Smart Factory

The Future of Manufacturing Process

Lean & Industry 4.0 – Journey to Operational Excellence

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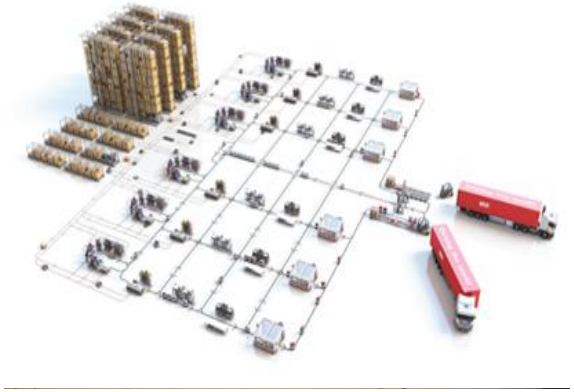
Journey to Operational Excellence

Assembly lines really long (25mt) and not flexible

2007 – Lean Deployment



2018 – Smart Factory

Optimization of the entire Value-Added-Chain

With the definition **“Added Value”** we mean all the activities that give a benefit to the customer. We can say that it is “all the customer pay for”.

Customer

Customer

The organization has to improve all the Added Value activity and eliminate/reduce the wastes.

How and with which tools lean is implemented in Solaro (Mi)

- Quickly and flexible reaction to the market requests → **One Piece Flow**
- Production based on the real needs of the customers and not with forecasts → **PULL**
- Easy scheduling and control of the production → **Kanban**
- Ergonomics and reduction of the movement of the operators → **U-shape cells**

Intra-logistics evolution

- Labor (Flexibility)

- Conveyors (Efficiency)

- Automated Guided Vehicles AGVs (Safety)

- AMRs (new technological method of material transport)

Natural Feature Navigation

- Self-navigating operation with NO facility modifications
- Automatically avoids people and obstacles
- Real-time scanning LIDAR localization sensor
- Acuity™ overhead lighting localization
- On board navigation controls via a digital map.

Natural Feature Navigation

Natural Feature Navigation

Passive Localization

- Indirect measurement of the robot configuration (position – rotation)
- Errors due:
  - Wheel sleep
  - Uncertainty of geometrical parameters
  - Numerical integration

Active Localization

- Main laser to “watch” the environment
- map owned by the robot (teaching)
- Comparison between the estimated position and the actual position (SLAM algorithm)

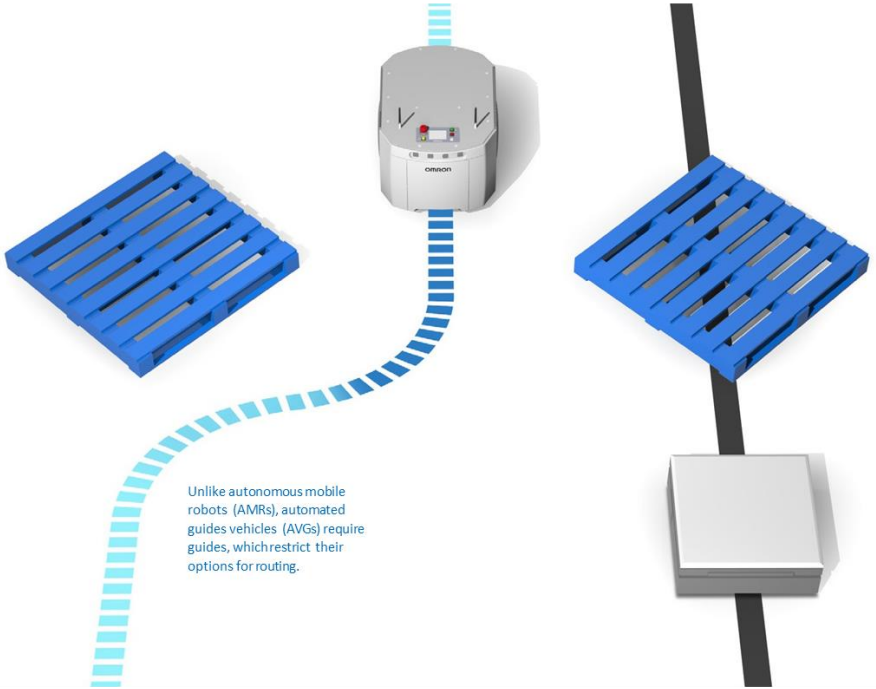
AMRs vs. AGVs

The difference is flexibility

Automated guided vehicles (AGVs) require a predefined path to follow, either a network of magnetic lines on the floor or beacons on the walls. So although AGVs allow modifications to production lines, facilities will need to install new equipment every time the AGV path is changed, leading to downtime and extra costs.

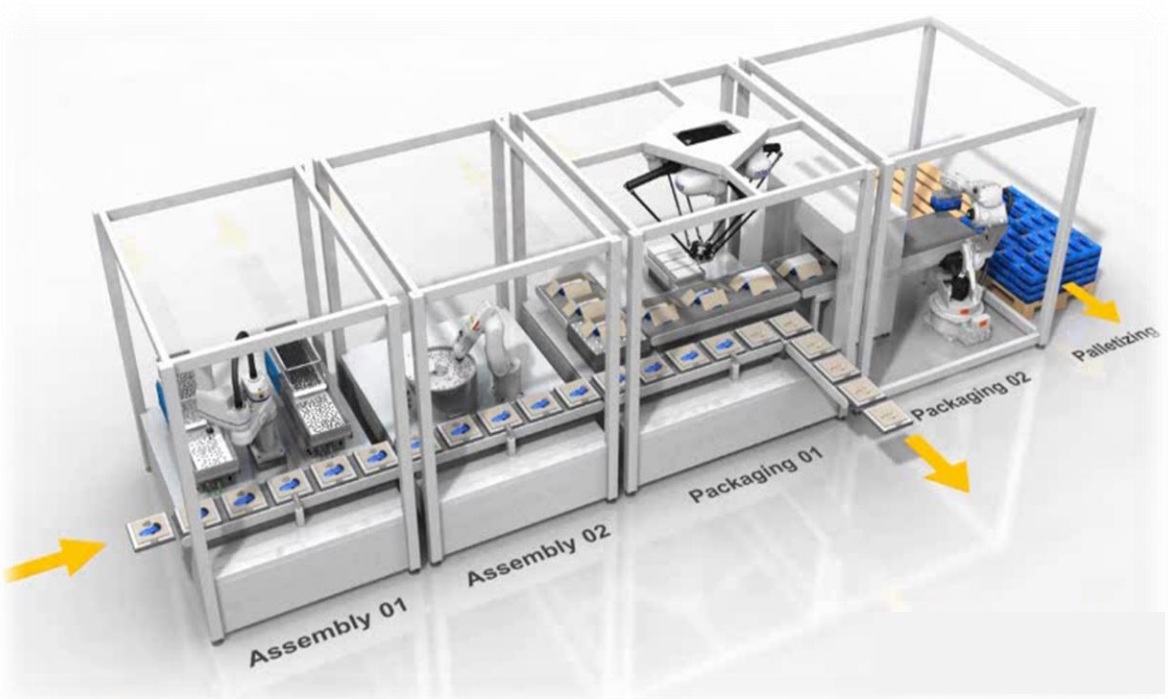
Automated Mobile Robots (AMRs) can safely navigate without the use of floor magnets or wall-mounted beacons. An AMR will first create a baseline map of a facility using built-in sensors, then will constantly detect its surroundings. When processes change, AMRs can easily change as well, creating networks of new routes or being reassigned to new tasks.

	OMRON AMR	AGV
Set Up	Ready to go after simple mapping	Requires navigation guides
Navigation	Navigates autonomously and **safely** without physical guides	Needs guides, such as floor magnets or beacons
Obstacles	**Safely** avoids obstacles without stopping	Stops at obstacles and remains still until obstacles are removed
Map Change	Easy	Factory modifications
Changing Destinations	Easy	Factory modifications
Scalability	Easy	Factory modifications



Lean Manufacturing: 8 deadly wastes

1. No errors – computer driven task list with traceable actions
2. Small-lot inventory (WIP & FGI) movement automated material flow optimized movement of WIP from cell to cell
3. Labour redeployment to high value-add tasks
4. "Necessary" movement performed by robot
5. No walking or manual material handling

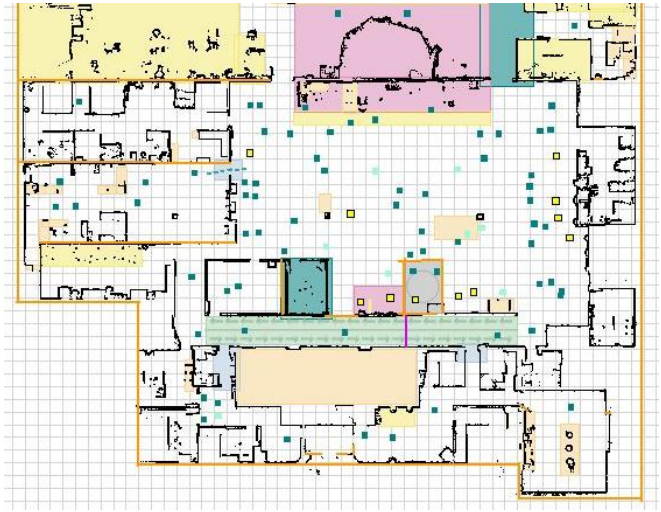


A new concept of an assembly line

Mapping the work space

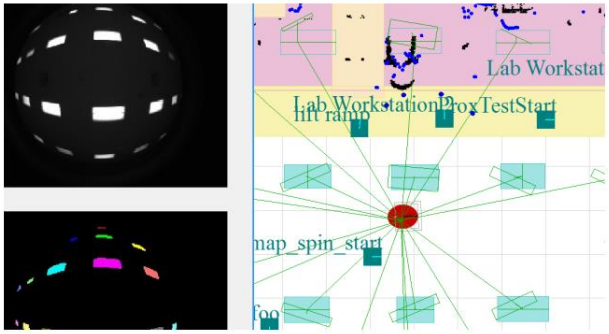
- Connect the joystick to the robot
- Drive the robot through the environment
- Edit the map on the pc
- Upload the map back to the robot

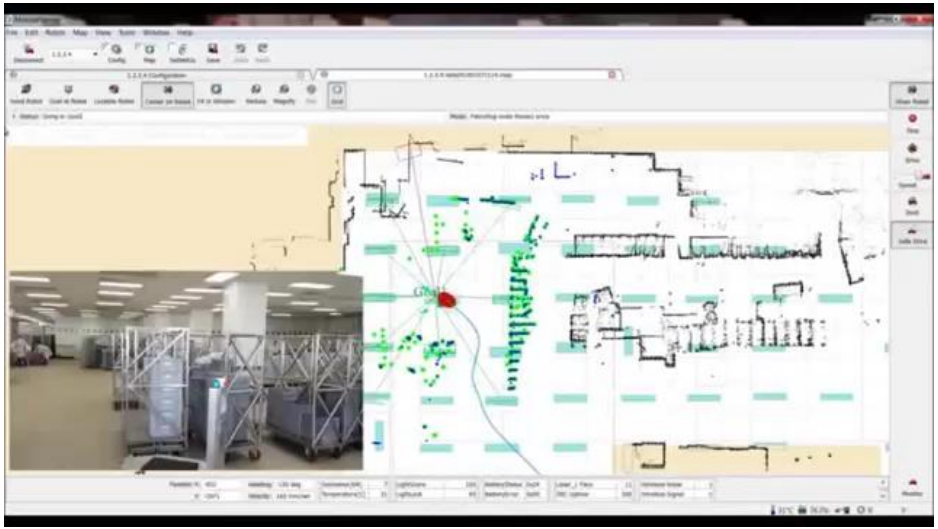
Sample Map



Camera Navigation System

- Dynamics environment
- Laser navigation very reliable, however 20% of the map must be known
- A camera oriented on the roof, triangulation using the lamps





The camera navigation system generates navigation markers from ceiling lights and objects, since these are more likely to remain fixed. Using these ceiling features, it generates an additional map to identify the fleet's position, no matter how frequently the environment on the floor changes.

Fleet Manager

The Fleet Manager, running with FLOW Core software, can manage fleets of up to 100 robots in any configuration.

Coordinating collective robot motion:

- Job dispatch and management
- Centralized configuration management
- Facilitates traffic flow
- Centralized point of communication
- Each EM controls up to 100 robots

Solaro Smart Factory (MI)

In the assembly plant of Solaro some tecnologies were implemented in order to improve the processes for the assembly and for the intralogistic. All the cells are connected by 45 *Automated Guided Vehicle (AGV) that share information with the other machines and with the fitters. In our meaning the AGV become a MAS (mobile assistance system).*

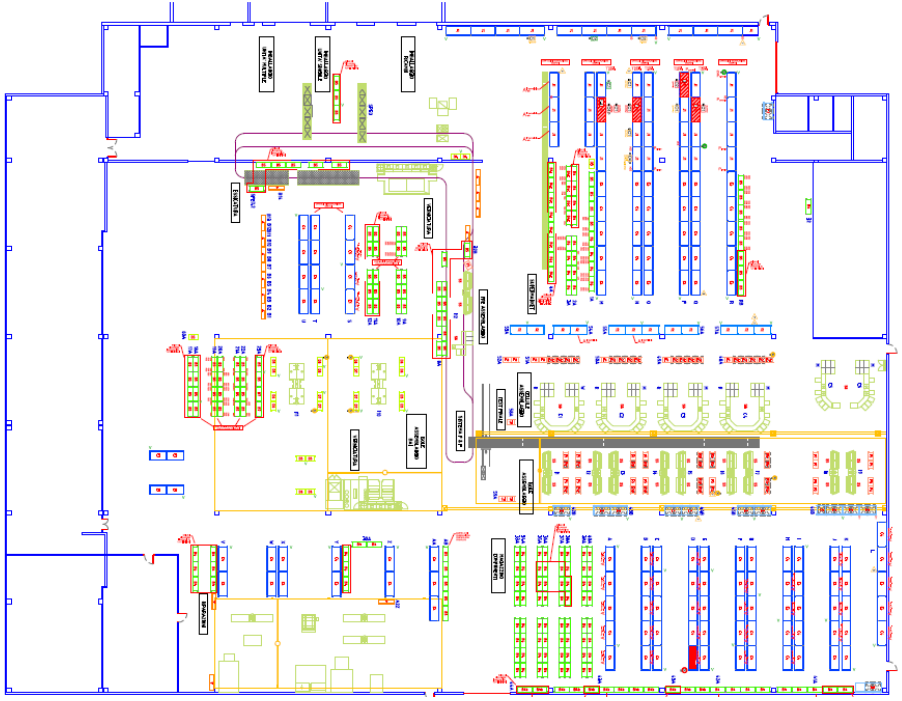
Performances of the Smart Factory:

- Daily output +70%
- Increasing of the assembly spectrum (product portfolio)
- Improvement of the Lead Time
- Improvement of the productivity +25% (with the same fitters)

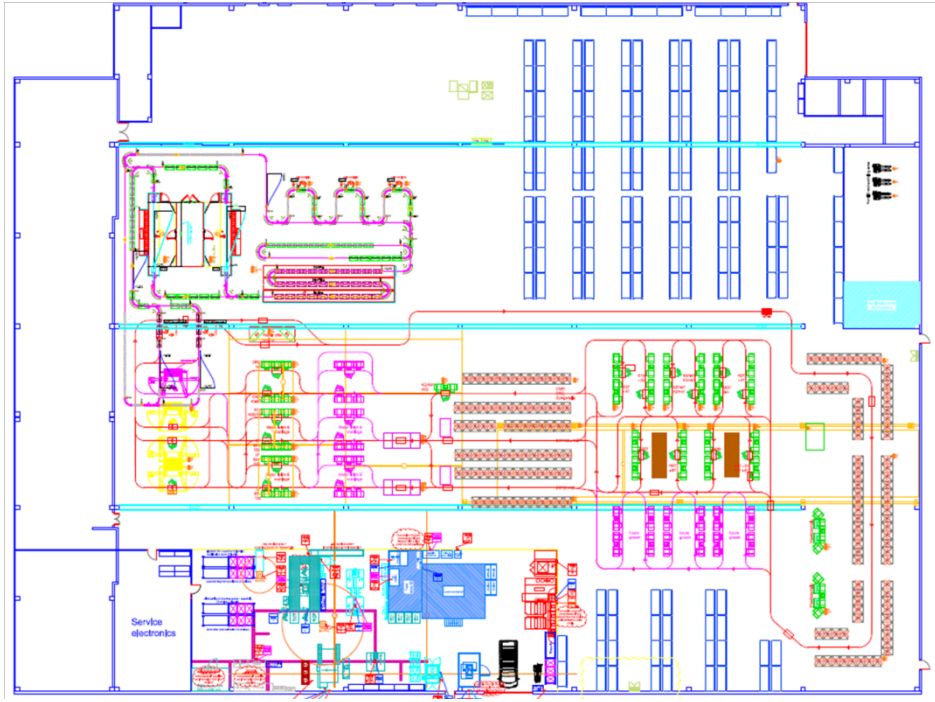
Cyber Physical Production System

- **Smart combination between man, tecnology and IT**
  Tecnology is not only a tool for the workers, it become a partner
- **Smart Factory Assembly**
  Lean at the basis of Industry 4.0
- **Smart Factory Production**
  Also the project of new products is done following the lean principles (all the produts are modular)
- **Mobile Assistance System**
  For a better co-operation between man and machine

Lean → Industry 4.0



Lean (2007 - 2018)



Lean + Industry 4.0 (2018 - ?)

Results and goals

Year	2004	2008 (Lean)	2015 (Lean)	Goal 2025 (Lean + I 4.0)
Lead Time	4/5 Weeks	3/4 Weeks	10/15 Days	5 Days
Workers	11+24 (logistics+assembly)	10+24 (logistics+assembly)	9+23 (logistics+assembly)	11+29 (logistics+assembly)
PCs assembled/day	180	200	205	350
PCs delivered/day	371	440	514	700

Smart factory concept at Ayabe factory

The Ayabe factory is using intensively AMRs to move goods and subassembly parts between production lines. Because of the shortage of the labor, the transportation automation will be necessary. This automation also increase the traceability of the components and drastically decreases errors and wastes.

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