NC STATE UNIVERSITY Industry Expansion Solutions

NC State University
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We Can Help.

Understanding Mobile Robots…

Are they a good choice for your operations?

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Senior Manufacturing Engineering Specialist

Contributing Roles

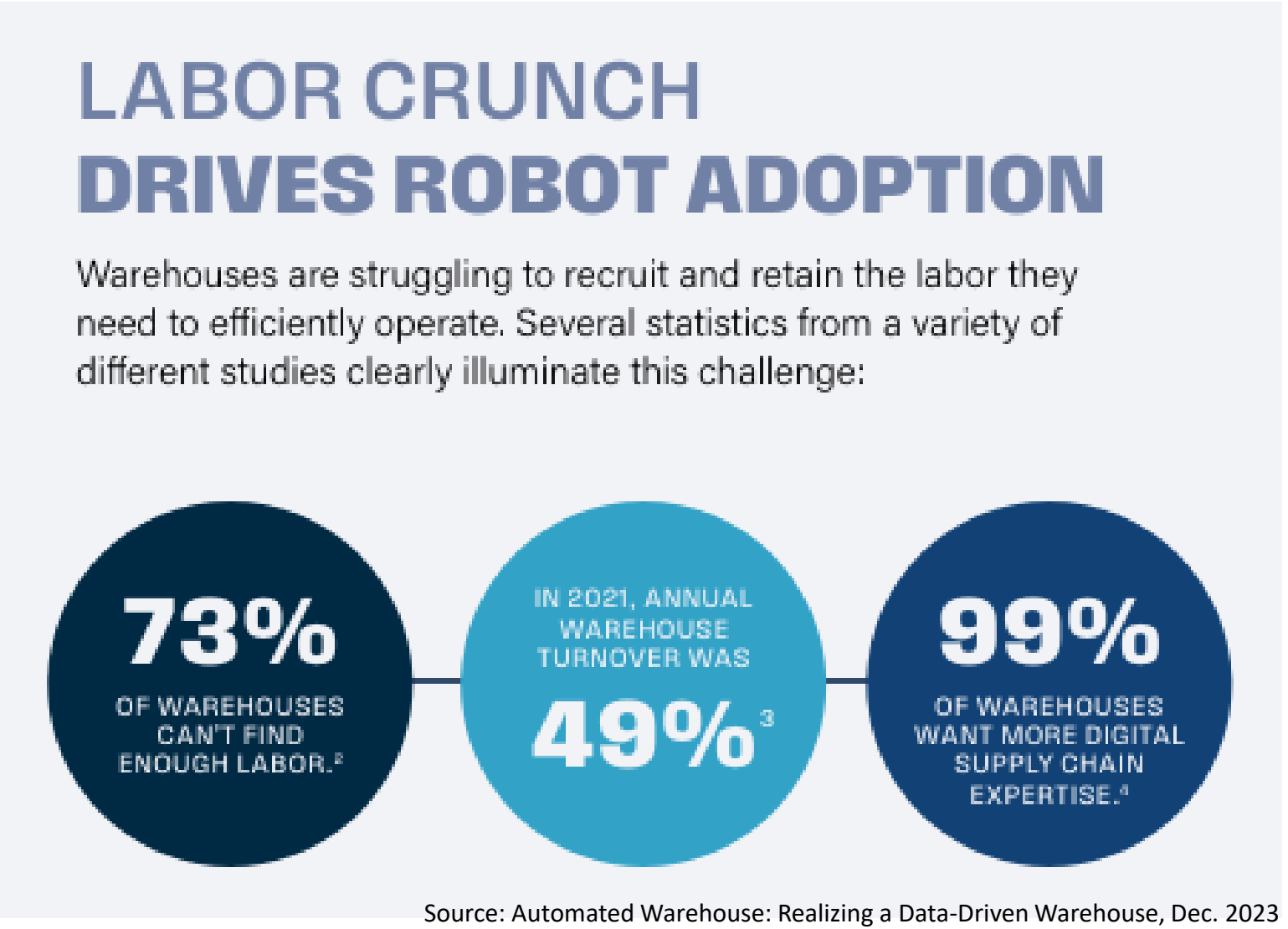
Assist manufacturing industry clients with the implementation of Industry 4.0 technologies

- Trusted advisor
- Provide training
- Serve as the SME for IES's initiatives in:
  - Automation
  - Robotics
  - Additive Manufacturing
  - …& other areas, such as AR and VR, and Analytics

Webinar Agenda

- What are Guided Vehicles
- Some Baselines
- The Field of Applications
- Where we're headed
- Support for you and your organization
- Time for Q&A

A Reality



Source: Automated Warehouse: Realizing a Data-Driven Warehouse, Dec. 2023

What brings you here?

Automation as a starting point

- What's driving your decision to automate?
- Do you have well-defined and documented processes?
- Do you know what requirements you'll be seeking?
- Do you know who could possibly do this work internally?

A good thing to remember throughout our discussion today is that automation adoption is a journey that should be considered in pieces.

Free Range Robots??

[ECU Food Delivery Robots]

Let's get our thoughts aligned…

What is a "Mobile Robot"?

"An automatic machine that is capable of locomotion"

IEEE Transactions on Vehicular Technology Safety

Further qualification…

- **Self-guided**
- **No human interaction oversight needed**
- **Useful…**
- **Deliver product/parts**
- **Can do what a human may not be able to do**
- **Always available**

When I think of an AMR…

Vola's journey with AMRs

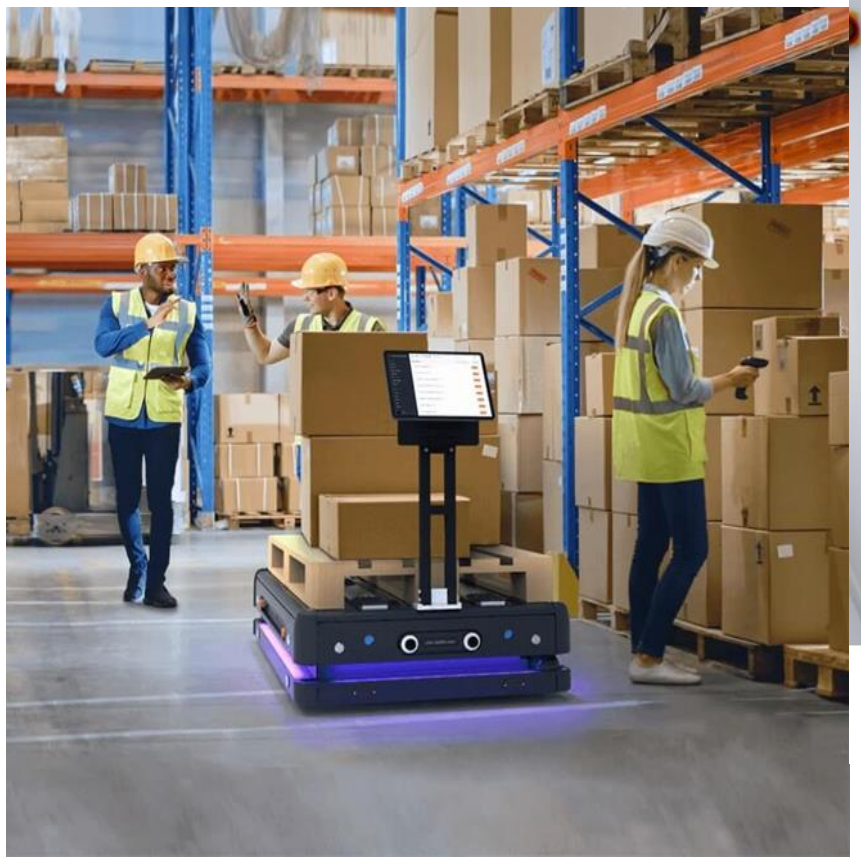
Reflecting on the video…

Let's think of the *classic* attributes of automation…

What do we want Automation to do for us?

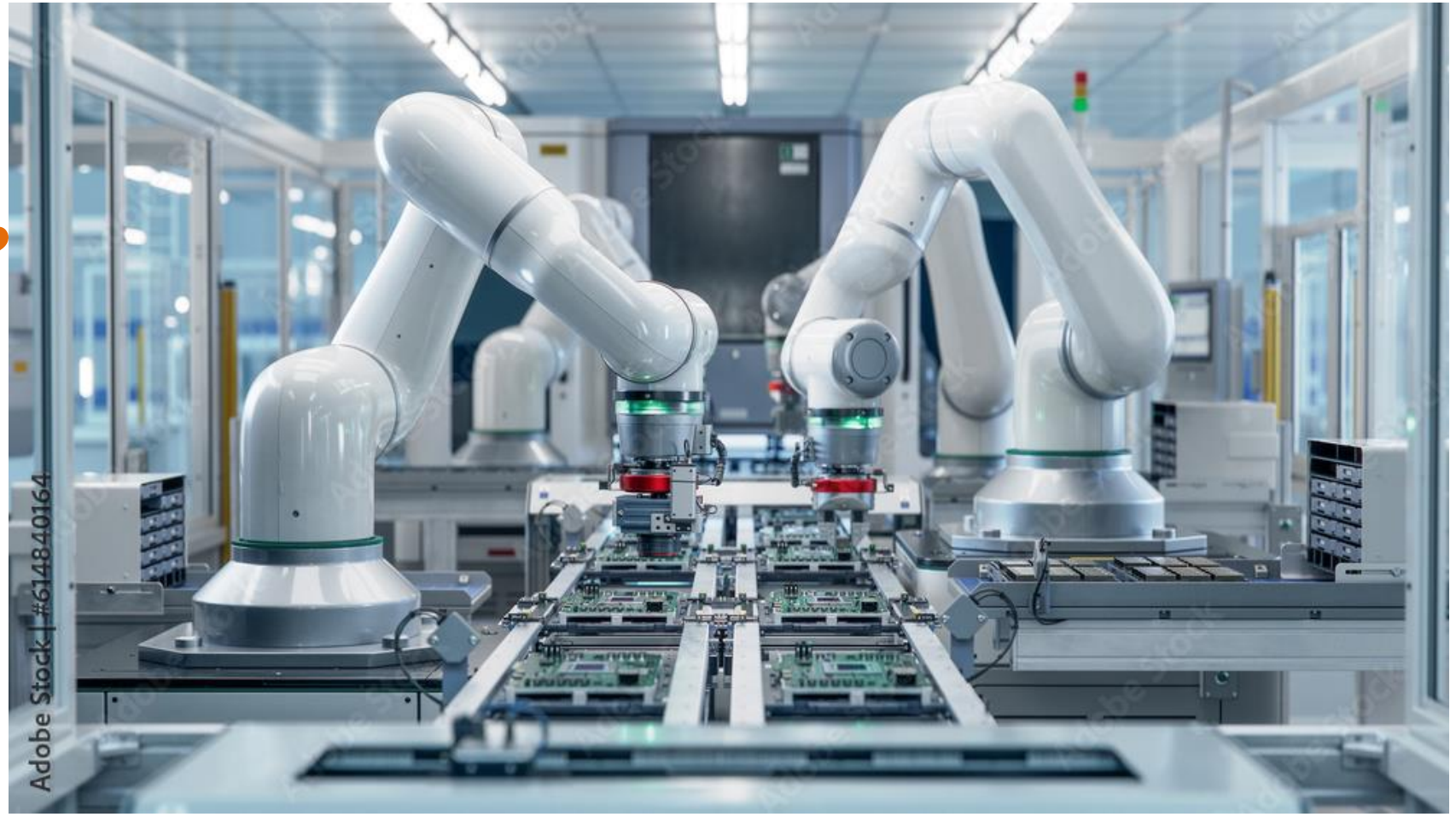
- Increase our efficiency
- Reduce lead times
- React quickly to changes in demand
- Better flow
- Production flexibility – no fixed material movers like conveyor systems
- Remove the physical burdens placed on humans
- Healthy, happy workers

Where We're Going to Focus our Discussion Today…



What We're Not Going to Focus on…

Industrial Robots



What We're Not Going to Focus on…

Service Robots

Source: Kiwibot

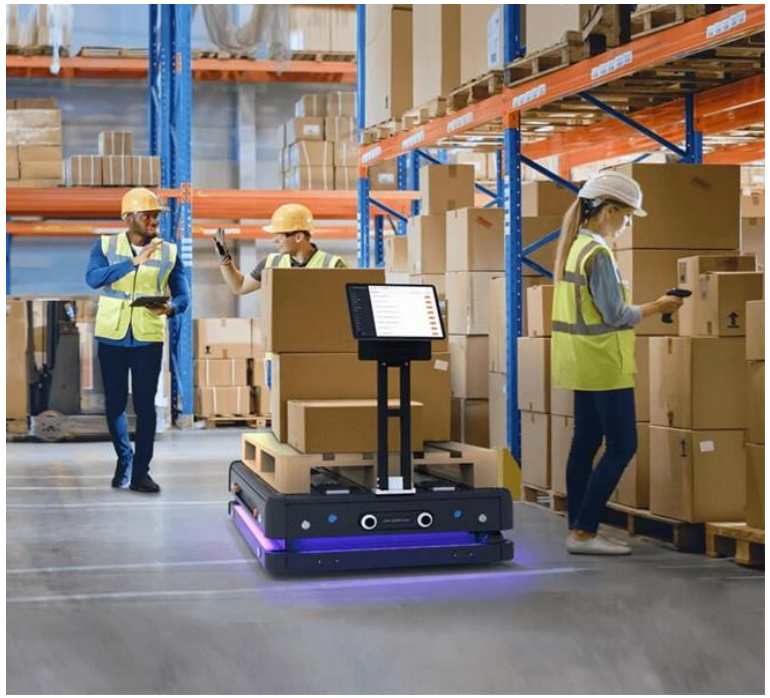
Autonomous Mobile Robots

The ANSI/RIA 15.08-1-2020 Standard treats three different types of mobile devices

- Industrial Mobile Robots (**IMR**s)
- Autonomous Mobile Robots (**AMR**s)
  - One that can navigate using obstacle avoidance and utilizes trajectory planning **instead of** following a defined path (e.g. tape on the shop floor), which is the case of an AGV
- Automated Guided Vehicles (**AGV**s)

IMR Types

Type **A**



Type **B**

Type **C**

AMR Distinctions

- Type **A** – a mobile device itself… basically not upfitted with any accessories
  - Think of a tugger or a device where items are placed on top for transport/material handling
- Type **B** – add racks, automation, lifts, but NOT a robotic arm
- Type **C** – …adds a robotic arm (*typically what is referred to as an **IMR***)

Which can address my needs?

It could be several!

What hat do you wear?

Am I the **Warehouse Logistics Manager** who is looking to…

- Overcome a worker shortage/labor hiccups.
- Create efficiencies in flows
- Reduce staging errors
- Enhance safety

Which can address my needs?

OR…

Am I the **Process Engineer** who is looking to…

- Fully automate a process that is:
  - Too dangerous for humans (e.g. work in prox. with other automation)
  - Very repetitive
- Dynamically balance lines

Which can address my needs?

OR…

Am I the **Inventory Specialist** who is looking to…

- Control locations
- Validate stock
- Reduce floor kanbans
- Move inventory to point of use in the quickest, most efficient manner possible

Let's Dive In!

AGVs

AGVs … An emphasis on GUIDANCE

Guided by…

- Magnetic Tape
- Embedded Floor Wiring
- Transpondence
- Vision
- GPS
- Network
- LiDAR

Simple, Preprogrammed Decision-makers

AGVs … Where I started…

>$80K

Vs.

<$8K

A Smart Cart

A Simple, Yet Versatile AGV

AGVs … Fast-forward

- Requires no infrastructure – No IT involvement
- Self-guided, autonomous operation
- Avoids obstacles
- Economical
- Little training needed for operation
- No complex maps to generate
- Simple programming — Push the cart anywhere, press a location button for 6 seconds and a destination is set.

A Smarter Cart

A Smarter Cart

Beyond "Smart Carts"…

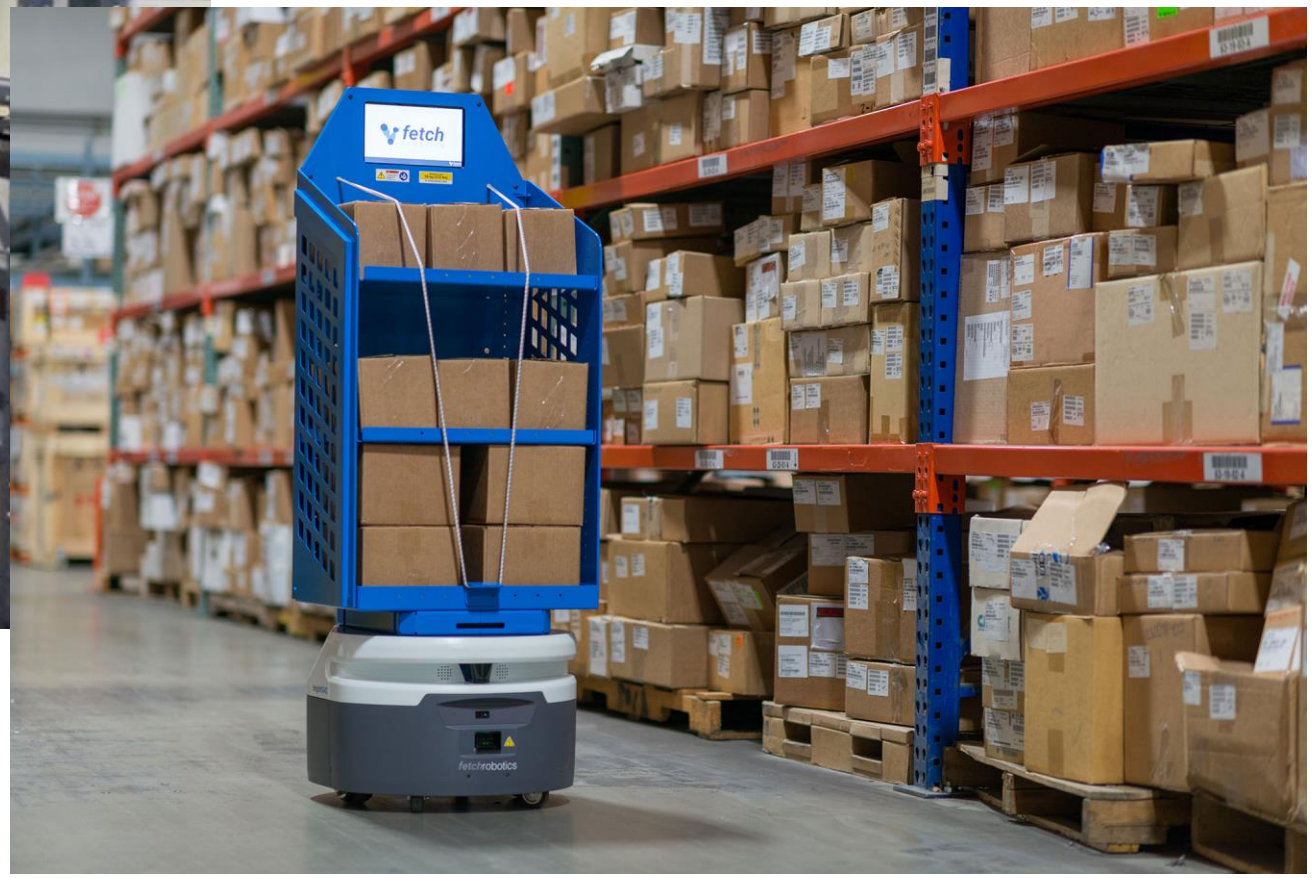
The Field of Applications for Today's Challenges

- Service
- Intra-workstation transfer
- Product picking
- Warehouse logistics

Intra-workstation Transfer – Open Shuttle AMRs

Fully Automated Assembly Cells with AMRs

Product Picking



Let's look closer at Warehouse ops…

Warehouse Logistics

Type B & C AMRs

Automated Assembly with mixed AMRs

Type C AMR

[Automated Loading and Unloading with Type C AMRs]

What about…??

- Forklifts, Stackers, Pickers
  - Are these considered a type of AMR?

By definition, NO...

but manufacturers are making them autonomous, just like our AMR classes, as they perform similar functions, share similar controls and fleet management software

They too can talk to each other for safety and mission priorities

Autonomous Pallet Jack

Smart Pallet Jacks

Which is "right" for your operations?

Of no surprise…

The answer should be driven by need

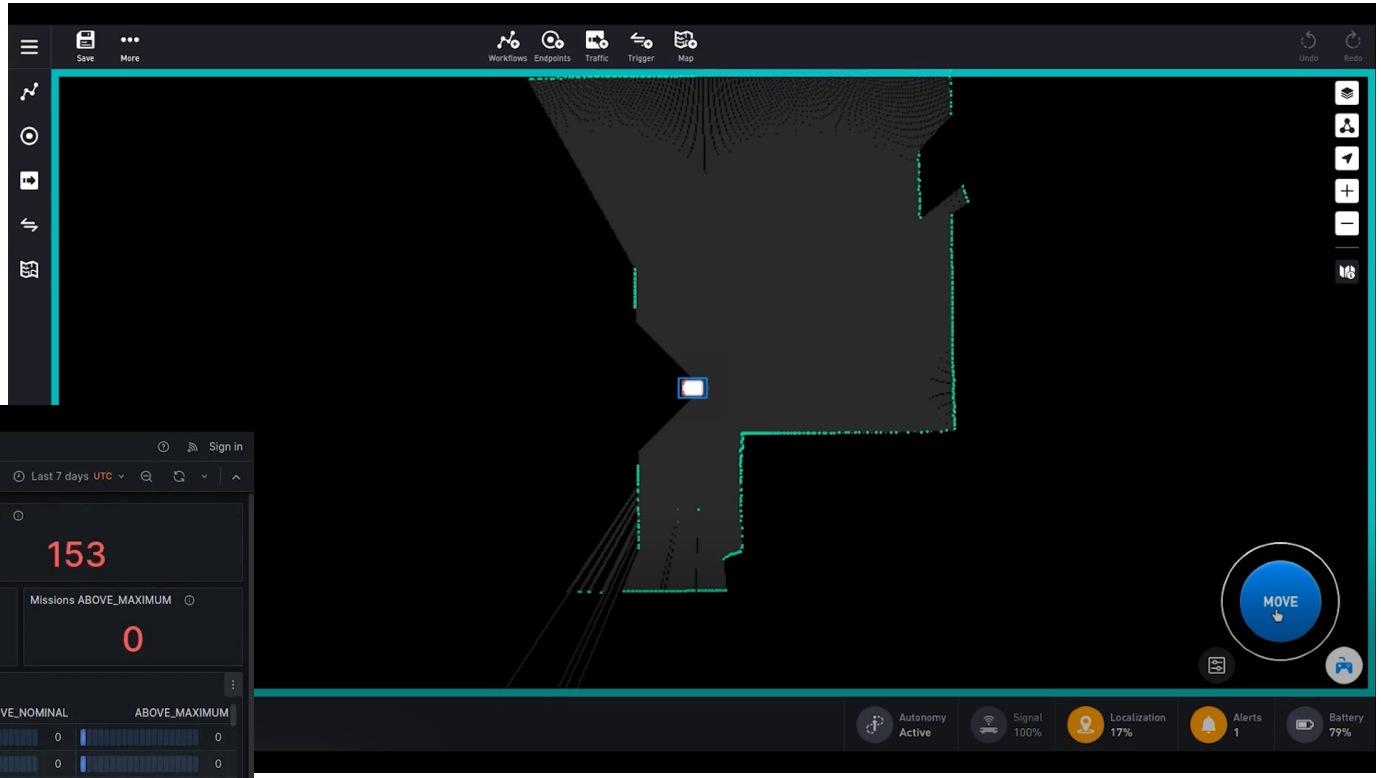
What about the software used to program these systems?

- Typically termed "*Fleet Control*" or "Fleet Operations"
  - Assuring smooth & safe operation
  - Maximize material movement efficiencies
- *High level job assignments based on master schedules*
  - *Yes, they tie in with WMS, ERP and MES platforms!*
- More than just a traffic controller
  - Mapping Tools
    - Decision logic can be assigned to different areas of the plant
- Real-time Battery Health/Charging
- Real-time Tracking
  - Device Notifications

Looking at what the AMR is being tasked to do

Source: https://ottomotors.com/fleet-manager/

Software Demo



Source: https://ottomotors.com/fleet-manager/

Circling back to what brought you here…

You may have more questions than answers, and that is <u>GOOD</u>!

Being informed leads to wise decisions

&

Going slow, or at least taking things in stages, often wins the race!

Automation adoption is a journey that should be considered in pieces. The possibility of things going wrong when information is lacking (benefits of simulation!) and adoption without practice can be costly and antithetical to true progress!

Maybe we should reconsider the humanoid idea…

[Are We Ready for Humanoid Robots in Mfg?]

At least for now…

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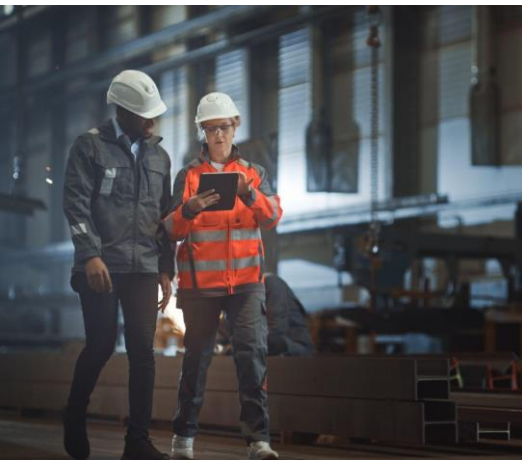

Industry Expansion Solutions Expertise

- › Advanced Manufacturing + Technology Adoption
- › Business Growth, Innovation + Marketing Solutions
- › Cybersecurity Strategies
- › Defense Industry Initiatives
- › Energy + Environmental Solutions
- › Grant Evaluation + Research
- › Instructional Design Services
- › Leadership + Organizational Coaching
- › Process Optimization + Training Within Industry
- › Quality + Management Systems
- › Supply Chain Optimization + Supplier Matching
- › Workplace Health + Safety

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We Can Help.

Key Extension Programs

NCMEP
North Carolina
Manufacturing Extension Partnership

› NIST Funded Center for Statewide Manufacturing Support

OSHA Training Institute Education Centers®
Southeastern OTI Education Center

› Professional Learning - OSHA Training Institute Education Center

DEFENSE INDUSTRY INITIATIVES

› NC Defense Manufacturing Community Support Program

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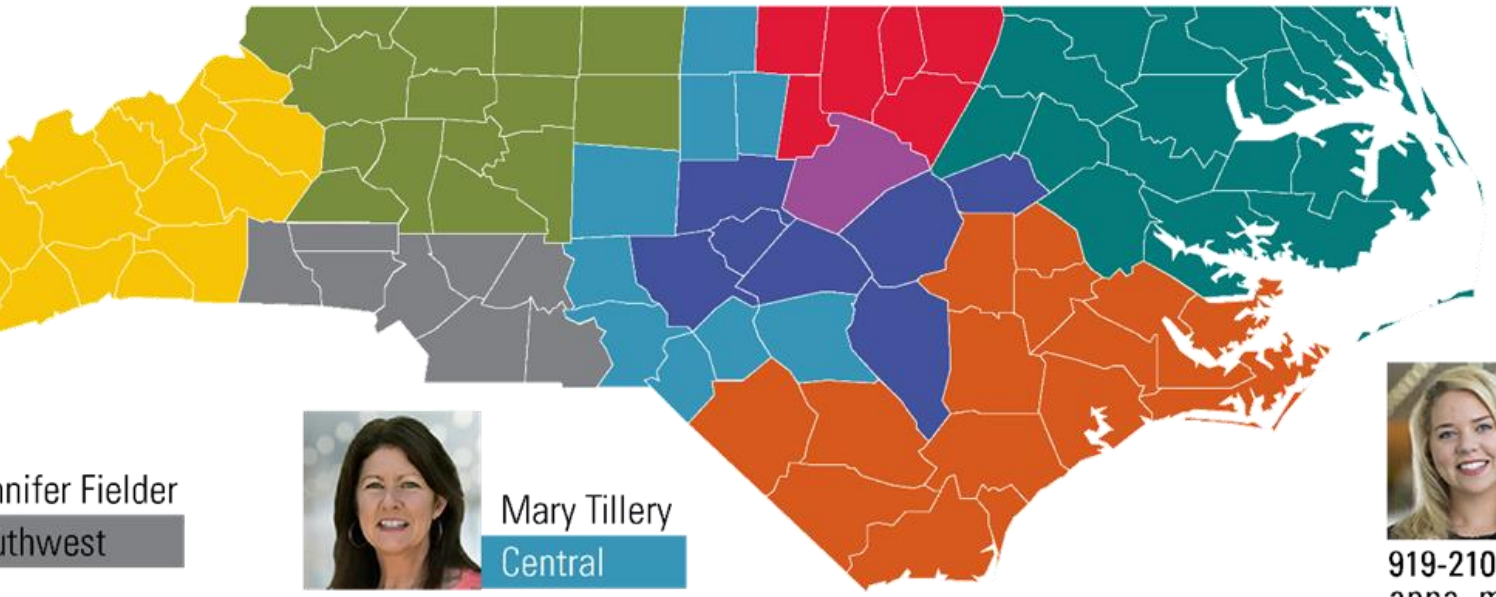
Regional Managers



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