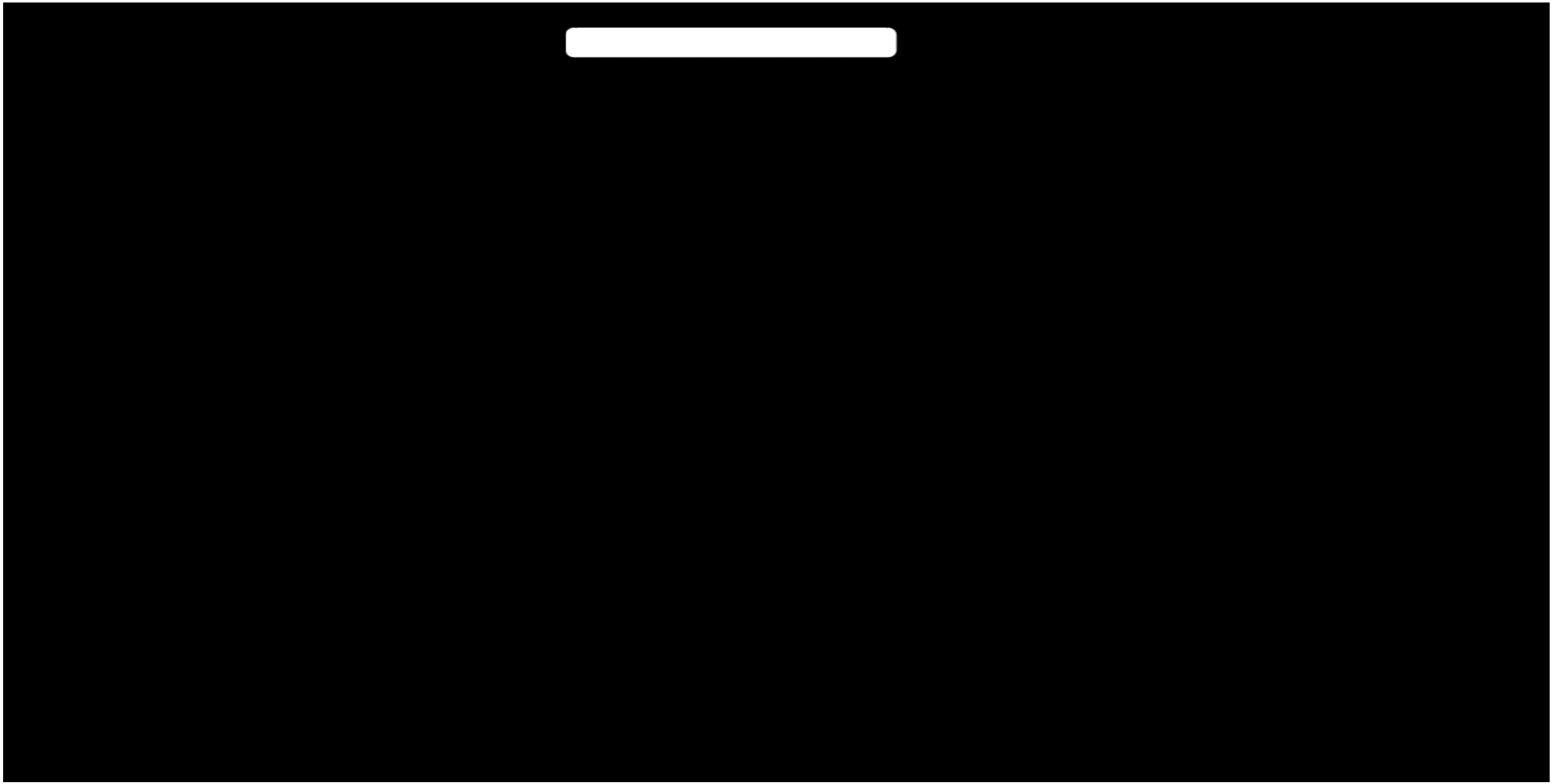

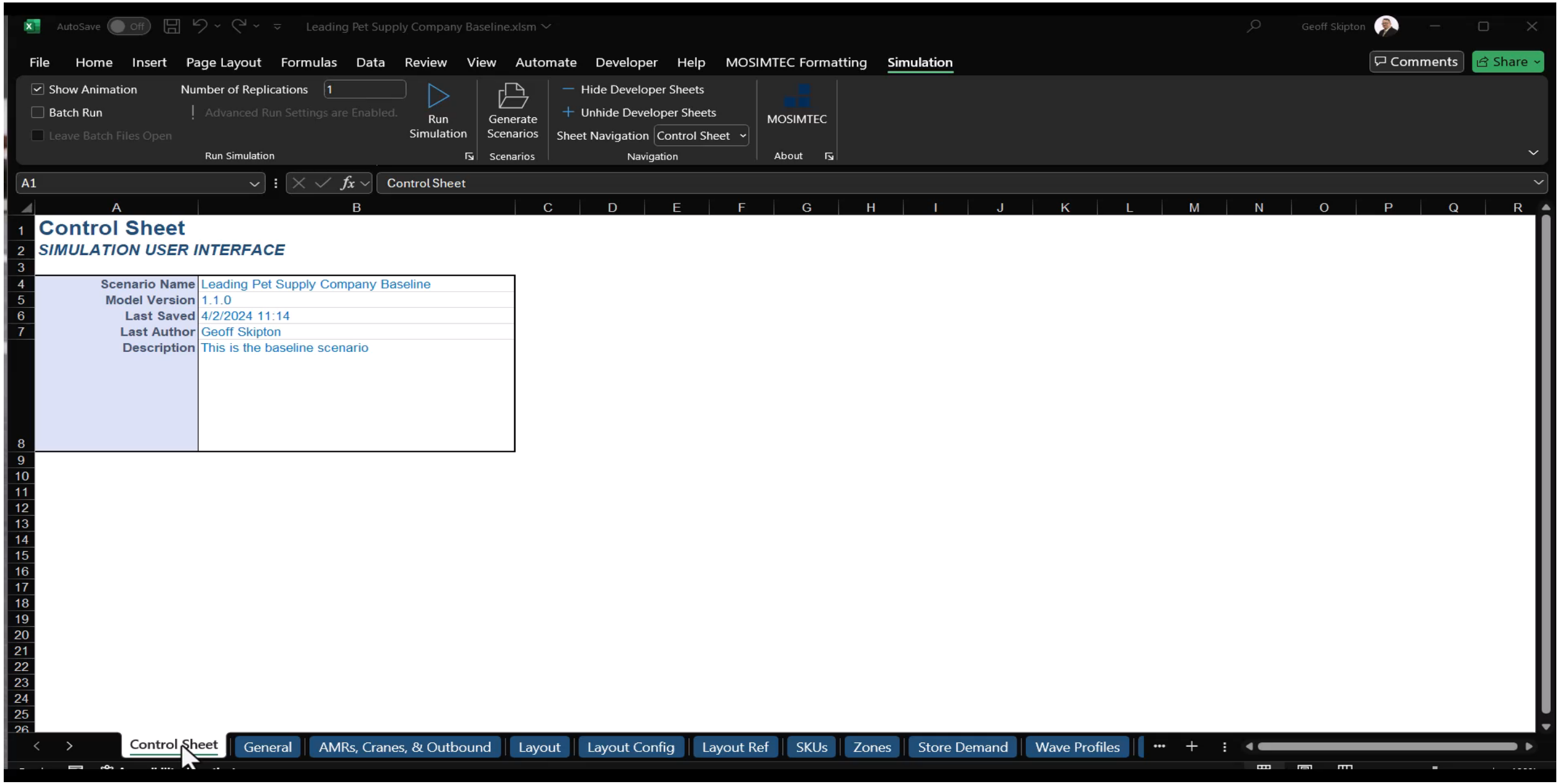

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DCS ANALYSIS

Analysis – Case 1 – High Level Targets

- Did we finish a day's worth of orders within the expected 20 hours?
- How utilized were the AMRs?
- How many bags were picked?
- How many store pallets created?

RUN PARAMETERS

	Minimum	Mean	Maximum	StdD	
Run Length	21.17	22.69	25.23	0.83	hours
Model Start to Last Outbound Dropoff	18.75	20.26	22.81	0.84	hours
First Pick to Last Pick	18.46	20.19	22.75		
Estimated Pallet Build Time Steady State	18.89	19.67	20.35		
Number of Replications			99		

Time to complete orders

AMRS (Averages Across Replications)

	Minimum	Mean	Maximum	StdD	
Utilization	51.8%	59.4%	67.3%		
Moving Percent	4.8%	5.3%	5.7%		
Blocked Percent (cannot go to next cell)	19.0%	21.7%	26.8%		
Assigned Percent (example: pallet building)	28.0%	32.4%	34.8%		
General Statistics					
Store Pallets Completed	10.62	11.06	11.44	0.17	Pallets
Manufacturer Pallets Moved	19.38	20.41	21.58	0.46	Pallets
Distance Traveled in Feet	23,769.65	24,851.39	25,854.27	440.69	Feet

AMR utilization base on 45 AMRs

STORE PALLETS (Averages Across Replications)

	Minimum	Mean	Maximum	StdD	
Pallets Completed per Hour Steady State	22.45	25.30	26.88	0.83	Pallets
Bags Completed per Hour Steady State	1,290.25	1,453.31	1,557.69	48.92	Bags
Pallets Completed	478.00	497.71	515.00	7.62	Pallets
Build Time	53.62	58.32	65.60	2.38	Minutes
Num Zones Visited	2.49	2.59	2.70	0.04	Zones

Pallets and bags processed

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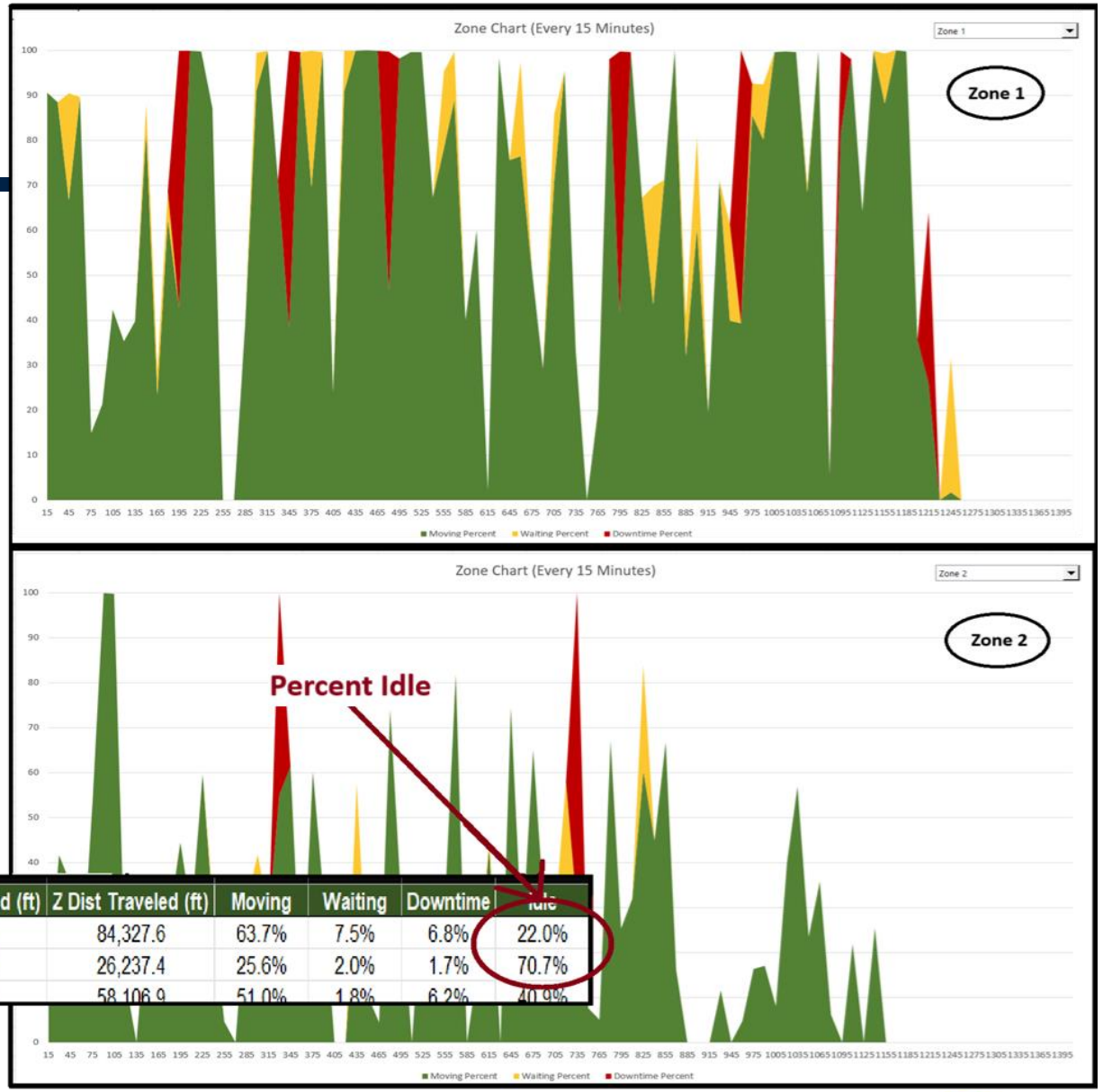
Analysis – Case 2
Zone Balancing

- SKU Balancing Between Zones
  - Change SKU zone assignments?
  - Balance high movers across zones?
  - Change store order waves?
  - Place high mover SKUs into multiple zones?



Zone	Store Build Cell Util	Swaps	Bags Picked	Store Pallets Processed	Manufacturer Pallets Emptied	XY Dist Traveled (ft)	Z Dist Traveled (ft)	Moving	Waiting	Downtime	Idle
1	55.3%	20	3,859	159	138	291,785.0	84,327.6	63.7%	7.5%	6.8%	22.0%
2	17.7%	11	1,350	94	30	131,029.0	26,237.4	25.6%	2.0%	1.7%	70.7%
3	56.7%	37	3,114	161	87	244,995.2	58,106.9	51.0%	1.8%	6.2%	40.9%

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Analysis – Case 3 – Crane Movements

- What SKUs are picked the most?
- Should SKUs be placed closer to the store pallets?
- Is the crane waiting for the SKUs to be replenished?

Brand	Orders with SKU	Pallets Emptied	Swaps	Total Bags Picked	Bags Picked Zone 1	Bags Picked Zone 2	Bags Picked Zone 3	Bags Picked Zone 4	Bags Picked Zone 5	Bags Picked Zone 6	Bags Picked Zone 7	Bags Picked Zone 8
Pallet Cardboard	0	0	0	480	159	23		84	59	72	36	11
PRO PLAN	26	8	0	203	203	0		0	0	0		
BIL-JAC	6	1	0	70	0	0		70	0	0		
BIL-JAC	5	0	0	24	0	0	0	24	0	0		
NATURE'S RECIPE	0	0	0	0	0	0	0	0	0	0	0	0
ROYAL CANIN VET	15	6	0	173	0	173	0	0	0	0	0	0
INSTINCT	1	0	0	3	0	0	0	0	0	0	0	0
INSTINCT	2	0	0									
INSTINCT	3	1	0									
NUTRISH	0	0	0									
FRESH STEP	24	4	0									
SIMPLY NOURISH	2	1	0									
SIMPLY NOURISH	2	0	2									
SIMPLY NOURISH	8	1	0									
SIMPLY NOURISH	19	4	0									
SIMPLY NOURISH	11	3	0									
SIMPLY NOURISH	4	1	0	28	0	0	0	0	0	28	0	0
SIMPLY NOURISH	2	0	0	6	0	0	0	0	0	6	0	0
SIMPLY NOURISH	3	1	0	25	0	0	0	0	0	25	0	0
SIMPLY NOURISH	0	0	0	0	0	0	0	0	0	0	0	0
Nutro	6	3	0	74	0	0	0	0	0	74	0	0
Nutro	1	0	0	6	0	0	0	0	0	6	0	0

How many bags picked

Feet Traveled

% of time waiting for SKU replenishment or swap

Zone	Store Build Cell Util	Swaps	Bags Picked	Store Pallets Processed	Manufacturer Pallets Emptied	XY Dist Traveled (ft)	Z Dist Traveled (ft)	Moving	Waiting	Downtime	Idle
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3	56.7%	37	3,114	161	87	244,995.2	58,106.9	51.0%	1.8%	6.2%	40.9%
4	86.4%	45	4,917	209	149	435,538.7	89,401.8	86.9%	2.8%	9.4%	0.9%
5	50.3%	19	3,236	170	94	257,726.1	60,216.6	53.5%	5.1%	6.0%	35.4%
6	68.4%	25	4,134	186	102	360,146.6	74,077.5	72.2%	4.4%	6.1%	17.4%
7	29.9%	25	3,057	151	60	254,992.4	58,763.7	52.2%	5.7%	6.1%	36.0%
8	29.5%	0	3,787	149	57	238,586.8	63,241.6	53.0%	2.2%	6.5%	38.2%

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Continuous Analysis – Production

- Model can test future changes to the facility
  - Remove or add zone(s)
  - Increase demand from stores
  - Changing profile of store SKU demand
- Can be used as part of operations
  - Preview expectations of store demand of an upcoming day, week, or month
  - Measure impact of the unforeseen
    - A long-term failure or maintenance, such a zone offline
    - Temporary reduction in forklifts or crew
    - Increased delay in manufacturer pallet retrieval

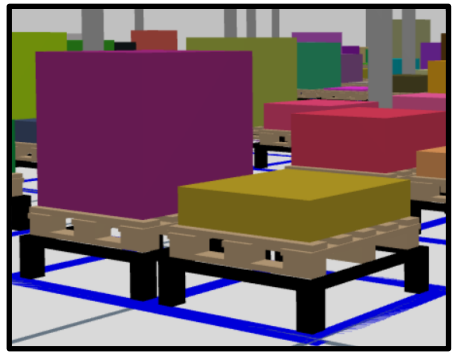
Take Aways

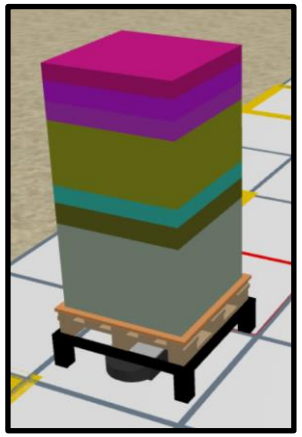
- Store pallets build within the expected time
- Original expected AMR counts may be able to be reduced
- Zones have excess capacity, can possibly reduce from 8 zones to 7
- Automated system can continue to operate while crew is on breaks
- Opportunities to continue to utilize model in production

DETAILED DESIGN APPROACH

Animation Speed

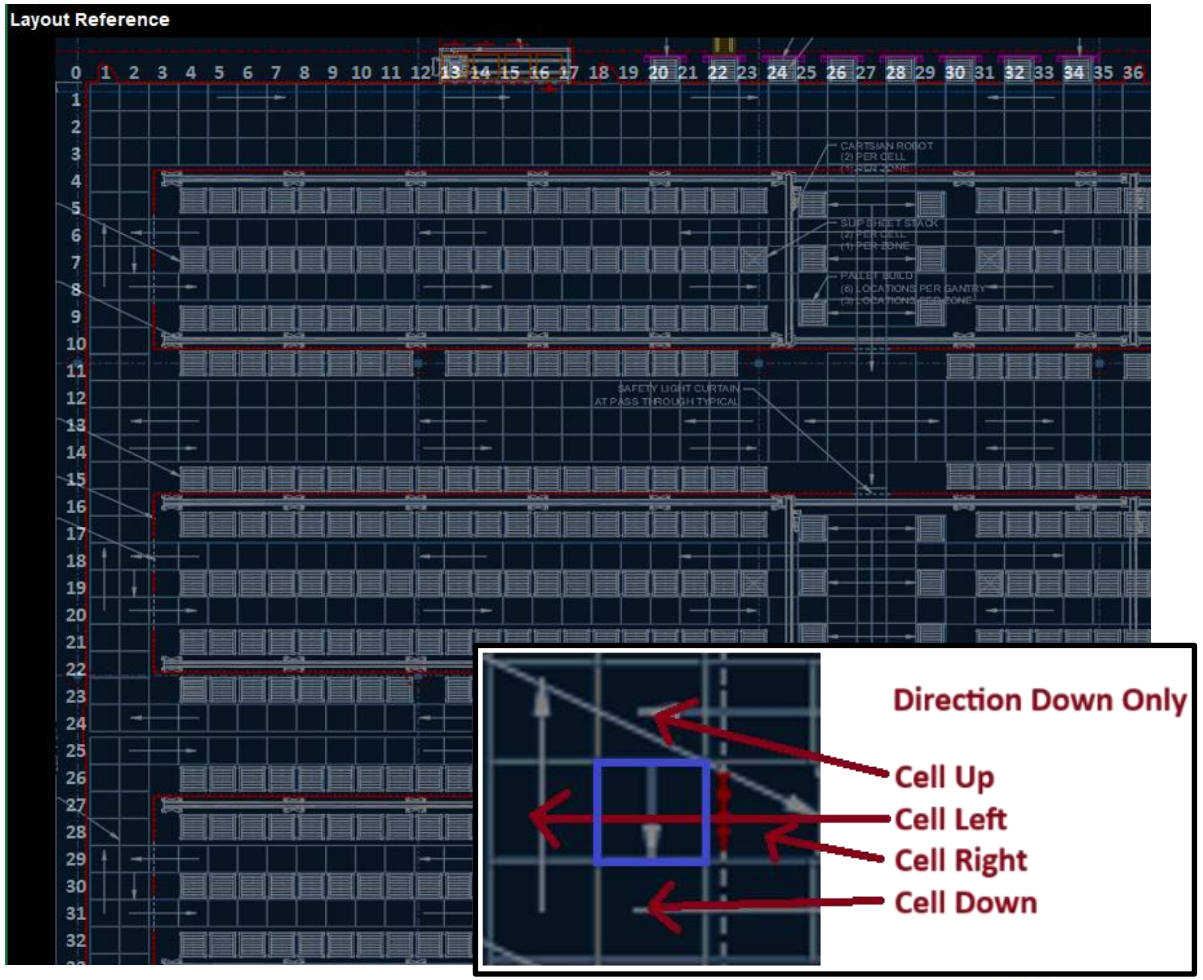
- Manufacturer Pallets
  - SKU represented by a single cube (6 polygons)
  - Color randomly samples – color maintained
- Store Pallets
  - One cube per SKU
  - Height based on volume % of pallet capacity
  - Color per SKU maintained from original color sample
  - Basically, a 3D stacked bar chart
- Zones
  - Crane/Zone represented by basic shapes





AMR Routing (A to B)

- Route Generation Algorithm
  - Columns/Rows single direction
  - Cells aware of adjacent cells
  - Cells have limited travel directions
- Cache routes (A to B)



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Questions to Answer

- Does the expected daily demand complete within a day?
- Are the zones load balanced (SKUs distributed evenly)?
- What is the impact of SKU placement in zones (high volume SKUs placed closer to the store pallets)?
- What is the impact of crane failures (dropped bags)?
- What is the impact of inbound/outbound crew breaks?
- What is the AMR count needed and what is their utilization?