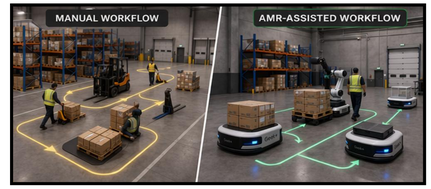
Ira A. Fulton Schools of Engineering

Arizona State University

SteelCase Regional Distribution Center AMR Integration Study – Spring 2026

Kimberly Shaugnessy, Jonathan Salazar, Andrew Jeraige, Matthew Bodziak

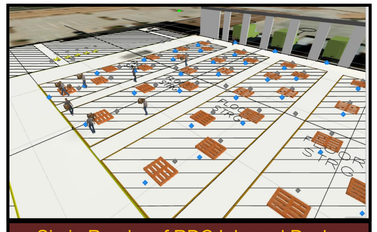


Project overview

- Collaboration with Steelcase, aims to optimize operation efficiency design within the company's Regional Distribution Centers (RDCs).
- Focuses on evaluating the integration of Autonomous Mobile Robots (AMRs) in warehouse operations to improve workflow.
- Steelcase operates 11 Distribution centers across NA. Warehouse Management and bulk packaging strategies, necessitate a data-driven redesign of workflows and facility layouts.
- Team developed a data-driven digital twin approach to simulate and analyze workflows
- Constructed a 3D model of the facility , gathered layout processes and AMR data for the simulation. Integrated real operational data, modeling receiving, staging, and shipping processes.
- Project aligns with EC2000 Criterion 4 promoting ethical, sustainable, and safe engineering practices, reducing labor strain, and supporting system-level design
- The digital twin will ultimately provide Steelcase with data-driven recommendations for modernizing its RDC operations.
- Their teams will use it to evaluate options, model process flows, and verify automation strategies before implementation. Allowing them to improve workflow designs with minimal cost and informed operational decisions.

Analysis

- SteelCase warehouse operations rely on manual workers for receiving shipments, unloading, and moving items
- The Arizona facility employs 15 to 20 workers who operate forklifts and pallet jacks, making hundreds of trips each day.
- Test if implementation of AMRs could improve the RDC facility's efficiency enough to justify their acquisition - adding them along workforce or modifying floor plan to create a workflow centered around their use.
- AMRs can carry heavier loads per trip than a worker but travel at a slower speed - encourage a flow that maximizes the value of each trip, mobbing max cargo each trip
- Digital twin will allow testing of layouts and integration without physical investment and implementation.
- Improvements will lower operating costs and increase throughput efficiency
- Current focus on single RDC location. After initial testing at this location, verified improvements can be deployed to all other locations continent-wide



Simio Render of RDC Inbound Docks

Evaluation

28,028 Inbound HUs scanned ~2,800 per day avg

26,798 Outbound HUs scanned ~2,680 per day avg

64.8 hrs Avg unit dwell time Median: 46.8 hrs

67.5% Units to single destination Predictable AMR routing

INBOUND FLOW DISTRIBUTION — 2 WEEKS OF DATA

OPP **High volume predictable routing** 67.5% of HUs share one destination. Ideal for AMR deployment on defined, repetitive paths.

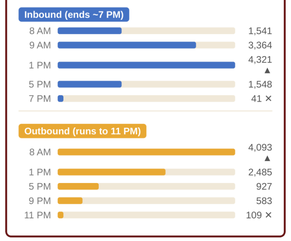
GAP **Outbound extends to midnight** Inbound ends at 7 PM while outbound runs to 11 PM or later, indicating a downstream constraint AMRs can alleviate.

GAP **Excess dwell time** Units averaging 65 hrs on floor (max 265 hrs) signal retrieval delays addressable with on demand robotic picking.

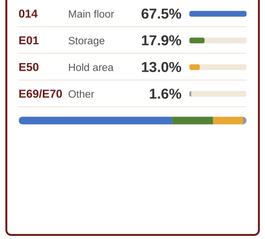
KEY INSIGHTS

- ✅ **68% ships directly to outbound** — flow through operation, minimal storage needed
- 🕐 **18% stored, 13% on hold** — early freight creates congestion in hold zones
- ⚠️ **Low buffering increases speed** but reduces flexibility when outbound timing shifts
- 🚛 **Performance sensitive** to outbound capacity and trailer timing alignment
- 🤖 **Predictable routing = AMR opportunity** — 68% on one path, ideal for Agilox automation

SCAN ACTIVITY BY HOUR OF DAY



INBOUND ROUTING



DWELL TIME SUMMARY

Average	64.8 hrs
Median	46.8 hrs
25th percentile	21.7 hrs
75th percentile	97.7 hrs
Max observed	265 hrs

SYSTEM FLOW — HOW UNITS MOVE THROUGH THE RDC

ENGINEERING EVALUATION

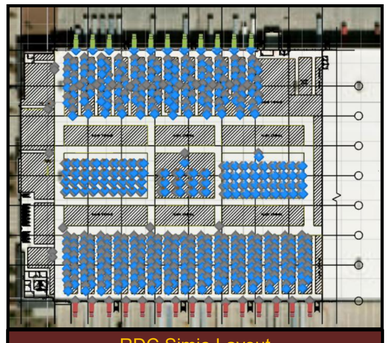
⚙️ **High Throughput** Efficient flow through with minimal storage reliance. Approximately 2,800 units processed daily.

⚠️ **Potential Bottleneck** Outbound congestion and timing mismatch drive hold usage and extend shifts to midnight.

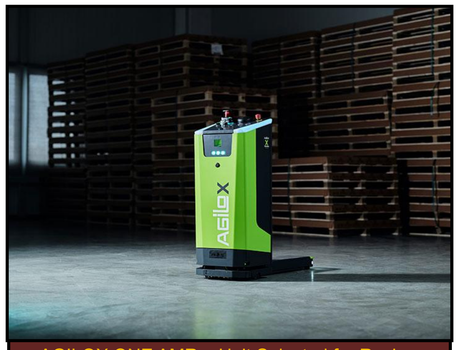
🤖 **AMR Validation** Simio model confirms Agilox pallet AMRs can handle 68% of routing autonomously.

Results

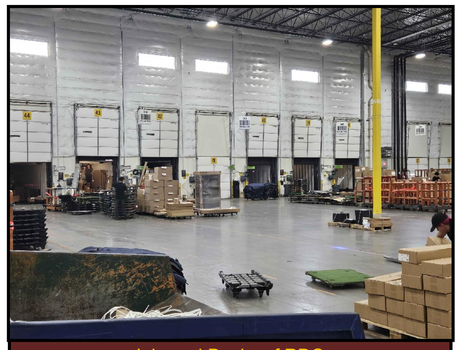
- Developed simulation scenarios for manual vs. AMR-assisted workflows
- Tested system performance under various routing strategies and load conditions
- Evaluated key metrics including:
  - Throughput
  - Cycle time
  - Travel distance
- Validated model behavior using real operational data inputs
- Results & Key Findings: AMR-assisted workflows showed reduced travel distance compared to manual operations Identified bottlenecks in staging and holding areas
- Improved material flow efficiency through optimized routing Simulation enabled clear comparison between system configurations Digital twin provided data-driven insight for decision-making



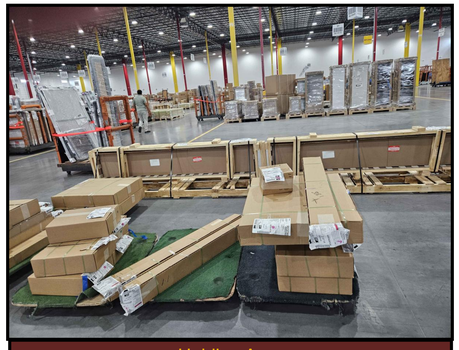
RDC Simio Layout



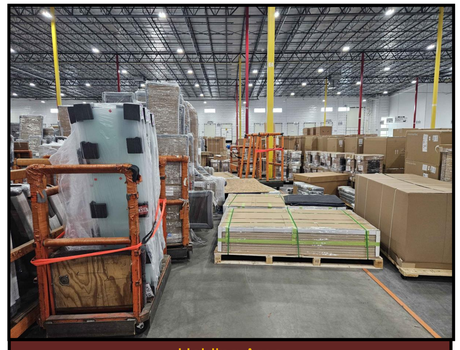
AGILOX ONE AMR – Unit Selected for Review



Inbound Docks of RDC



Holding Area



Holding Area

Manual Transport Carts